

ESVOT - VOS

1st WORLD ORTHOPAEDIC VETERINARY CONGRESS



European Society of Veterinary
Orthopaedics and Traumatology
and
Veterinary Orthopedic Society

Munich, Germany
September 5th - 8th 2002



**EUROPEAN SOCIETY
OF VETERINARY
ORTHOPAEDICS
AND TRAUMATOLOGY**



**VETERINARY ORTHOPEDIC
SOCIETY**

1st World Orthopaedic Veterinary Congress

**September 5th - 8th 2002
Munich, Germany**

P R O C E E D I N G S

Department of Veterinary Surgery
School of Veterinary Medicine
Ludwig-Maximilians-University,
Munich, Germany

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Previous E.S.V.O.T. Congresses

- 1st E.S.V.O.T. - Congress 1987 Frankfurt, Germany
- 2nd E.S.V.O.T. - Congress 1988 Milano, Italy
- 3rd E.S.V.O.T. - Congress 1989 Nice, France
- 4th E.S.V.O.T. - Congress 1990 Uppsala, Sweden
- 5th E.S.V.O.T. - Congress 1991 Amsterdam, The Netherlands
- 6th E.S.V.O.T. - Congress 1992 Roma, Italy
- 7th E.S.V.O.T. - Congress 1994 Birmingham, UK
- 8th E.S.V.O.T. - Congress 1996 Munich, Germany
- 9th E.S.V.O.T. - Congress 1998 Munich, Germany
- 10th E.S.V.O.T. - Congress 2000 Munich, Germany

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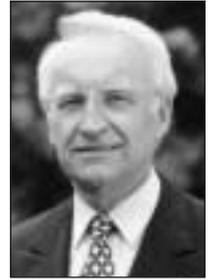
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Opening Address from Dr. Edmund Stoiber, Premier of Bavaria



1st World Congress of Veterinary Orthopaedics

Munich, September 5 – 8, 2002

As patron of the 1st World Congress of Veterinary Orthopaedics, I would like to extend a warm and cordial welcome to all who attend this convention. I am very pleased that the Bavarian capital has been chosen as the venue and I am sure that Munich will once more live up to its reputation as an international congress site.

The high standard of the scientific programme and the internationally renowned speakers promise to make this event a valuable experience and an impetus to veterinary medicine. The exchange of knowledge between experts from different continents meeting here in Bavaria is of utmost importance as all scientific lectures, wet labs and seminars deal with the state-of-the-art in veterinary orthopaedics and traumatology. I wish this international meeting many interesting talks and every success.

My best wishes go with this 1st World Congress of Veterinary Orthopaedics.

A handwritten signature in black ink, which appears to read "Edmund Stoiber". The signature is written in a cursive style.

Dr. Edmund Stoiber

Welcome Address from Prof. Herman A.W. Hazewinkel, President of ESVOT



Dear delegates,

We are very pleased that so many participants, from all over the globe, have made the effort to join us in Munich at this Congress. We should all be in for a treat as the 2002 congress of the European Society of Veterinary Orthopaedics and Traumatology (ESVOT) is unique in its organization. The scientific programme of both the small and large animal sections was devised by the congress committee representing the boards of both the Veterinary Orthopedic Society (VOS) and the ESVOT. It is the first time that two societies of different continents joined together to organize an orthopedic congress for its members. The idea was first conceived by Prof. Sumner-Smith, the highly respected and well know clinical scientist from Guelph who oversees veterinary orthopedics in both the old and new world and who has already bridged these worlds in the Journal of Veterinary and Comparative Orthopedics and Traumatology. He stimulated both boards of

VOS and ESVOT with his idea and the concept developed enthusiastically from there. Thanks to the hard work of the members of the congress committee a congress programme of high standard for both small and large animal practitioners has been created. Academic scientist and specialized veterinary surgeons from the United States of America, Europe and Australia accepted the invitation to participate in this first World Orthopaedic Veterinary Congress, to share the newest information in their field of expertise with veterinarians who are interested to keep their knowledge up to date and improve their skills in order to continue to improve their veterinary services. It is a great honor for the organizing committee that so many speakers accepted the invitation and so many participants from the different continents attend the meeting. This first World Orthopaedic Veterinary Congress is also made possible by the enthusiastic cooperation of the staff of the Department of Companion Animal Surgery and its neighboring departments of the University of Munich, who offered hospitality to house the pre-congress courses, the official opening ceremony, the lecturers and the exhibition hall. More than 200 years old, it is one of the most important faculties in the veterinary world and is, with its atmosphere so typical for a veterinary school, the perfect ambiance for veterinarians from all over the world to feel home and welcome. This first World Orthopaedic Veterinary Congress could not be held without the support of industry and friends of the veterinary profession, as listed in this brochure. Many of our sponsors are attending in the exhibition hall. The industrial exhibition is an integral part of the congress, open to all participants, and allows us all to become informed on the newest equipment, literature, drugs and ideas in our profession.

I would like to take this opportunity to thank all board members of ESVOT and Dr. Brian Beale and Dr. Daniel Lewis from VOS for their hard work to help make this first World Orthopaedic Veterinary Congress a success. They all volunteered to spend many free hours to organize this mega-event on top of their daily work.

I wish you all a fruitful World Orthopaedic Veterinary Congress; and when in four years time the next WOVC will be held in the U.S.A. you can tell everyone that you attend the first!

Herman A.W. Hazewinkel
President ESVOT

PROGRAMME

Thursday 5th September

8.00	Room A <i>Small Animal</i>	Room B <i>Small Animal</i>
	Osteoarthritis Seminar	TPLO wet lab

Friday 6th

8.45	Room A - Small and Large Animals State of the Art Lecture - Tissue Engineering -	
10.00	Room A <i>Small Animal</i>	Room B <i>Small Animal</i>
	Joint Replacement	(External) circular fixators
14.30	Room A - Small and Large Animals State of the Art Lecture - The evolution of	
15.10 16.30	Cervical spinal fusion	14.30 - The stifle Free communications
18.10	Annual General Meeting	

Saturday

8.45	Room A - Small and Large Animals State of the Art Lecture - Comparative imaging -	
10.00	Room A <i>Small Animal</i>	Room B <i>Small Animal</i>
	Imaging	Elbow Salvage
11.30	Hot topics	Management of orthopaedic complications
14.30	Hot topics	Abdominal and thoracic trauma

Sunday

8.30 9.15	Room A <i>Small Animal</i>	Room B <i>Small Animal</i>
	Shoulder luxation Overlooked causes of lameness	TPLO masterclass
11.45	Room A - Small and Large Animals State of the Art Lecture - Orthopaedics - quo vadis?	
12.45	Valete	
13.00	End of the meeting	

AT A GLANCE

pre-Congress day

Room C <i>Large Animal</i>	Room D <i>Small Animal</i>	Room E <i>Small Animal</i>
Neurosurgery wet lab	Basic Arthroscopy wet lab	Advanced Arthroscopy wet lab

September

Jimmy Cook, USA		
	Room D <i>Large Animal</i>	
	Tissue engineering seminar	10.00
intervertebral fusion - Bagby, USA		
	Wobbler Syndrome seminar	15.10 16.30
		18.10

7th September

Kaser-Hotz, CH & Reiser, D		
Room C <i>Small Animal</i>	Room D <i>Large Animal</i>	
Free communications	Comparative imaging of navicular syndrome	10.00
	New developments in orthopaedic infection	14.30

8th September

Room C <i>Small Animal</i>	Room D <i>Small and Large Animal</i>	
Free communications	Free communications	8.30
Sumner-Smith, Can		

Thursday 5th Septe**Pre-Con**

Room A Small & Large Animal	Room B Small Animal	Room C Large Animal
Small Animal OA SYMPOSIUM	Small Animal Short Course TPLO WET LAB	Large Animal Neurosurgery CERVICAL INTERVERTEBRAL INJECTION TECHNIQUES AND SURGICAL ARTHRODESIS, SUBTARSAL NEURECTOMY
<p style="text-align: center;">Study Design</p> <p>9.00 Introduction & classification of drugs for OA - Innes, UK</p> <p>9.20 Clinical trial design, a clinician's perspective Hulse, USA</p> <p>9.40 Clinical trial design, a statistician's perspective Shepstone, UK</p> <p>10.00 Clinical trials, the industry perspective - S. Fox, Pfizer, USA</p> <p>10.20 Discussion</p>	<p>8.45 Practical theory and demonstration of partial and complete CrCL rupture; diagnosis and treatment</p>	<p style="text-align: center;">Lectures</p> <p>9.00 Neurological examination Grant, USA</p> <p>9.30 Myelography Rantanen, USA</p> <p>10.00 Case selection for cervical intervertebral fusion Walmsley, UK</p> <p>10.30 Intervertebral injection techniques. Indications, technique and results Rantanen, USA</p>
10.40 Coffee Break	10.30 Coffee Break	11.00 Coffee Break
<p style="text-align: center;">Assesment of joint function</p> <p>11.00 Clinical metrology and semi-objective outcome measures Budsberg, USA</p> <p>11.20 Kinetic gait analysis Budsberg, USA</p> <p>11.40 Kinematic gait analysis DeCamp, USA</p> <p>12.00 Discussion</p>	<p>11.00 Measurement of tibial plateau slope and radiographic evaluation</p>	<p>11.15 Surgical instrumentation for cervical intervertebral fusion in the horse; old vs. new Bagby, USA</p> <p>11.45 Surgical techniques for cervical intervertebral fusion Grant, USA</p> <p>12.30 Postoperative considerations and aftercare following cervical fusion Nixon, USA</p>
12.20 Lunch Break	13.00 Lunch Break	13.00 Lunch Break

mber 2002 - Morning**gress Day**

Room D
Small Animal

Room E
Small Animal

Small Animal Short Course
**ARTHROSCOPY WET LAB
BASIC PROGRAM**

Small Animal Short Course
**ARTHROSCOPY WET LAB
ADVANCED PROGRAM**

Lectures

- 9.00 Instrumentation and equipment basics
Schulz, USA
- 9.15 Cannula systems - Innes, UK
- 9.30 Learning arthroscopy - Whitney, USA
- 9.45 Shoulder portals and normal anatomy
Hulse, USA
- 10.00 Shoulder pathology and basic treatment
Hulse, USA
- 10.15 Bicipital tendon tears and arthroscopic
treatment - Cook, USA
- 10.30 Elbow portals and normal anatomy
Schulz, USA
- 10.45 Elbow pathology and basic treatment
Schulz, USA

Introduction and wet lab

- 9.00 Clinical and arthroscopic diagnosis and
surgical treatment of shoulder instability
Bardet, F
- 9.30 Arthroscopic findings in dogs with shoulder
instability and radiofrequency treatment
Cook, USA
- 9.45 Arthroscopic appearance of lateral shoulder
instability and treatment - Innes, UK
- 10.00 **Wet lab**
- Shoulder

11.00 Coffee Break

11.15 **Wet lab**

Basic instrumentation and triangulation
technique

Shoulder arthroscopy

Lectures

- 11.15 Comparison of arthroscopy to other imaging
modalities for evaluating elbow incongruity
Hulse, USA
- 11.35 Indications and value of alternative portal
sites for selected elbow cases
Bardet, F
- 12.00 Viewpoints on management of advanced
elbow dysplasia
Schulz, Whitney, Hulse, USA
- 12.20 Arthroscopic humero-ulnararthroplasty for
severe DJD of the elbow
Bardet, F
- 12.30 Arthroscopic assisted TPLO - 41 cases
Whitney, USA

13.00 Lunch Break

Thursday 5th September**Pre-Cong**

Room A Small & Large Animal	Room B Small Animal	Room C Large Animal
<p style="text-align: center;">Small Animal OA SYMPOSIUM</p>	<p style="text-align: center;">Small Animal Short Course TPLO WET LAB</p>	<p style="text-align: center;">Large Animal Neurosurgery CERVICAL INTERVERTEBRAL INJECTION TECHNIQUES AND SURGICAL ARTHRODESIS, SUBTARSAL NEURECTOMY</p>
<p style="text-align: center;">Imaging and biochemistry</p> <p>13.20 Radiography for assessment of OA - H. van Bree, B</p> <p>13.40 MRI for assessment of OA H. van Bree, B</p> <p>14.00 Arthroscopic assessment of chondropathy - Beale, USA</p> <p>14.20 Biochemical markers for canine OA, where are we now? Johnson, USA</p> <p>14.40 The equine experience McIlwraith, USA</p>	<p>14.30 Demonstration of surgical approach, meniscal release and TPLO procedure</p>	<p>14.00-18.00 Wet lab rotations</p> <p>Group A Insertion of Bagby baskets with intraoperative radiography Grant, Nixon, Walmsley, Bagby</p> <p>Group B Ultrasonography of facet joints - Injection of intervertebral facet joints with ultrasonographic guidance - Rantanen, USA</p> <p>Group C Subtarsal neurectomy technique and results Bathe, UK</p>
<p style="text-align: center;">15.00 Coffee Break</p>	<p style="text-align: center;">15.30 Coffee Break</p>	<p style="text-align: center;">16.15 Coffee Break</p>
<p style="text-align: center;">Free communications</p> <p>15.20 Pain assessment in the evaluation of drugs used to treat canine OA - Millis, USA</p> <p>15.40 A comparison of Dual-Energy X-ray absorptiometry (DXA) and muscle girth measurements in dogs with OA Martinez, USA</p> <p>16.00 Comparison of radiographic and arthroscopic findings in OA Schulz, USA</p> <p>16.20 The use of in vitro systems for evaluation of candidate OA drugs - Cook, USA</p>	<p>16.00 Practical exercise on cadavers - 10 tables</p> <p>18.00 Questions and answers</p>	<p style="text-align: center;">Wet lab rotations (cont.)</p>
<p>18.30</p>		<p style="text-align: right;">End of</p>

ber 2002 - Afternoon**ress Day**

Room D
Small Animal

Room E
Small Animal

Small Animal Short Course ARTHROSCOPY WET LAB BASIC PROGRAM	Small Animal Short Course ARTHROSCOPY WET LAB ADVANCED PROGRAM
<p>Lectures</p> <p>14.00 Stifle portals and normal anatomy Beale, USA</p> <p>14.10 Stifle pathology and basic debridement Beale, USA</p> <p>14.30 Meniscal pathology and principles of treatment Whitney, USA</p> <p>Atypical and unusual shoulder pathology Bardet, F</p> <p>Atypical and unusual elbow pathology Bardet, F</p> <p>Basic lab overview (pre-recorded) Beale / Bardet, USA/F</p>	<p>14.00 Wet lab</p> <p>Stifle</p> <p>Elbow</p> <p>Hip</p>
<p>16.00 Coffee Break</p>	
<p>16.15 Wet lab</p> <p>Elbow arthroscopy</p> <p>Demonstration of arthroscopy of the stifle</p>	<p>Lectures</p> <p>16.15 Arthroscopic diagnosis and treatment of meniscal lesions Beale, USA</p> <p>16.30 Arthroscopic assisted evaluation of postoperative complications Hulse, USA</p> <p>16.50 Hip arthroscopy Schulz, USA</p> <p>17.00 Carpus and tarsus arthroscopy Beale, USA</p> <p>17.15 Arthroscopy and radiofrequency Cook, USA</p>
<p>Courses</p>	

Friday 6th Septem

ROOM

SMALL AND LARGE ANIMAL STATE OF THE

09.00 **Tissue Engineering - Jimmy Cook, USA**09.40 **Opening of the Commercial Exhibition.**Room A
Small AnimalRoom B
Small Animal**JOINT REPLACEMENT**

Chair Jan François Bardet

- 10.00 Tissue engineering & prostheses.
Dhert, NL
- 10.20 Practical applications of tissue
engineering in small animals.
Turner. USA
- 10.40 The dynamics of the canine hip joint.
Tepic. CH

(EXTERNAL) CIRCULAR FIXATORS

Chair Brian Beale

- 10.00 Hormonal influences of distraction
osteogenesis.
Theyse, NL
- 10.20 Hybrid linear constructs.
Lewis. USA
- 10.40 Circular external skeletal fixators
biomechanics.
Cross. USA

11.00

COMMERCIAL EXHIBITION

- 11.40 Long term results of the cemented
Biomechanique hip.
Matis. D
- 12.00 Update on the Zurich non-cemented hip.
Montavon. CH
- 12.20 Finite element analysis of the Zurich and
Biomechanique prostheses.
Shahar. Israel
- 12.40 Discussion

- 11.40 Management of angular deformities.
Latte, F
- 12.40 Discussion

13.00

COMMERCIAL

ber 2002 - Morning**A****ART LECTURE - Chair Herman Hazewinkel**Room C
Small AnimalRoom D
Large Animal**TISSUE ENGINEERING SEMINAR**

- 10.00 Cartilage engineering.
Nixon, USA
- 10.30 Genetic manipulation of the synoviocyte
in the treatment of OA.
McIlwraith, USA
- 11.00 A clinical role for bone substitutes in
equine orthopaedics?
Welch, USA

AND COFFEE BREAK

- 11.40 Bisphosphonates and therapeutic
manipulation of bone turnover - Clinical
opportunities in large animals?
Lepage, F
- 12.05 Tendon and ligament engineering -
experiences with IGF-1.
Fortier, USA
- 12.30 Tendon and ligament engineering -
experiences with TGF- β .
Bathe, UK
- 12.50 Tissue engineering in orthopaedic repair:
a realistic proposition? Round table with
all speakers.

EXHIBITION AND LUNCH

Friday 6th Septemb

ROOM	
SMALL AND LARGE ANIMAL STATE	
14.30 The evolution of intervertebral fusion - George Bagby,	
Room A Small Animal	Room B Small Animal
<p>CERVICAL SPINAL FUSION Chair Chris May</p> <p>15.10 Surgical arthrodesis of cervical instability. Meij, NL</p> <p>15.30 AO spinal implants for canine Wobbler Syndrome. Matis, D</p> <p>15.50 Discussion</p>	<p>THE STIFLE Chair Theresa Devine Slocum</p> <p>14.30 Biomechanics of the stifle joint. Tepic, CH</p> <p>14.50 Biomechanical Analysis of the TPLO Technique. Shahar, Israel</p> <p>15.10 Long term results of the Slocum technique. Dee, USA</p> <p>15.30 Non-traumatic CrCL injuries. Vezzoni, I</p> <p>15.45 Is meniscal release necessary? Hulse USA</p>
16.00 COMMERCIAL EXHIBITION	
<p>FREE COMMUNICATIONS Chair Darryl Millis</p> <p>16.30 Experimental mandibular regeneration by distraction osteogenesis (DO) with submerged devices. Preliminary results in a canine model. Garcia, E</p> <p>16.45 Modified-Stout multiple loop interdental wiring and dental acrylic for repair of mandibular fractures. Probst, USA</p> <p>17.00 Fixation of radio-ulnar fractures in toy breed dogs with biodegradable SR-PLA plates and metal screws - preliminary results. Saikku-Bäckström, FIN</p> <p>17.15 Customized single hook plate for fractures of metacarpal / tarsal bones in racing greyhounds. Piras, I</p> <p>17.30 Synovial fluid markers of spontaneous osteoarthritis in dogs. Johnson, USA</p> <p>17.45 Use of 4th generation CT in practice. Bardet, F</p>	<p>16.30 Arthroscopic assisted TPLO surgery & TPLO for partial cruciate tears. Whitney, USA</p> <p>16.50 Gait analysis of dogs following TPLO; results of a prospective study. Adriany, D</p> <p>17.10 Stifle joint replacement. Turner, USA</p> <p>17.30 Discussion</p> <p>18.00 <i>End</i></p>
18.10 ESVOT ANNUAL	

er 2002 - Afternoon

A

OF THE ART LECTURE - Chair Chris Riggs

USA

Room C

Room D
Large Animal

WOBLER SYNDROME SEMINAR

- | | | |
|--|-------|--|
| | 15.10 | Neurological abnormality or lameness - a diagnostic challenge.
Grant, USA |
| | 15.45 | Radiographic and CT diagnosis of cervical abnormalities in the horse.
Gerhards, D |

AND COFFEE BREAK

- | | | |
|--|-------|---|
| | 16.30 | Conservative management of cervical intervertebral arthropathies and cervical compressive myelopathy.
Grant, USA |
| | 17.00 | Results of surgical management of Wobbler syndrome.
Nixon, USA |
| | 17.30 | A European perspective on insurance and safety aspects of treating Wobbler syndrome.
Walmsley, UK |
| | 17.50 | Discussion |

GENERAL MEETING

Saturday 7th Septe

ROOM	
SMALL AND LARGE ANIMAL STATE OF THE	
8.45 Comparative Imaging - Kase-Hotz, CH & Reiser, D	
Room A Small Animal	Room B Small Animal
<p>IMAGING Chair Uli Matis</p> <p>10.00 Advanced Imaging. Kaser-Hotz, CH & Reiser, D</p>	<p>ELBOW SALVAGE Chair Don Hulse</p> <p>10.00 Pathophysiology of elbow dysplasia. Schulz, USA</p> <p>10.20 Humero-ulnar arthroplasty. Bardet, F</p> <p>10.40 Total elbow arthroplasty. Conzemius, USA</p>
11.00 COMMERCIAL EXHIBITION	
<p>HOT TOPICS Chair John Houlton</p> <p>11.30 Force plate data from an NSAID trial. Hazewinkel, NL</p> <p>11.50 Trochlear block recession for medial patellar luxation. Probst, USA</p> <p>12.10 Arthroscopic evaluation of the dysplastic hip. Beale, USA</p> <p>12.30 Topical treatment of cartilage defects. Schulz, USA</p> <p>12.50 Discussion</p>	<p>MANAGEMENT OF ORTHOPAEDIC COMPLICATIONS Chair Charlie DeCamp</p> <p>11.30 Management of fracture fixation failure. Turner, USA</p> <p>12.00 Management of non-unions. De Camp, USA</p> <p>12.20 Canine rehabilitation techniques. Millis, USA</p> <p>12.40 Discussion</p>
13.00 COMMERCIAL	

September 2002 - Morning

A

ART LECTURE - Chair Michael Schramme

Room C Small Animal		Room D Large Animal	
FREE COMMUNICATIONS Chair John Innes		SEMINAR ON COMPARATIVE IMAGING OF NAVICULAR SYNDROME Chair Michael Schramme	
10.00	Pathophysiology of oteoarthritic pain. Fox, USA	10.00	Radiography and CT of the navicular structures; what can we believe? Verschooten, B
10.15	Clinical comparative study of two NSAID (Etodolac and Meloxicam) in dogs with osteomuscular lameness. Alvarez, E	10.30	Scintigraphy of navicular syndrome and palmar heel pain. Dyson, UK
10.30	Field evaluation of the efficacy of tolfenamic acid for prevention of the postoperative pain in dogs. Grandemange, F		
10.45	Controlled delivery of Teicoplanin from an intra-articular Biodegradable Microparrticate System - Bilgili, Turkey		

AND COFFEE BREAK

	Chair Geoff Robins	11.30	The role of DDFT tendinitis in navicular syndrome - a CT perspective. Nowak, D
11.30	Tarsal luxations in cats. Vannini, CH	12.00	Soft tissue pathology in horses with navicular syndrome – MRI results. Schramme, UK
11.45	The tibial plateau angle in Labrador Retrievers with normal and cranial cruciate deficient stifle. Reif, USA	12.30	Bursoscopy – does it have a role in the diagnosis and management of navicular syndrome? Wurfel & Hertsch, D
12.00	Fatigue study of 2.7 mm cortical screws used in a 6 mm diameter interlocking nail. Johnson, USA		
12.15	Influence of limb psitioning and observation method on the measurment of the tibial plateau angle, Reif, USA		
12.30	MRI of the canine shoulder joint. Schuller, D		
12.45	Biomechanical properties of the canine schoulder joint. Maierl, D		

EXHIBITION AND LUNCH

Saturday 7th Septem

Room A Small Animal	Room B Small Animal
<p>HOT TOPICS Chair Curtis Probst</p> <p>14.30 Is force plate analysis the answer to lameness evaluation? Budsberg, USA</p> <p>14.50 Is kinematic gait analysis necessary? De Camp, USA</p> <p>15.10 How do kinematic and force plate analyses compliment each other? Bruggemann, D</p> <p>15.30 Finite Element Analysis – a useful investagative tool, Cross, USA</p> <p>15.50 Discussion</p>	<p>ABDOMINAL & THORACIC TRAUMA Chair Jean Francois Bardet</p> <p>14.30 Surgical Management, Kirpensteijn, NL</p>
<p>16.00 COMMERCIAL EXHIBITION</p>	
<p>HOT TOPICS Chair Ken Johnson</p> <p>16.30 Pubic symphysiodesis – theoretical and experimental aspects. Hayashi, USA</p> <p>16.55 Pubic symphysiodesis – clinical experiences, Vezzoni, I</p> <p>17.20 The effects of obesity on the clinical expression of osteoarthritis with cronic hip dysplasia (preliminary report). Lincoln, USA</p> <p>17.45 Discussion</p> <p>18.00 End</p>	<p>16.30 Pain management Fox, USA</p> <p>HOT TOPICS</p> <p>17.40 Is it really the plate? Bone blood and surgical trauma. Field, USA</p> <p>18.00 End</p>
<p>18.00</p>	

ber 2002 - Afternoon**Room C
Small Animal****Room D
Large Animal****FREE COMMUNICATIONS**

Chair Geoff Summer Smith

- 14.30 Femoral fractures associated with complicated canine THR. Liska, USA
- 14.45 Scintigraphic changes associated with complicated canine THR. Poteet, USA
- 15.00 Pulmonary thromboembolism associated with canine THR. Liska, USA
- 15.15 The effect of surgical technique on limb function in the Labrador Retriever - Conzemius, USA
- 15.30 Advancement of the tibial tuberosity for the treatment cranial cruciate deficient canine stifle. Montavon, CH
- 15.45 Low field magnetic resonance in equine orthopaedics. Gäch, D

**SEMINAR ON NEW DEVELOPMENTS
IN ORTHOPAEDIC INFECTION**

Chair Oliver Lepage

- 14.30 Rational choice of antibiotics in musculoskeletal infections in the horse. Riggs, UK
- 15.00 Joint lavage, articular debridement and synovectomy techniques - new developments. Fortier, USA
- 15.30 Local delivery systems for the treatment of septic arthritis. Walmsley, UK

AND COFFEE BREAK

- 16.30 Biological fixation and aspects of bone plate mechanics. Field, Aus
- 16.45 Biomechanical comparison of the VetFix system and commonly used AO bone plates. Zahn, D
- 17.00 Lateral condylar fractures in dogs by kirshner wire fixation. Peirone, I
- 17.15 Humeral overgrowth following condilar fractures in dogs - Langley, Hobbs, UK
- 17.30 Treatment of proximal interphalangeal joint subluxation in the dog with an external skeletal fixator. Guillard, UK
- 17.45 Comparison of 2 intra-capsular techniques for CrCL rupture using polyester surgical band and fascia lata. Adamiak, Poland
- 18.00 End

- 16.30 Recent developments in the treatment of septic arthritis in cattle. Steiner, CH
- 17.00 Diagnosis and management of bacterial osteitis and sequestration in large animals. Verschooten, B
- 17.30 How to manage fracture repair in the face of infection and vice-versa. Grant, USA
- 18.00 End

END

Sunday 8th SeRoom A
Small AnimalRoom B
Small Animal

<p>Small Animal SHOULDER LUXATION Chair Wayne Whitney</p> <p>8.30 Bardet, F</p> <p>9.00 Discussion</p> <p>Small Animal OVERLOOKED CAUSES OF LAMENESS Chair Rico Vannini</p> <p>9.15 Sesamoid disease. Robins, Aus</p> <p>9.30 Fabellar fractures. Houlton, UK</p> <p>9.45 Nerve sheath tumours. Meij, NL</p> <p>10.00 Supraspinatus tendon injuries. Beale, USA</p> <p>10.15 Infraspinatus bursal ossification. May, UK</p>	<p>FREE COMMUNICATIONS Chair Lars Theyse</p> <p>8.30 A new Minimal Invasive Technique for Management of some Spinal Diseases in Dogs; First Announcement. Ali, D</p> <p>8.45 Magnetic Resonance Imaging of Intervertebral Disc Disease. A Retrospective Study in 60 dogs. Altónaga, E</p> <p>9.00 Lateral corpectomy as surgical treatment of ventral thoracolumbar disk hernia. Study of 42 cases. Méheust, F</p> <p>9.15 Injuries of the Biceps Tendon in Dogs. Sager, D</p> <p>9.30 Arthroscopic Biceps Tenodesis in Dogs: Scientific Basis, Technique, and Outcome in Clinical Cases. Cook, USA</p> <p>9.45 Tendon transfer after brachial plexus injury in 4 dogs and 2 cats. Lorinson, A</p> <p>10.00 Flexural Deformity of the Carpus in Dogs: a retrospective Study of 15 cases. Petazzoni, I</p> <p>10.15 Achilles tendon injuries. Robins, Aus</p>
10.30	COFFEE
<p>11.00 Stenosing tenosynovitis of abductor pollicis muscle. Montavon, CH</p> <p>11.15 Incomplete ossification of the caudal glenoid. Olivieri, I</p> <p>FREE COMMUNICATIONS</p> <p>11.30 Bone in growth and resorption characteristics of two ceramic bone void fillers - An in vivo comparative study in a rabbit metaphyseal tibial defect model - Déjardin, USA</p> <p>11.45 Tissue engineering rotator cuff tendon using swine small intestinal submucosa. Histological and mechanical evaluation in a canine model - Déjardin, USA</p>	<p>Chair John Houlton</p> <p>11.00 Computer-Assisted Pre-operative Planning for Optimization of Placement of External Skeletal Fixators on the Antebrachium of Dogs. Rovesti, I</p> <p>11.15 Use of Intramedullary Pin-External Skeletal Fixator Tie-In Technique for Repair of Bone Fractures in Owls: A Review of Ten cases. Garcia-Gramser, E</p> <p>11.30 Evaluation of a novel non-toxic rigid polymer as a connecting bar in External Skeletal Fixators. Störk, B</p> <p>11.45 The efficacy of Rimadyl use for post-operative pain control in dogs undergoing cranial cruciate ligament surgery. Lincoln, USA</p>
<p>12.15 Orthopaedics - quo vadis? Geoff Sumner-Smith, CAN</p> <p>12.45 Valete</p> <p>13.00 End of the meeting</p>	<p>Small and Large Animals STATE OF</p>

September 2002Room C
Small AnimalRoom D
Large Animal

<p>TPLO MASTERCLASS Chair Aldo Vezzoni</p> <p>8.30 Common radiographic positioning errors resulting in perceived alignment abnormalities. Devine Slocum, USA</p> <p>8.40 Limb alignment: complex alignment problems and their corrections. Boulay & Lozier, USA</p> <p>9.40 Current thoughts of correction of excessive tibial slope. Boulay & Lozier, USA</p> <p>10.00 Arthroscopic assisted TPLO. Lozier, USA</p> <p>10.20 Dealing with operative TPLO complications. Boulay & Lozier, USA</p>	<p>Small Animals FREE COMMUNICATIONS Chair Kurt Schulz</p> <p>8.30 Catabolic cytokines and canine articular cartilage degeneration. Innes, UK</p> <p>8.45 Synovial chondrocalcin as a cartilage metabolic marker in canine osteoarthritis in its early stage. Okumura, J</p> <p>9.00 Effects of fatty acid diet supplementation on the development of osteoarthritis in dogs: biochemical, clinical and radiographic evaluation. Budsberg, USA</p> <p>9.15 Bone and muscle changes after CrCL transection and stifle stabilisation. Millis, USA</p> <p>9.30 Cellular and extracellular matrix transformation in dogs with ruptured canine CrCL. Hayashi, USA</p> <p>9.45 Quercetin protects canine articular chondrocytes from oxidative damage. Della Valle, I</p> <p>10.00 Validation of quantitative PCR in canine osteoarthritis. Hulse, USA</p> <p>10.15 Efficacy of Fortiflex in the prevention of OA in dogs. Bardet, F</p>
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BREAK

<p>11.00 Dealing with postoperative TPLO complications. Boulay & Lozier, USA</p> <p>11.30 Discussion</p> <p>12.00 End</p>	<p>Large Animals FREE COMMUNICATIONS Chair M. Schramme</p> <p>11.00 Speed of sound measurements of the third metacarpal bone in young exercising Thoroughbreds. Carstanjen, F</p> <p>11.15 Treatment of long bone fractures in calves using the Ilizarov Technique. Kürüm, Turkey</p> <p>11.30 Does claw-trimming provoke an endurable effect on claw quality? Stanek, A</p> <p>11.45 Local analgesic effect of ketamine in the abaxial sesamoid block in the horse. López-Sanroman, E</p>
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Room A

THE ART LECTURE - Chair Herman Hazewinkel

SPEAKERS & ABSTRACTS

INVITED SPEAKERS

Adriany, D
 Bagby, USA
 Bardet, F
 Bathe, UK
 Beale, USA
 Boulay, USA
 Bruggemann, D
 Budsberg, USA
 Conzemius, USA
 Cook, USA
 Cross, USA
 DeCamp, USA
 Dee, USA
 Devine Slocum, USA
 Dhert, NL
 Dyson, UK
 Field, Aus
 Fortier, USA
 Fox, USA
 Gerhards, D
 Gores, USA
 Grant, USA
 Hayashi, USA
 Hazewinkel, NL
 Hertsch, D
 Houlton, UK
 Hulse, USA
 Innes, UK
 Johnson, USA
 Kaser-Hotz, CH
 Kirpensteijn, NL
 Latte, F
 Lepage, F
 Lewis, USA

Liska, USA
 Lozier, USA
 Matis, D
 May, UK
 McIlwraith, USA
 Meij, NL
 Millis, USA
 Montavon, CH
 Nixon, USA
 Nowak, D
 Olivieri, I
 Probst, USA
 Rantanem, USA
 Reiser, D
 Riggs, UK
 Robins, Aus
 Schramme, UK
 Schultz, USA
 Shahr, Israel
 Smith, USA
 Steiner, CH
 Stepstone, UK
 Sumner-Smith, Can
 Tepic, CH
 Theyse, NL
 Turner, USA
 Van Bree, B
 Vannini, CH
 Verschooten, B
 Vezzoni, I
 Walmsley, UK
 Welch, USA
 Whitney, USA
 Wourfel, D

FREE

COMMUNICATIONS

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Adamiak, Poland
 El-M Ali, D
 Altónaga, Spain
 Alvarez, Spain
 Bilgili, Turkey
 Carstanjen, F
 Dejardin, USA
 Della Valle, I
 Gäch, D
 Garcia, E
 Garcia-Gramser, E
 Grandemange, F
 Guilliard, UK
 Kürüm, Turkey
 Langley-Hobbs, UK
 Lincoln, USA
 Lopez-Sanroman, E
 Lorinson, Austria
 Maierl, D
 Méheust, F
 Okumura, Japan
 Peirone, I
 Petazzoni, I
 Piras, N.Ireland
 Poteet, USA
 Reif, USA
 Rovesti, Italy
 Sager, D
 Saikku-Bäckström, Fin
 Schuller, D
 Stanek, A
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 Zahn, D

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ABSTRACTS

IN ALPHABETICAL ORDER
OF THE PRESENTING SPEAKERS

The comparison of 2 intra-capsular techniques for cranial cruciate ligament rupture using polyester surgical band and fascia lata

Zb. Adamiak, W. Brzeski

The purpose of this study was to document the long term clinical outcome of dogs having cranial cruciate ligament rupture (CCLR) stabilized with the polyester surgical band - Surgical Loop, and fascia lata using intra-capsular techniques.

METHODS

50 dogs with unilateral CCLR were enrolled in this clinical study. Before surgical stabilization all dogs were clinically examined. In each case x-ray, and arthroscopic examinations were done. The dogs were divided into two groups of 25 animals each. In-group I injured cranial cruciate ligament was repaired with polyester surgical band - Surgical Loop. An orthopedic band was routed through the intercondylar fossa and left the joint over the top of the lateral femoral condyle, than Surgical Loop was directed at the tibial crest and routed through a hole drilled in the tibial tubercle and tied. In group II all dogs were treated by over-the-top technique utilizing fascia lata graft.

Effects of the stifle operations were estimated by owner assessment, clinical examination, and plain film radiography. The mean time from surgery to follow-up was 12 months.

RESULTS

Three dogs were excluded from the study due to the inconvenient distance from the clinic. Forty seven dogs (24 dogs in group I and 23 dogs in group II) were included in the study, ranging from 1 to 8 years and weighting between 20 and 65 kg. Sixteen of 47 dogs had concurrent medial meniscal tears and underwent complete meniscectomy. Owner evaluation and clinical examination demonstrated that dogs in group I used operated leg earlier comparing to animal in group II, but results of the operations in both groups of dogs were excellent in 92% of the cases. Radiographic analysis demonstrated moderate to mild osteoarthritis (OA) changes in forty three dogs (91%). It was noticed that radiographic progression of OA has been lower in group I.

CONCLUSION

Both surgical techniques used in our study for CCLR were effective. We have observed lower progression of OA changes in group I on follow-up x-ray examination. It can explain that dogs in this group used operated legs earlier comparing to animal in group II.

Gait analysis in dogs following TPLO: short-term results of a prospective study

E. Adriany, U. Matis

Computerized gait analysis has proven to be a valuable means of assessing the outcome of surgical and medical interventions in orthopedic diseases.

It was the aim of this study to assess and document functional recovery following TPLO which is increasingly performed as a routine surgical procedure for the treatment of cranial cruciate ligament rupture in dogs.

MATERIAL AND METHODS

In a controlled prospective study, a total of ten dogs (38.6 ± 11.1 kg; 6.2 ± 2.4 years) suffering from degenerative rupture of the cranial cruciate ligament were examined. According to the dogs' history, mild to moderate lameness had been present for an average period of six weeks. Meniscal click was observed in four patients only. Clinical examination revealed a cranial drawer sign with a mean cranial translation of 0.5 - 1 cm. In all cases there was radiographic evidence of a joint effusion (\varnothing 193 mm²) and mild to moderate arthrotic changes. Tibial plateau angles ranged from 12° to 23° (\varnothing 16.1°). Surgery was performed by one single surgeon with the dog in lateral recumbency. With the exception of the stab incision for meniscal release, no arthrotomy was carried out. All dogs received NSAIDs during the first four weeks postoperatively. Gait analysis was performed on days 3, 10, 23 and 44 after surgery. Kinetic data was obtained on an instrumented treadmill at a speed of 0.66 m/s. The device was equipped with four separate force plates and four three-dimensional piezoelectric Kistler force transducers each. Two synchronized motors pulled two belts over the force plates (at a known coefficient of friction between belt and force plate). As the animal walked on the treadmill, ground reaction forces active at each of the limbs were measured at a sampling frequency of 500 Hz and digitally filtered at 50 Hz.

Kinematic data was obtained by recording the position of defined landmarks on the animal's hind limb, which represent anatomical structures and/or segmental orientations. The movements of each of these markers were recorded by at least two out of nine synchronized and genlocked video cameras operating at 50 Hz. Data analysis was performed using the SIMI[®] motion analysis system.

The data assessed included peak vertical force (PVF) in % BW, vertical impulse (VI) in % BW x second, stance phase percentage (T_{Stance}) and weight distribution (WD) in % BW, as well as active range of motion (minimum and maximum) and joint angles of hip, stifle and hock.

RESULTS

After 44 days, the drawer sign had decreased to an average of 0.5 mm of cranial translation with no meniscal click perceptible. Subjective lameness was indistinct to mild. The degree of arthrosis had remained the same and the joint effusion (capsule shadow) had experienced only minor changes (204 mm²). Tibial plateau angles averaged 6°.

Before surgery, a PVF of 24.3% BW, a VI of 10.2% BW x sec. and a T_{Stance} of 67.9% had been measured in the affected limb, while the stance phase percentage in the contralateral limb had been of 80.6%. There was a weight distribution (WD) of 13.1% in the diseased limb and of 22.2% in the contralateral leg. In the forelimbs, ipsilateral load was of 31.9%, while the contralateral load was of 32.8%.

The gait analysis performed 44 days post surgery showed that PVF had increased markedly reaching 30.8% BW, and VI had risen significantly to 13.9% BW x sec., while T_{Stance} had remained almost unchanged (68.8%). In the contralateral limb, however, this percentage was significantly lower ($p < 0.05$) than before surgery (75.8% versus 80.6%). Weight distribution (WD) in the affected limb had increased significantly ($p < 0.05$) to 16.8%, while contralateral WD was of 20.6%. In the forelimb, an ipsilateral WD of 31.2% and a contralateral value of 31.4% were measured. The active range of motion of the affected stifle joint had been 32° (106° - 138°) prior to surgery and was assessed at 30° (113° - 143°) in the measurements performed 44 days postoperatively.

These data show that vertical forces appeared significantly improved in this study when compared to the results obtained by Conzemius et al. (2001) two months after TPLO. Similar results had been achieved in a former study of Baetzner (1996) evaluating the combined use of the over-the-top technique and fibular head transposition. The significant reduction of the stance phase in the contralateral limb is indicative of a

preoperative compensation. The typical motion pattern of a diseased stifle joint as described by Baetzner (1996) and DeCamp et al. (1996) - characterized by pronounced flexion during the stance phase and lacking extension at the end of this phase - had improved markedly after 44 days. The surgically treated knee joint displayed only a reduced increase in flexion particularly during the second half of the stance phase.

CONCLUSION

Early functional recovery after TPLO is comparable and partly even superior to that achieved by other surgical techniques evaluated by gait analysis.

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A new minimal invasive technique for management of some spinal diseases in dogs, first announcement

S. El-M. Ali

This study was performed on a total number of 187 dogs with different breeds and sexes suffering from back pain and/ or motor incoordination. These cases were presented to the Small Animal Educational Hospital Hamburg – Rahlstedt, Germany. Disc prolapse and protrusion, acquired spinal canal stenosis, facet-syndrome and sacrodynny were the most common spinal disorders treated minimally invasively. All the dogs with slipped discs and/ or spinal canal stenosis associated with paralysis and / or paresis were treated with peridural catheter therapy (PDC), while the dogs suffering from disc prolapse / protrusion with pain and little motor deficit were treated with periradicular therapy (PRT). Dogs suffering from sacrodynny were treated with iliosacral-infiltration and S₂-nerve block (ISG), while the dogs suffering from facet-syndrome were treated with facet infiltration. CT-/ Fluoroscopy guided minimally invasive therapy was described and divided to 4 subtechniques. The intermediate results showed nearly 75-85% improvement of all patients suffering from back pain or motor deficits. Our minimally invasive techniques for the treatment of some spinal disorders open a new therapy modality in veterinary neuro-surgery.

Magnetic resonance imaging of the intervertebral disc disease: a retrospective study in 60 dogs

J.M. Gonzalo-Orden, J.R. Altónaga, L. Millán, J.M. Gonzalo, M.A. Orden

INTRODUCTION

In the last years, Magnetic Resonance Imaging (MRI) has gained a lot of importance on the evaluation of canine spine and its diseases, specially disc disease. The high contrast between epidural fat and disc material in T1-weighted (T1W) sequences or between cerebrospinal fluid (CSF) and the others structures of the spine in T2-weighted (T2W) sequences coupled with multiplanar imaging, allows an accurate assessment of position and grade of disc disease which is essential for surgical treatment. In addition this technique is less invasive than myelography.

MATERIAL AND METHODS

In this work, we evaluate the MRI features of intervertebral disc disease in 60 dogs with clinical and/or neurological signs of this disease. All dogs were imaged while they were under general anesthesia using a 0.2 Teslas MR scanner (SIGNA PROFILE 0.2T, GENERAL ELECTRIC MEDICAL SYSTEMS®). All dogs were positioned in dorsal recumbence; if location of the suspected lesion was cervical, head was first placed into the magnet; if location was thoracolumbar or lumbar, tail was placed into the magnet. We used a human head coil, 6 inch GP coil, 9 inch GP coil or Body Flex (L) coil depending on the size of the dog and of the region to explore.

The protocol employed was a T1W Spin Echo (TR=260-300 msec, TE=17-20 msec) sagittal plane scan and a T1W Spin Echo (TR=120 TE=20) coronal plane scan obtained as a localizer. After this, we programmed a T1W Spin Echo (TR=400-450 TE=23-30) sagittal scan, a T2W Fast Spin (TR>2500 TE>100) Echo sagittal images followed by T1W Spin Echo and T2W Fast Spin Echo transverse planes of specific interesting areas identified either by previous sagittal MRI abnormalities.

RESULTS

60 cases with intervertebral disc disease were diagnosed by MRI and confirmed at either surgery or necropsy. Cervical disc disease location was observed in 10 animals, thoracolumbar location in 31 animals and finally 19 cases with lumbar location.

Sagittal T1W Spin Echo images showed narrowing of the affected intervertebral disc spaces and, in chronic cases, there was a loss of signal intensity of the discs. Dorsal area of the affected disc suggested presence of extrusion or protrusion with various degrees of epidural fat displacement. Neural foraminal stenosis can occur from degenerative disc protrusion or extrusion. This stenosis is best appreciated on T1W parasagittal images.

Sagittal T2W Fast Spin Echo images confirmed narrowing of all affected disc, which were very hypointense in this sequence. When spinal cord compression was present, myelographic effect of CSF was lost, and spinal cord dorsal displacement seen.

In dogs with long clinical history there were changes in vertebral end plates adjacent to the affected disc.

Transverse planes, both T1W Spin Echo and T2W Fast Spin Echo allowed differential diagnosis between extrusion or protrusion. Tearing of dorsal annulus and the side of compression of the spinal cord is best visualized in T2W. In addition, axial images showed nerve root at intervertebral space.

It is very important to evaluate intensity and homogeneity of the spinal cord signal in both, either T2W Fast Spin Echo transverse or sagittal images, because these changes indicate neural tissue is damaged.

CONCLUSIONS

In T1W sagittal images is very difficult to make a differential diagnosis between protrusion or extrusion. In addition, in these sequences spinal cord compression is difficult to observe.

In sagittal T2W sequences all affected discs appeared hypointense. In this sequence, it is easy to evaluate spinal cord compression because we can observe myelographic effect of hyperintense CSF.

After sagittal sequences, both T1W Spin Echo and T2W Fast Spin Echo transverse planes were obtained. These planes were essential since allow us to establish the difference between protrusion and extrusion, and to see the exact location (central, paracentral or lateral) of disc material and nerve root compression. In axial images spinal cord typical ovoid shape and central anatomic position disappear with compression.

Based on our results, we can conclude that MRI is a very useful technique to evaluate intervertebral disc disease in dogs. MRI is a completely non invasive technique for the diagnosis of disc degeneration (extrusion or protrusion), position, presence or absence of compression of the spinal cord and nerve root; and it is excellent in the evaluation of several disc herniations. Finally, this technique is very important for the evaluation of the spinal cord gray and white matter.

Clinical comparative study of two non-steroidal anti-inflammatory drugs (NSAIDs) (etodolac and meloxicam) in dogs with osteomuscular lameness

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INTRODUCTION

The amount of patients who come to the clinic lame or painful is really high, and the most common pathology is the degenerative joint disease, a chronic and progressive process that it is usual diagnoses in middle-aged and old dogs. The most important clinical signs are pain, stiffness and motility reduction. However, predisponent factors and the best treatment are still unknown and we think that it is still necessary to develop clinical trials about NSAIDs.

OBJETIVES

The aim of the research is to evaluate osteomuscular processes associated with pain lameness in dogs and to study the clinical efficiency, adverse and long-term effects of two NSAIDs, etodolac and meloxicam.

MATERIAL AND METHODS

82 dogs were selected by some criteria and were divided into two groups: Group 1: Dogs treated orally with etodolac at 10 mg/kg/day under 28 days; Group 2: Those treated orally with meloxicam at 0,2 mg/kg the first day and 0,1 mg/kg no more than 28 days. The investigator collected information about the sort of NSAIDs, dose, initial and final date of treatment, pathology and clinical evolution. In order to evaluate the efficiency temperature, corporal condition, lameness, inflammation, pain, weight distribution, articular mobility, crackling, biochemical parameters and adverse effects were analysed. The statistic computer program SPSS 10.0 and Excel were used to analyse them.

RESULTS

When etodolac and meloxicam were compared, both NSAIDs present statistic differences in the dates were parameters were taken and both produced a favourable evolution during the treatment. On the other hand, there were differences when etodolac and meloxicam were analysed about pain and articular mobility, getting better results in dogs treated with etodolac. However, there was no difference in the rest of the parameters, but etodolac tended to produce better results. Adverse effects were also studied, involving 20% of the animals treated.

CONCLUSION

When pain and articular mobility were studied, etodolac produced significantly better results than meloxicam. In the rest of the parameters, there was no significant difference but etodolac tended to be better. Both NSAIDs were relatively "safe" since adverse effects appeared only in 20% of dogs treated.

The evolution of intervertebral stabilization techniques across the species

G.W. Bagby

The initial stage of this sequence of events were at 1978, when I was practicing as an M.D. in orthopedics at Spokane, Washington, which is close to Washington State University Veterinary School in Pullman, Washington. I was asked to meet with them relative to a self-compressing bone plate that I had initiated when a resident at the Mayo Clinic in 1956. In the process, Dr. Barrie Grant, veterinarian in charge of large animal surgery, and I met and we discussed multiple problems that we both had but centered on the "Wobblor" horse which was ataxic secondary to cervical spine stenosis. There was not a satisfactory treatment for the condition and the veterinarians raised the question of the practicality of the Cloward procedure being reasonable for such a horse. It so happened that I was using that procedure in the human. We all agreed that it was worthwhile to proceed and in doing so the veterinarians assisted me in surgery to carry out the Cloward procedure in humans and then that same year we proceeded to do the same in the horse cervical spine only after an appropriate myelogram showed indications of stenosis. Although the first few cases were not successful, we went through a learning phase and realized that it was practical. An early problem stems from recovery after surgery with the horse awakening with continued partial paralysis, transitional anesthesia effects, the pain in the neck from the primary surgery but also the pain over the iliac crest where the bone dowel was harvested. This was the initiation for my inventing the "Bagby Bone Basket" (BBB) which was to avoid the secondary incision. For clarity, the BBB was of the same size and shape as the dowel we cut for the Cloward procedure but it was made out of stainless steel, hollow in the center and had multiple fenestrations to allow bone to grow through the fenestrations from one vertebra to the other. Furthermore, the chips of bone in preparing the bed were used as autogenous bone graft to be placed in the BBB and also outside of it on the ventral surface. It proved to be at least as effective as the bone graft, avoiding a second incision or a bone banking process.

The other valuable point for clarification is to indicate that this was not a process of experimenting on a lower animal for the benefit of the human. Furthermore, it was a process of Veterinarians and M.D.'s working equally together, primarily for the horse. Under the circumstances of its success, it automatically spilled over into being recognized by the human profession and through Dr. Stephen Kuslich primarily, who worked with me and inspired many others to proceed with introducing it to the human lumbar spine. Along with many other details, he was the first to recommend to me to add threads to the outside of the implant. The horse experience was presented at the North American Spine Society Meeting at Banff, Alberta, Canada in 1987. Approximately one-thousand cases were done in the USA by way of the investigative device exemption (IDE) to be accepted by the Food and Drug Administration following which it was approved to be on the open market. Various other metallic cages have been designed in competition, all of which have an encouraging success.

Finally, as a design change and competing in the field of osteogenesis stimulation, the Kerf Cut Cylinder (KCC) is being investigated at the present time and is designed by way of an open cylinder to cut into two vertebra with the disc space in the center and maintaining peninsulas of living, intact, vascularized bone inside of the cylinder to encourage successful arthrodesis. The details of this will be introduced at this meeting.

Three – dimensional computed tomography in private referral practice

J.F. Bardet

Computed Tomography (CT), is a digital imaging technique which uses x-rays energy and computed tomography to create transverse sectional images of internal structures. One of the main advantages of CT over conventional radiography is the ability to eliminate superimposition; CT images are not only clearer but can isolate a specific internal region. One of the limitations of CT is that transverse sectional anatomy is often unfamiliar to most veterinary surgeons. Also, it can be difficult to mentally picture anatomic relationships from a set of transverse images. Post-processing CT working stations have new software features that create high quality multiplanar and three-dimensional images to help clarify anatomic relationship. Our system includes a 4th generation spiral CT (General Electric Medical) and a remote post-processing CVT workstation (Advantage Windows Station, General Electric Medical System).

Shoulder instability and joint pain in dogs and cats

J.F. Bardet

Glenohumeral instability encompasses a spectrum of disorders of varying degree, direction, and etiology. The instability is classified according to the timing of diagnosis (acute versus chronic) and frequency of the event, the degree, the direction(s) and, the etiology of the first occurrence.

The goals of this conference are to review the surgical anatomy and biomechanics related to shoulder stability, describe the diagnosis of shoulder instability and joint pain as well as the treatment.

ANATOMY AND BIOMECHANIC OF GLENOHUMERAL INSTABILITY

The glenohumeral joint is suited for mobility. The large spherical head of the humerus articulates with the small shallow glenoid fossa of the scapula. The glenoid provides little coverage of the humeral head. It has been suggested that glenohumeral stability results from a hierarchy of mechanisms, including those that do not require the expenditure of energy by muscle (passive mechanisms) and those that do (active mechanisms). The shoulder joint is capable of movements in any direction, but its chief movements are flexion and extension.

PASSIVE MECHANISMS

Muscle activity is not required to hold the shoulder together. The intact shoulder of a fresh, anatomical specimen is quite stable. It appears appropriate to discuss the "passive" mechanisms of the glenohumeral joint which include ligamentous and capsular restraints, joint conformity, glenoid labrum, finite joint volume and adhesion/cohesion.

The glenohumeral ligaments can be identified on the deep surface of the articular capsule on the medial and lateral sides of the shoulder joint. The medial glenohumeral ligament (MGHL) appears either as a Y shape or a transeverse band. The MGHL extends downward from the medial surface of the supraglenoid tubercle of the scapula across the shoulder joint to attach to the joint capsule at the junction of the humeral neck and lesser tubercle.

The lateral glenohumeral ligament (LGHL) extends downward from the lateral rim of the glenoid cavity to attach to the neck of the humerus and to the caudal portion of the greater tubercle. In large breed dogs, the ligament is approximately 2cm wide at its proximal insertion and 1,5cm wide at its humeral attachment.

Until recently, it was agreed that the insertions of the "cuff muscles" were responsible for maintaining joint integrity. More recently it has been shown that the joint capsule and collateral ligaments of the glenohumeral joints play significant roles in stability. An in vitro study revealed that cutting the tendons of the "cuff muscles" results in minimal loss of stability. Stability decreased substantially by transecting the capsule and collateral ligaments. The humeral joint is not luxated easily when the collateral ligaments are intact.

Other contributing mechanisms to stability are concavity and compression. The depth of the bony glenoid is enhanced by the articular cartilage and the glenoid labrum when present. The concavity and the fit of the glenoid to the humeral head provide stability to the joint, which is enhanced by forces pressing the ball into the socket (see active mechanisms).

The glenoid labrum is a fibrous rim that serves to deepen the glenoid fossa and allow attachment of the glenohumeral ligaments and the biceps tendon to the glenoid in human. It is the interconnection of the glenoid periosteum, bone, articular cartilage, synovium, and joint capsule. This labrum is described in dogs.

Anatomical studies, surgical findings attempts at aspiration, confirm that there is minimal (less than 1ml) free fluid in the normal shoulder joint. The normal shoulder is sealed by the capsule. Thus, like the syringe, the shoulder joint is stabilized by its limited joint volume.

ACTIVE MECHANISMS

Dynamic glenohumeral stability in humans is provided by the biceps and the subscapularis, supraspinatus, infraspinatus, and teres minor muscles of the rotator cuff. The cuff muscles serve several stabilizing functions. First, by virtue of the blending of their tendons with the glenohumeral capsule and ligaments, selective contraction of the cuff muscles can adjust the tension in these structures, producing "dynamic" ligaments. Second, by contracting together, they press the humeral head into the glenoid fossa, locking it into position and thus providing a secure scapulohumeral link forelimb function. Third, by contracting selectively, the rotator cuff muscles can resist displacing forces resulting from contraction of the principal shoulder muscles.

PATHOPHYSIOLOGY OF SHOULDER INSTABILITY AND JOINT PAIN

SHOULDER INSTABILITY

Luxations of the shoulder are relatively uncommon in the dog. Traumatic luxations are seen in all breeds, but Toy poodles and Shelties show a particular propensity to develop medial luxations without any history of obvious trauma. At the time of presentation, many of these animals have a history of lameness of several months duration. Most luxations (approximately 75%) are medial, and a large proportion of the remainder are lateral. Cranial and caudal luxations are seen only occasionally.

Fixed luxations are easily diagnosed. However subluxations are difficult to objectivate. The use of diagnostic arthroscopy allows us to recognize subluxations of the shoulder joint as a major pathology. In order to properly treat shoulder instability, the type of instability must be known. A classification of shoulder instability is presented.

Classification of shoulder instability

- | | |
|------------|---|
| I | Frequency <ul style="list-style-type: none"> a. Acute b. Recurrent c. Fixed |
| II | Direction <ul style="list-style-type: none"> a. Cranial b. Medial c. Lateral d. Caudal e. Multidirectional |
| III | Onset <ul style="list-style-type: none"> b. Atraumatic c. Overuse |
| IV | Degree <ul style="list-style-type: none"> a. Dislocation b. Subluxation |
-

Historically, shoulder dislocations had been classified as either “traumatic” or “atraumatic”.

Shoulders were thought to become unstable either on the basis of a major traumatic injury or multiple small traumas. Repetitive microtrauma has been implicated as an etiology of shoulder instability, mainly in athletes who use their arms to throw objects. If these stresses are applied at a rate that is greater than the rate of tissues repair, these repetitive insults can produce damage to the tissues. It is well accepted that if a material is subjected to a large number of loading cycles, it will fail at a stress lower than its ultimate tensile stress. It is quite possible that the repetitive, high-velocity motions of the shoulder may cause fatigue failure to the fibres of the glenohumeral ligaments because the endurance limit is exceeded during these motions. It has been shown that a ligament undergoes significant stretching before ultimate failure when it is tested in unaxial tension. It is suspected that the high-demand, repetitive loading of certain shoulders may lead to fatigue failure of the ligament, resulting in stretching of the ligament and impairment of the proprioceptive function of the capsule.

The arthroscopic examination of instable shoulder in dogs reveals 2 major groups: the medial and the lateral instability most of which result from overuse activity.

JOINT PAIN

Pain is an important component of joint disease. Unfortunately many aspects of nociception (reaction of the nervous system to noxious stimuli) and pain remain unclear. The peripheral nerve anatomy of joint appears to be similar in many species.

Mammalian appendicular joints are supplied with two types of nerves: primary articular nerves and accessory articular nerves. Neurons within these nerves innervate receptors having specific functions. A popular classification scheme includes four receptors types whose information is carried by 3 classes of neurons.

The nociceptor population of joints is mainly composed of high-threshold nerve endings, and in normal

joint intense mechanical stimuli are required to produce pain. Acute trauma to or disruption of joint capsules or articular ligaments is an obvious source of pain, and changes in intraarticular pressure may also result in articular pain. Surprisingly, the specific anatomic sources of pain in disease joint are unclear. Since all tissues are affected in osteoarthritis there are several potential sources of pain: increased intramedullary pressure, periosteal elevation, chemical capsulitis, osteophytes, and desmitis.

EVALUATION OF SHOULDER INSTABILITY

Shoulder instability is diagnosed and classified on the basis of history, physical examination, plain radiographs and arthroscopy. Classification of the instability is of considerable importance because the surgical treatment varies with the direction of the instability.

The clinical signs of shoulder instability is that of a chronic foreleg lameness. Most dogs are lame for more than 2 months and some for several years. Atrophy of the shoulder muscles is common. Some dogs are presented for cervical disk disease.

When the cause of lameness is located, the orthopedic examination included range of motion, presence of pain in hyperextension, biceps tendon test, and palpation to assess joint instability. Each animal is anesthetized and the same orthopedic examination is repeated. Mediolateral, craniocaudal, and stress mediolateral radiographs are taken of each shoulder. The preoperative radiographic status of osteoarthritis involving the shoulder joint is graded. Osteoarthritis is observed in 60% of the cases. Other radiographic anomalies may be seen: osseous defect of the medial aspect of the humeral head (11%), calcification of the tendon of the supraspinatus muscle (11%) and flattening of the medial rim of the glenoid cavity.

None of the tests are effective for assessing abnormalities of the joint capsule, nor can they assess the competency of the capsule and its ligamentous structures in preventing translocation of the head of the humerus on the glenoid cavity. Shoulder arthroscopy appears effective for identifying impression lesions of the head of the humerus and glenoid margins and for assessing the volume and relative laxity of the capsule, anomalies of the synovium, lesions of the glenohumeral ligament, biceps tendon, and labrum.

TREATMENT

The non surgical treatment of shoulder instability uses an activity restriction associated with nonsteroidal antiinflammatory and chondroprotective drugs. However, the conservative treatment is often palliative and most patient remain lame.

The surgical treatment of shoulder instability is based on the restauration of the anatomic anomalies. We recognize two major groups of shoulder instabilities: medial and lateral.

Medial shoulder instability is associated with an abnormal medial glenohumeral ligament (stretch torn, distended, absent) and a distended or torn joint capsule. The surgical procedure uses a craniomedial approach to the shoulder joint. The tendon of the subscapularis is incised and free. The medial joint capsule is incised halfway between the medial rim of the glenoid and humeral head and then imbricated using 3 to 4 n°1 Ethibon sutures. Closure is done in a routine maner. The postoperative treatment uses morphine for the first 24 hours. Patients are then kept on prednisolone, 1/4mg/kg for 10 days. A Velpeau sling is applied for 2 weeks and activity is limited strictly for 6 weeks.

Lateral shoulder instability is associated with torn labrum off the lateral rim of the glenoid cavity. The labrum is sutured back to the glenoid using a craniolateral approach to the shoulder. The post-operative medial shoulder care is identical to that of medial shoulder instability.

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Efficacy of Fortiflex in the prevention of osteoarthritis in dogs

J.F. Bardet

A prospective study was performed in patient treated arthroscopically for a fragmented coronoid process. Eighteen patients were used, thirteen receiving the chondroprotective drug and five a placebo. The patient had a orthopedic examination, radiographs preoperatively and one, two and four months postoperatively. The synovial membrane was biopsed during the initial surgery and the second look arthroscopy four months postoperatively. The pain, lameness, histologic score and radiographic findings were graded.

The results of this clinical research clearly demonstrated the clinical improvement of the histologic score in patient receiving the chondroprotective drug. Fortiflex also demonstrates protective effects against osteoarthritis radiographically.

In conclusion, Fortiflex appears clearly to have a protective effect against osteoarthritis in a fragmented coronoid process model in dogs.

Treatment of Elbow Degenerative Joint Disease With Arthroscopy

J.F. Bardet

Severe degenerative joint disease (DJD) of the elbow joint is a common finding in dogs treated for elbow dysplasia and incongruity. In severely affected dogs, secondary DJD is often a debilitating disease. Following any form of surgery, a crippling lameness is usually present by the age of 3 to 4 years that may be unresponsive to exercise limitation, weight control or drug therapy. Huibreytse, et al., provided evidence that elbow DJD progressed radiographically in dogs following nonsurgical and surgical treatment, and using force plate gait analysis found that there was no difference in limb function between treatment groups. They also found that owners reported a recurrence of lameness in 78% of dogs treated without and 69% of dogs treated with surgery. Regardless of treatment, DJD progressed radiographically and range of motion decreased over time.

Currently, no reliable treatment alternative exists as a means to manage patients that have had unsatisfactory outcomes following medical or surgical management. Treatment alternatives for dogs with significant DJD of the elbow include nonsurgical management (anti-inflammatory drugs and weight reduction), removing loose body and osteophytes, arthrodesis and total elbow prosthesis. De Hann et al. retrospectively investigated results after arthrodesis of the elbow and found that although pain was alleviated, function of the limb was poor. Total elbow prosthesis in dogs is still in its infancy with no middle and long term results. There are no reports on the clinical results following the surgical treatment of elbow DJD in dogs.

Primary osteoarthritis of the elbow is an uncommon disease in man. Open fenestration of the olecranon fossa for the treatment of osteoarthritis of the elbow was originally described by Kashiwagis in man and popularized by Outerbridge. Morey has popularized the Kashiwagi-Outerbridge arthroplasty and refers to it as the ulnohumeral arthroplasty. With the development of elbow arthroscopy in man, the treatment of elbow osteoarthritis under arthroscopy has become successful.

PATHOPHYSIOLOGY

Examination of autopsy specimen with severe elbow DJD shows several lesions : large osteophytes on the dorsal border of the anconeal process and on the cranial border of the radial head, marginal osteophytes along the medial and lateral margins of the trochlear notch, osteophytes of the olecranon and radial fossae and very thick hypertrophic joint capsules. Loose bodies are often found free in the cranial and caudal joint spaces. The fragmented medial coronoid process may still be present. The articular cartilage may have minimal degenerative changes. However, most often, the articular cartilage of the medial humeral condyle, medial coronoid process and trochlea of the humerus shows moderate to severe degenerative changes with eburnation and exposed subchondral bone.

Clinical signs of severe DJD of the elbow are associated with the compression of loose bodies and the impingement of osteophytes on the thickened joint capsule and soft tissues.

CLINICAL SIGNS

Many patients show the first clinical signs as early as 2 or 3 years of age. Because of pain, exercise endurance may be limited especially with bilateral involvement. The dog may appear quiet because of pain. The lameness is worse after rest and prolonged activity.

On physical examination, pain is demonstrated on both flexion and extension of the elbow joint. Joint effusion and thickening of the joint capsule is noted along with proeminence of the medial humeral epicondyle. Muscle atrophy is evident. Flexion and extension of the elbow joint is limited. In the most severe cases the range of motion of the elbow joint may be as low as 30 to 40°. Crepitation is common during extension and flexion.

IMAGING STUDIES

Mediolateral, craniocaudal and oblique radiographs are used to evaluate the degree of degenerative change

and the size of the osteophytes. Unfortunately, 30 to 40% of the loose bodies are not detected on preoperative films.

Computer tomography with both axial and reformed two-dimensional reconstructions, may be necessary to assess the bony architecture of the joint. Computer tomography is the imaging study of choice to visualize the osteophytes on the olecranon and radial head as well those in and around the olecranon and radial fossae. The computed tomography may clearly demonstrate ingruity, lateral coronoid fragmentation, loose bodies, calcification of the tendon of insertion of flexor muscles, and both ulnar trochlear notch malformation and asymmetrical growth between the radius and ulna. Three-dimensional reconstructions are most useful to properly assist the surgeon during the procedure.

ARTHROSCOPIC PROCEDURE

Dorsal recumbency is used initially to explore the medial and caudal compartments of the elbow. The cranial portals require a lateral position. A standard 2.7 mm 30° arthroscope is used. A variety of handled graspers, power shaver blades and burrs, and osteotomes are used.

The procedure starts with the exploration of the medial compartment of the elbow joint using the medial and accessory medial portal. The remains of the medial coronoid process and its osteophytes, the lateral coronoid process (when fragmented) are removed as well as the chondromalacic cartilage of the medial humeral condyle. Then the caudal olecranon fossa is approached using the caudodorsolateral and caudodorsomedial portals. In most cases, the caudal articular space is reduced because of the synovial proliferation and osteophytes. The joint space is expanded using a motorized shaver. The osteophytes of the olecranon fossa are burred and the larger osteophyte of the dorsal aspect of the olecranon is osteotomized and excised. The caudolateral and caudomedial recess of the elbow are then explored. Marginal ulnar osteophytes may be burred out and loose bodies removed.

The patient is then moved in lateral recumbency. The cranial elbow joint space is explored using the craniodorsolateral portal for the arthroscope and the craniolateral portal as the instrument portal. The loose fragments are excised and the joint space is expanded with a shaver. The largest osteophyte of the radial head is either burred or osteotomized and excised.

The use of postoperative analgesic is mandatory in the postoperative phase for 10 days. We also recommend the use of cryotherapy for 10 days.

RESULTS AND CONCLUSIONS

The clinical results of the arthroscopic ulnohumeral arthroplasty has been most encouraging over the last 5 years. Most patients have an increased range of motion with an improved extension and at least 90° of flexion. The gait is improving rapidly. The use of computer tomography has recently been most helpful in evaluating and localizing all the lesions that required an arthroscopic treatment. At our 5 years midterm evaluation, the results are still good. However, when the articular cartilage is severely damaged some patients would probably benefit in the future from a total elbow prosthesis. In spite of this limitation, the arthroscopic ulnohumeral arthroplasty appears as an excellent technique to improve the function of the crippling elbow associated with severs DJD.

Tendon and ligament engineering – experiences with TGF- β

A.P. Bathe

INTRODUCTION

TGF- β is a growth factor with a pivotal role in the regulation of extracellular matrix. It up-regulates the expression of several structural matrix proteins, including collagen types I and III. The exogenous use of growth factors such as TGF- β may have application in situations of poor or compromised healing of a soft tissue injury.

MATERIALS AND METHODS

Commencing in 1999, a prospective trial was commenced where a number of clinical cases of superficial digital flexor tendonitis and suspensory ligament desmitis were treated by intralesional injections of TGF- β_1 . Both chronic, non-healing injuries and acute injuries were treated. No cases were treated sooner than one month after injury. All cases received a thorough clinical examination and a thorough ultrasonographic examination of palmar metacarpal region of both forelimbs. A total of 3ng of TGF- β_1 was injected into the damaged areas of the tendon or ligament in 0.1ml aliquots of a 1ng/ml solution. The limb was bandaged and walking exercise was commenced one week after injection. The plane of exercise was increased dependent upon the ultrasonographic appearance at 2 monthly rechecks.

RESULTS

The initial clinical results were encouraging, with horses returning to full athletic use in a shorter time period than that expected with conservative treatment, although a number of horses developed considerable thickening of the treated limb. A full analysis of the results is currently being undertaken.

Arthroscopic Evaluation of the Dysplastic Hip

B. Beale, K. Schulz

INTRODUCTION

Hip arthroscopy can be readily performed with minimal difficulty. Hip arthroscopy allows thorough visual assessment of the normal and pathologic intraarticular anatomy. The prime indication for hip arthroscopy is assessment of juvenile canine patients for triple pelvic osteotomy. There is a significant degree of cartilage, femoral capital ligament and joint capsule pathology with no radiographic evidence of osteoarthritis in some juvenile dogs. A poor correlation between radiographic and arthroscopic findings, shown by Holsworth et.al., makes accurate assessment of suitable surgical candidates by radiography alone difficult. Arthroscopy of the hip is only in its infancy; future applications will certainly grow as expertise and experience are gained.

INDICATIONS FOR HIP ARTHROSCOPY

Hip arthroscopy is a new treatment modality in small animal surgery. As small animal surgeons become more adept at arthroscopy, more conditions will be treated totally or with assistance of the arthroscopist. Potential indications for hip arthroscopy include: hip dysplasia, evaluation of the joint prior to triple pelvic osteotomy surgery, osteoarthritis, hip dislocation, and diagnostic examination (biopsy or culture of bone, cartilage, or synovial membrane). The arthroscope can also be used to place a drain within the joint capsule to allow ingress/egress flushing in patients with septic arthritis.

EQUIPMENT AND INSTRUMENTATION

The surgical table should be one that can be lowered, raised, and tilted in at least one direction. When performing hip arthroscopy, the surgery table should be adjusted to a position that allows the surgeon and assistants to hold his/her arms as close to the body as is possible. The surgeon's shoulders should be in neutral position with the elbows close to 90 degrees. This position prevents fatigue and improves efficiency of the operating team. The imaging tower is positioned at the back of the patient or opposite the surgeon. Fluid ingress is achieved with a pressurized gravity bag or infusion fluid pump administered through the arthroscopy cannula. Fluid can be evacuated by allowing it to flow freely through the egress needle (or cannula) or through a working cannula; evacuation of fluid can be assisted with suction attached to the egress needle (or cannula). If suction is used, it must be set at a low level or bubbles will be produced that obscure the surgeon's view.

In most dogs, a 2.7 mm arthroscope is easily inserted into the joint space. In small breeds of dogs, a 1.9 - 2.4mm arthroscope is suggested to prevent iatrogenic cartilage damage during insertion or manipulation during surgery. Each arthroscope cannula is fitted with a blunt obturator and sharp trochar. The authors do not find it necessary to use the sharp trochar to enter the joint. If one chooses to use the sharp trochar, caution must be exercised when entering the joint to prevent iatrogenic cartilage damage. The authors recommend entering the joint with a pointed, blunt obturator.

An assortment of hand instruments is necessary for hip arthroscopy. Recommended are instruments to assist in the inspection of intra-articular structures (probes), grasping forceps for removal of free bodies, biopsy forceps, and instruments for surface abrasion and synovectomy. Instruments can be inserted into the joint through an open instrument port, instrument cannulas, or a combination of the two. If one chooses to work through an instrument cannula, different size cannulas and "switching sticks" are necessary.

PATIENT PREPARATION AND POSITIONING

Clip and prepare the patient as if an open craniolateral hip arthrotomy were to take place. The reason for this strategy is that the arthroscopy procedure may need to be aborted for technical reasons and an open arthrotomy performed. Arthroscopy is also most commonly used as a diagnostic or assessment tool in the hip and not as a definitive surgical treatment. If the surgeon wishes to have maximum maneuverability during arthroscopy of the hip or if a surgical procedure is to be performed at the time of arthroscopic examination, a hanging limb preparation is recommended. As the surgeon becomes more experienced and adept at hip arthroscopy or if diagnostic arthroscopy is only needed, less maneuverability is needed and a lateral limb preparation can be used.

PORTAL SITES FOR HIP ARTHROSCOPY

The number of portal sites used for hip arthroscopy is two or three depending upon the purpose of arthro-

scopic intervention. If visual joint exploration of the hip joint is all that is required, an egress portal and an arthroscope portal are necessary. If tissue biopsy or treatment of joint pathology are undertaken, then an additional instrument portal can be made. The egress and instrument portals can be converted to a single portal when using a cannula system. A clock face analogy is helpful when planning the location of portals. Using a right hip, the scope portal is placed at 12:00, the instrument portal at 2:00 and the egress portal at 5:00. For the left hip, the scope, instrument and egress portals are placed at 12:00, 10:00 and 7:00, respectively. The scope and instrument can be switched with switching sticks for access to different parts of the joint.

Landmarks should be used only as starting points; optimal instrument portal placement can be verified intraarticularly by visualization of a guide needle.

The scope portal is established first. An 18-22 gauge spinal needle (2½ - 3 inch) can be used as a guide to confirm the position for the arthroscope portal. An assistant should apply traction to the leg while applying countertraction to the

inguinal region, to separate the joint surfaces and ease the insertion of the guide needle and arthroscope. Flex the hip slightly and position the femur parallel to the table to maximize joint space width. If the knee is flexed, the tibia can be used as a handle to place traction on the hip. A traction device has been developed that eliminates the need for an assistant. Little manipulation of the limb is possible when the distraction device is in use. Palpate the hip and insert the needle at the midpoint of the proximal edge of the greater trochanter. Insert the needle perpendicular to the skin surface and maintain this orientation through the soft tissues as the needle enters the joint. A popping sensation is often felt when entering the joint. To assure placement within the joint, attach a syringe to the needle and aspirate synovial fluid. In most cases, when the needle is properly placed, synovial fluid is easily aspirated. If synovial fluid is not aspirated and the surgeon believes the joint has been entered, he/she can instill fluid (lactated ringers) into the joint. If the needle is located in the joint, fluid is easily instilled. If joint fluid is not aspirated, slightly withdraw the needle and aspirate again. Occasionally the needle is advanced into the ligament of the head of the femur preventing fluid aspiration. Also, as one begins to fill the joint cavity with fluid, reverse pressure is felt on the syringe plunger from the instilled fluid. This too insures proper placement of the needle into the joint. Distend the joint cavity with 5 - 10cc of lactated ringers and maintain the joint distension by leaving the syringe attached to the needle (the assistant will need to keep pressure on the plunger). The reason for distending the joint cavity is that distension makes it easier to correctly position the arthroscope portal. Use a number 11 Bard-Parker blade to make a small entry wound through the skin and superficial soft tissues adjacent to the needle. It is not advisable to enter the joint with the scalpel blade, as extravasation of fluid outside the joint cavity is more likely when this occurs. Another concern is prevention of iatrogenic injury to the sciatic nerve. The nerve courses caudal to the joint in the ischiatic notch; therefore, caudal portals to the hip are not recommended. Blunt dissection with small Metzenbaum scissors can be performed through the stab incision to ease insertion of the arthroscope cannula in heavily muscled dogs in order to avoid a traumatic insertion due to the need to apply excessive force. Remove the needle and insert the arthroscope cannula with the attached pointed blunt obturator in the same direction as the needle. The tip of the blunt obturator can be walked off the lateral edge of the dorsal acetabular rim to aid localization of the joint space if needed. When using a pointed blunt obturator, pressure must be applied to penetrate the joint capsule. With experience, the surgeon will learn to feel when the joint is entered. Once in the joint, remove the obturator from the cannula. Fluid will flow freely from the cannula confirming correct placement. Attach the fluid ingress line to the cannula and lavage the joint for 10-15 seconds prior to inserting the arthroscope to help obtain a clear fluid field.

The egress portal is established second. A 2-1/2 - 3 inch 18-22 gauge spinal needle is inserted approximately 2 cm cranial and 2 cm distal to the scope portal. Use of a needle that extends only a small distance above the level of the skin helps to avoid interference with the light cable of the arthroscope as it is manipulated to view the caudal aspect of the joint. The needle is directed perpendicular to the limb. If the needle is properly placed fluid will flow from the needle hub. Evacuation of fluid maintains fluid flow through the joint enhancing visualization. One can attach IV tubing or suction tubing to the needle to capture fluid as it leaves the joint. Alternatively, fluid is allowed to spill onto the floor and to be captured by a floor suction unit, basin



*Portal sites of the hip. A. scope portal
B. instrument portal C. egress portal*

or towels.

The instrument portal is established if a biopsy of intra-articular tissue is desired or if treatment of joint pathology is required. If using a cannula system, the egress portal is converted to a portal that functions both as an instrument and an egress portal. If a cannula system is not used, a new egress portal is created slightly distal to the original portal; the instrument portal is then placed at the site of the original egress portal. The craniocaudal and proximodistal position of the instrument portal relative to the greater trochanter can be estimated from the lateral radiograph. This site is often approximately 2cm cranial to the scope portal. These numbers are only an estimation and will vary with the size of the dog. It is best to learn to triangulate the instrument portal site relative to the position of the arthroscope tip.

SURGICAL ANATOMY

Being a ball and socket joint, the hip joint is well suited for movement in all directions. Although capable of movement in all directions, the hip primarily moves in flexion and extension. Joint stability is provided through a combination of passive and active mechanisms. Passive mechanisms include the ligamentum teres, surrounding joint capsule, joint conformation, and synovial fluid cohesion. The ligamentum teres appears thick and courses from the fovea capitis of the femoral head to its origin in the acetabular fossa. The joint capsule originates from the periphery of the acetabulum, dorsal acetabular rim and labrum. The labrum is a well-defined fibrocartilagenous band between the acetabular rim and the joint capsule. The labrum continues as a free ligament, the transverse acetabular ligament across the acetabular notch. The concavity of the acetabulum and the fit of the femoral head into the acetabulum provide joint stability. Dynamic active coxofemoral stability is provided by contraction of the surrounding hip muscles. These include the gluteal, obturator, iliopsoas, and adductor muscles. Active contraction of the muscles of the hip cause compression across the hip joint as well as increasing tension in the joint capsule.

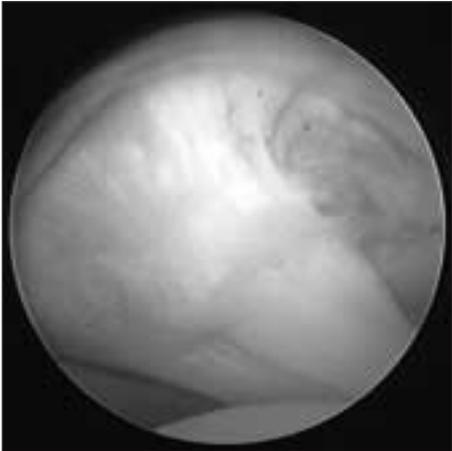
When the arthroscope enters the joint, position the camera such that proper spatial orientation is present when viewing the monitor. Orientation is correct when one views the monitor as follows: right is to the right, left is to the left, ventral is down, and dorsal is up. The buttons on the camera will face upwards. The fore-oblique direction is the surgeon's preference but most prefer to initially view 30 degrees down, which positions the light post up. The proper spatial orientation and fore-oblique view is obtained when the buttons on the camera head are upright and the light post is in the upright position. With the camera and light post in this position, the ligamentum teres and the acetabular fossa will be visible. The articular cartilage of the medial and deep portions of the femoral head and acetabulum can also be seen. The scope can be carefully retrieved a very small distance to visualize the remaining articular cartilage surfaces on the proximal and lateral aspect of the femoral head and acetabulum. Manipulations that may improve visualization of the articular surfaces include distraction of the limb to separate the joint surfaces and adduction and internal rotation of the hip. Position the light post caudally to visualize the cranial compartment of the hip. Note the articular cartilage of the femoral head, synovial membrane, and the recess of the joint capsule as it attaches to the femur cranially. Move the arthroscope tip caudally and turn the light post cranially to view the caudal joint compartment. Note the articular cartilage of the femoral head, synovial membrane, and the recess of the joint capsule as it attaches to the femur caudally. Return the arthroscope and light post to the original entry position to begin exploration of the acetabulum, DAR, labrum and dorsal synovial membrane attachment. The tip of the arthroscope must be slowly retracted a small distance, but this must be done very carefully to avoid inadvertent displacement of the scope from the joint. Maintaining distraction of the limb can help prevent displacement of the scope from the joint. Gently move the tip of the arthroscope dorsally to view the dorsal compartment and joint capsule. Turn the light post to view cranially or caudally. An example of standard hip arthroscopic examination would be to visualize and image each area of joint as follows:

1. ligamentum teres
2. femoral head
3. cranial joint pouch
4. caudal joint pouch
5. acetabulum
6. acetabular labrum
7. synovial membrane

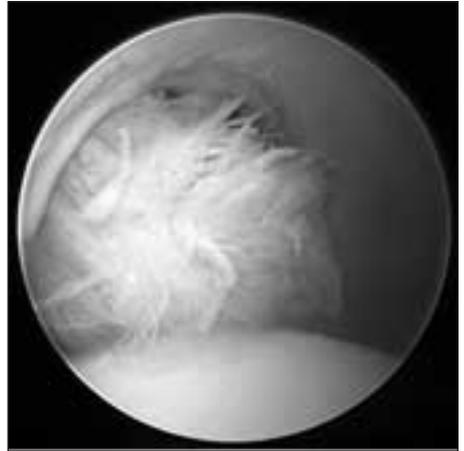
Stretching of the ligamentum teres or the joint capsule may be identified upon palpation and visualization, but are not direct contraindications for TPO. If excessive wear of the articular surfaces of the acetabulum or femoral head are identified, consideration should be given to abandoning a planned triple pelvic osteotomy (TPO). Other potential contraindications for TPO surgery include tearing of the cartilaginous labrum, joint capsular tears or wear of the dorsal acetabular rim.

SUGGESTED READING

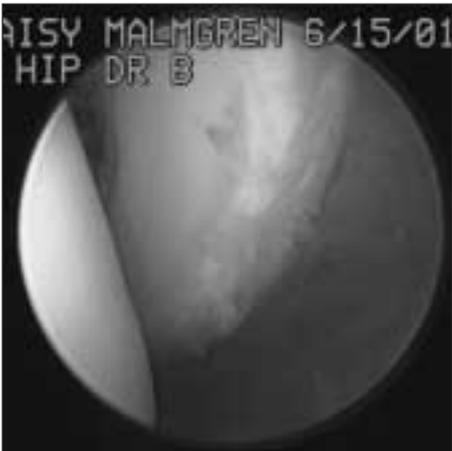
Person MW. Arthroscopy of the canine coxofemoral joint. *Compend Contin Educ Pract Vet* 11(8): 930-935, 1989.



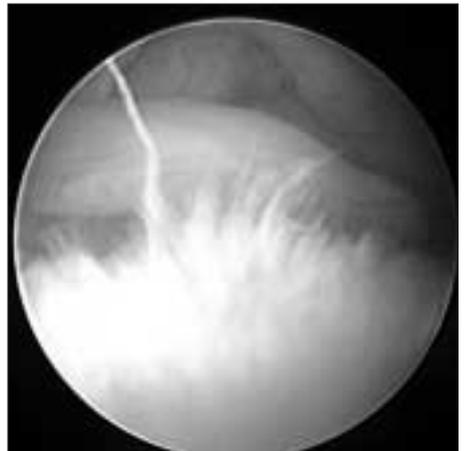
Normal ligamentum teres



Frayed ligamentum teres



Early labrum tear



Fibrillation of cartilage of the femoral head

Supraspinatus Tendon Injuries

B. Beale

INTRODUCTION

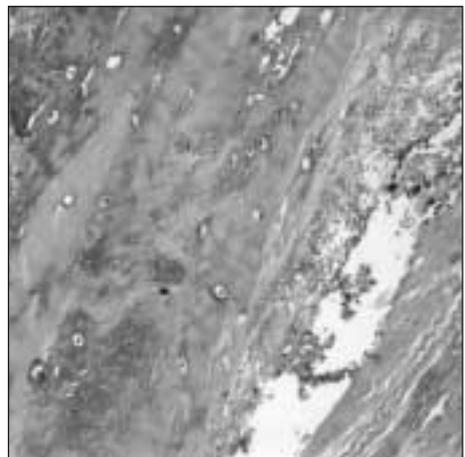
Lameness of the forelimb is a common clinical complaint in dogs. Many causes of lameness are readily diagnosed based on historical, clinical and radiographic findings. Subtle causes of lameness complicate the ability to make an accurate diagnosis. Lameness associated with the shoulder joint can be particularly difficult to diagnose, particularly if the injury is to a soft tissue structure. Arthroscopy of the shoulder is indicated for the diagnosis of osteochondritis dissecans (OCD) of the humeral head, fractures of the glenoid and pathology of the glenohumeral ligaments, biceps tendon and tendon sheath, subscapularis tendon and the joint capsule (Person 1989; Van Ryssen et al. 1993a; Van Ryssen et al. 1993b; Bardet 1998). Injury to the supraspinatus tendon cannot be diagnosed arthroscopically, but is a recognized cause of shoulder pain and lameness. This condition has been reported more frequently in large breed dogs, particularly the Labrador retriever and Rottweiler.

DIAGNOSIS

Diagnosis of supraspinatus tendinopathy can be difficult. Affected dogs often have a chronic weightbearing lameness that may progress from intermittent to persistent. Localization of pain may be difficult. Direct palpation of the greater tubercle of the humerus or along the course of the supraspinatus tendon may illicit a painful response in some affected dogs. Rotation, flexion and extension of the shoulder can also be painful. Muscle atrophy of the affected leg is usually generalized, rather than specific to the supraspinatus muscle. Radiographic views should include standard anteroposterior and lateral projections of both shoulders. Mineralization is often seen bilaterally, although the opposite limb is often asymptomatic. Mineralization is seen adjacent to the greater tubercle of the humerus. Patterns of mineralization are either irregular, non-homogeneous or well circumscribed dense foci. This calcification must be differentiated from that associated with damage to the biceps tendon. An anteroposterior radiographic view can sometimes help to differentiate the two injuries because the mineralized tissues associated with supraspinatus injury should lie more lateral. A "skyline" view of the bicipital groove is also helpful to delineate the location of dystrophic mineralization. Arthrography can be used to outline the bicipital groove to determine if irregularities or filling defects suggestive of bicipital tenosynovitis are present. Computerized tomography (CT) of the shoulder is an excellent resource to delineate the position of dystrophic mineralization. Arthroscopic evaluation of the shoulder



Typical radiographic appearance of supraspinatus tendinopathy.



Histopathological changes of supraspinatus tendinopathy include tendon degeneration with dystrophic mineralization and fibrocartilaginous metaplasia replacing tendon fibers.

should be considered to rule-out other causes of shoulder pain because shoulder injuries commonly involve multiple ligaments or tendons. The differential diagnosis includes OCD, bicipital tenosynovitis and shoulder instability.

TREATMENT

Conservative treatment is initially attempted in many cases. Activity should be restricted to short periods of walking for 2 months. Antiinflammatory therapy with NSAIDs should be considered. Local injection of a long acting steroid (methylprednisolone) has also been described. Conservative therapy is unsuccessful in many patients. If conservative therapy is helping, the patient should be gradually returned to normal activity over the next 2 months. If conservative therapy fails, surgical intervention should be considered.

Surgical treatment of supraspinatus tendinopathy is performed through a craniolateral approach to the insertion of the supraspinatous tendon. The tendon is isolated and a tendonectomy of the supraspinatous insertion performed. Resection of the mineralized tissue has been recommended, but is probably not necessary. Long-term follow-up of dogs treated by resection of the mineralized tissues showed recurrence of mineralization in one study.

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Controlled delivery of teicoplanin from a intraarticular biodegradable microparticulate system; in vitro / in vivo evaluation

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INTRODUCTION

The use of antibiotic impregnated biodegradable carriers has been shown to be a valuable adjunct in the treatment of chronic bone infections. Therefore, the current study was designed to evaluate the controlled antibiotic delivery from a biodegradable microparticulate system to establish levels above the minimum inhibitory concentration for the common causative organisms of bone infections.

METHODS

We used poly lactide-co-glycolide (PLGA 75:25, MW 136000) polymer based microspheres as a biodegradable antibiotic delivery systems. Teicoplanin incorporated PLGA microspheres were prepared by emulsion/solvent evaporation process. For characterization of PLGA microspheres and regulation of the release rate, particle size, surface morphology, and drug content was standardized. Agar diffusion method was used for the biological assay of Teicoplanin. Staphylococcus aureus ATCC 25923 strain was inoculated in agar plates. For in vitro release; 30 mg of PLGA microspheres were weighted accurately in separate polypropylene vials for each time point and tubes were placed in a thermostated and bath shaken continuously at 40cpm at 37° C. Samples were taken every 24 hours and after the centrifugation at 10000 rpm, the supernatant was removed and drug content was determined by zone inhibition measurements. The in vivo study was carried out on three groups of 8-month-old skeletally mature New Zealand white rabbits, weighing around 2,5-3kg (n=18). This delivery system was implanted into the femoral condyle of rabbits through an intraarticular defect of 4mmx10mm. The animals were randomized in to three groups. In Group I plain microspheres were implanted into the defect, while in Group II Teicoplanin loaded PLGA microspheres were implanted into the defect, and in Group III Teicoplanin loaded PLGA microspheres were embedded in chitosan gel media. After implantation, regular samples of joint fluid were obtained in 24hr, in days 2, 3, 5 and weekly thereafter. The antimicrobial activity of this fluid was also measured using an agar gel plate technique as described in vitro analysis. Fischer's exact chi-square test was used for statistical analysis.

RESULTS

Teicoplanin incorporated PLGA microspheres were prepared by 66% yield and average particle size was measured as 29±4,5 µm, while total drug content in microspheres were determined as 1,7%. Differential Scanning Calormetry (DSC) data showed no interferences in formulation between polymer and antibiotic. Scanning Electron Microscopy (SEM) photographs before and after in vitro release studies revealed that microspheres were homogenous and had a spherical surface. Teicoplanin release from PLGA microspheres were continued for 5 weeks. Almost 100% of release was occurred on 35th day. In vivo analysis revealed that the drug concentration exceeded the MIC for the test organism for two weeks without inducing serum toxic levels. There was no statistical significant difference detected between Groups II and III. (p>0.05). Samples from the Group I presented no antimicrobial activity. At the end of second week, 86% of animals were complicated with wound infection and 92% of them were healed without any treatment at the fourth week follow-up. Further testing demonstrated antimicrobial activity in 40% of samples at the fourth week.

DISCUSSION AND CONCLUSION

The treatment of muskuloskeletal infections with biodegradable materials has the advantages of providing high local levels of antibiotics while maintaining low systemic levels without the need of a second surgery for removal. Various types of carrier materials and antibiotics have been used based on their abilities to achieve controlled bactericidal concentrations. PLGA composite is among the most promising biodegradable biomaterials. It is nontoxic, have FDA approval, elicits minimal inflammatory response, has a controlled resorption rate, and eventually can be resorbed with no accumulation in the vital organs. Teicoplanin is an antibiotic complex recently in clinical use; it is water-soluble, bactericidal, nontoxic to tissue, has a low rate of producing allergen reactions and effective against infections caused by methicillin resistant Staphylococci.

In the in vitro part of our study, therapeutic concentrations of Teicoplanin still found during 35 days. Measurement data suggested that the antibiotic is released evenly and duration of release was satisfactory. In vivo study further demonstrated that the antibiotic release maintained in the bone defect 28 days after implantation. In conclusion, this biodegradable formulation of Teicoplanin embedded PLGA microspheres appear to be a promising controlled release delivery system for the treatment of bone and joint infections.

How do kinematic and force plate analyses complement each other?

G.P. Brüggemann

Kinematic analyses of animal or human movement allow the description of the position of body's segment, the identification of segmental center of mass, and using additional information on the mechanical properties of the body segment the calculation of the position of the center of mass (CM). From the segmental position one can easily derive the relative position of the segments to each other and their intersegmental joint angles. With some reservation joint axis of rotation can be determined. When the joint center locations or the position of the CM are described in discrete but homologue time intervals the first derive of the position time function allows the calculation of the CM velocity as well as the segmental velocities. From the intersegmental angles or the position angles the angular velocities can be derived. With the given reservation the CM's and segments' linear acceleration can be estimated of the velocity time data. The rotational acceleration is calculated from the angular velocity data. Due to the fact that the optically measured segment or joint position are noisy the kinematic raw data have to be carefully smoothed with more or less sophisticated mathematical techniques. Kinematic analyses in human and animal biomechanics are often performed two dimensional and focused on the major plane of motion. In general the sagittal plane is used as major plane of interest. More sophisticated kinematic analyses perform three dimensional quantification of the segmental and entire body movement. In order to identify segments positions during the whole movement and to reduce the problem of hidden segments or points a sufficient number of cameras from both sides of the object under study have to be used. Often retroreflective markers are used to simplify the joint or segment localization. Such marker glued or mounted on the skin of the segment do represent a point or position on the segment but do not represent a joint center or the segmental longitudinal axis. A transformation of the measured marker position to the anatomical landmark as a prerequisite when using this technique. The outcomes of all kinematic analyses describe positions, locations, and the changes of the segmental positions in time and space. Angular and linear velocities can be derived. Accelerations derived from kinematic data are relatively poor in terms of errors and can generally not be used for force or load calculations. The kinetic access the motion analysis is the use of ground reaction force measures. Using stationary force plates the vertical as well as the horizontal shear force are easily to quantify. It is to be underline that the ground reaction forces are the summary of all segmental mass accelerations and the segmental gravitational forces. They can be interpreted as total forces acting at the CM. When the GRF are measured under the different limbs with separated measuring devices they can be used as limb GRF acting at the distal end of the limb. The inverse dynamic technique allows now the calculation of the net joint moment at the next proximal joint and the joint forces. The procedure demands knowledge on the segment's position, on the segment's center of mass location, on the segment's mass, and on the segmental linear and angular acceleration. From that one can identify that the kinematic approach gives necessary complementary information for an efficient and more sensitive use of force platform data. In a next step from the net joint moment and the forces at the proximal portion of the segment the net muscle moment throughout the joint and the net bone on bone forces can be derived.

Pure kinematic data do not allow any access to forces and loading of the biological structures. The combination of kinematic techniques and GRF measuring techniques is the only way to give access to for the analysis and quantification of mechanical loading during locomotion.

Effects of fatty acid supplementation on the development of osteoarthritis in dogs: biochemical, clinical and radiographic evaluation

S. Budsberg

INTRODUCTION

Omega-3 (N3) fatty acid supplementation has been used as adjunctive therapy for inflammatory and degenerative osteoarthritis. Inflammation involves release of cytokines from membrane-bound fatty acids. These fatty acids may be modified by feeding different types of polyunsaturated fatty acids (PUFAs). Arachidonic acid (AA), a 20-carbon omega-6 (N6) fatty acid, is the predominant PUFA incorporated into cell membranes. However, when N3 PUFAs are fed, eicosapentaenoic acid (EPA), a 20-carbon N3 fatty acid, substitutes for AA.¹ When eicosanoid metabolism is induced, EPA competes with AA as substrate for cytokine-producing enzymes and different inflammatory prostaglandins, leukotrienes, and thromboxanes are produced.^{1,2} These cytokines of the 3 and 5 series tend to be less inflammatory. We tested the hypothesis that consumption of a low N6:N3 diet by healthy dogs would be associated with incorporation of N3 fatty acids into synovial membranes, lower serum lipid parameters, lower synovial prostaglandin E synthesis, and no adverse effects when compared with consumption of a high N6:N3 diet.

MATERIALS AND METHODS

The study was conducted with the approval of the Animal Care and Use Committee (ACUC #A960087C2). Eighteen dogs were randomly assigned to 3 dietary groups. Group 1 (High N6) was fed a diet formulated to contain an N6:N3 ratio of 28.8:1.0, group 2 (Control) was fed a diet formulated as a maintenance diet with an N6:N3 ratio of 8.7:1.0, and group 3 (Low N6) was fed a diet with an N6:N3 ratio of 0.7:1.0. Diets were fed in a double-blinded fashion throughout the study. Diets contained the same total amount of dietary fat (21.4% dry matter), and the same amounts of saturated and unsaturated fatty acids. Amount of diet fed was based on body weight using the formula: Caloric intake (kcal/d) = $2[(30 \times BW_{kg}) + 70]$, and amounts fed were adjusted to maintain stable body weight throughout the study. Dogs were fed their respective diets for 3 months prior to surgical transection of the left cranial cruciate ligament. At 6 months post transection, stifles were explored, and any damaged menisci were removed. Stifles were stabilized using an extra-capsular technique. Serum was obtained at baseline, 1, 2, and 3 months (pre-transection) following randomization to diet groups; following transection at 1, 2, 3, and 6 months (post-transection); and 1, 3, 6, 9, and 12 months following stifle stabilization (post-stabilization). Radiographs, vertical ground reaction force gait analysis, and synovial fluid (without lavage) were obtained at similar time periods except for 1 and 2 months following diet initiation. Synovial fluid levels of PGE₂ were measured using a commercially available enzyme immunoassay kit (Cayman Chemical #514010). Serum and synovial concentrations of (HA), (AgKS) and (CRP) were determined as previously described.^{3,5} Synovial concentrations of COMP were performed as previously described.⁶ Serum cholesterol, triglyceride, and phospholipid concentrations were measured using commercially available colorimetric assays (Fischer Stanbio®, triglyceride #2000, cholesterol #1010, Waco phospholipid B, 99654001). Fatty acid composition of synovial membranes and diet were determined using gas chromatography after extraction.⁷ Mean and standard deviation results were calculated using absolute numbers as well as changes from baseline. A mixed linear-model repeated measures analysis was used. ($p < 0.05$).

RESULTS

Serum cholesterol, triglyceride, and phospholipid concentrations. The Low N6 group had significantly lower serum concentrations of cholesterol, triglycerides, and phospholipids when compared with the Control and High N6 groups at all time points. No significant differences were found between the Control and High N6 groups.

Synovial membrane fatty acid composition. The Low N6 group had significantly decreased N6 fatty acid and increased N3 fatty acid concentrations in synovial membranes when compared with the other diet groups. Neutral lipid and phospholipid concentrations were not significantly different between time points; however, diet groups were significantly different from each other.

Synovial fluid PGE₂. While synovial fluid PGE₂ levels increased post-transection in all dietary groups, by 3

months, the High N6 group had significantly higher PGE₂ than did the Low N6 group. At 1 month post-stabilization, PGE₂ levels in the High N6 group were significantly greater than both the Control and Low N6 groups. This relationship continued until 9 months post-stabilization.

Radiographic scores. As expected, radiographic scores increased in all dietary groups after transection (Fig. 1). Post-stabilization, radiographic scores continued to increase at a slower rate, with the low N6 group score significantly lower than the other groups at 9 months post-stabilization.

Ground reaction force data. Post-transection, data documented decreases in vertical impulse in all groups. In addition, all groups showed increased force transmission through the limb at 3 and 6 months post-transection, with low N6 transmitting significantly more force through the affected limb than high N6 by 6 months. Post-stabilization, all groups had improved vertical data with groups not different from baseline by 6 months post transection.

Serum KS, HA and CRP Levels. Results to be presented.

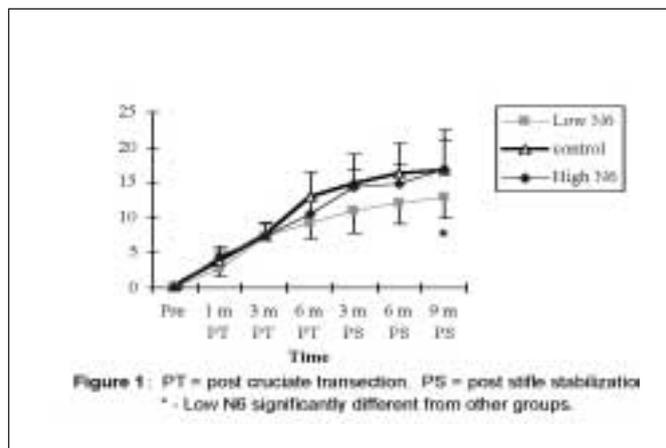
Synovial KS, HA, CRP and COMP Levels. Results to be presented.

DISCUSSION

Consumption of a Low N6 fatty acid diet by healthy dogs undergoing cranial cruciate transection and extra-capsular surgical repair was associated with lower serum concentrations of cholesterol, triglyceride, and phospholipids, incorporation of N3 fatty acids into synovial membranes, decreased PGE₂ concentrations, and less severe clinical and radiographic evidence of osteoarthritis. A low N6 diet may decrease joint inflammation and inflammatory cytokine production as well as decreasing lameness when fed to dogs prior to induction of osteoarthritis.

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Is force plate analysis the answer to lameness evaluation?

S. Budsberg

IN POINT OF FACT, THE QUESTION IS NOT WHETHER FORCE PLATE ANALYSIS IS THE ANSWER TO LAMENESS EVALUATION, THE QUESTION IS WHAT ARE YOU TRYING TO MEASURE?

In veterinary orthopedics the introduction and use of force platforms has gained popularity and a great deal of interest among surgeons, researchers, and regulatory agencies. These platforms, which are capable of measuring ground reaction forces generated during locomotion, can be used individually, in groups of two or more, or within a treadmill. If you are looking to measure an objective indicator of functional use, the force plate provides you with data that is reproducible, precise and very sensitive. The data is however limited by the conditions under which it is collected. Furthermore, force plate data is not joint specific and it can be argued it is not limb specific. Yet data from studies using force plates have become almost the "gold standard" for the measurement of improved limb function in both drug trials and evaluation of surgical procedures.

WHY IS THIS THE CASE?

Because force plate data provides you with a number of potential objective outcome measurements for a given study, this drastically decreases the potential for observational or measurement bias in a study. Subjective clinical outcome measurements are especially susceptible to this type of bias. As a consequence, the results of a subjective study design may lack credibility, especially if the potential for type II error is not considered in the study. Committing a type II error is to conclude that there is no difference when, in fact, a difference does exist. The potential for type II error should be evaluated when a clinical trial concludes that there is no difference between the two treatment protocols when examining for type I error (chance of a false-positive result). Two recent studies highlight the potential of this happening in relation to the sensitivity of the outcome measurement in an OA trial. In multicenter evaluations of the efficacy of etodolac and deracoxib for treatment of canine OA, a significant positive outcome measurement for the primary response variable using ground reaction forces was obtained from a force plate. No such determination was found, however, using concurrently collected blinded, subjective veterinarian based clinical assessments of the dogs. Thus, if no objective measurement had been used, the subjective outcome measurement would have shown no improvement. Interestingly in both studies, the owners were able to assess improvement with nearly the same accuracy as the force plate.

DATA COLLECTION

The proper collection of the data is as important as any other aspect of this type of evaluation. Controlling gait, dog/handler velocity, and acceleration during the trial is paramount. The key is consistency in trials to allow for valid data collection. Without careful control at this stage, data produced can often be unusable. The force platform collects data at a very high sampling rate producing a stream of data which is presented graphically as a wave form. From this graph, a variety of measurement values can be calculated. The most commonly used parameters are peak force, and total force or impulse. Another method is to evaluate portions of the waveform itself. These evaluations are less common, but may turn out to yield data as important as the individual parameters commonly used today as they may be attributable to more physiology events. Currently no data is available to suggest that a force plate can be used to diagnose a specific injury or pathology however there is data emerging that suggests that certain values derived from force plate data waveform including discrete points may be helpful in evaluation certain pathological conditions. With a growing body of literature that describe alterations of ground reaction forces seen with common orthopedic diseases in the elbow (fragmented coronoid process and osteochondrosis), the hip (dysplasia) and the stifle (cruciate insufficiency) there is a possibility that joint specific variables can be identified. Data from the equine literature does not favor this potential and argues for combination of kinetic data from force plates combined with kinematic data. Most investigators in canine gait laboratories agree with the push toward combination analysis.

Thus no single method of gait analysis provides you with all the data available during gait evaluations. The force plate interfaced with a computer provides rapid, quantitative kinetic data that can document changes

in these gait parameters. While the force plate may provide limb function data it will not tell you, for example, the changes in a particular joints flexion and extension angles.

APPLICATIONS TO RESEARCH AND CLINICS

There are many applications for the use of computer-assisted force plate analysis. The literature is beginning to contain more and more studies which this technology in part or as the major method of gait evaluation. Specific areas of use include: 1) evaluation of drug efficacy such as the effects of different NSAID or DMOAD/SMOAD drugs or dosage titration of an individual drug on experimentally induced or naturally occurring DJD; 2) quantification of success of surgical intervention; comparison trials for different surgical procedures for a given injury; 3) finally, it can be used to define and document subtle lameness.

CONCLUSION

The collection and evaluation of ground reaction force data in canine gait analysis has vast potential for providing objective data to aid the researcher and clinical orthopaedic surgeon. However, like any tool, there are potential misuses, misinterpretations and is entirely dependent on the quality of the study design.

REFERENCES AVAILABLE UPON REQUEST

Speed of sound measurements of the third metacarpal bone in young exercising thoroughbreds

B. Carstanjen, P. Langlois, J. Detilleux, H. Amory, O.M. Lepage

INTRODUCTION

Sore shin formation in Thoroughbreds often implies complete box rest or a significant reduction of the exercise level. Moreover, catastrophic injuries in the athletic race horse often occur as stress fracture and cause a considerable ethical and economical problem to the race industry^(1;2). However, non invasive assessment of bone remains still difficult^(3;4;5). The purpose of our study was to evaluate speed of sound (SOS) values obtained at the lateral, dorsal and medial aspect of the third metacarpal bone (MC III) in 2-years old thoroughbred horses and to study the influence of race-training on those SOS values.

MATERIAL AND METHODS

Forty 2-years old thoroughbred horses, 20 females and 20 stallions, were included in this study. The horses were subjected to flat racing-exercise and belonged to three training-stalls. Quantitative ultrasound (QUS) measurements were performed with a "multi site" QUS device (Sunlight Ltd., Rehovot, Israel). The first measurement cycle was performed in February 1999 before the horses started high speed work. Altogether 6 measurement cycles were performed in 5 to 7 week intervals ending in November 1999. All horses performed canter to high speed work. Quantitative ultrasound measurements of each horse were performed at the lateral, dorsal and medial aspect of the mid level of both MC III. For acoustic coupling 1000 mPa.s silicone oil was applied to the skin and the hand-held "multi-site" CM-probe was percutaneously and axially applied to the corresponding region of interest. Speed of sound measurements were performed by one operator and results were recorded on a hard disk. Statistical analysis was performed with SAS. The significance level was set at $p < 0.05$.

RESULTS

A significant difference between SOS values was obtained at the aspects of MC III ($p < 0.05$). Speed of sound values obtained at the lateral aspect were highest and SOS values of the dorsal aspect were lowest. Speed of sound values obtained at the dorsal aspect of MC III decreased from cycle 3 on, showed a nadir at cycle 5 and increased at cycle 6.

DISCUSSION AND CONCLUSION

The influence of exercise on equine bone was studied with ultrasound at the lateral and medial aspect of MC III⁽⁶⁾. The described "multi site" QUS-device allows SOS measurements at the lateral, dorsal and medial aspect of MC III. which are not influenced by a physiologic soft tissue layer⁽⁷⁾. Differences between SOS values obtained at various aspects of MC III might be due to aspect specific differences in MC III's geometry, composition, elasticity and/or density⁽⁸⁾. The decrease and subsequent increase of SOS values at the dorsal aspect of MC III might be due to modeling and remodeling processes and subsequent changes in bone properties due to exercise in thoroughbred horses.

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Total elbow replacement in the dog

M. Conzemius

Elbow osteoarthritis (OA) secondary to fragmentation of the medial coronoid process (FCP), osteochondrosis, asynchronous growth between the radius and ulna, ununited anconeal process, intra-articular fracture, or luxation is the most common cause of forelimb lameness in dogs. In addition, conditions that lead to OA in the elbow frequently occur bilaterally. Medical and/or surgical management of these conditions frequently leads to unsatisfactory results. Huibregtse et al. provided evidence that elbow OA progressed radiographically in dogs following nonsurgical or surgical treatment and using force plate gait analysis found that there was no difference in limb function between treatment groups. They also found that owners reported a recurrence of lameness in 78% of dogs treated without and 69% of dogs treated with surgery. Bouck et al. studied dogs diagnosed with FCP and/or OCD that were treated medically or surgically using physical, radiographic and kinetic evaluations and found similar results. Regardless of treatment OA progressed radiographically and range of motion decreased over time. They also found dogs in both groups improved but there was no difference in the amount of improvement between treatment groups.

Currently, no reliable treatment alternative exists as a means to manage cases that have had unsatisfactory outcomes following medical or surgical management. Treatment alternatives for dogs with moderate to severe elbow OA include nonsurgical management (anti-inflammatory medication and weight loss), removing loose bodies and osteophytes from the joint, and arthrodesis. de Hann et al. retrospectively investigated results after arthrodesis of the elbow and found that although pain in the joint was alleviated, function of the limb was limited. In a review article addressing the surgical treatment of OA, it was stated that debridement of osteophytes was the primary and arthrodesis the secondary option for OA in the elbow. The same article also stated that total elbow arthroplasty (TEA) was likely to be the best future option. I am not aware of a commercially available canine total elbow arthroplasty system.

Improvements in implant design and surgical techniques have made TEA a satisfactory treatment for arthritic disorders of the elbow in man since the mid-1970's. In two separate evaluations, 91% of TEA patients had excellent long-term (approximately 4 years) outcomes. TEA has been described in dogs. Lewis reported on his experiences with the use of a constrained (hinge-like) implant and although there were some successes he concluded that because of a high complication rate it needed to be redesigned. Our research group used morphometric data from normal canine elbow joints to design a two component, semiconstrained system and tested it in six greyhounds. It was determined from that study that moderate success could be achieved (mean peak vertical force (PVF) of affected limb 24 weeks after surgery was 82% of preoperative normal) but that success was limited primarily because of component loosening secondary to design flaws (stems of radioulnar component too short, snap-fit too constrained). A more recent publication from our group reported on limb function in 6 dogs after implantation of a modified, nonconstrained total elbow arthroplasty system. In that report, 3 dogs had complications (infection, ulnar fracture, implant malalignment). Limb function, as measured by force platform gait analysis, in the remaining three dogs was normal 1-year after surgery. Those dogs were adopted by private owners and continue to have near-normal limb function on the operated limb 3-years after surgery.

After evaluation of the most recently published data additional modifications were made to the implant designs and an in vivo study investigating the total elbow arthroplasty in client-owned dogs with naturally occurring elbow osteoarthritis began. For the purposes of this study criteria for inclusion were severe unilateral radiographic elbow OA, severe daily lameness and elbow pain upon physical examination, exhaustion of nonsurgical treatment alternatives, and informed client consent. The first twenty clinical cases to fit these criteria were studied at no financial cost to the owner. Radiographic, physical and force platform examinations were performed prior to surgery and 3, 6 and 12 months after surgery. The cause of elbow OA in the cases included idiopathic OA (n=16), chronic elbow luxation (> 6 months, n=2), malunion of humeral condylar fracture (no primary internal fixation, n=2). Sixteen of twenty cases had a good or excellent outcome. Of the cases with a poor outcome two had infection (a second elbow surgery was performed at the referring veterinarians) and one fractured and one developed recurrent luxation. Of the remaining cases limb function in the diseased limb was at least 25% greater than before surgery.

The future for total elbow replacement in dogs is good. Clinical evaluations, using the previously described nonconstrained two component system, need to be continued. Improvement in design and technique would likely benefit from multi-institutional use. Alternative designs, e.g. ball-in-socket design, has also been studied extensively by our group and found not to be as successful.

The effect of surgical technique on limb function after surgery for cranial cruciate ligament disease in the labrador retriever

M.G. Conzemius, W.J. Gordon, M.F. Besancon, W.D. Hoefle, M.A. Nieves, S.D. Wagner, R. Evans

Rupture of the cranial cruciate ligament (RCCL) is a common cause for lameness in the dog. Numerous surgical techniques have been described in the literature to address this injury with each having theoretical or realized advantages and disadvantages. Tibial plateau leveling osteotomy (TPLO) and lateral femoral-fabellar tibial sutures (LFFT) are two commonly performed techniques. These techniques differ not only in concept but also in technical difficulty, invasiveness, necessary equipment and licensing, and cost to the owner. These differences have led to much controversy. One glaring limitation of most debates, however, is the lack of objective data that describes patient limb function after these techniques have been performed. The purpose of this study is to document the effect that numerous clinical variables have on limb function in dogs after surgery for RCCL. We hypothesized that surgical technique (TPLO or LFFT) would have no influence on limb function (as measured by force platform gait analysis) in Labrador Retrievers 6-months after surgery for RCCL.

This is an ongoing, prospective clinical study. All dogs greater than 40 pounds that present to the veterinary teaching hospital and are diagnosed with RCCL are included in the study. Force platform gait analysis is performed prior to surgery on all dogs. Each dog is walked (velocity 1.0 to 1.3 m/s; acceleration $\pm 0.5 \text{ m/s}^2$) across an AMTI force platform. Patient history, signalment, surgeon, technique performed, surgical pathology and follow-up care and complications are noted. Owners of dogs are actively recruited to return for a 6-month follow-up gait analysis evaluation. If a patient does not have both preoperative and 6-month gait analysis evaluations it is excluded from the database. For the purposes of this study, inclusion criteria included Labrador Retriever breed, all dogs had medial meniscal surgery performed, no current diagnosis of RCCL, no previous surgery within 6-months, no complications, and all dogs had preoperative and 6-month gait analysis evaluations. Pairwise tests (t-tests or chi-square tests) were used to determine if surgeon's experience, body weight, age, body condition score (bcs), and duration were balanced across groups. Pearson's correlations for continuous outcomes or Kendall's tau for ordinal outcomes were calculated to assess the relationships between previously listed variables and 6-month limb function. To determine the effect of surgical technique on 6-month limb function a linear regression model, with 6-month limb function as the dependent variable, was used. All data are reported as mean \pm standard deviation.

Sixty-eight dogs fitted all inclusion criteria. There was no significant difference in age, body weight, bcs, or duration of injury between groups. Age ($r^2=0.06$), body weight ($r^2=0.08$) and duration ($r^2=0.12$) had a significant correlation with 6-month limb function; bcs and surgeon experience did not correlate with 6-month limb function. Dogs that had TPLO ($n=33$) performed had a 6-month peak vertical force (% BW) of 40.58 ± 6.82 and a vertical impulse (%BW) of 14.16 ± 2.57 . Dogs that had LFFT ($n=35$) performed had a mean peak vertical force of 39.89 ± 5.34 and a vertical impulse of 13.28 ± 1.93 . No significant difference was found in 6-month peak vertical force ($p=0.13$) or vertical impulse ($p=0.57$) between these surgical techniques. Statistical evaluation was also performed on a single faculty surgeon that had greater than 15 cases in each group and again no difference was found.

We elected to focus this abstract on Labrador Retrievers because they have been identified as a breed that is significantly predisposed to RCCL. Our data clearly demonstrates that when evaluated at a walk 6-months after surgery surgical technique has no influence on limb function. It is possible that a similar evaluation in a different breed would produce different findings. In addition, it is possible that if these patients were evaluated at a trot a different outcome would have been found. However, mean 6-month limb function of dogs in both groups is approximately 95% of the function measured in a normal dog; therefore, regardless of the type of lameness evaluation or statistical model it will be difficult to demonstrate that one technique is superior to the other. The correlations found, although statistically significant, were weak and are not likely clinically relevant. In conclusion, there are many justifications for selection of a surgical technique for repair of a RCCL in a dog. If deciding between TPLO and LFFT in the Labrador Retriever postoperative limb function should be cautiously used as one of those justifications.

Tissue engineering in orthopaedics

J.L. Cook

Tissue engineering is one of the most exciting and dynamic fields of study in the world of science today. Pursuits in this intriguing field involve billions of dollars each year worldwide, but surprisingly, the first significant revenue-generating product has yet to be realized. Tissue engineering has been defined in many different ways, but essentially entails the use of the sciences to design and develop materials that augment or enhance the repair, replacement, or regeneration of biological tissues. Using this basic definition, all orthopaedic surgeons can be considered *Tissue Engineers*. Orthopaedic surgeons use cancellous bone grafts to augment and enhance regeneration of bone, fascial grafts to help repair tendons and ligaments, and curettage to stimulate fibrocartilage repair. These are the principles on which tissue engineering has been built and on which we can continue to progress in our goal of regenerating functional musculoskeletal tissues.

An interesting observation that provides a premise for work in tissue engineering is that of the regenerative capacity of amphibians and fetal tissues. Complex tissues can be completely regenerated in an appropriate time frame under the right circumstances. What are "*the right circumstances?*" This is the basic question that stimulates research in tissue engineering. The key to success in this arena is driving the tissue response to regeneration rather than repair. While repair provides a quick fix through the production of scar tissue, regeneration allows for long-term maintenance of tissue architecture and function. There is evidence to suggest that every tissue has the capacity to replace dead or damaged cells with newly differentiated cells by gaining access to pluripotent progenitor cells. One problem that may hinder successful tissue regeneration relates to the number of, or access to, progenitor cells for a given tissue. However, other factors besides progenitor cell number and access govern the process of successful tissue regeneration, including biomechanical stresses, blood supply, immunogenicity, cell signaling, and many more. Therefore, researchers have attempted to understand the process of tissue regeneration by breaking down the process into the major components involved. Currently, the major components involved in tissue regeneration are considered to be: the cells, the matrix (or substrate), the bioactive factors, and the bioreactor. We will discuss each of these components and give examples of how we can manipulate each in the process of tissue engineering. If we can delineate the effects of each component on tissue regeneration, we can then begin to understand the entire process and determine *the right circumstances* for regenerating each tissue of interest.

As is true of any biotechnology, side effects and complications can be seen in conjunction with tissue engineering, and therefore, must be considered in any discussion on this topic. Untoward effects associated with tissue engineered structures vary widely and range from severe, potentially fatal problems to mild complications requiring no further treatment. Some of the more severe problems that have been reported with various tissue engineering technologies include anaphylaxis, rejection, pain, and dysfunction. These issues must be addressed for each application before widespread clinical use can be advocated. Another related problem to consider is that of immunogenicity. Tissue engineering technologies employ manipulated autografts, viral-vector gene transfections, recombinant and synthetic bioactive factors, allografts, and even xenografts. The immunologic ramifications of these substances must be comprehensively considered during development and testing.

A final consideration that should be addressed in a discussion of tissue engineering is that of patient/client perception of these technologies. Manipulation of tissues using the patient's own cells, other patients' cells, other species' cells, viruses to change the patient's DNA, and xenografts has far-reaching ramifications that need to be carefully considered and explained to patients/clients. These are major issues that may limit the use of these technologies in the *real world*, especially within the veterinary patient population. This exciting field holds promise for significant advances in science and surgery, and tissue engineers and surgeons employing these strategies must be held to the highest ethical standards and professional guidelines and evaluation.

Arthroscopic biceps tenodesis in dogs: scientific basis, technique, and outcome in clinical cases

J.L. Cook, K. Kenter

INTRODUCTION

Bicipital tenosynovitis (BTS) and biceps tendon trauma are causes of forelimb lameness in dogs that require treatment. Non-surgical management of biceps tendon pathology may be effective in many cases. However, surgical management may be necessary in a significant number of these patients. Currently, arthroscopic biceps tendon release and biceps tenodesis via an open approach have both been advocated for surgical treatment of these disorders. We have developed a minimally invasive, all-arthroscopic technique for biceps tenodesis in dogs. The purposes of this report are to discuss the basis for the use of biceps tenodesis over biceps tendon release and the basis for the use of an all-arthroscopic technique, to describe the technique used for this procedure, and to present the outcome in a small number of clinical cases treated using this procedure.

TECHNIQUE

The technique is performed using a caudolateral camera portal and two instrument portals (craniolateral and cranial). The Arthrex (Naples, FL) Biceps Tenodesis System is used for the procedure. The 5.5 mm non-absorbable interference screw has been used for fixation in all cases to date. The technique is technically demanding, but repetition and experience allow for more efficient and precise implementation of the procedure.

CASE REPORTS

At the time of abstract submission, 3 cases of all-arthroscopic biceps tenodesis that have adequate follow-up data were available for inclusion. Two cases were treated for BTS and one for partial biceps tendon avulsion (BTA). Two dogs (1 BTS and 1 BTA) were working dogs, and one dog (BTS) was a very active pet. All cases were managed non-surgically for the problem for various amounts of time and had become refractory to this method of treatment. All-arthroscopic biceps tenodesis was successful in all cases. Follow-up times are 11 months, 7 months, and 3 months at the time of writing. Complications consisted of a seroma in one dog that resolved with exercise restriction and warm packing. All dogs have been judged to have a successful outcome with return to full function according to the owners. No biceps muscle displacement or laxity has been noted. Return of muscle mass and resolution of lameness were evident in all cases.

Circular external skeletal fixation biomechanics

A.R. Cross, D.D. Lewis

The mechanical characteristics of an external fixator determine the environment in which bone union proceeds. Through the '60s and '70s rigid internal fixation and primary bone healing, were championed as the gold standard in fracture management. More recently the value of alternative methods of fracture stabilization and their impact on bone union have received considerable attention. Goodship and Kenwright, as well as Wolf, et al, demonstrated shorter fracture healing times in animals treated by external skeletal fixation with intermittent cyclic axial dynamization. More recently, Kenwright, et al, demonstrated this effect in humans with tibial fractures. In addition, Ilizarov's discovery of distraction osteogenesis has devalued much of the formerly accepted dogma regarding bone biology and bone healing.

Circular external fixators possess biomechanical characteristics which can enhance fracture healing and allow for distraction osteogenesis. The circular fixators differ primarily from standard unilateral and bilateral frame fixators because the circular fixators maintain axial elasticity. Circular fixators classically use tensioned wires, rather than pins, as fixation elements. The fine wire circular fixators differ from standard unilateral and bilateral frame fixators in that the tensioned wires immobilize the bone fragments and adequately resist bending, shear, and torsional forces while allowing axial micromotion at the osteotomy/fracture site. This characteristic is considered to be important in creating a mechanical environment conducive to osteogenesis. Fine wire circular fixators exhibit a nonlinear, dynamic behavior under axial compression. This translates to a decrease in stiffness under low loads, allowing axial micromotion at the osteotomy site, whereas stiffness increases as load increases protecting the osteotomy/fracture gap from excessive forces during ambulation. At loads less than 100 N, circular fixators are less stiff in axial loading than unilateral or bilateral fixator frames. At high loads (> 500 N) circular fixators have comparable stiffness. This nonlinear behavior of the circular fixators is attributed to increased tensioning of the wires with increased loading. This "controlled instability" at low loads occurs only in the axial plane and may favorably alter the fracture healing pathway.

Extrinsic (apparatus-related) factors which have been shown to increase the stability of the fixation include the type (olive, smooth), number, angle, diameter, and tension of the wires, as well as, the diameter, number, and position of the rings. Intrinsic factors which theoretically contribute to stability of the bone fixator construct include the area of tissue contact and amount and nature of interlock between bone segments, the modulus of elasticity of tissue between bone segments, and the tension of the soft tissues surrounding the bone.

Orientation of the wires, wire tension, wire diameter, and ring diameter all effect the stability of the apparatus under axial loads. There are two considerations relative to wire orientation: 1) the positioning of the bone relative to the center of the ring; and, 2) the angles at which the wires intersect. Stiffness is an inverse nonlinear function of wire length. In order to maximize stability and minimize shear, the angle between wires should be as close to 90° as the regional anatomy safely permits and the wires of the second ring on a given fragment should be offset in relation to the other pair of wires so as to bisect their angles, if possible.

In limb lengthenings, tension generated as a result of soft tissue elongation and maturation of the developing regenerate can increase wire pre-tension by as much as 50 kg. A lower wire pretension can be considered in such cases, however, inadequate tensioning of wires can result in premature consolidation of the regenerate. In contrast no additional tension, except for the forces associated with weight-bearing, will be generated in the wires on frames used to stabilize fractures. Consequently, wires should always be fully and appropriately tensioned for fracture treatment.

Obviously as the diameter and number of wires used increases, so does the stiffness of the fixator. Olive (or stopper) wires can enhance the stability of fixation, particularly in oblique fractures. Two counter-opposed olive wires, per bone segment can significantly improve bending stiffness and stability by minimizing translation of the bone along the wire. This is particularly important when wires are placed on the same ring with little divergency.

The diameter of the ring has a profound influence on the mechanical properties of the fixator. While ring diameter affects stability in all modes of loading, ring diameter has its greatest influence on axial stability. Bronson, et al, found a 30% reduction in axial stiffness when the diameter of a single ring construct was enlarged from 120 mm to 160 mm. Obviously, the smallest ring possible should be selected. Ilizarov recommends that a minimal distance of 1 to 2 cm should be maintained between the ring and the skin to allow for soft tissue swelling and cleaning of the wire-skin interfaces.

Most of the biomechanical studies that have been reported evaluated fixators designed for use in humans. Ring diameters used in dogs and cats are obviously much smaller than those used in humans, even children. Thus, the mechanics of these fixators will be markedly deficient. We have examined the effects of wire tension and ring diameter in circular external skeletal fixation systems designed for animal. We have also investigated the effects different ring-block configurations on fixator biomechanics. Wire tension and ring diameter each play a significant role in the axial stiffness of fixator constructs, however, the contribution due to ring diameter is remarkably greater than that of wire tension, within recommended wire tension ranges. Ring diameter is usually dictated by patient size leaving only wire tension as a surgeon controlled parameter. We have recommended maximally tensioning wires to achieve the desired biomechanical behavior. Additional construct modifications such as additional rings, drip-wires, and half pins attached to the rings can be used to further increase stiffness when necessary.

Similarly, the number of levels of fixation influence the mechanical properties of the fixator. Ilizarov found that four ring fixators (two rings per fragment) were more stable than two ring fixators (one ring per fragment). Additionally, Gasser, et al, showed that if a four ring fixator is used to stabilize a simulated fracture, the stability of the configuration is increased if the middle two rings are positioned in close proximity to the fracture site. It is important to distribute the levels of fixation and subsequently the weight-bearing forces evenly over the length of each bone segment involved in the stabilization.

Finite element analysis. A useful investigative tool?

A.R. Cross

Finite element analysis (FEA) is a numerical method for solving engineering problems including structural analysis, heat transfer, fluid flow, mass transport, and electromagnetic potential. Development of the modern FEA method began in the 1940's through the work of Hrennikoff and McHenry. Their work and the work of others was not widely recognized due to the cumbersome mathematical calculations involved with the technique. This began to change with the development of digital computers in the 1950's. In the 1960's and 70's, the applications of FEA began to expand away from traditional structural analysis and the complexity of the problems solved with FEA increased with the availability of increasing computational power. Brekelmans et al. introduced FEA to the medical literature in 1972 in their study of the behavior of skeletal parts. Wolff established a relationship between the architecture of bone and its load bearing function as early as 1870, however, classic mathematical tools available for stress analysis were not very applicable to the irregular structural properties of bone. FEA was quickly recognized as the logical solution to this problem, due to its ability to evaluate stress in structures of complex shape, loading, and material properties. Since this time, medical FEA application has grown exponentially. Although its primary medical use is in the field of orthopedic biomechanics, especially arthroplasty and fracture fixation, other varied applications include artificial heart valves, intraocular implants, tension on skin grafts, and recently, examining the mechanics of DNA supercoiling.

THE FINITE ELEMENT METHOD

FEA is a technique for predicting the response of structures and materials to environmental factors such as forces, heat and vibration. We will deal with forces in this description. When a structure is loaded, stresses are generated in the materials which compose the structure. The magnitudes and directions of these forces are dependent upon the shape of the structure, the material properties of the structure (elasticity, homogeneity etc.), the magnitude of the load or loads, and where the load(s) are applied. The response is also dependent upon how the structure interacts with its environment; is it rigidly attached to a solid surface or is it allowed to slide? These interactions are called boundary conditions. So, to perform an analysis, four pieces of information must be available: geometry; material properties; loading conditions; and boundary conditions.

A computer model of the structure is created using known geometry. Biological structures are very difficult to model using solid modeling software so other methods have been used such as three dimensional digitization and computed tomography three dimensional reconstruction. The model is then mathematically divided into a number of blocks (elements) which are connected to each other at specific points, usually corners, called nodes. This process is called meshing. Material properties are then assigned to the elements. Loading conditions are applied to the structure which must include the locations of the load, the direction of the load, and the magnitude of the load. Boundary conditions, which are usually displacements, are applied to the structure at the appropriate locations.

The analysis software determines equations which describe the displacement of each node and all the equations are assembled into a stiffness matrix. The program then solves the matrix of simultaneous equations. Most software packages also include post-analysis programs to assist in interpretation of the data. This includes maximums, minimums, graphical full field stress and strain plots, displacement plots, deformation analysis and animation of deformation and strain as load is applied.

INTERPRETATION

It is important to remember that the solution obtained using FEA is approximate. The approximate solution converges on the exact solution for a given model as the mesh density (or number of nodes/elements) approaches infinity. The accuracy of the model can be tested by increasing the mesh density and observing the change in results. This is called a convergence test.

It is of perhaps greater importance to remember that the results of an analysis are only as good as the information used to construct the model. This is called the validity or the precision by which the mathematical descriptions of structural aspects (loading conditions, model geometry, material properties, and boundary conditions) mimic the real structure. Only accuracy can be checked with a convergence test, validity must be assessed by experimental verification.

The initial application of FEA to biomechanics frequently produced results of questionable validity. This

was due, in part, to a poor understanding of the limitations of the technique, but mainly due to the number of assumptions that had to be made in order to produce a problem that could be solved using existing technology. Today, extremely powerful and far less cumbersome software packages are available. Complex geometries can be imported directly from CT imaging, and the solutions times are greatly reduced. Questions will always exceed available investigative resources, however, a recent study of trabecular bone stress in osteoporotic human femurs by van Rietbergen *et al.* used over 96 million elements and required 6 weeks of solver time on Cray supercomputer using 30 parallel processors.

ADVANTAGES

The benefits of using FEA in orthopedic research are obvious. At the most recent Orthopedic Research Society meeting, 60 of the research projects accepted used FEA. Many studies would be impossible without using FEA. For instance, a several investigators are using micro-CT scanning and FEA to look at stress on individual cancellous bone trabeculae. Models of biomechanical systems can be changed quickly enabling many variables to be analyzed in a shorter period of time. The labor requirement for *ex-vivo* research is greatly reduced. The expense of performing experimental studies is decreased. Implant optimization is now more feasible as many small changes in design can be performed and the results of those changes can be observed immediately.

DISADVANTAGES

Powerful FEA software is expensive. The market is relatively small and competitive so prices frequently exceed \$10,000.00 US for advanced systems. Smaller systems suitable for evaluating simple models are available as shareware. Several software companies will provide demo software as well.

The largest disadvantage is the possibility of invalid results. As discussed previously, the output is only as good as the input. A thorough understanding of the finite element method is necessary before undertaking an analysis to avoid invalid assumptions and meaningless results.

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Quercetin protects canine articular chondrocytes from oxidative damage

M. Fabris, M. Dalle Carbonare, A. Leon, M.F. della Valle, A. Miolo

Reactive oxygen species (ROS) have long been implicated as mediators of tissue damage in many disease states, including osteoarthritis characterized by a slow progressive degeneration of articular cartilage. Chondrocytes, embedded in an avascular matrix, are exposed to a low partial pressures of oxygen and exhibit a predominantly anaerobic metabolism. Accordingly, chondrocytes are susceptible to the attack of reactive oxygen species (ROS). In addition, the production of ROS by chondrocytes has been reported to contribute to degradation of the cartilage matrix.

Flavonoids, such as quercetin, rutin etc, constitute a group of phyto-polyphenols to which an array of patho-preventative effects, including anti-inflammatory actions, have been attributed. In addition, flavonoids are reported to function as antioxidant agents and, hence, of utility in the clinical management of osteoarthritis. Notwithstanding this, the anti-oxidative efficacy of flavonoids has been studied most extensively in cell-free assays, and few studies have employed cell-based systems.

We here evaluated the efficacy of quercetin in decreasing oxidative damage in canine articular chondrocyte cultures, obtained from autoptic samples of articular cartilage from non-diseased adult dogs. Oxidative damage was induced by exposure of the cells to hydrogen peroxide (H_2O_2 , 500 μM) in the presence or absence of quercetin (10-100 μM) for 2 hours. Cell vitality was assessed 24 hours later. While sole exposure of the cells to H_2O_2 caused approx. 70% cell death,, the addition of quercetin together with H_2O_2 resulted, on the other hand, in a significant concentration-dependant decrease in death of the cultured cells. At all times, quercetin alone (i.e. in the absence of H_2O_2) had no effect.

Altogether these results not only confirm the anti-oxidant efficacy of quercetin, but also further support the utility of flavonoids in pathological osteoarthritic conditions, including those of interest in the veterinary field.

Management of nonunions

C.E. DeCamp

Successful bone healing requires specific biologic and mechanical events to occur, that when disturbed, may result in failure to achieve the expected union of a fracture. A delayed union is a fracture that has not healed in an expected time interval. A nonunion is an ununited fracture where the healing process has apparently ceased. Delayed and nonunion fractures may be attributed to errors in clinical judgement, technical errors, biologic condition of the fracture site, and poor postoperative management.¹ In addition, delayed and nonunion fractures may themselves contribute to fracture complications, including loosened fixation and fracture disease.

DEFINITIONS/CLASSIFICATIONS

The expected time duration to fracture healing is always relative to an animal's signalment, fracture type, location, and treatment. A delayed union infers that fracture healing is progressing, but at a slower rate than expected compared to other animals with similar fracture conditions. A nonunion is where all evidence of healing has effectively stopped. Classification of nonunion fractures provides the framework upon which treatment is based and should include: fracture type and site, displacement, stability of fragments, presence of infection, and biologic activity. Two main categories of nonunions are based upon the "biologic" activity at the fracture site.

A biologically active (viable) nonunion has good healing potential with adequate blood supply to the fracture site.² Biologically active nonunions may be further divided into three categories based on the amount of callus present: hypertrophic callus, minimal callus, and no callus (oligotrophic) nonunions.² Hypertrophic callus nonunions have very good healing potential and result from insufficient fixation of a fracture. Oligotrophic nonunions have viable fracture ends with no visible callus. This category may demonstrate only subtle clinical differences from biologically inactive nonunions.

A biologically inactive (non-viable) nonunion typically indicates a severely damaged or altered blood supply at the fracture site, with poor healing potential. Dead bone, large fragment displacements or bone loss with large fracture defects, and bone atrophy are common features of biologically inactive nonunions. They may be further classified into four categories: dystrophic, necrotic, defect, and atrophic nonunions.² Dystrophic nonunions have an intermediary fragment which has healed to one main fragment but not the other, indicating partial necrosis. A necrotic nonunion has loose necrotic fragments present at the fracture site. A defect nonunion results from a large bone loss at the fracture site typically from gunshot or large open wounds. Atrophic nonunion may result from any of the previous three, but severe bone atrophy and osteoporosis are present.

ETIOLOGY/PATHOPHYSIOLOGY

The most important cause of delayed or nonunions is inadequate stabilization of the fracture site. Inappropriate external coaptation, loose cerclage wires, improperly placed intramedullary pins, and other inappropriate fixation choices may result in an unstable fracture and poor healing. In addition, numerous local factors interact and contribute to an inadequate rate of healing. For instance, fracture location may affect fracture healing. Diaphyseal fractures or fractures in bones with little soft tissue cover (radius, tibia) may not heal as readily as metaphyseal fractures. A fracture gap, due to bone loss, poor fragment reduction or soft tissue interposition retards healing. Damage to soft tissue may disturb the extra osseous blood supply to healing bone, and so retard the development of periosteal callus. Soft tissue or bone infection at the fracture site will also delay healing.

PATHOLOGY

A varied degree of periosteal and endosteal callus may be present in either delayed or nonunion fracture, depending on local conditions at the fracture site. Fibrous connective tissue, fibrocartilage, and bone may be present within the site, without bridging callus. Sclerosis of the fragment ends may develop and seal the medullary cavity. Necrotic bone fragments are devoid of callus and when infected may become a sequestrum surrounded by an involucrum. As a nonunion becomes more chronic, a synovial-lined pseudarthrosis may develop. Varied degrees of bone atrophy develops at the fracture site and eventually affects most bones distal to a nonunion.

CLINICAL SIGNS AND DIAGNOSIS

Varied lameness, pain and swelling on local palpation are seen with delayed or nonunions. Poor alignment of the joints of the limb may indicate poor reduction of fracture fragments within. Draining sinus tracts may be present if chronic infection has developed. Muscle atrophy, joint stiffness with loss of range of motion, and occasionally flexor contraction develops with continued limb disuse. The diagnosis of delayed union is based on serial radiographic examination with progressive but insufficient bridging callous formation for the specific fracture conditions present. The diagnosis of nonunion is based on serial radiographic examination, with insufficient callous bridging and no progress in healing. Radiographic evidence of necrotic bone, progressive bony remodeling and atrophy, and loose implants may also support the diagnosis. Nuclear scintigraphy may be considered as an aid for the diagnosis of biologically inactive nonunion.

TREATMENT OF DELAYED UNION

Treatment of delayed union may be conservative, with continued restriction of the animal's activity, passive physical therapy, and maintaining previous skeletal fixation. Should insufficient fracture stability exist, fixation may be improved by repairing existing or adding to the fixation. Loose bone screws may be replaced with larger screws or redirected for better purchase. An external fixator may be considered as adjunct fixation for numerous unstable internal devices and may often be easily placed with minimal surgical intervention. Necrotic bone may need to be excised, and autogenous cancellous bone graft is often used to stimulate more rapid healing.

TREATMENT OF NONUNION

Specific treatment of nonunion depends on identification of factors which have contributed to the condition. Infected nonunion - If infection is present with nonunion, all dead bone, sequestra, loose metal, and infected granulation tissue must be surgically removed.² Culture and sensitivity from deep swabs or tissue biopsy must be used to identify antimicrobial sensitivity. Improved fixation with external fixators is preferred, if serious infection is present. Autogenous cancellous bone graft may be used once the soft tissue environment of the fracture has improved. Primary closure with closed drainage, delayed primary, or secondary closure techniques may be considered, depending upon severity of infection.

Biologically active (viable) nonunion - Fracture stability must generally be improved with repair of existing or addition of fixation. Bone plates with compression are ideal for providing early function and avoiding complications of joint stiffness. Autogenous cancellous bone graft is optional for hypertrophic nonunions, but is strongly advised for oligotrophic nonunion.

Biologically inactive (non-viable) nonunion - All loose metal, dead bone, sequestra, or suspected infected tissue should be removed or excised. Culture and sensitivity should be employed, whether the tissue has visible infection or not. Fibrous tissue may be excised from the fracture site and the medullary canal reestablished by removing or drilling the sclerotic ends of the bone. Decortication, (Judet technique) may be considered if the bone is of sufficient size.³ Autogenous cancellous bone graft is liberally applied to the unhealed fracture site. Large bone defects may require massive or serial grafting. Stable fixation must be applied. Rigid bone plate fixation with compression allows early return to function and may prevent continued development of joint stiffness. Oversized bone plates, which may contribute to subsequent osteoporosis, should be avoided. Other fixation systems, such as intramedullary devices or external fixators, may be considered in specific instances.

NEW AND FUTURE TREATMENTS OF NONUNION

Distraction osteogenesis - Nonunions with large segmental defects may be treated with osteotomy away from the defect and bone transport using a dynamic distraction type external fixator. As the one fragment is transported slowly into the nonunion gap, the osteotomy site fills in behind with new bone. The classic distraction external fixator is the Ilizarov technique, however, numerous expensive systems have been designed for human orthopedic surgery.

Vascularized bone grafts - Microvascular free flaps are a reality in veterinary surgery and are now commonly used for soft tissue reconstructive procedures. Recently, an experimental vascularized bone graft was described using the canine distal ulna and the caudal interosseous artery.⁴ In theory, this graft could be applied to a nonunion site. The microvascular anastomosis will maintain the bone's periosteal blood supply to aid in healing.

Bone Morphogenic Protein - Osteo inductive proteins have been identified and described as bone morphogenic protein (BMP).⁵ These products are capable of inducing endochondral bone formation at ectopic sites, and may find application for use in nonunion fracture treatment.

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Is kinematic gait analysis necessary?

C.E. DeCamp

Robert Soutas-Little is a mathematician-engineer who developed a human gait laboratory called the Biomechanics Evaluation Laboratory with his partner Patricia Soutas-Little at Michigan State University. Fifteen years ago, Dr. Steve Budsberg, a first-year MSU resident in surgery, approached the Soutas-Littles about a dog gait study, and thus originated modern gait analysis in our profession. Two years later, another first-year resident, Dr. Dermot Jevens, had a cruciate gait project and had more data than he could possibly manage. His discomfort stimulated the first of dozens of contracts with Mr. Bob Wells to write software to support canine gait. There are now 30 sites around the world that use the Bob Wells/MSU programs for canine gait including:

3 sites in Europe

2 sites in Canada

4 top secret commercial (proprietary) sites

There are huge benefits to the development of this software for force plate gait analysis. This software has allowed researchers from diverse backgrounds to develop projects and speak essentially the same language. Gait analysis methodologies are now well defined, so that protocol design and statistical analysis are predictable and practical.

WE HAVE CREATED A MONSTER

Predictable and practical gait projects are not necessarily compatible with highly creative science. The same software that makes it "easy" to process force plate data also defines how you are going to look at and think about that data. This is utilitarian for the host of drug studies that are circling the profession at this time. The Food and Drug Administration (FDA), however, is much more interested in regularity, rather than creativity. The influx of money from drug studies into gait laboratories has been a positive force for our profession; however, we must not allow the origin of money to define the direction of scientific discovery.

LIMITATIONS OF FORCE PLATE GAIT ANALYSIS

We have already approached the limitations of force plate technology. Dogs with cranial cruciate rupture approach "normal" after 5-6 months when examined with force plate gait analysis. Do any of us believe that to be true? Studies of hip dysplasia depend on differences in vertical forces of 2-4%. We know that these dogs are suffering and yet we need to include over a hundred dogs to see statistical significance. This is not the hallmark of a sensitive instrument. Force plate gait analysis is rarely helpful in a diagnostic sense because it is somewhat limb specific and absolutely not joint specific.

KINEMATIC GAIT ANALYSIS

The language for kinematic gait analysis is just beginning to be developed in canine orthopedics. Robert Soutas-Little would often admonish his graduate students to "let the data speak to you," i.e., allow the data to participate in the act of discovery. Kinematic gait analysis does not have the constraints of standard force plate software language. We are guided by the human gait community, however, kinematic gait analysis is at a phase where each project requires identification of new variables and the creative management of information. We are beginning to develop variables that describe joint specific function, with sample variables including dynamic joint angles and angular velocities. Force plate and kinematic information is combined to calculate joint specific moment, work, and power that define energy expenditure within a specific joint. Our capacity to define musculoskeletal function in dogs is just beginning to be explored. Our capacity to study musculoskeletal disease and its therapies has just begun.

SUMMARY

Kinematic gait analysis is not needed for routine objective assessments of gait. Kinematics, however, is essential to the progress of canine gait analysis, and to the creativity and refinement of our new science.

Long term results of the slocum technique

J.F. Dee

The TPLO (tibial plateau leveling osteotomy) has been performed and proposed by Barclay as a method of eliminating the cranial tibial thrust that is present in ACL deficient knees. By chance or design the procedure was initially taught to a small group of AVORE surgeons, the result of which was to minimize the incidence of technical failures allowing the TPLO method to stand or fall on its own merits. The growth of the TPLO as a procedure was rather slow...primarily because of the reluctance/inability of the average competent veterinary orthopedist to make the "leap of faith" from the traditional (anatomically based) procedures to the new (force driven) technique. The leap was particularly difficult in the early years, prior to peer group approval. However, once the leap was made, there was no turning back. Virtually no one, after having successfully performed a TPLO in the large breed of dog reverts back to offering the traditional options. The rest is history: From the "full house" presentations at the most recent ACVS meeting in San Francisco by Christine Warzee and Peter Schwarz, to lectures and labs at the ESVOT (European Society of Veterinary Orthopedics and Traumatology) meeting in Munich, 2000; the TPLO currently is being embraced by much of the veterinary orthopedic community. The objective/subjective results of approximately 500 consecutive TPLO's will be discussed. To include the following parameters: previous surgery, other orthopedic disease, pre-op radiographic assessment, pre-op slope, post-op slope, meniscal release, complications at surgery, post-surgical complications, subjective results and radiographic progression. All cases were performed by the same surgeon and all films were read by the same radiologist.

Bone in growth and resorption characteristics of Two Ceramic Bone Void Fillers *in vivo*

L.M. Déjardin, R.B. Clarke, C.A. Johnson, M.J. Jayo, M.A. Richter, S.P. Bruder

INTRODUCTION

Bone grafts are considered the most effective technique to enhance bone healing despite inherent shortcomings. To decrease complications associated with bone grafts, ceramic bone substitutes have been investigated. Our purpose was to compare the biological behavior of a porous calcium carbonate-phosphate bioceramic (ProOsteon-500R [PO]) to that of a new injectable synthetic apatitic calcium phosphate bone void filler (BSM).

MATERIALS AND METHODS

Bilateral tibial metaphyseal defects were created in 30 rabbits. Defects were left empty or filled with PO or BSM. Radiographic and histologic evaluations were conducted at time 0 (n=3/group) and at 6, 12 and 24 weeks (n=6/group). Bone ingrowth and implant resorption were compared radiographically and histologically at each time period and over time.

RESULTS

By 24 weeks, empty specimens showed no radiographic evidence of bone healing. While PO granule definition decreased after 12 weeks, there was no radiographic reduction in PO over time. By 24 weeks, a slight increase in radiographic density suggested moderate bone ingrowth in PO specimens. In contrast, steady BSM resorption occurred over time. By 24 weeks, defect margins were radiographically indiscernible, suggesting progressive bone ingrowth. Histologically, starting at 6 weeks, BSM steadily resorbed via marked osteoclastic activity by ~50% between each time period (overall 92% decrease). In contrast, most PO resorption (65%), occurred after 12 weeks via hydrolysis (overall 75% decrease). By 12 weeks, the greater osteoblastic activity seen with BSM resulted in significantly more bone formation with BSM than with PO or empty at 12 weeks. By 24 weeks bone fill was similar in all groups.

DISCUSSION

This study demonstrates that BSM is an effective bone graft substitute yielding earlier cortical bone ingrowth compared to PO in a critical size metaphyseal defect model. Compared to PO, BSM results in equal or greater bone formation at each time point. BSM resorption occurred via cell-mediated events involved in normal bone remodeling and resulted in early, near complete, implant resorption by 24 weeks. In contrast, PO resorption occurred via dissolution as evidenced by the lack of osteoclastic activity. At 24 weeks, only 8% of the BSM remained while 25% of PO persisted at the defect site. These findings suggest that BSM acts as a more effective osteoconductive scaffold than PO for bone void filling.

Tissue engineered rotator cuff tendon using swine small intestinal submucosa: histological and mechanical evaluation in dogs

L.M. Déjardin, S.P. Arnoczky, B.J. Ewers, R.C. Haut, R.B. Clarke

INTRODUCTION

Chronic injuries of rotator cuff tendons (RCT) often result in tendon degeneration requiring extensive tendon mobilization or replacement techniques. Previous studies have demonstrated that swine small intestinal submucosa (SIS) acts as a scaffold promoting a reconstructive healing response rather than formation of a non-specific scar tissue. Our purpose was to determine the efficacy of SIS in stimulating regeneration of a RCT in a canine model.

MATERIALS AND METHODS

A 15 x 50 x 1mm, 10-ply SIS implant was used to replace a fully resected infraspinatus tendon (IST) in 21 dogs. The contralateral IST was elevated then reattached, to the humerus to mimic conventional large cuff defect repairs (sham). The mechanical properties of the constructs were compared at 0, 3, and 6 months (n=5/time period) and over time. Histological comparisons were made at 3 and 6 months (n=3). Fresh cadaveric specimens were used to evaluate native IST mechanically and histologically.

RESULTS

At 3 and 6 months, the gross appearance, histological continuity and failure mode of the SIS-regenerated constructs mimicked those of sham-operated and native ISTs, suggesting host tissue ingrowth and implant remodeling with solid integration of the regenerated tissue to muscular and bony interfaces. Importantly, tissue regeneration occurred without evidence of foreign body or immune-mediated reactions or adhesions to peripheral tissues. Although the strength of SIS-regenerated tendons was significantly smaller than that of native ISTs, it was similar to that of re-implanted tendons at 3 and 6 months ($p>0.05$).

DISCUSSION

The gross and histological appearances and the failure mode of SIS-regenerated tendons mimicked those of sham-operated and native ISTs, suggesting host tissue ingrowth and implant remodeling with solid integration of the regenerated tissue to muscular and bony interfaces. Our results show that by 3 months, SIS-regenerated tendons were as strong as tendons repaired using conventional techniques. In this study, SIS materials were capable of creating a tissue engineered replacement of an RCT in a canine model. The use of 10-ply SIS implants may represent an alternative to current tendon mobilization procedures, especially in the presence of degenerative tissues and/or large rotator cuff defects.

Tissue engineering and prostheses

W.J.A. Dhert

Although total joint prostheses have in general a high long-term success rate, their most common complication is aseptic loosening, for which a so-called revision arthroplasty is the treatment of first choice. However, as the reason for revision is loosening due to bone resorption, the local implant bed is frequently characterised by a lack of sufficient load-bearing capable bone. To allow for a successful revision procedure, the loss of bone needs to be augmented using donor bone. To date, allograft donor bone, obtained from bone banks has been successfully used, but has several disadvantages such as the risk of disease transmission, a suboptimal activity of the allograft in terms of new bone formation, and the need for a bone bank with associated requirements (administration, harvesting procedures). In recent years, tissue engineering has been propagated as a potential method to overcome these disadvantages, by aiming at the formation of patients' own (autologous) bone. Although tissue engineering has not yet been implemented in routine clinical practice, extensive research has been performed on this technology. In tissue engineering technologies for joint replacement surgery, two main approaches can be identified:

(I) The use of growth factors that stimulate local bone formation. This approach is based upon the availability of osteogenic growth factors from the TGF-beta superfamily. Several single growth factors (BMP's, e.g. rhBMP-2, rhOP-1) can now be produced using recombinant techniques. The principle of BMP induced bone formation is that osteoprogenitor cells migrate towards the implant and start the process of endochondral ossification. Thus, an important prerequisite is that living (precursor) cells are locally present or have access to the site of interest. So far, animal studies have demonstrated that when implants are loaded with BMP's, periprosthetic bone formation will increase.

(II) *Ex vivo* culturing of patients' own osteoprogenitor cells and combining these cells with a porous scaffold to create a hybrid autograft. In this approach, stem cells from the mesenchymal lineage, e.g. obtained from bone marrow and proliferated *in vitro* are either directly seeded onto a prosthesis surface, or onto a porous three dimensional scaffold. Subsequently, cells can differentiate into the osteogenic lineage and start *in vitro* production of bone matrix. Such a hybrid construct (either a prosthesis or a scaffold loaded with differentiated osteogenic cells) could then be used to augment a bone defect in a revision arthroplasty. Animal studies have so far demonstrated the feasibility of this concept *in vitro* and in ectopic implantation sites.

In summary, bone tissue engineering technology might provide in the future new solutions for the augmentation of bone defects in prosthetic surgery. It will however still be necessary to demonstrate the feasibility of this concept in applied preclinical and clinical studies.

Scintigraphy of navicular syndrome and palmar foot pain

S. Dyson

It was hypothesised that in solar bone phase images of the front feet of clinically normal horses, or horses with lameness unrelated to the front feet, there would be less than 10% difference in the ratio of uptake of radiopharmaceutical in either the region of the navicular bone, or the region of insertion of the deep digital flexor tendon (DDFT), compared to the peripheral regions of the distal phalanx. Nuclear scintigraphic examination of the front feet of 15 Grand Prix show jumping horses, all of which were free from detectable lameness, was performed using dorsal, lateral and solar images¹. The results were compared with the examinations of 53 horses with primary foot pain, 21 horses with foot pain accompanying another more severe cause of lameness and 49 horses with lameness or poor performance unrelated to foot pain. None of the horses with foot pain had radiological changes compatible with navicular disease. All the images were evaluated subjectively. The solar views were assessed quantitatively using regions of interest around the navicular bone, the region of insertion of the deep digital flexor tendon (DDFT) and the toe, medial and lateral aspects of the distal phalanx. In 97% of the feet of normal show jumpers there was <10% variance of uptake of the radiopharmaceutical in the navicular bone, the region of insertion of the DDFT and the peripheral regions of the distal phalanx. There was a significant difference in uptake of radiopharmaceutical in the region of the navicular bone in horses with foot pain compared to normal horses. There was a large incidence of false positive results related to the region of insertion of the DDFT. Lateral pool phase images appeared more sensitive in identifying potentially important DDFT lesions. There was a good correlation between a positive response to intra-articular analgesia of the distal interphalangeal joint and intra-theal analgesia of the navicular bursa and increased uptake of radiopharmaceutical in the region of the navicular bone in the horses with primary foot pain. It was concluded that quantitative scintigraphic assessment of bone phase images of the foot, in combination with local analgesic techniques, can be helpful in the identification of pain causing lameness related to the foot, but false positive results can occur, especially in horses with low heel conformation.

These conclusions were tested prospectively in a 15 of 18 horses with palmar foot pain which underwent both nuclear scintigraphic examination and magnetic resonance imaging (MRI) of the front feet². Uptake of radiopharmaceutical in the navicular bone was graded as normal (the ratio of uptake in the navicular bone and the peripheral regions of the distal phalanx was <110%), mildly (>110%<120%), moderately (>120%<140%) or markedly (>140%) increased. Seven horses had primary lesions of the DDFT in 2 of which there was increased radiopharmaceutical uptake (IRU) in the lateral pool phase image of the lame limb; in one horse there was marked focal IRU in the solar view in the region of insertion of the DDFT. Four of these horses had mild or moderate IRU in the navicular bone, 3 of which had abnormal bright signal in the navicular bone detected using fat suppressed images. Seven horses had primary abnormalities of the navicular bone detected using MRI, 6 of which were examined scintigraphically. Uptake of radiopharmaceutical was normal or reduced in 2 horses; in the remaining 4 horses there was moderate or marked IRU in the navicular bone of the lame or lamer limb. One of 2 horses with primary lesions of the distal interphalangeal (DIP) joint had normal radiopharmaceutical uptake in the joint and mild IRU in the navicular bone of the lamer limb and moderate IRU in the less lame limb. Two horses with several abnormalities in the region of insertion of the DDFT and distal sesamoidean impar ligament, the navicular bone and the DIP joint had IRU in lateral pool phase images in the region of insertion of the DDFT and DSIL and moderate IRU in the navicular bone in bone phase images.

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Biological fracture fixation and aspects of bone plate mechanics

J.R. Field, H. Törnkvist

Biological fixation of fractures appears to have a warranted place in the armamentarium of the veterinary and human orthopaedic surgeon. Various modalities have been employed in the pursuit of a 'biological fixator'. These have included changes in bone plate design, with a view to reducing the perceived effect of interface contact on vascularity, the emergence of bridge plating for many diaphyseal fractures utilizing fewer screws and in many cases percutaneous application of bone plates. The percutaneous application of plates has certainly had the benefit of diminishing the vascular disturbance at the time of fracture repair; this technique avoids the necessity for exposure of the entire site combined with the insertion of fewer screws. The concept of rigid internal fixation with full anatomical reduction, at least not in complex fractures, does not seem as important as it once was. This is certainly the case in humans and in animals who's movement can be restrained or confined (cats and dogs). To a lesser extent the same may hold true in the large animal species (horses and cows) however, the requirement for full, immediate weight bearing still remains a major issue in these species. Questions are now raised regarding the benefit of plate interface contact reduction (as in the LC-DCP and PC-fixator) in light of only marginal interface contact reduction and, more importantly, the substantial effect on bone vascularity of surgical trauma.

Implant rigidity and shape dramatically effect the construction stiffness and distribution of strain within the bone. Technical inconsistency in the application of plates, both within and between surgeons, and the variable nature of the level of applied screw torque and number of screws applied are implicated in alterations to construction stiffness, strain distribution and the interface features of contact area and average force.

All of the features mentioned above are capable of being modified. One wonders whether we might not derive additional benefit by placing fewer screws in a given plate at lower levels of torque, thereby reducing both the interface contact area and force at the interface; this would certainly provide a more biological environment with which fracture repair could proceed. It remains to be seen if the concept of biological fracture fixation will win application across all species in which internal fixation is attempted.

Tendon and ligament engineering-experiences with IGF-I

L.A. Fortier

Tendon and ligament injuries are slow to heal, frequently recur, and are a significant cause of loss in the equine industry. New approaches are continuously being developed with common aims of enhanced tendon healing and prevention of re-injury. The majority of research in tendon healing is focused on the use of growth factors to enhance cell proliferation, stimulate vascular ingrowth, and upregulate the metabolic capacity of tendon fibroblasts to produce new matrix.

There are several growth factors studied in tendon and ligament healing. Insulin-like growth factor-I (IGF-I) has received the most research attention and has seen moderate clinical application in the horse. In an equine model of collagenase-induced injury of the superficial digital flexor tendon (SDF), intralesional injections of IGF-I improved tendon healing with enhanced return of tendon fiber pattern and better mechanical characteristics. Early clinical follow-up on 25 racing Thoroughbred horses, indicates that 16 (62%) have raced more than twice without re-injury and 3 (19%) re-bowed. The most commonly treated injuries were core lesions of the SDF with a combinatorial approach of IGF-I injections and transection of the accessory ligament of the SDF. Longer term results are being gathered.

The most straight forward approach to IGF-I administration is through the use of recombinant IGF-I protein so that one is confident of the dose being administered. There is no commercial source for equine IGF-I so human IGF-I is most commonly used. The equine and human IGF-I proteins are nearly identical and no adverse side effects have been seen (like an immune reaction) subsequent to administering human IGF-I to horses. Current research efforts are aimed at gene therapy approaches to IGF-I delivery.

An alternative method, which may achieve results similar to IGF-I injections, is the use of bone marrow aspirates. The cellular and growth factor contents of bone marrow aspirates vary tremendously between animals and with age, so less consistent results should be expected. However, bone marrow aspirates have the advantage of containing growth factors other than IGF-I, and mesenchymal stem cells, which may transform into tendon fibroblasts. Finally, growth hormone (somatotropin) may indirectly increase the amount of IGF-I in an injured tendon. Growth hormone stimulates the liver to produce IGF-I. Equigen® is an equine growth hormone marketed in Australia to improve the nitrogen balance in aged horses. However, growth hormone administration is considered illegal by the majority of racing boards throughout the world and local administration of IGF-I to the site of injury is a much more efficient means of delivering IGF-I to the intended site. While most data has been gathered on the use of IGF-I and bone marrow aspirate injection into the SDF, their use is indicated in deep digital flexor tendon and suspensory ligament injuries as well.

Engineering of replacement ligaments and tendons is also under investigation. Most methods utilize a cell/matrix composite which is cultured under mechanical stimulation to increase matrix content and bio-mechanical strength prior to implantation. Most likely, a combination of bioengineering, growth factor, and novel rehabilitation approaches will be necessary to substantially affect tendon and ligament healing.

Joint lavage, articular debridement and synovectomy techniques - new developments

L.A. Fortier

JOINT LAVAGE

Lavage of a joint compartment is commonly performed in combination with arthroscopic exploration or in the treatment of septic arthritis. Advances in lavage have primarily centered around solution choices. There is good evidence that chlorhexadine solution at concentrations greater than 0.05% (0.5 ml of chlorhexadine / liter of flush solution) is toxic to cartilage if exposure time is greater than 1 minute. Alternatively, a solution of 0.0005% chlorhexidine in Tris-EDTA is lethal to bacteria without causing synovial inflammation. However, its effects on cartilage have not been fully investigated.

Heparinized indwelling drains are popular for administration of antibiotics in cases of septic arthritis. However, heparin has been shown to potentiate the growth of *Staphylococcus* organisms. Indwelling drains also provide a route for further contamination. While the use of indwelling drains remains popular, the use of regional intravenous or intraosseous perfusion should be considered. Regional intravenous perfusion of antibiotics results in extremely high tissue levels of antibiotics to all layers of the perfused joint. This is particularly attractive when treating an infected joint with thickened soft tissue and when administering costly or aminoglycoside antibiotics, for example, amikacin.

ARTICULAR DEBRIDEMENT

Recent innovations in articular debridement center around the theme that less is more. Mechanical debridement is still the mainstay, however, only detached cartilage is removed while partial thickness defects and fibrillated cartilage are minimally debrided, left alone, and/or micropic is applied to enhance cartilage healing. Micropic involves creating microfractures through the subchondral plate with an awl to allow mesenchymal stem cells and growth factors from the marrow to gain access to the cartilage defect.

Thermal chondroplasty using either bipolar or monopolar radiofrequency devices is popular in human beings for treatment of chondromalacia and fibrillated cartilage. The idea is to smooth the cartilage surface and prevent further fibrillation and cartilage loss. There is substantial evidence that both devices kill cartilage and subchondral bone cells. Until specific recommendations can be made for each animal species and within each joint, radiofrequency devices should be used with extreme caution.

For full-thickness cartilage flaps, either from OCD or trauma, reattachment to the subchondral bone should be considered. There are several items marketed for this application including PDS pins and polyglycolide tacks.

SYNOVECTOMY TECHNIQUES

The most common indications for synovectomy in human beings, which may be applicable to small animals, are haemophilic synovitis and rheumatoid arthritis. In both cases, chronic, active synovitis leads to cartilage destruction through the release of cartilage-degrading enzymes and by direct invasion of the synovium over the cartilage surface. In the equine patient, synovectomies are most commonly performed when septic arthritis is present with the goal to remove sequestered fibrin, bacteria, and cartilage degrading enzymes.

Arthroscopic synovectomy using motorized equipment is the most commonly employed method. This procedure results in transient synovitis with subsequent insult to the articular cartilage. Particular consideration should be given to animal with pre-existing cartilage damage as further inflammation may accelerate joint destruction.

Alternative methods of synovectomy include the use of a Holmium:Yag laser, chemical synovectomy, and the use of radiopharmaceuticals. None of these techniques have gained popularity in animals due to increased equipment costs and expertise required.

Pain management

S.M. Fox

PAIN EFFECTS PRACTICALLY EVERY ASPECT OF OUR DAILY ACTIVITIES!

No doubt you will agree that if you are suffering from lower back pain, headache, etc. you are likely not pleasant company. If we accept that animals do, in fact, also experience pain, why would we believe their days are any different?

It is estimated that nearly 11 million canine surgeries and painful procedures are performed in the US each year. Yet only about 23% of those involve pain management. Although most would acknowledge orthopedic procedures are among the most painful, only 46% receive analgesia. Sterilized patients (castrations and spays) receive analgesia only about 20% of the time. (Rimadyl Pain Management Study. PAH 2000: RI 200001)

Pain is a very subjective phenomena. In his book, "The War on Pain", Dr Scott Fishman, MD, states, "Because pain is an intangible sensation, it challenges doctors and patients alike to describe and fathom it. It's usually a symptom, not a disease. Compounding the riddle is the subjective nature of pain. There is no single accepted pain experience—no one feels it the same. Like the perception of beauty, it's very real, but only in the eye of the beholder. What hurts me may not hurt you. **Pain is what the patient says it is!**"

Of course the issue is far more complex in veterinary medicine where our patients are non-lingual. Pain is a complex phenomena. Patients in pain are also often suffering from fear, anxiety, loss of hope, frustration, and depression that can't be separated from the physical aspects of their condition (Scott Fishman, M.D. The War on Pain, 2000). Nowhere is Hippocrates' directive to "study the patient rather than the disease" more critical than in pain medicine, because pain is a symptom of a patient's suffering. Our challenge is to interpret the painful state.

The International Association for the Study of Pain (IASP) has proposed the following definition: "PAIN IS an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage". And, pain is the most frequent complaint presented in human health care.

It's not unusual that many of us become "squeemish" when we witness trauma to our human friends; however, at the same time we are rather cavalier to the same trauma seen in animals. Perhaps reason for this polarization in response is because we have become "callused" from the frequent treatment of our patients. Accordingly, this callused response often impacts our sensitivity to our patients' accompanying pain.

Historically, HR, RR and BP have been used to note the presence of pain. This is resultant from the HPA axis response to pain-induced-distress. Further, vocalization has been identified as the hallmark of pain. Hansen & Hardie (Appl Anim Behav Sci 1997) have shown that HR, RR and BP are inconsistent parameters by which to judge pain. Additionally, they showed that vocalization is not statistically significant as an indicator of pain. Animals vocalize for many reasons—pain is simply one of them. These findings underpin the emerging attitude that an animal must prove that it is NOT in pain before withholding analgesics, rather than having to prove it is painful before analgesics are administered.

Ironically, those patients that are the least able to 'behave' painfully are also the least able to tolerate and survive pain and may have the greatest need for analgesia. Moreover, individuals express pain differently, and to demand presumed evidence of pain denies the "non-conformant" animal.

Pain is so important to the overall well-being of a patient that it has become the 5th cardinal sign of human assessment. (Philips DM. JCAHO pain management standards are unveiled. J Am Med Assoc 284(4):428-429, 2000) In fact, the mandate is such that federal funding is at risk if supported institutions are not routinely assessing for pain as a cardinal sign.

Animal behavior is the window through which we may observe the impact of the unmeasurable—pain—on the physical and psychologic well-being of our patients (Bernie Hansen 1997). Observation and careful interpretation of behavior and physical signs remain essentially the only clinically useful means to assess patient responses to injury or disease at many levels, both psychologic and physiologic.

There are many different pain scoring or assessment systems in human medicine. When a printed pain assessment form was provided to nurses, there was an increased awareness of patients' pain which resulted in an increase in the administration of analgesics with improved relief of pain. (Baillie L: Clinical pain management: A review of pain assessment tools. Nursing Standard 7:25-29,1993) Scales consist of verbal rating scales (VRSs) or simple descriptive scales (SDSs), numeric rating scales (NRSs), and the visual analogue

scale (VAS). The VAS is a ruler (usually 100mm in length) with only a description of the limits of pain placed at either end of the scale such that 0 represents no pain and 100 represents the worst pain possible. The observer or patient is asked to mark anywhere along the scale where the perceived or experienced pain, respectively, would fall. This technique is widely used in human medicine and has been used in many veterinary analgesic studies. The VAS has proved to be sensitive, reproducible, and feasible in studies requiring evaluation of pain. (Jensen MP, Karoly P, Braver S: A comparison of six methods. *Pain* 27:117-126, 1986)

Two types of pain, acute and chronic, are recognized. Acute pain, as seen associated with surgery, eg fracture repair or 'routine' spay is often short in duration, serves a protective function and routinely responds to unsophisticated treatment. In contrast, chronic pain such as is seen in osteoarthritis or cancer, is enduring, serves no physiologic protective role and is less responsive to treatment. Chronic pain is more physiologically complex than acute pain and therefore requires more strategic management. **"Acute pain is a symptom of disease; chronic pain itself is a disease."**

Inflammatory mediators promote vasodilation with extravasation of plasma proteins and the recruitment of inflammatory cells. Mast cells, macrophages, lymphocytes and platelets contribute to the scenario, such that a complex milieu of inflammatory mediators, including hydrogen ions, norepinephrine, bradykinin, histamine, potassium ions, cytokines, serotonin, nerve growth factor, nitric oxide and products from the cyclooxygenase and lipoxygenase pathways of arachidonic acid metabolism is produced. It appears that these molecules act synergistically rather than individually, generating what is often referred to as a sensitizing "soup" which effectively lowers the response threshold for A δ and C fiber activity. As a result, the CNS receives nociception that signals a state of hyperalgesia (both greater duration and amplitude). Further, in the state of allodynia, A β fibers are recruited from their role of transmitting innocuous information to one of transmitting signals for pain.

Hypersensitization is sometimes referred to as 'wind up' and involves both peripheral sensitization and central sensitization. At their peripheral terminals nociceptors are exposed to a cocktail of inflammatory mediators in reaction to tissue damage. This results in an increased sensitivity of the transduction mechanism of the high-threshold nociceptor primary sensory neurons. Additionally, 'silent' nociceptors are recruited. These nociceptors are a class of unmyelinated polymodal C fibers that demonstrate little if any activity even when subjected to extreme stimulation; however, they are extremely sensitive to the effects of local inflammation and may discharge vigorously in such conditions.

Pain can have a profound effect on the CNS's very architecture. Your brain is highly impressionable, so much so that scientists consider it virtually 'plastic' or changeable. Pain does more than ring a bell (as Rene Descartes originally proposed)—it hammers the bell into a new shape to produce harsh and jarring sounds. Once rung, the bell never sounds exactly the same! Scientists now know that unrelenting pain can alter the way neurons handle information; it can make sensation more intense, twist its character, create additional sensations like stabbing pain, or set off other neurological events common with stress. Lasting pain can produce a cycle of chemical and electrical action and reaction that becomes an automatic feedback loop—a chronic, self-perpetuating hurting that persists long after the original trauma has healed. Pain can reconfigure the architecture of the nervous system it invades.

The physiological mechanism of central sensitization is complex and occurs within both the spinal cord and brain. Glutamate, acting as the N-methyl-D-aspartate (NMDA) receptor, is likely the main transmitter involved. The NMDA receptor is initially blocked by a magnesium ion; when glutamate causes depolarization of a neurone by an action at the amino methylisoxazole propionic acid (AMPA) receptor (the main process involved in normal fast transmission across a synapse), this magnesium ion is displaced so the next packet of glutamate causes both the AMPA and NMDA receptors to open and the cell is more likely to fire. Just a few **seconds** of C-fiber input can generate several **minutes** of postsynaptic depolarization. Once the dorsal horn has been sensitized by nociceptive input, activation of A β fiber mechanoreceptors by previously nonpainful tactile stimuli actually contributes to the pain response—allodynia. Thus the pathophysiology of post-injury pain hypersensitivity involves dynamic changes occurring in the periphery, enabling low-intensity stimuli to produce pain by activating sensitized A δ and C fibers, while input in low-threshold A β sensory fibers generates pain as a result of altered central processing in the dorsal horn of the spinal cord.

Historically, we have focused our attention of pain relief to the postoperative period. Under such circumstances, we are playing "catch up" for pain control. By focusing our attention to the administration of analgesics before the occurrence of 'windup', we will require far less postoperative analgesics. In addition, 'pre-emptive' analgesia will spare intraoperative drug administration (including inhalant anesthesia).

Fundamentally, we have 4 classes of drugs from which we can choose to treat pain: **local anesthetics, NSAIDs, opioids and alpha-2s**. It is interesting to note how the World Health Organization's ladder of suggested treatment of pain has evolved over the past decade. Several years ago it was suggested that mild

pain be treated with a non-opioid such as a NSAID, moderate pain be treated with a mild opioid, and severe pain be treated with a strong opioid. Those recommendations remain standing today; however, NSAID treatment is suggested at each step. This brings our attention to the ever-increasing role NSAIDs are playing in the entire spectrum of pain management. We are learning more and more about this class of drug, and many new molecules of this drug class are entering the market. Accordingly, we must learn as much as possible about these drugs.

We take advantage of drug synergism in our approach to balanced (multimodal) analgesia. Historically, we may have used a single agent, such as morphine which has no ceiling effect, to control pain. The more we gave, the less painful the patient. However, under such circumstances we were obliged to accept the adverse side effects of the morphine as we increased the dose. We are now much wiser from the observation that 'cocktailing' analgesic agents can yield a better analgesic response (synergism) and with lower doses of each cocktail agent. As a result we have less potential for adverse side effects from any individual agent. In selecting the analgesic agents for our 'cocktail', we choose from the list of drugs effective in blocking the four physiologic processes composing the pain response: transduction, transmission, modulation and perception. By blocking pain at multiple foci rather than a single location, we have a much more effective protocol.

Grimm, et al (AJVR 2000) have demonstrated the synergism of opioids and alpha 2-agonists. In this study the extremely short duration of butorphanol (approximately 40 minutes of analgesia) was extended by the addition of a small dose of medetomidine. Herein the synergistic response of nearly 6 hours was seen as compared to the additive response of approximately 4 hours.

IN SUMMARY, WE CAN MAKE SEVERAL GENERAL CONSIDERATIONS!

- The 'gold standard' for diagnosing pain is response to appropriate analgesic therapy
- Younger animals are much less tolerant of pain
- Cats and geriatrics tend to withdraw when in pain
- Distractions can produce temporary reduction in pain response
- Pain is usually enhanced in the presence of inflammation
- Visceral stretching or distention is extremely painful
- Tissue handling impacts postoperative pain
- Physiologic parameters (alone) are poor indicators of pain
- Anxiety lowers the threshold of pain perception
- Sedation is often misinterpreted as analgesia
- An almost universal emotion that magnifies pain is fear
- Analgesic therapy must be individualized
- there is at least a 5X variation in analgesic requirements between different animals for the same surgical procedure
- In general, the sicker or more badly injured an animal is, the more likely it is to withdraw and not show behavioral evidence of distress

Pathophysiology of Osteoarthritic Pain

S.M. Fox

Two types of pain, acute and chronic, are recognized. Acute pain, as seen associated with surgery, eg fracture repair or 'routine' spay is often short in duration, serves a protective function and routinely responds to unsophisticated treatment. In contrast, chronic pain such as is seen in osteoarthritis (OA) or cancer, is enduring, serves no physiologic protective role and is less responsive to treatment. Chronic pain is more physiologically complex than acute pain and therefore requires more strategic management. **"Acute pain is a symptom of disease; chronic pain itself is a disease."**

Inflammatory mediators promote vasodilation with extravasation of plasma proteins and the recruitment of inflammatory cells. Mast cells, macrophages, lymphocytes and platelets contribute to the scenario, such that a complex milieu of inflammatory mediators, including hydrogen ions, norepinephrine, bradykinin, histamine, potassium ions, cytokines, serotonin, nerve growth factor, nitric oxide and products from the cyclooxygenase and lipoxygenase pathways of arachidonic acid metabolism is produced. It appears that these molecules act synergistically rather than individually, generating what is often referred to as a sensitizing "soup" which effectively lowers the response threshold for A δ and C fiber activity, leading to a neurological state of hyperalgesia.

Hypersensitization is sometimes referred to as 'wind up' and involves both peripheral sensitization and central sensitization. At their peripheral terminals nociceptors are exposed to a cocktail of inflammatory mediators in reaction to tissue damage. This results in an increased sensitivity of the transduction mechanism of the high-threshold nociceptor primary sensory neurons. Additionally, 'silent' nociceptors are recruited. These nociceptors are a class of unmyelinated polymodal C fibers that demonstrate little if any activity even when subjected to extreme stimulation; however, they are extremely sensitive to the effects of local inflammation and may discharge vigorously in such conditions.

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Approximately 85% of Americans over 55 years of age are afflicted with osteoarthritis, and approximately 1 in 5 adult dogs is osteoarthritic. Yet many pet owners do not know that osteoarthritis is a disease of dogs (and cats). However, since OA is so prevalent and there is much contemporary information in the popular press about treatment options for human OA, the analogy of human OA to pet OA establishes a compassionate discussion with pet owners.

Osteoarthritis is a disease condition of the entire diarthrodial joint, to include the articular (hyaline) cartilage, synovial membrane, synovial fluid, subchondral bone, and surrounding supporting structures (muscles and ligaments). The term enthesophytes, refers to bony proliferations found at the insertion of ligaments, tendons, and capsule to bone. Ligaments and muscles surrounding the OA joint are contributors to the pain of OA. Although ligamentous neuroreceptors serve mainly to determine spatial orientation of the joint, tis-

sue strain incites the pain state. Muscle weakness accompanying OA is also associated with pain and disability. Stimulation of neuroreceptors within the damaged OA joint can stimulate a reflex arc resulting in constant stimulation of muscle tissue. Muscle spasm and muscle fatigue may greatly contribute to the pain of OA. Mild muscle trauma thereafter likely releases inflammatory mediators sensitizing muscle nociceptors to further mechanical stimulation. Local tenderness often results from the release of inflammatory mediators such as bradykinin and prostaglandin E₂. Nociceptors are found in muscle, fascia and tendons, and since afferent nerve fibers from muscle distribute over a relatively large region of the dorsal spinal horn, poor localization of muscle pain is common.

Normal age-related changes occur in articular cartilage throughout life. Data from porcine articular cartilage has shown a decrease in hydration, a decrease in collagen on a dry matter basis, a decrease in glycosaminoglycan concentration especially chondroitin sulfate, and a decrease in proteoglycan size with age. Although the total GAG concentration may not vary much with increasing age, the ratio of keratan sulfate to chondroitin sulfate increases. Regarding chondroitin sulfate, the 4-sulfated compound decreases while the 6-sulfated compound increases. The link proteins are also subject to proteolytic cleavage as aging progresses. The end result of these normal age-related changes is a matrix of reduced capability to withstand the forces associated with normal joint functioning. (VOS Articular Cartilage and Joint Health Symposium Proceedings, 2000)

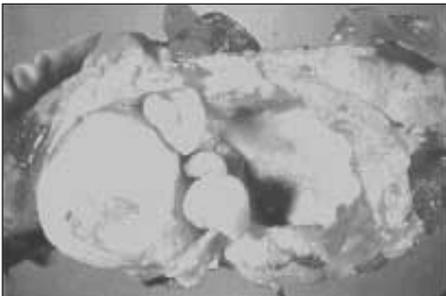
One of the earliest changes seen in OA is an increase in hydration (2-3%). This hydration appears to be the result of the cleavage of type II collagen by collagenase. The functional collagen network is disrupted thereby permitting the proteoglycans, the hydration capacity of which are no longer restricted by the collagen network, to bind increased amounts of water resulting in the cartilage swelling.

With the progression of OA, chondrocytes necrose. Extracellular matrix synthesis ceases while degradation increases. The collagen network becomes increasingly disorganized and disintegrated, with the content of collagen and proteoglycans reduced. The removal of functional proteoglycans from the extracellular matrix results in decreased water content of the cartilage and subsequent loss of biomechanical properties. Resultant mechanical stress and trauma to chondrocytes perpetuates the OA process. (VOS Articular Cartilage and Joint Health Symposium Proceedings, 2000.)

It is proposed that the chondrocyte is the most active source of degradative protease production; however this is stimulated primarily by cytokines and leukotrienes produced by the synovium. Yet it appears that synovitis alone is insufficient as the sole etiology of OA, and that physical trauma is also necessary. Nevertheless, the impact strict hemostasis makes on the development of degenerative articular change in the cruciate deficient model (producing less inflammatory stimulus) illustrates the importance of synovitis in the development of OA changes. *It is therefore logical to assume that intervention in the inflammatory process of OA will slow the disease progress.*

Osteoarthritis is a progressive catabolic disease exhibiting a vicious cycle. For what is often an unknown etiology, but likely involving some form of joint trauma, be it normal stress on an abnormal joint or abnormal stress on a normal joint, the animal experiences pain. The pain leads to a decrease in exercise and often a state of over-weight. Muscle loses its tone and begins to atrophy from disuse, placing increased stress on the joint structure itself. Cartilage damage is accentuated with accompanying inflammation of joint structures. Inflammatory mediators decrease nociceptive thresholds and lead to hyperalgesia, further adding to the animal's pain. The cycle continues in a degradative spiral.

Considerable information can be gathered from a gross necropsy specimen. Appreciating that hyaline cartilage has no vascularity, while subchondral bone does, apparent bruising of cartilage suggests that little or no cartilage remains covering the subchondral bone. Focal eburnation of the humeral head further suggests a long-standing OCD flap that has become detached, and the roughened area demonstrates the difference



between hyaline and replacement fibrocartilage. An OCD type of lesion is supported by multiple joint mice, that have apparently grown in size from synovial fluid nutritional support. Finally, joint capsule thickening/hypertrophy is appreciated, suggesting that the animal had a restricted range of motion in this hip.

We take advantage of drug synergisms in our approach to balanced (multimodal) analgesia of the patient. Historically, we may have used a single agent, such as morphine which has no ceiling effect, to control pain. The more we gave, the less painful the patient. However, under such circumstances we were obliged to accept the adverse side effects of the morphine as we increased the dose. We are now much wiser

from the observation that 'cocktailing' analgesic agents can yield a better analgesic response and with lower doses of each cocktail agent. As a result we have less potential for adverse side effects from any individual agent. In selecting the analgesic agents for our 'cocktail', we choose from the list of drugs effective in blocking the four physiologic processes composing the pain response—transduction, transmission, modulation and perception. By blocking pain at multiple foci rather than a single location, we have a much more effective protocol.

The drug class of choice for treating OA is non-steroidal anti-inflammatories. Should the pain of OA become uncontrolled by an NSAID alone, we may add other drug class analgesics for 'multimodal analgesia'. NSAIDs are believed to act mainly through their disruption of the cyclooxygenase enzyme. When cells are injured, arachidonic acid is released, which then enters the cyclooxygenase or the lipoxygenase route of metabolism. The cyclooxygenase route gives rise to prostaglandins which sensitize nociceptors in the region of injury. Lipoxygenase gives rise to leukotrienes which decrease nociceptive thresholds and chemotactically attract neutrophils.

In the early 1990's it was observed that some NSAIDs caused ulceration more than others. Resultant from investigations to answer why that is, two isoenzymes of cyclo-oxygenase were discovered. COX-1 (constitutive) is relatively plentiful and contributes to homeostasis of the stomach, kidney, hemostasis, etc.

In contrast COX-2 (inducible) is systemically sparse, EXCEPT in the face of inflammation, when it is considerably up-regulated. Subsequently, it was concluded that an optimal NSAID would target COX-2 and spare COX-1, i.e. show COX-2 specificity.

The diagnosis of osteoarthritis can be challenging, and I would suggest that most dogs are in as state of moderate-to-severe OA at the point of diagnosis. After all, "lameness is a pain-induced behavior", and most dogs diagnosed with OA show some lameness. However, convincing owners that early treatment for OA is necessary is often a greater challenge than diagnosing OA itself. This is because many pet owners refuse to believe their dog is in pain unless it is vocalizing. As veterinary practitioners, it is incumbent upon us to explain to clients that animals express pain in a variety of altered behaviors, and vocalization is only one of those behaviors.

Low field magnetic resonance imaging in equine orthopedics

A. Gäch, H. Gerhards

OBJECTIVE

The purpose of this study was to depict pathologic changes of the equine digit using an open low field system and to set up an imaging protocol to examine living horses.

MATERIALS AND METHODS

36 cadaver limbs and 2 in vivo limbs were imaged with an open low field system (0, 2 Tesla). The facility design and the installation allow limbs or heads of anaesthetized horses to be placed into the centre of the magnet. 19 sequences and 4 coils were tested. A standard imaging protocol, including T1- and T2-weighted, spin echo and gradient echo and inversion recovery sequences was set up. Images were acquired in sagittal, transverse and coronal plans. Routine radiography was carried out on each joint. Anatomic structures and changes were identified and compared with cryosections of the imaged limbs.

RESULTS

The results were presented as casereports. The use of multi slice and multi sequences provides a thorough evaluation of pathologic abnormalities. Articular surface defects in the metacarpophalangeal and distal interphalangeal joint without radiological findings were identified. The low field system produced high resolution images and it was possible to visualise a contusion (bone bruise) of the distal metacarpus and the fibrocartilage of the distal interphalangeal joint. Especially the use of short tau inversion recovery sequences made it possible to distinguish between a case of acute (haemorrhagic ligamentum sesamoideum colaterale) and a case of chronic (enlarged and fibrous ligamentum sesamoideum collaterale) navicular syndrome. This will help to identify horses with acute painful navicular syndrome without abnormalities on routine radiographs. Further, an evaluation of the subchondral bone, the cortex, the spongiosa and the synovial fluid was possible.

CLINICAL RELEVANCE

MRI is a very promising tool in diagnosis of acute or chronic limb disorders without evidence of radiographic abnormalities. The high resolution images of the navicular bone, the deep digital flexor tendon and the collateral sesamoidean ligament and the possibility to distinguish between acute and chronic changes will be useful for defining the pathogenesis of the navicular syndrome. Using this technology facilitates the localisation of chip fragments and the evaluation of joint alterations, due to its ability to depict articular cartilage, synovial fluid, cortical and subchondral bone. These advantages allow the clinicians to detect early pathological changes in case of degenerative joint disease and to initiate early treatment.

CONCLUSIONS

This study shows the potential of MRI in equine medicine in the diagnosis of equine limb diseases. The advantages such as excellent soft tissue contrast, multiplanar capability and tomographic nature are useful for equine medicine. After thorough clinical and radiographic examination MRI will greatly enhance diagnosis of soft tissue and osseous abnormalities of the extremities.

Experimental mandibular regeneration by Distraction Osteogenesis (DO) with submerged devices. Preliminary results in a canine model

P. Garcia, F. San Román, P. Rubio, S. Murillo, P. Llorens, M. Sanchez, E. Alvarez, F. Diaz-Gonzalez

INTRODUCTION

Reconstruction of the mandible after ablative surgery is difficult in humans to achieve both from aesthetic and functional point of view. The use of free vascularized flaps has improved the results in extensive defects but unfortunately, the surgical procedure is complex, and morbidity and cost are high. Distraction osteogenesis is a simple procedure in which new bone is produced without the need for bone grafts. Mandibular distraction osteogenesis has shown to be effective to treat congenital and acquired mandibular hypoplasias, but however, we could not find reports about segmental mandibular regeneration by means of submerged distraction devices.

AIM

To investigate in a canine model the feasibility of distraction osteogenesis with submerged devices for reconstruction of segmental mandibular defects.

MATERIAL AND METHODS

We used five non-growing healthy dogs, weighing around 10 kg. They stayed in the Clinic Veterinary Hospital (HCV) of Madrid. We employ the general material and equipment for the mandibular surgical procedure and all the facilities of the Surgery Service of HCV.

The animals were under general inhalatory anaesthesia and implanted to the mandibular body an unidirectional submerged distraction device with a transcutaneous activator and parallel to a titanium reconstruction plate with a six bicortically screws of 2 mm. It was created a 20 mm segmental defect in the third molar area by osteotomy. Design of a transport disk of 20 mm in the forth premolar area.

Postoperative cares included careful analgesia, antibiotherapy and a soft diet.

And for the distraction we followed next steps: neutral fixation (5 days), gradual distraction (20 days, with a rate of 1 mm per day), consolidation period (65 days).

We complete the study with radiographic and histopathologic examinations.

RESULTS

Complete bone regeneration of the surgical created gap occurred in 3 of the dogs without complications, except some temporary discomfort. There was radiographic evidence of progressive regeneration and calcification of the gap, however it was still slightly less dense than pre-existing mandible. Macroscopic examination showed a regenerated segment similar when compared with the rest of the mandible, but with an outer thick fibrous layer. Microscopically, the histologic examination confirmed the presence of new bone deposition along the mandibular defect. Two animals failed to create new bone. The distraction devices were loose and there was a lack of ossification (pseudoarthrosis). Radiographs shown a radiolucid gap and no evidence of complete bone callus formation. Histologically a fibrocartilage tissue was observed.

DISCUSSION

Distraction osteogenesis with submerged devices is a new technique with enormous advantages respect to others (bone grafts, prosthesis, external devices): simple procedure, no donor-site morbidity, accurate anatomical reconstruction, less prone to postoperative complications (trauma, infection, unaesthetic scars), proper stability, comfortability, socially more acceptable. In canine model, there was 3 animals with complete bone regeneration of the surgical created gap and a 2 failed due to technical problems and instability. This experimental study demonstrates the possibility to use internal distraction devices to reconstruct segmental mandibular defects in a canine model. Internal devices may become very useful option in human mandibular reconstruction. Additional experiment may improve our knowledge on bone transport in mandible, resulting in a more precise application of the distraction.

Use of intramedullary pin-external skeletal fixator tie-in technique for repair bone fractures in owls: a review of ten cases

A. Garcia-Gramser, J. Rodriguez-Quiros

INTRODUCTION

Bone fractures are one of the most common injuries in wild birds admitted to Recovery Centers. Some of the numerous factors which contribute to their high incidence and which make their repair more difficult are thin and brittle cortices, a large medullary canal and little soft tissue support in most of the long bones. Over the past 15 years, great advances have been made in the treatment of fractures in birds. With recent technical advances, surgeons are now attempting to repair more challenging and difficult avian fractures and have a more predictably successful outcome. Bone plates and external skeletal fixator (ESF) are the most stable fixation devices. In the last years, we have used an intramedullary pin-external skeletal fixator tie-in (IM pin/ESF tie-in) because this device increases its strength and reduces morbidity associated with limb immobilization.

AIM OF THE STUDY

The purpose of this work is to familiarize practitioners with the application of an easy and inexpensive technique for repair of long bone fractures in small birds.

MATERIAL AND METHODS

Ten birds with long bone fractures were surgically treated using an IM pin/ESF tie-in over a year period. Species affected were: Little owl (*Athene noctua*) 6 cases, Tawny Owl (*Strix aluco*) 2 cases, Long-eared Owl (*Asio otus*) 1 case, and Barn Owl (*Tyto alba*) 1 case. Fractures were located in the following bones: Tibio-tarsus (6 cases), femur (2 cases), and humerus (2 cases). In all cases, we used an intramedullary pin, one to two threaded transfixation pins placed in half-pin fashion in each major fragment and a veterinary thermoplastic casting material applied over the outer border and molded around the pins.

RESULTS

Pin loosening and intolerance were not a common clinical problem when using IM pin-ESF tie-in in small birds. All fractures treated healed without complications. The average time for bone healing was 27 days, with a range of 20 to 40 days. All animals were released to the wild once their rehabilitation was completed.

CONCLUSIONS

The employment of the IM pin-ESF tie-in is recommended in birds when return to normal anatomy and function are required for successful resolution of complex fractures. When ESF is combined with IM pinning to stabilize a fracture, the resultant repair is able to resist all of the forces acting on the fracture, and the combination is much stronger than either devices used alone. Advantages to this technique include ease of maintaining axial alignment, prevention of pin loosening and migration and applicability to open fractures with comminution and bone loss. This allows full load bearing/sharing in the period immediately posterior to the surgery. The results of this series indicate that this technique is one of the first choices for orthopaedic injuries in small birds.

Radiographic and ct diagnosis of cervical abnormalities in the horse

H. Gerhards

Abnormalities of the cervical vertebrae are not uncommon in horses and foals. A radiographic examination of the cervical region completes each clinical examination. Survey radiographs of the vertical spine are always indicated with neurologic abnormalities that could be localized to the cervical spinal cord with the help of clinical and neurologic examinations. X-ray examinations can be performed in the standing animal or under general anaesthesia. Conventional X-ray technique with grids, rare earth screens and large film formats, or computed radiography (digital luminescence imaging equipment) can be used. The advantage of taking X-rays in the standing horse is that there is no risk for recovery from general anaesthesia, as injuries or other problems with recovery are not uncommon in neurologically compromised animals. The main disadvantages of standing examinations is that only lateral views can be taken. Under general anaesthesia, flexed and extended, as well as ventro-dorsal and oblique views can be taken. Also under general anaesthesia, myelography of the cervical spinal canal can be performed to localize any reductions in the canal diameter. Survey radiography permits the detection of congenital malformations, such as occipitoatlantoaxial malformation and malformations of other vertebra, fractures and evidence of osteomyelitis in the cervical spine. Furthermore, survey films can be used as a screening tool for the identification of cervical stenotic myelopathy (CSM). The normal cervical spine has a gently curving appearance, with only slight changes in angulation at each intervertebral space. The contours of the vertebral canal should be evaluated for any obvious changes, such as subluxations, and for the presence of remodelling and proliferation of the caudal vertebral epiphyses.

The articular facets are checked for osteoarthritis, osteochondrosis, and/or old fractures which can be identified by enlargement, irregular contours, radiolucencies of the facets and/or irregular or obliterated joint spaces. Normal facets are rounded and smooth, and the joint space between them can be seen. Severe alterations in the bony appearance of the cervical spine are highly suggestive of cervical stenotic myelopathy (CSM). However, one has to bear in mind that survey films in ca. 50 % of horses led to an incorrect diagnosis of CSM. Measurement of the vertebral canal and determination of the minimum sagittal diameter can be used to diagnose CSM. This is done by measuring the spinal canal at its narrowest point between the dorsal aspect of the vertebral body and the ventral aspect of the dorsal laminae. The sagittal ratio can be determined by dividing the minimum sagittal diameter by the width of the widest part of the cranial aspect of the corresponding vertebral body and comparing it with known sagittal ratios from the literature.

A promising application of MR imaging is the detection of soft tissue alterations of the spinal cord, which would be a tremendous diagnostic advantage of MR imaging over more invasive imaging modalities. However, there are several important limitations to the use of MR imaging in adult equine patients. General anaesthesia and the time required for scanning must be considered as disadvantages. Because of the gantry design, adult horses can be scanned only from the head to C3-C4, whereas the distal neck and the shoulder region do not fit into the gantry. Interpretation of MR imaging requires detailed knowledge of the normal and pathologic anatomy, but optimal imaging sequences and parameters still need to be determined.

Field evaluation of the efficacy of tolfenamic acid for prevention of the postoperative pain in dogs

E. Grandemange, S. Pheulpin, F. Woehrlé, B. Boisramé

In order to evaluate the efficacy of the tolfenamic acid (TA) administered in one single preoperative injection for prevention of the postoperative pain, 62 dogs aged less than 10 years and taken to the veterinary practice to have an orthopaedic surgery with a postoperative painful component were enrolled in this randomized, comparative, blinded trial.

One hour before the induction of anaesthesia (T0), the animals received according to the randomization either an intramuscular injection of Tolfedine® 4% solution at the posology of 4 mg/kg of TA (1 ml/10kg) or an intramuscular injection of the placebo (1 ml/10kg). The clinical parameters related to the pain were investigated at T1 + 1H, T1 + 4H, T1 +24H (T1 = desintubation) and the pain was evaluated on a VAS scale (Visual Analogic Scale).

The efficacy results showed a statistical superiority of the TA to prevent the postoperative pain. The evolution of the pain (VAS scale) was statistically in favour of TA treatment ($p=0.004$). This was confirmed by a global clinical score statistically higher in the placebo group ($p=0.03$) and by the evolution of the respiratory rate which was statistically lower in the TA treated animals ($p=0.048$) and so indicated a better postoperative comfort.

The TA treatment was very well tolerated as no clinical sign or change in the biochemical and haematological values showing a renal or hepatic or blood intolerance was observed. The safety of the association of the TA with the anaesthetic drugs used in the study was very good.

Field evaluation of the efficacy of marbofloxacin in the treatment of osteo-articular infections in dogs

E. Grandemange, F. Woehrlé, B. Boisramé

In a multicentric, international, non comparative field trial, marbofloxacin tablets at the dosage regimen of 2 mg/kg per day were evaluated in the treatment of osteo-articular infections in the dog occurring as acute or chronic osteomyelitis (AOS or COS), discospondylitis (DIS) or septic arthritis (SEP).

Duration of treatment depended on the type of pathology: SEP and AOS: 28 days, DIS and COS: 42 days. A radiography and swabbing for bacteriological culture were performed at the beginning of the study as well as at the end of follow-up/treatment. Authorized associated treatments consisted in local treatments (surgical interventions to remove infected tissue, stabilization of possible fractures if necessary, irrigation-drainage, sterile dressing), anaesthesia or tranquillization if necessary and in administration of tolfenamic acid in tablet form (4 mg/kg) for 5 days if necessary. Clinical follow-up of dogs was performed according to the following examination schedule: SEP / AOS on D0, D7, D14, D28, D42 and DIS / COS on D0, D7, D21, D42, D56. Data from 38 dogs enrolled by 9 investigators in France, Italy and the United Kingdom were analyzed. Among osteo-articular infections, there were 7 cases of each AOS and COS, 9 cases of DIS and 15 cases of SEP.

Regarding the 2 main efficacy criteria, there were 94.1% of bacteriological cure rate at the end of treatment and 81.6% of positive assessment (cases evaluated as cured or clearly improved) by the investigator at the end of follow-up (42 or 56 days). Bacteriological cure was even 100.0% in the COS, DIS and SEP groups. Clinical cure at the end of treatment (28 or 42 days) could be obtained in 42.1% of dogs, failure rate was 13.2% and there was no case of relapse. General (rectal temperature, general condition and appetite) as well as local (suppuration, aspect of the wound, pain and locomotion) parameters showed good regression to normal conditions during the follow-up of animals.

It has to be emphasized here that beside the high bacteriological cure rates, even the clinical cure rates of about 42% represent very good results in the treatment of osteo-articular infections in the dog. These infections include complex pathologies difficult to treat, which need long-term treatments and where cases of failure or relapse often occur.

Thus, marbofloxacin tablets at the dosage regimen of 2 mg/kg once daily proved their efficacy in the treatment of osteo-articular infections.

Neurological abnormality or lameness - a diagnostic challenge

B.D. Grant, J.H. Cannon

A “Wobbler” is a horse with a damaged spinal cord. The most obvious clinical sign is an abnormal gait characterized by wobbling, or a horse that looks like he’s had a fair amount of tranquilizers. Severe damage can actually result in a horse that may fall and have difficulty getting up. Mild cases may only present an inability to change leads, stop smoothly, or a negative change in behavior that results in poor performance. The mild cases are often confused with subtle problems of the hind legs, especially of the hock and stifle. The hind limbs are affected because the nerves which supply the area are located on the outside of the spinal cord in the cervical (neck) area and therefore are more easily damaged than nerves leading to the front limbs which are protected deep within the spinal cord.

The major causes of spinal cord damage include malformation of the cervical vertebra, trauma to the vertebra from falling, and viral (herpes or rhinopneumonitis) and protozoa (*Sarcocystis neurona*) infections. The clinical signs of each of these problems can be very similar as each one can damage the spinal cord in the neck region.

In order to provide accurate information for the treatment and long term prognosis it is necessary to obtain a complete diagnosis as soon as possible. Arriving at a clinical diagnosis usually requires combining the information from a complete neurological exam, radiographs of the skull and cervical area, a myelogram, and testing the spinal fluid.

A neurological exam is not complicated but the interpretation of the results does require some experience and good observation. We recommend that the exams be videotaped so other examiners – often in the eastern states – can render an opinion without having to travel. The tapes can also serve as a reference to determine if there is any clinical improvement with treatment. The following are some of the more basic tests and what is normal and abnormal about each.

1. Back withdrawal:

Pressure is placed over the back and pelvis to determine if the patient resents the pressure. A normal horse will not react but a “Wobbler” will withdraw by depressing the spine in a squatting position. This is not a sign of pain but a sign of weakness as a result of nerve damage. Horses with painful spines do not usually squat because squatting would result in more pain.

2. Tail and anal tone:

The normal horse should have tone in the tail when it is elevated. A horse with spinal cord problems will have a very flaccid tail especially if the damage is in the lumbar or sacral areas. The anus should pucker when stimulated and not remain wide open.

3. Panniculus or skin sensation:

The sensation along the entire spine is tested with the end of a ballpoint pen on both the left and right sides. A normal horse should move the skin and muscles as though being irritated by a fly. Horses with spinal problems often do not react in the area that is damaged. This test can be quite variable as some horses are very stoic while others react as though they were going to have an injection.

4. Mobility of the neck:

The horse is quietly and gently encouraged to bend their neck so that the nostrils reach behind the shoulder. This should be repeated on both sides. The use of a carrot or a handful of grain will often encourage the patient to reach their neck back behind the shoulder. A horse with a painful neck, cervical fracture, or an arthritic vertebra will refuse to bend the neck or will try to twist around to the carrot by moving their legs. Some horses with severe problems will become more ataxic (drunken) after this test. Others may have a difficult time eating either off the ground or from an elevated hay net.

5. Placement tests:

The front legs are taken one at a time and crossed over the front of the other leg or placed in a wide stance. Normal horses should instantly replace their legs to the proper position while horses with spinal cord prob-

lems can take a long time to recognize their awkward stance. This test should be repeated on the opposite side and can also be done on the hind legs on subtle cases. We do not recommend doing this on very obvious "Wobblers" as there is some risk to the patient, handler, and examiner when trying to perform this on horses with very poor balance.

6. Tail sway:

The tail is pulled to each side by the examiner while the patient is being walked by an experienced handler. Normal horses resent the tail pull, but wobblers are easily pulled to the side while walking and when the pressure is released, they overcorrect or sway to the other side.

7. Tight circles:

The patient is walked in a very tight circle pattern. A normal horse has the outside front foot placed in front of the inside front foot and the inside hind foot placed in front of the outside hind foot. Horses with spinal cord problems will be confused and often reverse this order or pivot on the inside foot instead of lifting the leg. They will also swing the hind leg very wide (circumduction). The severe cases may even step on themselves or almost trip and fall.

8. Hills:

The patient is led up and down an incline with the head in a normal position and then again with the head elevated. Normal horses place their hind feet flat on the ground and do not elevate the front feet (hypermetria) when going down hill. When coming up hill the normal horse should also walk with flat rear feet. Abnormal horses walk downhill as though they have been tranquilized (truncal ataxia) and will knuckle over on the hind fetlocks. The patient will walk on their toes coming up hill and swivel the toes and hocks laterally trying to get enough strength to get up the hill. Walk the patient with the head elevated and if the horse is affected, the signs should be even easier to see.

9. Free exercise:

If the patient is not severely affected then they are allowed to run free in a paddock. Horses with spinal cord abnormalities bunny hop with the hind legs at a canter, will often be on the incorrect lead behind, and will knuckle over behind when trying to stop. Mildly affected horses have a very impressive animated gait at the trot that usually makes dressage owners salivate.

10. Hopping:

This test should only be done by an experienced examiner on soft footing. Affected horses will almost fall if encouraged to hop with one front leg held off the ground. Some horses have a strong side and a weak side. If the horse hops when the left front leg is off the ground and refuses to hop when the right leg is off the ground, we assume that the left side is affected.

11. Blindfold:

This test should only be done by an experienced examiner on soft footing. We do not usually do this test because it does not work on horses that only have spinal cord problems. If the horse has a brain or middle ear problem then they will fall down or start to lean.

After the neurological exam is complete and there is a high index of suspicion that the cervical area may be the source of the problems, a series of radiographs (x-rays) are taken with the patient lightly sedated. The radiographs are then examined for fractures, collapsed intervertebral disc space, misalignments, narrowed spinal canal measurements, and arthritic articular facets. Depending on the findings and the relative urgency, a myelogram is the next procedure indicated. The myelographic procedure, laboratory results, treatments, and preventions will be discussed in the next issue.

Fracture repair in the face of infection

B. Grant

There is probably little argument to the statement that fractures of horses have a more successful outcome if they can heal in a sterile environment but it is possible for fractures to heal in the presence of infection. Factors influencing the healing in the presence of infection include the bone that is fractured, type of fracture, patients age, organism and its antibiotic resistance and expectations of the owner.

Fracture Location. Comminuted and compound fractures of the mandible, premaxilla and the facial bones can heal if the basic principles of fracture healing are followed. These include adequate debridement, stabilizing the fracture fragments, appropriate antibiotic therapy and providing drainage when indicated.

Comminuted and compound fractures of the long bones or those involving synovial structures can be very challenging, expensive and significantly reduce a successful return to previous function or the anticipated use of the patient (if less than 2 years of age). The type and location of the fracture is also most important in deciding upon the type of fixation. As a general rule the more secure and stable the fixation the more likely that the fracture will heal in the face of infection. Fractures that involve the medullary canal and interosseous arteries can be very difficult to treat. A perfusion study with contrast media or a nuclear scintigraphy exam may be necessary before surgical intervention is started.

Patient's age and size. We attempt repair on more young horses with comminuted compound fractures as the reduction in mass lends itself to better results with internal and external fixation. Younger patients (< 1 year) often learn to lie down with an injured leg sooner than older patients and this certainly reduces the chances of compensatory laminitis. Recumbancy can be a problem with some fractures (such as an ulna) whose incisions have to be protected from the soiled bedding.

The bacteria cultured at the fracture and more importantly the antibiotic sensitivity plays a significant role in the outcome. Enterobacteriaceae, *Streptococcus* sp and *Staphylococcus* sp each account for 20 to 25% of bacterial isolates. (Snyder et al)¹. We have been utilizing the techniques such as intramedullary infusion or infusion into a peripheral vein while leaving a tourniquet in place for 30 minutes to increase the concentration of the antibiotic at the fracture site.

The expectations of the owner are a most important consideration and they need to have as much information as possible before proceeding. While some comminuted, compound fractures of the small metatarsal bones and severe trauma to the bones of the head can be resolved and not lower the patient's athletic ability the majority of compound fractures have the potential to seriously affect the soundness and usability. They need to be aware of all the potential problems that can and often develop even though the repair process is technically successful. These include but are not limited to a traumatic recovery, pleuropneumonia, diarrhea from stress or antibiotic use, wound dehiscence, compensatory laminitis, loss of vascular supply to the foot, decubital ulcers from the cast or lying down excessively and septic arthritis.

The economic considerations need to be discussed before starting treatment as even the most straightforward case can be costly. We recommend requesting a large deposit before starting treatment as a method to test their resolve.

PRINCIPLES OF TREATMENT

The main considerations in designing a treatment plan are:

1. Rigid fixation – Using metallic plates and screws in the midst of an obvious infected fracture to obtain rigid fixation is recommended over a less rigid procedure (cast or splints). Fractures can heal in the presence of purulent material if they are rigid. If the fracture is in a location that rigid fixation can be provided without placing implants in the fracture then so much the better.
2. Adequate debridement while preserving as much blood supply as possible. Using techniques that will allow for the covering of the fracture with viable soft tissue is encouraged.
3. Adequate drainage of the area to reduce the media that allows for excessive bacterial growth. Many times the drainage systems can also be used to infuse the area with mild bactericidal compounds and /or antibiotics.
4. Appropriate antibiotics delivered in adequate concentration. This depends on credible culturing techniques and results received in a timely manner. We will increase the concentration of antibiotics by the use of intramedullary infusion or intravenous injection after the vein proximal to the fracture site has been occluded with a tourniquet. (Murphey, Santschi² and Whitehair³) We usually leave the tourniquets on for a half-hour and repeat every day for 5 to 7 days. Amikacin and Naxcel are the most common

antibiotics used in these two methods. We have used methylmethacrylate beads and plate augmentation that has been impregnated with antibiotics (usually gentocin or naxcel) but have not been overly impressed. (Butson and Schramme⁴)

5. Timely changing of the external fixation devices especially if a cast is used to allow for wound inspection and monitoring the development of any pressure sores. This also provides for local lavage and application of any bone marrow or hydroxapatite crystals.
6. Protection of the contralateral leg from excessive pressure to reduce chances of compensatory laminitis. The use of NSAID's to encourage weight bearing of the leg under repair is recommended. In addition the use of shock reducing shoes (Seattle Shoes) also seems to be beneficial. Many cases that are reluctant to lie down can benefit from the use of a sling. We have had patients in slings for up to year for neurological conditions.

Not all horses have the personality to adapt to slings but when they do it is worth the effort. Slings require daily monitoring to prevent decubital ulcers.

The use of a sling to induce and recover patients that have long bone fractures neurological deficits or weakness is recommended. If the patients can receive even one training session before anesthesia they often adapt very easily.

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Conservative management of cervical intervertebral arthropathies and cervical compressive myelopathy

B. D. Grant, J.H. Cannon

Methods of conservative treatment include change of activity level, injection of osteoarthritic articular facets, dietary management in young horses, long-term anti-inflammatory therapy with NSAID's and Vitamin E. We have not had any direct experience with the benefit of alternative forms of therapy such as chiropractic manipulation or acupuncture.

There are a number of factors to consider in devising a conservative approach to the management of cervical cord compression. These include the accuracy of diagnosis, location of the cord compression, the degree of ataxia, insurance status, current occupation and the owner's reasonable expectations.

ACCURACY OF DIAGNOSIS AND LOCATION OF LESION

Ideally each patient will have had the diagnosis confirmed with a complete workup and especially a complete, diagnostic quality myelogram. The other common causes of ataxia such as EPM or EDM will also have been ruled in or out. If the workup shows only mild compression (<grade 2/5) at C3/C4 or C4/C5 in flexion only and the patient is trying to be shown as a dressage horse then a change in training, lowering expectations can produce a horse that is safe to ride on even safe surfaces. Avoiding the need or desire to have the cervical area in flexion reduces pressure on the cord.

The same lesions with more obvious clinical signs in a young racehorse candidate do not lend themselves to just a change in intensity of training. If the patient is under a year of age then a marked reduction in dietary supplementation (to slow the growth rate) and reduction of exercise (to reduce trauma to the cord) has been shown to result in athletes as two year olds.

Mild myelographic compression at C6/C7 in a horse that is currently being ridden without falling might respond to injections of the articular facets with corticosteroids if the myelogram shows the compression to be the result of synovial proliferation from an arthritic facet joint. If the compression at C6/C7 is due to a stenosis of the spinal canal then the chances of any improvement from an articular facet injection are greatly reduced.

If the clinical signs are greater than Grade 3/5 and the compression at C5/C6 or C6/C7 is very obvious then the chances of any response with medication, time, dietary change and reduction in the amount of exercise are very poor. Breeding stallions can be managed with the use of NSAID's but mares in this category will have a difficult time conceiving (unless done by AI).

DEGREE OF ATAXIA

The degree of ataxia must be taken into account when advising the owner's on treatment options. Patients that are greater than grade 3/5 can be at risk to themselves and should not be placed into situations that force them to contend with other horses, uneven and unsafe (muddy, frozen or snowy) paddocks as they are prone to fall and in the process injure themselves or spend countless hours unable to rise until discovered by their caretakers. They can also be at risk to their handlers as they can fall and injure the handler in the process or when the handler is trying to assist them to stand if they are recumbent. Patients in this category who have not been conditioned to handling and being led, feet picked up and examined are more prone to resist pressure on a halter and respond by sudden backing and rearing – often falling on their head with resultant fractures of the skull.

Patients with a neurological grade less than 3/5 can be turned out in a paddock and may function well in a herd situation as long as they are with compatible horses. . Patients that are less than a grade 3 and less than 2 years of age may show significant improvement if given a year or more for the cervical vertebra to remodel and reduce the compressive site. Patients over 2 years with a grade 2 or 3 ataxia do not have a good chance to respond.

Patients with signs less than grade 2 can respond if the work level (and Expectations) is significantly

reduced. If the compressive lesion is a result of an enlarged facet and the patient is a large patient (C6/C7) who has been kept in a stall then having more access to a paddock that allows them lie down in an unrestricted position are most likely to improve.

INSURANCE STATUS

The guidelines for the treatment of cervical compressive lesions varies with insurance companies, type of policies and the unique aspect of each patient/ owner / veterinarian involved. Euthanasia does not seem to be a conservative treatment method but if the patient is a grade 4 or 5 and the owners do not want to attempt surgical correction then euthanasia is indicated and most North American insurance companies would honor the claim. Many would do the same if 2 equine veterinarians would do the same if the patient was judged a grade 3/5. Horses with an ataxia grade less than 3/5 may or may not have a claim honored.

EXPECTATIONS OF OWNER

The degree of improvement with conservative therapy depends a great deal on the clinical signs, and the site and degree of cord compression. While anything is possible it would be difficult for me to assure the owner that improvement over one grade would occur. For example a 5 year old lesion with a grade 2/5 and a single or double level compression in flexion only that was presented due to inability to perform even entry level dressage is unlikely to progress to a entry level with a regime of NSAID's, Vitamin E, dietary reduction and a 4 to 6 month rest period.

In fact the most important aspect of conservative management is a reduction in the expectations of the owner.

If the owner is willing to change the occupation of the would be dressage horse to that of a pleasure or trail horse that can be ridden with the cervical area in a neutral position then outcome may be more favorable. Grade 2/5 patients do not usually become safe or useful trail horses as they do not enjoy going up or down hills and many will develop personality traits trying to avoid this type of activity. They usually will not stumble or fall but may do so if the trail is steep, has poor footing and they are startled by unusual objects or movements on the trail. We try to discourage the use of Grade 2/5 patients for trail work. The owners should be warned of the potential safety problems and young or inexperienced riders should not ride these horses.

Treatment of proximal interphalangeal joint subluxation in the dog with an external skeletal fixator

M. J. Guilliard

Subluxation of the proximal interphalangeal joint is common in high activity dogs and can be classified as stable, unstable or chronic. Treatment by external coaptation, prosthetic ligament replacement or primary ligament repair have, in the author's experience, given inconsistent results. Joint luxations all heal by periarticular fibrous irrespective of the treatment regime and require normal articular surface congruency throughout the repair process. The hypothesis is that if the proximal interphalangeal joint is rigidly held in normal congruency then periarticular fibrosis would give satisfactory support and allow a return to normal function.

A prospective study was undertaken in which the joint was supported for three weeks by a transarticular fixator comprising of two 1.1mm arthrodesis pins inserted into the first phalanx and two into the second phalanx, and the pins joined with a connecting bar of epoxy resin.

This procedure has been performed on six dogs to date, three being classified as stable, two as unstable and one as chronic. Post-operative complications were recorded in four dogs involving pin loosening, pin migration, osteomyelitis and impingement on the neighbouring digit. All these complications resolved after frame removal. Complications were thought to be due to suboptimal position of frame placement and post-operative bandaging of the foot. Safe corridors for pin placement are dorsal to the coronal midline excluding the sagittal midline along which is found the digital extensor tendon. The mechanically optimal positioning for the fixator is over the torn ligaments but, due to small lateral forces, placement anywhere in the dorsal quadrants will suffice.

Five of the six dogs have now returned to normal activity with no instability of the joint or lameness. Periarticular thickening is minimal. The author concludes that the hypothesis is proven and the external fixator is a successful way of treating this injury. The study is continuing.

Juvenile Pubic Symphysiodesis (JPS) in dysplastic puppies

R.T. Dueland, A.J. Patricelli, W.M. Adams, K. Hayashi

Canine hip dysplasia can be a severely debilitating condition, most commonly seen in large breed dogs. Current surgical treatment options (triple pelvic osteotomy, excision arthroplasty, femoral osteotomies, shelf procedures, total hip arthroplasty, etc.) are often initiated after clinical signs and with varying degrees of degenerative joint disease (DJD) in progress. Many of these procedures are costly, with post-operative exercise limitations, discomfort, and physical therapy requirements.

A new surgical technique, juvenile pubic symphysiodesis (JPS), originally reported in immature guinea pigs¹ prompted our initiation of JPS investigations in young puppies.^{2,3,4} In this presentation we will discuss theory, indications and contra-indications, limitations of JPS, objective and subjective interpretation of results, and future indication for research. A total of 54 dogs were used in our studies (45 treated, 9 controls). Cox-ofemoral joints had major evaluations pre-operatively and at follow-ups by: transverse CT, laxity palpation, and limb extended and stress radiography. Testing included Ortolani palpation, measurement of hip reduction angle (HRA), hip-extension with pain scoring, force plate gait analysis, radiology-DJD scoring, Norberg angles, distraction (laxity) index (DI), acetabular angle (AA), and dorsal acetabular rim angle (DARA). After surgical exposure, JPS puppies received symphysiodesis by electrocautery applied every 2-3 mm along the pubic symphysis. The electrocautery dose was generally 40 watts for 12-30 seconds depending on pubic size. All puppies in this study are owned, and were in four groups: pilot study, cautery dose response group, age response group, and Veterinary Medical Teaching Hospital (VMTH) clinical cases. Pubic symphysiodesis was performed between 12 to 24 weeks of age. Spatula or needle monopolar cautery electrodes were used after calibration of electrocautery machines so that wattage could be controlled.³ With the exception of the dose response dogs (n=11) that had JPS and were biopsied and examined microscopically, all JPS cases and controls were rechecked at one year and at 2 years of ages if available. Data were analyzed using t-tests, one way ANOVA with contrasts, linear regression, and McNemar's testing.

When the VMTH schedule permits, our desired protocol is to perform all diagnostic palpation/gait observations/pain response and CT/radiographic tests to determine eligibility for JPS, and perform surgery under the same anesthesia. Inclusion for surgery was determined mainly by the degree of stress radiographic laxity. Only pups with $DI > 0.30$ were treated by JPS. We categorized laxity as $DI < 0.30$ = no laxity, mild laxity = $0.30-0.49$, moderate laxity = $0.50-0.69$, and severe laxity ≥ 0.70 . All surgeries were completed within 30 minutes. Post-operative recovery was excellent, other than an initial loose stool. All puppies were entirely normal within the usual recovery time after surgery (12 hours). Many pups were discharged the same day as surgery. After suture removal there were no exercise restrictions. Neutering of all dogs treated by JPS either at the time of JPS surgery or later, is mandatory to prevent misrepresentation by the owner.

Compared to controls, JPS treated dogs showed marked improvement in all measurable aspects at one and two years of age ($P < 0.05$). Objective result comparing pre-op values to one and two years of age respectively were: JPS AA, 26% and 31% improved acetabular coverage, control not significant (ns); DARA, 31% and 37% improvement, controls ns; and DI, 16% and 40% decrease in laxity ($P < 0.05$), controls, 1 year ns, 2 years 20% decrease in DI. Norberg angles improved significantly in JPS dogs on both distracted and hip extended radiographic views. At one year of age all dogs (JPS and controls) had a normal gait by force plate analysis.

Subjective results: Pre-operatively 28/34 treated dogs were Ortolani positive (at least in one hip). At one year of age, 18/31 dogs had converted to negative ($P < 0.01$), a 40% improvement; at two years 15/18 were negative, a 65% improvement from the pre-op value. All controls were positive and remained so. Evaluating DJD radiographically was done pre-operatively and at 1-2 years of age to determine whether the DJD was better, static (not degenerating), or worse than pre-operative values. In controls 71% (5/7) were worse. In 69% of JPS treated dogs the radiographic signs of DJD were improved or did not progress. When JPS dogs were analyzed for DJD by less than 19 weeks at surgery, or older than 19 weeks-the breakdown was as follows: $< 19W = 77%$ static or improved, $> 19W = 63%$ were static or improved.

These studies clarified the responses of young dogs to JPS surgery. The procedure, by limiting growth of the pubis and pubic rami, rotated the acetabula ventrally - similar to results in the guinea pig, thereby improving the coverage of the femoral head. We interpret the JPS decreased in laxity (DI) over time as a result of improved conformation (AA and DARA), with resultant diminished forces acting on the hip joint.

In contrast we feel the decrease in control DI that occurred mainly between year one to year two was secondary to increased hip stresses with resultant increased DJD. Clinically it is well known that DJD acts to tighten the coxofemoral joint by a fibrotic response.

Limitations of our studies include an unreliable response of owners to return for the two year follow-ups, use of "unofficial" in-house DI determinations, a limited number and only one year post-operative force plate gait evaluations, and early loss to follow up of two controls and one JPS dog.

In conclusion, our experience indicates objectively and subjectively that JPS improves hip conformation and aids in alleviating the progressive degenerative results of hip laxity seen in hip dysplasia. Severe hip laxity and delayed surgery diminish the beneficial results. Dogs older than 24 weeks and dogs with DI greater than 0.70 will have less improvement in hip conformation. Our results indicate the best "window of opportunity" for JPS to be performed is within 12 to 20 weeks of age.^{2,4} Testing of the low and higher ages and additional longer-term DJD results are needed to further verify the excellent results seen to-date. Although JPS is not a cure-all, the procedure appears to be benign and improves or alleviates the degree of severity of hip dysplasia.

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Cellular and extracellular matrix transformation in ruptured canine cranial cruciate ligament

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INTRODUCTION

Progressive rupture of the cranial cruciate ligament (CCL) and concurrent development of osteoarthritis is one of the most prevalent orthopedic diseases in dogs. Although acute ligament injury does occur because of single-event overload from trauma, the majority of CCL ruptures appear to occur secondary to progressive adaptive changes within the ligament tissue over a period of time. It has been reported that characteristic age-related adaptive changes occur within the CCL of larger dogs, including loss of ligament fibroblasts, metaplasia of surviving cells from ligament fibroblasts to chondrocytes, and failure to maintain normal collagen fibers and primary collagen bundles. We hypothesized that the phenotypic transformation of ligament fibroblasts and the associated changes to the ligament extracellular matrix may precede rupture, and may predispose to structural failure of the ligament during normal daily activity. However, the cell signaling pathways that regulate these adaptive changes in rupturing CCL are unclear. Furthermore, the degree and magnitude of the cellular and matrix changes in ruptured CCL have not been studied in detail. The purpose of this study was to determine qualitative and quantitative alterations in cellular and matrix constituents in dogs with CCL rupture and in young-normal dogs with intact CCL.

MATERIALS AND METHODS

Ruptured ligament specimens were collected from 29 clinical cases at the time of removal of ruptured CCL during surgical treatment, and intact CCL specimens were obtained from 6 young normal dogs without stifle joint pathology that were used for other approved research projects. CCL specimens were evaluated histomorphometrically for cell number density and fibroblast phenotypes in the two regions-of-interest for each CCL specimen: (1) the core region that was distant from the synovial surface and comprises the major portion of the ligament tissue; and (2) epiligamentous region that was adjacent to the synovial surface. CCL fibroblasts were determined to be fusiform, ovoid, or spheroid phenotype based on their shape and nuclear aspect ratio and counted. The birefringence of ligament extracellular matrix was determined by examination of the CCL core region in circularly polarized light. The percentage area of normal birefringence was determined for each image quantitatively using pixel counting. Collagen hierarchical structure was quantified by measuring crimp angle (θ) and true (L), as opposed to projected (d), crimp length using circularly polarized light microscopy. The Student's *t* test and Mann-Whitney U test were used to compare ruptured and normal CCL groups for parametric data and non-parametric data respectively. Repeated-measures analysis-of-variance was used to evaluate the effect of CCL region and status on cell number density. Simple linear regression analysis was performed to correlate independent values (body weight, age, duration of lameness) to ruptured CCL dependent variables. Differences were considered significant at $P < 0.05$. Probability values less than 0.15 were reported as trends.

RESULTS

Both CCL region and rupture status had significant effects on cell number density ($P < 0.0001$). CCL rupture was associated with significant loss of ligament fibroblasts and significant changes to the phenotype of the remaining cells, as well as expansion in the volume of the epiligamentous region. Bridging scar tissue was not seen between the ends of the ruptured CCL. In the core region, there was loss of cells with rupture (280.3 ± 144.1 cells/mm²), compared with normal CCL (693.3 ± 249.8 cells/mm²) ($P < 0.001$), whereas in the epiligamentous region, cell number densities were similar in ruptured CCL (3524 ± 1453 cells/mm²) and normal CCL (3247 ± 434.9 cells/mm²) ($P = 0.7$). In the core region, CCL rupture was associated with decreased number densities of fusiform and ovoid cells, and an increased number density of spheroid cells ($P < 0.001$). In the epiligamentous region, CCL rupture was associated with only an increase in the number density of spheroid cells ($P < 0.05$). Birefringence and a crimped pattern to the matrix collagen was seen in normal CCL when viewed using circularly polarized light. In ruptured CCL, birefringence was absent in the regions of the matrix which had an amorphous glassy appearance, when viewed with bright light. Birefringent tissue area ($17.8 \pm 13.0\%$) was decreased in ruptured CCL, when compared with normal CCL ($72 \pm 5.5\%$) ($P < 0.001$). Eleven of 25 (44%) specimens from dogs with CCL rupture had no detectable crimp when viewed under circularly polarized light. In 14 of 25 specimens (56%) the crimp of the

collagen fibers in residual fibrous portions of the ruptured CCL appeared irregular and elongated, when compared with normal CCL. In the ruptured CCL specimens in which crimp was detectable, crimp length was significantly longer than in normal CCL ($P < 0.01$), and there was a trend for crimp angle in ruptured CCL to be smaller than in normal CCL ($P = 0.10$). Age, body weight, and duration of lameness did not significantly influence total cell number density, cell number density of each phenotype, birefringent tissue area, crimp length and crimp angle in the ruptured CCL ($P > 0.05$).

DISCUSSION

We found loss of ligament fibroblasts, chondroid transformation of cells to a spheroid phenotype, and disruption to the organized hierarchical architecture of the matrix collagen in the core region, including loss of birefringence and loss of crimp. These data suggest that, over time, CCL adaptation to microinjury or aging may be associated with progressive structural weakening, and may eventually predispose the CCL to completely rupture under normal loading. Although ruptured CCL exhibits a proliferative epiligamentous repair response, there is a lack of any bridging scar formation. A more detailed understanding of the biology of the response of the CCL to rupture will be key to the development of novel approaches to prevent rupture and facilitate healing of this important tissue.

Force plate data from ketoprofen trial

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M. Pollmeier, P.D. Hanson

A study was conducted in 8 Labradors to determine the lowest effective analgesic dose of ketoprofen. Three different dose levels (i.e., 0.25, 0.5 and 0.75 mg per kg body weight [bw]) were tested double blind and compared with placebo controls. Arthritis was induced by intra articular (i.a.) injection of sodium urate crystal. The efficacy was determined by improvement in peak vertical force weight bearing on force plate analysis. Analysis of results revealed that 0.25 mg/kg ketoprofen administered orally once (1 dd, p.o.) was significantly better ($p < 0.01$) than the control (0 mg) at each time point following i.a. urate crystal injection, and 0.5 and 0.75 mg/kg ketoprofen 1dd, p.o., did not yield increased weight bearing.

Consecutively the efficacy and safety of 0.25 mg ketoprofen/kg bw, 1 dd, p.o., was evaluated when administered daily for 30 days in 8 other Labradors using force plate analysis before, at Day 1, and at Day 29 of the 30 day period. The beneficial effects of 0.25 mg/kg ketoprofen was constant over 30 days of administration, with approximately 90% of baseline vertical force at 4 hours after i.a. injection in ketoprofen treated dogs on Day 1 and Day 29 compared to approximately 40% of baseline in untreated dogs.

We concluded that ketoprofen at 0.25 mg/kg bw once per day provided effective analgesia in arthritis in dogs. No gastrointestinal or other side effects are observed with this dosage during treatment for long periods. This reduced dosage of ketoprofen in dogs is both a safe and effective analgesic drug.

Use of real time quantitative reverse transcriptase polymerase chain reaction (RT-PCR) for assessment of a molecular marker of canine osteoarthritis

D. Hulse, P. Spencer, D. Kochevar

Osteoarthritis (OA) affects more humans and dogs than almost any other musculoskeletal disorder. Although surgical intervention is an option for some cases with OA, most are treated medically. Identification of reliable, objective parameters for diagnosis of disease and measurement of treatment effectiveness has been challenging. Presently, clinical assessment and radiographic changes are the most commonly used methods for diagnosis and evaluation of treatment. Many protein-based assays (e.g., enzyme linked immunosorbent assays (ELISAs) or bioassays for matrix metalloproteases) have been used in dogs for diagnosis and assessment of early OA. However, clinical investigations have shown lack of sensitivity and reproducibility of these modalities as well as lack of correlation with clinical function. The objective of this study was to validate the usefulness of real time rt-PCR as compared to a standard bioassay for measurement of tumor necrosis factor (TNF) alpha, a molecular marker of canine OA. TNF alpha promotes joint degeneration by inhibiting extracellular matrix synthesis, inducing synthesis of degradative enzymes such as collagenase, stromelysin and aggrecanase, and by induction of other cytokines such as interleukin one beta.

DESIGN

TNF alpha was assessed in two sample sets: 1) medium harvested from cultured canine macrophages (DH82 cells) stimulated to produce TNF alpha by incubation with lipopolysaccharide (LPS) and 2) in synovial fluid (SF) collected from normal dogs (n=7). All samples were assessed using two methods: 1) a routinely used bioassay assessing TNF alpha inhibition of proliferation of cultured murine WEHI clone 13 cells and 2) real time rt-PCR.

RESULTS

TNF alpha Bioassay: A standard curve was constructed using human recombinant TNF alpha (detection limit 10 pg/ml). Canine SF samples spiked with recombinant human TNF alpha were processed prior to assessment using the WEHI bioassay. After yield from sample processing was considered, the bioassay detection limit for human recombinant TNF alpha spiked into canine SF was approximately 50 pg/ml. As a positive control for WEHI bioassay detection of canine TNF alpha, medium from LPS-stimulated DH82 canine macrophages was assessed and found to contain activity equivalent to approximately 3 ng/ml of recombinant human TNF alpha. TNF alpha concentration in normal canine SF was below the level of detectability of the WEHI bioassay. **Real time rt-PCR:** Pre-spinning SF prior to RNA extraction resulted in the sedimentation of >95% of the RNA present indicating that the majority of RNA was contained within intact cells. Theoretical RNA yield per cell is approximately 10 pg (approximately 75 copies of the glyceraldehyde-3-phosphate dehydrogenase (GAPDH) control gene message), representing the detection limit of real time rt-PCR for GAPDH expression. The cycle at which a given reverse transcribed message amplifies is referred to as the cycle threshold or Ct value. Ct values obtained for a pair of expressed genes should give the same ratio between any two points regardless of the concentration of RNA assayed. In practice this relationship was found to deviate at both very high and low RNA copy numbers. Therefore accurate determination of expression ratios was confined to a region which spanned some five orders of magnitude RNA concentration. The detection limit for cytokine mRNA was dependent upon both the level of intracellular gene transcription and the number of cells within the population expressing the message. For TNF alpha, the detection limit from normal canine SF was 100 cells (0.1 µl SF). However, to establish an accurate Ct value for gene expression required at least 2 orders of magnitude more RNA (e.g., for TNF alpha, 10 µl SF or 10⁴ cells per assay). TNF alpha expression could be detected and accurately determined in normal canine SF at a level approximately 1% that of the control GAPDH gene and 1% that measured in LPS-stimulated canine DH82 macrophages. TNF alpha was detected at an average Ct of 27.02 (std.dev.= 1.99) in normal canine SF.

CONCLUSIONS

Real time rt-PCR compared favorably with the WEHI bioassay technique for evaluation of canine TNF

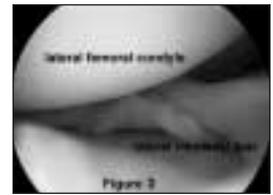
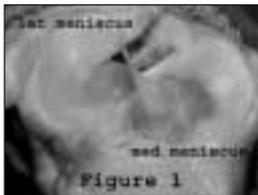
alpha and was able to detect TNF alpha mRNA in samples of normal canine SF in which TNF alpha was undetectable by bioassay. Real time rt-PCR was superior to the bioassay technique in that it allowed for sensitive, convenient and rapid assessment of an mRNA marker using small volumes of sample compared to larger volumes needed for bioassay measurement. Additional real time rt-PCR assays could be developed for screening of new markers by preparing additional primer-probe combinations for use with the RNA originally extracted for the first real time rt-PCR assay.

Is Meniscal Release Necessary?

D. Hulse

ANATOMY AND FUNCTION

The lateral and medial menisci are two semilunar fibrocartilage discs interposed between the femur and tibia. They are positioned in the joint with the open side of the "C" facing the midline and are held in place by cranial meniscotibial ligaments, caudal meniscotibial ligaments, and meniscocapsular ligaments. The lateral meniscus has an additional ligament which inserts into the caudal intercondyloid fossa of the femoral condyles. (Fig 1) This ligament and loose meniscocapsular ligaments of the lateral meniscus render it (the lateral meniscus) more mobile than the medial meniscus. Clinically, the lack of mobility of the medial meniscus predisposes it to injury in the CCL deficient joint. The menisci are important intra-articular structures; functions attributed to the menisci include: 1.) load transmission and energy absorption, 2.) rotational and varus-valgus stability, 3.) lubrication, and 4.) rendering joint surfaces congruent. Almost all meniscal tears causing clinical lameness in dogs are associated with cranial cruciate ligament ruptures. The incidence of meniscal tears in conjunction with CCL ruptures may be as high as 75% and almost always involve the caudal body of the medial meniscus. This is because the craniocaudal instability associated with CCL rupture displaces the medial femoral condyle caudally during flexion of the stifle joint. The caudal body of the medial meniscus becomes wedged between the femur and tibia and is crushed upon weight bearing and extension of the joint. The most common type of tear is a "bucket handle tear" of the medial meniscus. (Fig.2) This is a transverse tear in the caudal body of the medial meniscus which extends from medial to lateral in a transverse direction. The free portion of the meniscus is frequently folded forward with these tears. The second most frequently seen meniscal injury is a peripheral meniscal tears. These injuries are associated with a severe traumatic episode which results in a multiple ligament injuries. Clinically significant isolated meniscal injuries are not common in the dog. Small radial tears of the lateral meniscus are frequently seen on arthroscopic examination of the CCL deficient stifle joint but these are not clinically significant. Clinically significant isolated meniscal tears involving the mid-body of the lateral meniscus are rarely diagnosed. These have been associated with a fall and twisting. (Fig. 3)



PHYSICAL EXAMINATION FINDINGS

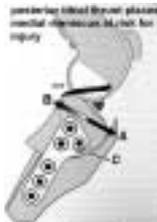
Meniscal injury is almost always associated with cranial cruciate ligament injury. Often the client will report a popping sound when the dog walks or one will feel a popping sound upon examination of the stifle. This is due to movement of the "free" section of the bucket handle tear. Not all patients with meniscal tears will present with an audible or palpable click. Close inspection of the medial and lateral menisci at surgery will provide a definitive diagnosis.

TREATMENT OF MENISCAL INJURY

Inspection and treatment of meniscal injuries must be completed at the time of CCL reconstruction whether performed through the arthroscope or open joint surgery. If one encounters a bucket handle tear of the medial meniscus, removal is indicated. (Fig.4) The caudal body of the meniscus is torn in a transverse direction. The torn meniscus retains an attachment at the lateral border near the meniscotibial attachment (axial) and at the medial border near the center of the meniscal body (abaxial). The treatment method that results in the least long term OA is partial meniscectomy. Through the instrument port, insert a right angled probe beneath the torn meniscus and pull it forward maintaining slight

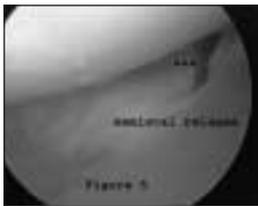


tension. Transect the abaxial attachment of the “bucket handle” with a hand instrument or tissue ablator placed through the instrument port adjacent to the angled probe. Once the abaxial attachment is released, excision of the body of the bucket handle tear is accomplished with the ablator, motorized shaver, or basket forcep.



Following removal of a torn section of meniscus or if the meniscus is not injured at original surgery, the question then becomes whether the surgeon should or should not perform a prophylactic procedure. Techniques used for treatment of a CCL deficient stifle joint are intra-articular reconstruction, extra-articular reconstruction, or TPLO. Reconstructive techniques do not provide absolute stability in most cases leaving the caudal horn of the medial meniscus at risk for injury after reconstruction. Follow up reports on reconstructive techniques suggest an incidence of 10 - 15% meniscal injuries following surgery.

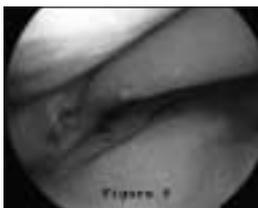
TPLO also places the caudal horn of the medial meniscus at risk for injury following surgery. Rotation of the tibia and the creation of a posterior tibia thrust with weight bearing contribute to a high incidence of meniscal injury following TPLO. Given the incidence of meniscal injury following a reconstructive procedure prophylactic meniscal treatment might be considered. However, with the advent of arthroscopic intervention, addressing a meniscal tear carries little morbidity in the 10-15% of cases requiring a second surgery. However, given the high incidence of meniscal injury following TPLO, prophylactic meniscal therapy should be strongly considered. Prophylactic meniscal therapy can take the form of meniscal release or meniscal ablation. Each has its own unique clinical and theoretical advantages and disadvantages.



MENISCAL RELEASE

Meniscal release is a technique describe by Slocum to prevent meniscal injury following a TPLO. Slocum believes the TPLO procedure will place the caudal body of the medial meniscus in a position where it can be frayed postoperatively. Releasing the meniscus allows caudal retraction of the body to a position where it is unlikely to be crushed by the medial femoral condyle.

The theoretical disadvantage of a meniscal release is that normal hoop stress function of the meniscus is lost. Experimentally, a meniscal release is identical to a radial tear through the body of the meniscus. The result is increased local stress concentration on the tibial plateau and femur. However, clinically, a meniscal release does not appear to be detrimental to clinical function and does not appear to result in compartmental arthritis. Perhaps as the radial cut through the meniscus (meniscal release) heals, the caudal body is less subject to injury and affords some cushioning for the articular surface. The technique of arthroscopic meniscal release can be approached from inside the joint or from outside the joint. To perform an outside to in meniscal release, pass a guide needle into the joint. The point of guide pin entry is caudal to the medial collateral ligament. The guide pin is then directed to triangulate with the arthroscope. Once the guide pin is visualized and in position, pass a number 11 scapel adjacent to the pin and transect the body of the meniscus. An intra-articular meniscal release can be performed at the caudal tibial meniscal insertion or through the central meniscal body. Visualize the area to be released and insert the cutting instrument through the instrument port. Transect the meniscus under arthroscopic guidance.



MENISCAL ABLATION

Meniscal ablation is a technique used for frayed menisci or for prophylaxis with TPLO in lieu of a meniscal release. The medial meniscus is visualized arthroscopically. If frayed or if incomplete radial tears are present, ablate the damaged meniscus. Place an ablation probe through the instrument port and under arthroscopic guidance ablate the damaged meniscus. (Fig. 6) Meniscal ablation can be used with TPLO. The premise of this procedure is that by prophylactically removing the thin central section of the meniscus, the incidence of future meniscal injury is decreased. Also, this procedure simulates a partial meniscectomy and partially preserves the mechanical function of the meniscus. This is conjecture and is not proven scientifically.

Visualize the medial meniscus. Under arthroscopic guidance, ablate the central section of the meniscus caudally to the peripheral rim.

Fabellar fractures in the dog

J.E.F. Houlton

The paired fabellae are sesamoid bones found within the two tendons of origin of the gastrocnemius muscle. Their major function is to protect these tendons from high frictional forces.

Fractures of the fabellae are an uncommon cause of lameness. This presentation is based on eight cases seen in seven dogs⁽¹⁾. Four were Border collies or Collie crosses, two were Labrador Retrievers while the remaining one was a Golden Retriever. They either went lame at the end of exercise or during running but in no instance could the owner associate a traumatic event with the onset of signs. Five of the seven dogs were skeletally mature.

The clinical picture was similar in all cases. The dogs continued to use the affected limb but walked with a restricted stifle movement. The lameness deteriorated with exercise and the limb was stiff after rest. In all instances, the fracture involved the lateral fabella and point pain could be elicited when the joint was palpated. Range of joint movement was normal and there was no evidence of joint laxity or effusion.

Four dogs were treated conservatively with 10–15 minutes lead exercise twice daily. In the remaining cases the lateral fabella was surgically excised. The latter group became sound sooner (2 out of 3 sound by 6 weeks; the third being lost to follow up) while the conservatively treated group took 10 weeks (3 dogs) and 12 weeks (1 dog).

The conservatively treated fractures healed in a very characteristic fashion. The fragments lost their sharply delineated borders and the intervening spaces gradually filled with mineralised callus. This reflects the environment of the fabella. There are considerable tensile forces encouraging the formation of fibrous tissue rather than primary bone healing. Moreover, as the fabella lacks a periosteum, it has a low osteogenic potential.

It is suggested that lateral fabellar fractures occur spontaneously. One possibility is that the normal balance between the gastrocnemius and quadriceps muscles is lost. When the stifle is extended, inward rotation of the tibia is largely restrained by the lateral collateral ligament and the stability of the femoropatellar joint. This stability is influenced by the axis of the quadriceps muscle and the straight patellar ligament, by the muscular forces on the fascia, the conformation of the trochlea and the integrity of the retinacula. Unusual muscular forces probably play a role in this cause of this injury.

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Catabolic cytokines and canine articular cartilage degeneration

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B. Caterson

One of the earliest features of cartilage degradation, a hallmark of joint diseases, is proteolysis and loss of the proteoglycan aggrecan, which severely impairs the load dissipating properties of the tissue. While there is significant evidence in other species that catabolic cytokines play a central role in cartilage degeneration in arthritis, there is limited information on the response of canine articular cartilage to these agents.

We have evaluated the effects of cytokines implicated in joint disease (IL-1alpha, IL-1 beta, TNF-alpha, IL-6 ± IL-6 soluble receptor (IL-6SR) and oncostatin M (OSM)) as well as LPS and retinoic acid (RA), on the induction of canine articular cartilage catabolism in vitro. Outcome measures included proteoglycan release, Western blot analysis for aggrecanase and matrix metalloproteinase (MMP)-generated aggrecan metabolites and RT-PCR analysis using primers for the aggrecanases (ADAM-TS4 & -TS5), MMPs-1, -3 & -13 and TIMPs-1, -2 & -3.

Canine articular cartilage was metabolically responsive as shown by the 8-fold increase in aggrecanase generated proteoglycan loss from the tissue with RA treatment. In contrast with cartilage from other species, IL-1alpha, IL-1-beta, TNF-alpha, IL-6 ± IL-6SR ± IL-1 or LPS stimulated no degradation of aggrecan in normal canine cartilage. Surprisingly, OSM without co-stimulation with IL-1 or TNF, induced a 5-10 fold increase in aggrecan loss, which resulted from aggrecanase but not MMP activity. Nevertheless, OSM upregulated expression of mRNAs for MMP-1, -3 & -13 as well as ADAM-TS4 & -TS5.

These studies have demonstrated significant differences in the catabolic response of canine cartilage compared with that from other species. Elucidation of the pathophysiologic effectors involved in the initiation and progression of articular cartilage destruction may provide therapeutic targets for arthritis treatment.

Fatigue study of 2.7 mm cortical screws used in a 6 mm diameter interlocking nail

R.L. Aper, K.A. Johnson, A.S. Litsky, S.C. Roe

The purpose of this study was to determine the fatigue strength of 2.7 mm diameter cortical bone screws currently used in the 6 mm interlocking nail. The effects of bone diameter and eccentric loading of the screw on fatigue strength were examined. The authors hypothesized that the fatigue strength would 1.) decrease with an increase in the diameter of the bone, and 2.) increase with eccentric loading of the screw.

Locking screws were tested in cyclic three point bending for fatigue strength. A simulated bone model using aluminum tubing and a 6 mm diameter interlocking nail were used to cyclically load each screw in tension. Each screw was cycled at a rate of 10 Hz, with a peak load of 300 N reached during each cycle. The number of cycles until implant failure was recorded. Three groups of screws were tested with 6 screws in each group. Group 1: 2.7 mm cortical screws centrally loaded within 19 mm (3/4") diameter aluminum tubing. Group 2: 2.7 mm cortical screws centrally loaded within 31.8 mm diameter aluminum tubing. Group 3: 2.7 mm cortical screws loaded an offset distance of 5.5 mm (7/32") from center in the 31.8 mm diameter aluminum tubing. Data were examined to determine the effect of bone diameter (Group 1 vs. Group 2) and eccentric loading (Group 2 vs. Group 3).

An increase in the diameter of the aluminum tubing from 19 mm to 31.8 mm resulted in a significant decrease in the number of cycles to failure (761,215 +/- 239,853 and 16,941 +/- 2,829, respectively). Eccentric loading of the locking screw resulted in a significant increase in the number of cycles to failure (16,941 +/- 2,829 and 43,068 +/- 14,073, respectively).

Within a bone, locking screws are subjected to different loading conditions depending on location (diaphyseal vs. metaphyseal). The results of this study indicate that the fatigue life of a locking screw centrally loaded in the metaphyseal region of bone may be significantly shorter than in the diaphysis. Eccentric loading of the locking screw in the metaphysis may help to improve its fatigue life.

Synovial fluid markers of spontaneous osteoarthritis in dogs

K.A. Johnson, C.W. Hay, Q. Chu, S.C. Roe, B. Caterson

INTRODUCTION AND HYPOTHESIS

Currently there is considerable interest in using synovial fluid markers of osteoarthritis (OA), such as 3B3 and 7D4, for early diagnosis, and the monitoring of progression and response to therapy. We hypothesised that concentrations of these two markers in joints of dogs with spontaneous OA would be elevated, and that concentrations would be correlated with stage and severity of OA.

MATERIAL AND METHODS

In 95 dogs with naturally acquired CCL rupture and varying degrees of secondary OA, synovial fluid was assayed for 3B3 and 7D4 by ELISA, and for glycosaminoglycan (GAG). Correlations of marker concentrations with demographic data, duration of lameness, radiographic score of OA, and extent of intra-articular pathology, including CCL rupture and medial meniscal injury were calculated. As controls, synovial fluid from canine knees that had undergone experimental CCL transection 13 weeks previously ($n = 8$), and from normal canine knees ($n = 24$) were also assayed.

RESULTS

Concentrations of 7D4 and 7D4/GAG in synovial fluids from joints with both spontaneous and experimental OA were significantly elevated above values for normal joints. Although 3B3 concentrations in both OA groups were similar, it was only in spontaneous OA that the 3B3 concentration was significantly greater than the normal control group. Within the spontaneous OA group there was a significant correlation between 3B3 and 7D4 (Spearman correlation = 0.3973, P-value for independence = 0.0001). However, there were no significant correlations in marker concentration with continuous demographic or disease-related variables, or differences in marker concentrations with different categories of disease.

DISCUSSION

These synovial fluid marker concentrations were useful indicators of naturally acquired OA. However, further understanding of these markers is needed before they can be used to monitor disease progression or response to therapy.

Comparative Imaging

B. Kaser-Hotz, M. Reiser

While modern imaging modalities, such as computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound (US) are widely used in patient care of human individuals, their diffusion in veterinary medicine is limited. Moreover, a large amount of clinical experiences could be accumulated in humans, which might be valuable for further implementation of imaging modalities in veterinary medicine. In this lecture, which aims to be a dialogue between human and veterinary medicine, the application of modern imaging modalities in various pathological entities will be discussed and emphasis will be put on musculoskeletal trauma and degeneration as well as neoplasms of various organ systems.

TRAUMA

CT and MRI may be very useful in the assessment of traumatic injuries, both to the bones and soft tissues. When plain films and ultrasound nondiagnostic or ambiguous, CT and MRI may serve as "problem solving tools".

Occult fractures which remain undetected on adequately performed and interpreted plain radiograms, mainly undisplaced or minimally displaced fractures or when superimposition by other bony structures prevents for detection. On CT, even tiny fracture lines are visualized. In MRI, the fracture line is readily delineated and adjacent bone marrow edema and hemorrhage highlight the underlying traumatic injury. **Bone bruises** are due to blunt trauma to the bones, frequently located in a subchondral area. They are most sensitively detected with fat saturation techniques. In the early stages, **stress fractures** are not detected on plain radiograms while they may be symptomatic. MRI enables to early detect stress fractures as horizontal, oblique or longitudinal linear signal alterations. Extensive bone marrow and soft tissue edema in stress fractures may mimic other pathologies such as malignant bone tumors or infection. In MRI, **ligaments and tendons** exhibit a uniform low signal intensity. Dependent on the degree of injury, circumscribed or extensive signal alteration or even disruption can be detected. **Hyaline cartilage** is well displayed on MRI. Good contrast versus adjacent subchondral bone and fluid within the joint space can be obtained.

ONCOLOGY

MRI proved to be the method of choice for the assessment and staging of **bone and soft tissue tumors**. Intramedullary extent and extraosseous infiltration of bone tumors are clearly visualized. MRI adds in precisely assessing the longitudinal extent of a lesion. The affected compartments are clearly identified and the involvement of neurovascular structures can be verified. Viable tumor components, necrosis and hemorrhage can be characterized due to their signal intensities and contrast material enhancement. CT and MCT is valuable for the assessment of **ENT tumors** and detection of infiltration into adjacent structures. In early laryngeal tumors the examination is performed with e-phonation and Valsalva manoeuvre in order to assess the motion of the vocal cords. For the diagnosis of **brain tumors**, MRI is highly useful and can be regarded as method of choice. The tumor and adjacent brain edema, as well as intratumoral hemorrhage are readily displayed. Contrast enhancement and brain edema aid in the differentiation of benign and malignant tumors.

Advanced imaging

B. Kaser-Hotz, M. Reiser

Even if alternative physical principles for purposes of imaging have been proposed recently (e.g. molecular imaging) the most important innovations are based on improvements in existing technologies, such as CT, MRI, PET, and novel contrast agents. Moreover, postprocessing of imaging data and image based navigation systems proved their clinical utility.

COMPUTED TOMOGRAPHY (CT)

Major innovations of CT-technology were reduction of scanning times as well as spiral (helical) scanning. Multislice CT (MSCT) was another quantum leap. With simultaneous acquisition of 4, 8 and 16 slices respectively, the potential of CT was greatly enhanced. Combined with a reduction of scanner rotation time to less than 500 ms, imaging time could be accelerated by a factor of 8 to 32. This can be employed in different ways: To shorten acquisition time in non-cooperative and severely ill patients and to improve spatial resolution in the longitudinal (Z-) axis. Due to the high Z-axis resolution of 0,75 to 1mm, isotropic voxels are generated allowing for high quality secondary reconstructions or 3-D-visualisation techniques. When hollow organs, such as the GI-tract, biliary system, tracheobronchial tree are filled with contrast agent or have an intrinsic high contrast, virtual endoscopic views and fly throughs can be made. Superb CT-angiograms can be obtained following i.v. contrast. Also vessels with small diameter are clearly visualized. MSCT also enables to delineate and characterize the vessel wall and plaques.

CT is increasingly used for interventional procedures. CT-fluoroscopy and CT-based navigation systems enable for highly accurate procedures. CT-guided biopsy, and drainage procedures are well established. Recently, CT guided thermotherapy (radiofrequency or laser ablation) of various malignancies, became treatment options. In osteoporotic and neoplastic compression fractures, CT guided vertebroplasty and kyphoplasty has been introduced. CTPET machines, a combination of an CT and PET-scanner allow for simultaneous acquisition of CT and PET data. The metabolic and functional information gained with PET can thus be precisely localized.

MAGNETIC RESONANCE IMAGING (MRI)

Major achievements in MRI include higher field strengths, gradient systems with superior performance and "parallel imaging" techniques. Array coils with multiple channels allow to greatly increase volume coverage without sacrificing spation resolution. All these technical innovations contribute to major advances in terms of scanning speed, as well as spatial and temporal resolution. MR-angiography (MRA) is performed following intravenous injection of Gadolinium-chelates. With phased-array coil assemblies large vascular territories, such as the supraortic vessels from the aortic arch to the intracerebral vessels can be readily depicted. In the examination of the abdomen, chest and heart, breath-hold examinations eliminate motion artifacts. Great progress has been achieved in cardiac imaging. Various types of dynamic (cinematic) MRT studies enable for the visualization of physiologic organ movements. Pelvic floor disorders or joint motions can be assessed with this method.

Trauma to the chest, what is the rush?

J. Kirpensteijn

INTRODUCTION

Emergency thoracic surgery poses a challenge for the practising veterinarian. Trauma cases are often presented without warning and need immediate veterinary attention. During this seminar, the most common surgical thoracic emergencies are presented in an interactive manner. Active participation of the audience is expected.

HISTORICAL ASSESSMENT AND PHYSICAL EXAMINATION

The most important step in treating thoracic patients (dogs and cats) is the initial assessment and examination. Thoracic trauma patients are by definition emergencies and your speed of action depends on how dyspnoeic they are. In the ABC's our main focus should cover the respiratory system.

ABCD AND CLINICAL SIGNS

The basic life support of a patient should follow the following steps:

- A Establishment of airway/oxygen
- B Breathing support/thoracic wall
- C Circulatory support/MM/Pulse
- D Disabilities/neurologic/posture

After your basic life support you will have more time to perform a more complete physical examination.

The most common thoracic wounds presented at the University are little dog- big dog incidents. The little dogs (the Jack Russel in particular) are grasped by the large dog and shaken around for a while. This causes multiple thoracic puncture holes and extensive damage of the deeper tissues. Always clip the entire affected area in search of these little breaks in the skin. Other common causes for thorax trauma are hit by car accidents and blunt and penetrating traumatic events.

Clinical abnormalities may include contusions, lung trauma, fractured ribs, rupture of the intercostal muscles, penetrating injury to the chest, hernias (diaphragmatic and ventral), and haemorrhage in or outside of the chest.

INITIAL THERAPY

Initial therapy should include providing oxygen, calming down the patient (and owner) and addressing the wounds. Especially, in open chest wounds or in case of a flail chest, supportive bandages may prevent a continuous pneumothorax and asphyxia.

DIAGNOSIS

Radiographs are essential in diagnosing the extent of damage (Fig. 1). It is important to evaluate both sides of the chest for lung contusions, pneumothorax, rib fractures, hernias, and pleural fluid. In case of pneumothorax and obvious dyspnoea, chest drains will have to be placed or the air should be evacuated using centesis. Once again, the wounds are small on the outside but the internal damage is extensive. Broad-spectrum antibiotics are always indicated in thoracic trauma cases. Intravenous administration is the preferred method.

SURGICAL INTERVENTION

Exploratory surgery always needs to be performed in dogs with thoracic/abdominal trauma and

1. There is an open connection to the pleura or peritoneum
2. Extensive flail chest
3. Progressing emphysema of neck and chest
4. Free gas in the abdominal cavity
5. Extensive herniation of abdominal or thoracic organs (like lungs)
6. Any signs of internal organ damage or uncontrollable haemorrhage

The dog should be stabilised, however, before surgery is performed. In case of abdominal wounds, a ventral approach is preferred. Thoracic trauma is often approached laterally. After the initial skin incision the damage to the subcutis, muscles and ribcage is evaluated. Simple muscle tears can be sutured primarily but extensive rib fractures and avulsions often need innovative reconstruction techniques. The goal is reinstatement of the negative pleural pressure to allow full lung expansion. After reconstruction of an airtight thoracic wall, the other tissues are primarily sutured over Penrose drains. External coaptation for the management of flail chest has been described, with variable success (Fig. 2). Immediate intervention of diaphragmatic hernias is seldom necessary, except if the stomach is located in the chest. In these cases, the stomach will fill with air and severely impede breathing. In other cases, a delayed surgery is better to allow demarcation of the diaphragmatic wound edges.

POSTOPERATIVE CARE

Postoperative care is as important as the surgery itself. Respiratory support (oxygen tube or cage) is essential in these cases. Most of the dogs are small, hypothermic and in shock. Heating pads, temperature controlled environment and fluid support will be necessary. Analgesia is of extreme importance in any trauma case. Pain prevents good function of almost any body system.

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Fig. 1 - Radiographs of the thorax in a dog that was shot. The bullet went through the thorax and is lodged in the muscles on the left side.



Fig. 2 - A supportive bandage may be helpful in certain thoracic trauma dogs

Treatment of long bone fractures in calves by Ilizarov technique

H. Bilgili, B. Kürüm, B. Olcay

INTRODUCTION

Metacarpal fractures are the most common ones seen in cattle, while fractures of the forelimbs. Metacarpal and metatarsal fractures comprise 50% of all bovine fractures. Metacarpal fractures occur twice more frequently than metatarsal fractures and are more frequently diagnosed than those of the radius and tibia.

Although there is a restrictive soft tissue surrounding the bone. Open fractures of the metacarpus are rarely seen quite frequently. Open fractures occur during delivery of the calf following the use of force. Fractures affecting the growth plate are frequently diagnosed in young animals. Metacarpal fractures are usually a sequel to various kinds of injuries (traffic accidents, etc) being kicked by other animals or use of extreme force in parturition. Many different methods that depend on the animal's weight and the type of the fracture are used for treating fractures. The most common is the transfixation pinning, plate and screw applications. Treatment of long bone fractures comminutive, infected, defected and open fractures continue to be confronted with many problems.

The Ilizarov's techniques, which provides the whole limb and joint earlier mobility, also enables compression and distraction between the fragments, has now become a useful alternative for treatment of fractures. In this study we present the treatment methods and results of five long bone fractures in calves with Ilizarov techniques.

MATERIAL AND METHODS

The study was performed on 5 calves which referred to the Department of Orthopaedics and Traumatology, Faculty of Veterinary Medicine, University of Ankara. A communicated fracture of the metacarpus in 3 and of the tibia in 2 cases were detected.

The treatment was managed under general anesthesia by the Ilizarov's circular external fixation system. Taking the diameter and number of the rings. Kirschner pins (2 mm diameter) of appropriate thickness, the blood circulation and innervations of the area and the anatomical construction into consideration. The direction and the presentation level of the transcortical pins were determined by preoperative radiography. An Ilizarov's circular external fixation system of 150mm. diameter with 3 full rings and rods were applied in case one. The fixator in case 2 of 150mm diameter and 3 rings of which the proximal one is half ring. In the third case of 160 mm diameter with 3 rings of which the proximal one is a half ring and on which 2 Schanz pins (diameter 4 mm) were applied for hybrid fixation and 3 rods were applied. The fixator in case 4 of 120mm diameter and 3 rings and rods, of which the proximal one is half ring. The fixator in case 5 of 150mm diameter and 3 full rings and rods were applied.

The daily care of the base of the pins was done by the owner with polyvinylprolidon (Polyod Sol. 10%, Drog-san-Turkey) solution.

RESULTS

It was followed that the animals tolerated the apparatus well. The animal began to use their limbs on the 2nd, 6th, 5th, 8th, 2nd days, respectively; and weight bearing was followed on the 15th, 20th, 27th, 23rd and 17th days, respectively. The radiographic follow up examinations revealed complete consolidations on the postoperative 45th, 35th, 48th, 43rd and 37th days, respectively. The apparatus were removed on the 60th, 45th, 60th, 57th and 63rd days, respectively under sedation. Any complication, but pin track infection in case no 3 and 4 were encountered and full functional healing was provide.

DISCUSSION

Several treatment regimes for metacarpal and metatarsal fractures such as external cooptation bandage, transfixation pinning, open reduction and internal fixation, plate and screw applications, pin applications, circular external fixation are considered by following treatment regimens. The treatment must focus on a rapid return to normal limb function, optimal cosmetic results, prevention of complications including malunion, joint disease and fractures complications and simple aftercare. While there are various traumas causing metacarpal fractures in cattle. In our cases, the fracture occurred during transportation. It was the first time in Turkey, Ilizarov's circular external fixation system was used for the treatment of long bone fractures, and experiencing this method revealed that this apparatus can be safely used in these cases.

Humeral overgrowth following condylar fractures in dogs

S.J. Langley-Hobbs, T.R.A. Robertson, S.J. Baines

The hypothesis was that after a 'Salter Harris' type IV fracture of the lateral aspect of the humeral condyle in immature dogs the affected bone would attain a shorter length than the unfractured one.

Eight dogs that had suffered fractures of the lateral aspect of the humeral condyle when less than one year of age were followed up and re evaluated when they were older than a year. Radiographs were taken of both humeri including craniocaudal and flexed mediolateral views of both elbows and lateral views of the length of the whole bone. The overall longitudinal length of the two humeri was compared by taking the mean of four specified measurements of each bone from the lateral radiographs. To compensate for minor differences in positioning and magnification, measurements were taken of the olecranon, radius and ulna, glenoid and first sternbrae. The position of the transcondylar lag screw in relation to the physis was recorded for each case.

The results showed a statistically significant increase (Wilcoxon Signed Rank Analysis test $p < 0.05$) in length of the fractured bone as compared to the unfractured one. The differences in the measurements between the small bones were not statistically significant. On radiographs the screw was noted to cross the physis in six out of the eight cases.

Bone overgrowth of fractured bones is a well recognised phenomenon in children with fractures of the femur resulting in varying amounts (8-13mm) of overgrowth. To allow for this and avoid a limb length discrepancy in later life, which may cause lameness in humans, certain non articular fractures are purposely left slightly unreduced or over riding. Bone overgrowth has been reported as occurring in opposing bones in the same limb in dogs with femoral overgrowth occurring after a tibial fracture, and humeral overgrowth occurring after antebrachial physeal damage. However a literature search did not reveal any reports of overgrowth of the fractured bone itself. In this series the overgrowth varied from 1-6mm and did not result in any appreciable lameness. Previously attempts have been made to avoid the physis when placing a transcondylar lag screw as a means of minimising damage and hence limit any shortening. The results of this study would suggest that is not necessary.

Management of axial deformities by circular fixators

Y. Latte

BASIC PRINCIPLES OF ILIZAROV'S METHOD

There are three main principles in Ilizarov's method:
-a surgical technique: corticotomy (Fig. 1)

-a circular external fixation using small-diameter pins under tension
-a distraction rate of 1 mm by day

In -depth cross-sectional anatomical knowledge (Fig. 2) is required in order to avoid nerve, vascular or tendon lesions. The technique has the advantage of lengthening limbs and regenerating new bone (Fig. 3) by progressive traction, without any need of bone graft. Any deformity can be corrected progressively or immediately.

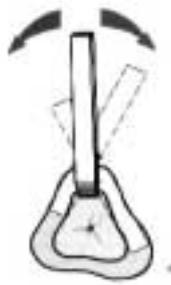


Fig. 1 - Corticotomy

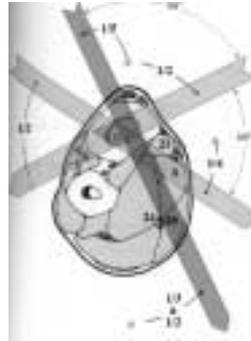


Fig. 2 - Anatomical cross-section (J-M Putod)



Fig. 3 - the regenerate

THE MATERIAL: POLYFIX

Polyfix apparatus (Fig. 4) is adapting a Ilizarov's fixation to veterinary needs although it is of simpler design than the hardware of human beings, any orthopaedic operation can be performed. The ring-shaped structure ensures excellent flexional and torsional stability. The pins on the same ring must form an angle from 60° to 90° . With our domestic carnivores, the preferred sites of application are the level of the lower foreleg and the lower hindleg. In order to use the Polyfix at the level of the upper hindlimb and upper forelimb a ring must be cut to make a half-ring or at hird of a ring.

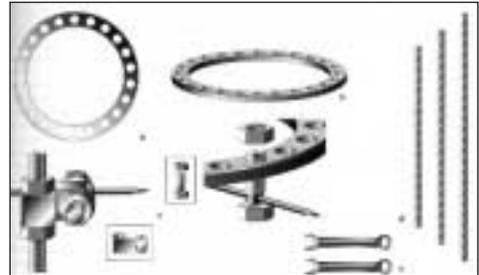


Fig. 4 - Polyfix 6

AXIAL DEFORMITIES

Axial deformities can be seen in growth deformities and malunions. The premature closure of a growth plate or a malunion produces different lesions: angular and rotational deformities, shortening and articular incongruency. It's very important to study the X ray before surgery to know the right plane of the deformity and its angle (Fig. 5). If the shortening of a long bone is less than 10%, it's not necessary to lengthen the bone. If the dog is young, you must calculate the shortening in the adult dog.

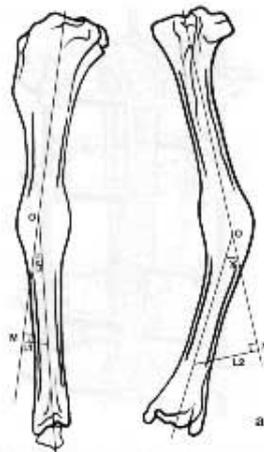
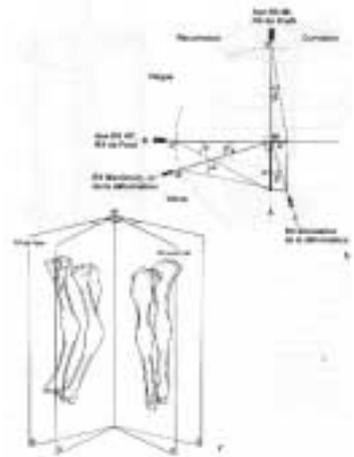


Fig. 5 - Geometric method for an angular deformity



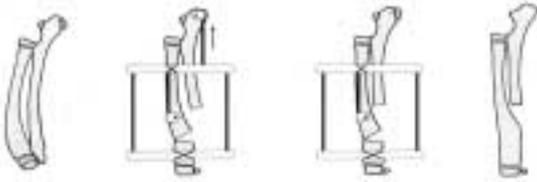


Fig. 6 - Radius curvus type 1A: Premature closure of the distal ulnar growth plate in a growing dog



Fig. 7 - Radius curvus type 1B: Premature closure of the distal ulnar growth plate in a growing dog

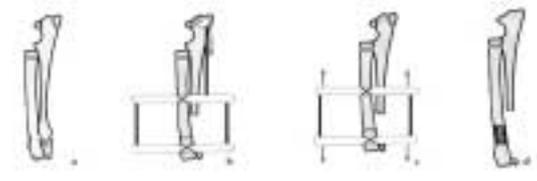


Fig. 8 - Radius curvus type 2: Premature closure of the distal radial growth plate in a growing dog < 5months



Fig. 9 - Radius curvus type 2: Premature closure of the distal radial growth plate in a growing dog > 5months

which on Polyfix 6, corresponds to half a turn of the nut twice a day. Lengthening by a single turn each day encourages the appearance of localised ischaemic zones and by way of consequence slowing down of the formation of regenerated bone. On a puppy of a great size, in order to avoid premature union, lengthening can be carried out once a day and one can be forced to lengthen by 1,5mm-2mm.

The lengthening of soft tissue close to the zone of bone distraction poses few problems in young animal compared to the adult. Whatever the age of the animal, it is less painful if one operates in a muscular area (upper

We can treat all the lesions with a circular fixator whatever the age of the animal. The best indication is the Radius Curvus. A protocol for the treatment of each case of Radius curvus using all the possibilities of the circular fixator can be used whatever the age of the animal (Fig. 6, 7, 8, 9).

PRINCIPLES OF APPLICATION

Before all applications, a plan must be established for an effective design of montage. In most cases, the use of complete rings means the rings should be put on the limb before fixation of the bone.

Angular deformity

Two rings put in parallel to the articular surfaces define two planes which correspond to the ideal cuneiform osteotomy. The bone section is performed at the point of maximum deformity. A partial correction is manually achieved with the rings and aid the passage of the threaded bars. The two rings are finally oriented parallel to each other with the help of the bolts, then they are fixed on the threaded bars (Fig.10). In this way, an open osteotomy is achieved and the bone is realigned. The montage is completed by additional rings or flags.

Rotational deformities

After pulling into place the rings as above, one unhinges all the threaded bars the same amount of holes in order that the correction is made between one ring and another. The start of the correction is achieved by manual turning of the rings and this allows the passage of the threaded bars. On tightening the nuts a final rotation of the bone fragments is produced (Fig.11). The minimum correction is function of the number of holes on the ring used.

Limb-lengthening

It is relatively difficult to achieve a perfect corticotomy. If the medullary canal is damaged (in the course of making an osteotomy) one must wait ten days before beginning traction. On the other hand, if it is perfect one can proceed after the third day. The periosteum must be sutured. The rate and length of daily lengthening must be modulated by the age and weight of the patient. It is generally 1mm/day divided in to two parts

foreleg) rather than a tendinous area (distal antebrachium). During the whole duration of the lengthening procedure one must keep a careful eye on the degree of weight-bearing on the limb, a normal foot position and that there is no pain on extension of the toes.

COMPLICATIONS OF THE LENGTHENING

The significant number of complications shows that this technique is difficult and requires experience. It also explains that we use the classification of Paley and not a classic one. Paley describes three types of difficulties: problems, obstacles and complications. The main difficulty is the tendon or muscle pain during lengthening. Physiotherapy and swimming are a good treatment to avoid ankylosis of the joint (Fig.12). A special bandage (Fig.13) is used during the night. A threaded rod is fixed on the distal ring to put the toes in extension with the bandage.

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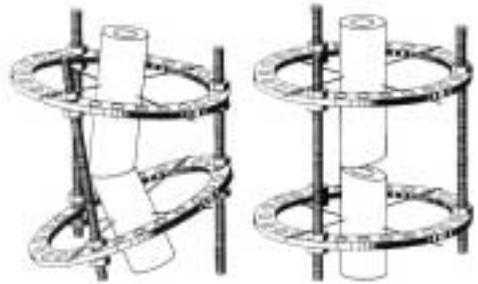


Fig. 10 - Principles for correction of an angular deformity

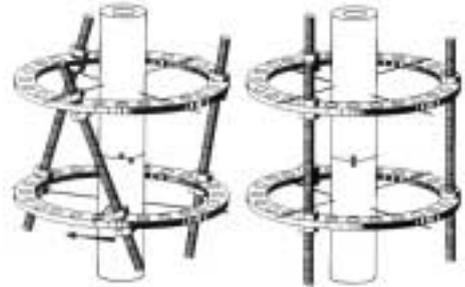


Fig. 11 - Principles for correction of a rotation



Fig. 12 - Ankylosis of the carpus



Fig. 13 - Special bandage on a threaded rod

Bisphosphonates and therapeutic manipulation of bone turnover – Clinical opportunities in large animals?

O.M. Lepage, A. Varela

Bone is continuously turned over by modelling and remodelling. In a steady state, the amount of bone formed equals the amount destroyed. Modulation mechanisms of this process are still not fully understood, but a series of hormones and cytokines are involved as much as mechanical forces, which allows the skeleton to maintain an optimal structure to fulfil the mechanical function of bone. In horses, assessment of bone turnover is done indirectly by measuring serum biochemical markers such as osteocalcin or different collagen I breakdown products.

Fleisch and coworkers (1962) found that inorganic pyrophosphate characterised by a P-O-P bond, present in biological fluids, inhibits both the formation and the dissolution of calcium phosphate *in vitro* and prevents ectopic calcification *in vivo*. They searched for analogs and developed synthetic compounds called bisphosphonates characterised by a P-C-P bond. These are now recognized as an important class of antiresorptive drugs and are developed for use in various diseases of bone and calcium in humans. Since the sixties many bisphosphonates have been investigated with different characteristic profiles of activity, but it is only in 2002 that one of them, tiludronate, received a commercial licence for horses in France.

The affinity of bisphosphonates for bone mineral is the basis for their use as skeletal markers (nuclear medicine) and as inhibitors of ectopic calcification and of bone resorption. In normal animals they increase calcium balance. Two main groups of bisphosphonates can be distinguished by their mechanisms of actions: the nitrogen-containing bisphosphonates (aminobisphosphonates) such as pamidronate and the non nitrogen-containing bisphosphonates including tiludronate. For example non-aminobisphosphonates such as tiludronate inhibits proinflammatory cytokines from activated macrophages *in vitro* (Mönkkönen *et al.*, 1998) and shows anti-inflammatory properties *in vivo* in experimental models of arthritis in animal. By contrast, aminobisphosphonates can induce an acute inflammatory response and fever *in vivo* (Adami *et al.*, 1987).

In large animals, a study in ponies revealed that pamidronate was effective in reducing the development of induced experimental exostosis while no signs of bone turnover toxicity were observed (Lepage and François, 1989). However, this drug was unsuccessful in the treatment of navicular syndrome in horses (McGuigan *et al.*, 2000). More recently work has been performed with tiludronate, developed in horses for the treatment of diseases associated with osteolytic lesions. Slow intravenous administration of 1 mg/kg of tiludronate in horses was well tolerated with no evidence of clinically relevant adverse effects (Varela *et al.*, 2002). The drug induced a rapid and marked decrease in serum CTX-I, indicating an antiresorptive effect. However in another study to evaluate, over a 4 month period, the clinical safety of tiludronate on bone metabolism in normal healthy non-exercised horses divided in 4 treatment groups, the biochemical markers selected were not able to show significant differences between groups (Varela, 2002). This drug is now under clinical investigation by different research groups.

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Hybrid linear-circular external skeletal fixators

D.D. Lewis

The use of circular fixators (CF) and application of the methods of Ilizarov has become more widely accepted in small animal practice. Circular fixators are useful for stabilizing simple and complex tibial/fibular and radius/ulnar fractures, particularly those extending to the metaphyseal region with short juxta-articular fracture segments. Wire tract inflammation has been the most consistently reported complication associated with the use of CFs in small animals. Wire tract inflammation is characterized by erythema and serosanguineous or purulent discharge and is often associated with decreased weight-bearing. In animals with major wire tract inflammation there is radiographic evidence of osteolysis adjacent to the implants and these wires can (and should) be removed from the bone with negligible resistance once detached from the fixator frame. Wires stabilizing the proximal antebrachium and crus are particularly problematic as wires in these locations often traverse through large muscle groups, suggesting that soft tissue impingement plays a prominent role in the development of wire tract complications. Similar problems with wire tract inflammation in human patients has prompted interest in hybrid CF constructs which utilize half-pins rather than wires as fixation elements in high morbidity locations. We have used multiple divergent half-pins as fixation elements in the proximal tibia in a small number of dogs with CFs in an effort to decrease morbidity during the convalescent period. Half pins are placed from the cranial and medial aspects of the proximal tibia, thus avoiding the large muscle groups located caudal and lateral to the proximal tibia. Further evaluation of this technique is warranted.

Recently IMEX Veterinary, Inc. (Longview, TX, USA) began producing 6.3 mm diameter titanium hybrid rods. The smooth shaft of the hybrid rods accommodates linear fixator (small IMEX-SK) clamps. The hybrid rods also have 6 mm diameter threads at one end which allow the rods to be secured to ring components of the IMEX CF system to construct hybrid SK-CF frames. The IMEX-SK clamps have a two-piece clamp body which can be readily assembled and disassembled allowing clamps to be added or removed from a construct at any time. The SK clamp bolt features a retained clamp washer that secures the fixation pin. The clamp washer has a multi-toothed surface that interdigitates with the clamp body which eliminates unwanted fixation pin/clamp slippage on the connecting rod and allows stable fixation, irrespective of fixation pin angle. The clamp washer has a semicircular meniscus that firmly engages the shank of a wide range of fixation pin diameters and the clamp bolt can accommodate direct placement of appropriate diameter positive-profile partially threaded fixation pins.

Hybrid SK-CF constructs can be applied using either a closed or open approach. If an open reduction is done, the fracture is anatomically reconstructed using interfragmentary cerclage and Kirschner wires. An intramedullary Steinmann pin or Kirschner wire(s) can also be placed to further stabilize the repair. Following closure of the surgical approach, the ring components are secured to the distal metaphyseal fracture segment using a single, centrally threaded, positive-profile pin or two or more Kirschner or olive wires. Proper placement of the ring fixation elements can be confirmed during surgery with fluoroscopy if available. An appropriate length hybrid rod is then secured in one of the holes in the ring component using paired spherical washers and nuts. This primary hybrid rod is placed laterally on the humerus and femur and medially on the tibia. The spherical washers and nuts allow the hybrid rod to be rigidly secured to the ring with some degree of angulation. A half-pin is then placed in the proximal fracture segment and secured to the primary hybrid rod with a SK clamp. Additional intermediate SK clamps and half-pins are then placed where deemed appropriate.

If a closed reduction is performed, the ring component is secured to the distal fracture segment via a fixation pin or wires. The primary hybrid rod is loosely secured in one of the holes in the ring component (again laterally on the humerus or femur and medially for the tibia). The fracture is then reduced by applying traction to the limb segment, ring component, or both, and a half-pin is placed in the proximal fracture segment. When the fracture is perceived to be aligned, the SK clamp and spherical nuts are tightened. Acceptable reduction can be confirmed by palpation or with fluoroscopy if available. The construct is completed with the placement of additional intermediate SK clamps and fixation pins.

If deemed necessary, frame rigidity can be improved by adding additional connecting elements. A secondary shorter hybrid rod can be secured to the ring at a craniomedial hole when the primary rod is placed laterally, and at a craniolateral hole when the primary rod is placed medially. Placing the secondary connecting rod slightly cranial (rather than directly medial or lateral) prevents contact between the articulating rod(s) and the animal's limb segment. A tertiary carbon fiber SK connecting rod can then be added using two dou-

ble clamps to articulate the primary and secondary rods over the cranial aspect of the limb. The SK carbon fiber rods are lightweight and radiolucent: their use as tertiary rods increases construct stiffness without adding substantial weight or obscuring radiographic visualization of the fracture. Alternatively a hinge assembly can be used to allow the secondary hybrid rod to be angled across the cranial aspect of the limb so that its proximal end can articulate directly with the primary hybrid rod. The titanium hybrid rod is screwed directly into the hinge assembly and the hex broach fitting on the hinge is tightened to lock the hinge in position.

Hybrid SK-CFs have proven useful for managing long bone fractures with short proximal or distal juxta-articular fracture segments. Since hybrid SK-CF constructs typically utilize both small diameter wires and larger diameter pins as fixation elements, these constructs possess advantageous properties inherent to both fixation elements. Ring components are particularly advantageous in fractures that extend into the metaphyseal region as they allow for multiple points of fixation, as many as three or four fixation wires, even in extremely short fracture segments. Bicortical bone purchase is more feasible with fixation wires than with pins, because fixation wires can be driven across a bone segment at virtually any angle (within the transverse plane) increasing the probability that wires will engage two cortices. Divergency of the fixation wires mitigates translocation of a bone segment while improving the bending stiffness of the construct. Optimally, two fixation wires placed on a ring should intersect at a 90° angle; however, anatomic constraints often prevent maximal wire divergency. Olive wires should be used to improve shear stiffness and prevent translocation of bone segments along the wires, particularly if the angle of divergency between fixation wires is small. The linear components confer advantages typically associated with the use of half-pins such as improved bending stability and avoidance of large muscle masses (such as those located on the proximolateral aspect of the tibia) which results in decreased morbidity and improved limb function during the convalescent period. Utilization of wires as fixation elements on ring components in fractures which have not been reconstructed may be beneficial in promoting fracture healing. Previous studies have shown that controlled axial micromotion associated with the use of small diameter wires as fixation elements stimulates callus formation and purportedly accelerates fracture healing. Use of more rigid half- or full-pins as fixation elements on ring components in anatomically reconstructed fractures may be preferable as axial micromotion could be detrimental by placing excessively high strains on the reconstructed fracture segments.

Hybrid SK-CF constructs also allow utilization of ring elements proximal to the stifle and elbow including “tie-in” constructs. Application of type II and III linear fixators, which provide greater stability than type I linear fixators, and traditional CF constructs is limited to fractures distal to the elbow and stifle. Modified type I linear configurations, in which a full-pin (or pins) is (are) placed through the distal fracture segment, have been described to manage comminuted supracondylar humeral and femoral fractures: a bent Steinmann pin or connecting rod, articulated Kirschner-Ehmer connecting rods and clamps or an acrylic column have been described to secure the medial portion of the transcondylar pin to the lateral frame elements. Utilization of hybrid SK-CF constructs simplifies assembly of these complex frames. Hybrid SK-CF frames, unlike constructs made with the acrylic connecting columns, can be easily and rapidly disassembled and reassembled, simplifying postoperative modifications or adjustments. The high-strength, tempered aluminum alloy CF ring components imparts strength to the supporting elements without adding excessive weight to the frame and their circular design offers a convenient means to provide bilateral support with greater flexibility in the placement of the linear connecting elements. Although complete rings are biomechanically superior to partial rings, use of complete rings near high-motion joints is usually not feasible due to anatomic constraints. Partial rings are used in close proximity to high-motion joints: five-eighths rings are typically used on the distal tibia and humerus, while stretch rings conform nicely to the distal femur. The ability of the SK single clamp to accommodate a variety of pin diameters simplifies assembly of “tie-in” constructs.

Three or four rings are generally used to stabilize fractures with traditional CF constructs and the limited anatomic working space can complicate their application in the small dog and cats. Application of hybrid SK-CF constructs is simpler than three or four ring CFs in smaller animals. Hybrid SK-CFs allow the surgeon to apply the fixator using a more traditional “linear mentality” and are more “user friendly” for individuals less proficient in the methods of Ilizarov. We have also used these hybrid SK-CF constructs for performing transarticular stabilization, most commonly to stabilize arthrodeses, to supplement internal (interlocking nail or plate) fixation of fractures and for performing limb deformity correction and lengthening.

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The effect of perioperative carprofen (Rimadyl®) administration on the alleviation of pain associated with ruptured cranial cruciate ligament surgery: results from two multicenter, double-blinded, prospective studies in 174 dogs

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INTRODUCTION

Interest has grown in the use of non-steroidal anti-inflammatory drugs (NSAIDs) for systemic analgesia following surgery. Pain scores suggest that NSAIDs may have analgesic properties equal to or greater than selected opioids.^{1,2} Carprofen (Rimadyl®), a propionic acid derivative and NSAID, has been approved in Europe and the US to control of discomfort associated with osteoarthritis in dogs. Carprofen has also been used in Europe and Canada to control pain before and after surgery.^{2,5} The objective of these studies was to evaluate the effectiveness of oral and subcutaneously administered carprofen in alleviating pain associated with surgery for cranial cruciate ligament rupture.

MATERIALS AND METHODS

Two prospective, randomized, double-blinded, placebo-controlled, multicenter studies were conducted at 12 veterinary practices across the US. Study subjects were client-owned dogs presented to veterinary hospitals for cranial cruciate ligament surgery. Inclusion criteria included, in part, that each dog must have been confirmed to be suitable by physical examination for cruciate surgery and that satisfactory clinical pathology results were obtained within 7 days prior to enrollment. Prior to surgery, all qualified dogs were randomly assigned to placebo or caprofen groups in a 1:1 ratio. Carprofen (4.4 mg/kg) or placebo were administered PO (study 1) or SC (study 2) approximately 2 hours prior to surgery and subsequent treatments were administered q 24 hr on an as needed basis for the next three days. Each dog was assessed for pain by the same veterinary assessor (VA) in each center using a visual analogue scale (VAS) prior to surgery, 4, 8, and 12 hours after surgery, twice daily for the next 3 days, and once on the 4th day after surgery. Dogs determined to be in excess pain at any time were withdrawn from the study and treated with analgesics at the discretion of the VA. The effects of treatment vs. placebo on VAS data at each time point were analyzed using a repeated measures ANOVA. *A priori* contrasts among least squares means of the VAS scores were used to assess the difference between placebo and carprofen at each time point, if the treatment main effect or the treatment by time interaction was significant ($P \leq 0.05$).

RESULTS

174 dogs were randomly allocated to placebo (n = 88) and carprofen (n = 86) groups. The mean age was 6 years (range = 0.8-14 years). There were a total of 102 purebred dogs and 72 mixed-breed dogs enrolled. Extracapsular-based stabilization was the most common surgery performed (83%). Dogs treated with carprofen PO had significantly lower mean VAS pain scores approximately 4, 12, 24, 28, 52, and 72 hours after surgery compared to placebo-treated dogs. Dogs administered carprofen SC had significantly lower mean VAS pain scores at all postoperative time points assessed. Fourteen dogs treated with placebo and 6 dogs treated with carprofen were withdrawn due to an apparent lack of efficacy and were considered treatment failures. Instances of abnormal health were small in number and approximately equally distributed between treatment groups. No deaths occurred during the study.

CONCLUSION

Preemptive followed by post-operative PO or SC administered carprofen resulted in significantly improved VAS values in dogs undergoing surgery for cranial cruciate ligament-based instability compared to placebo. It is concluded that both PO and SC administered carprofen significantly reduces pain associated with surgery for cranial cruciate ligament-based instability in dogs.

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The effects of obesity on the clinical expression of osteoarthritis in dogs with hip dysplasia: a prospective study (Preliminary Report)

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INTRODUCTION

Obesity may allow patients to be more prone to enhance the clinical effects osteoarthritis.^{1,2} Human medical studies indicate that the clinical manifestation of osteoarthritis (pain, lameness, discomfort) is enhanced with obesity, sedentary behavior, and poor physical fitness.^{3,4} A recent clinical study examining overweight dogs with chronic hip dysplasia (CHD) reported that clinical scores significantly improved in dogs with percent bodyweight loss.² The objectives of our study were to evaluate the effectiveness of weight reduction in attenuating the clinical signs of OA in obese dogs with CHD using clinical evaluations, force plate, and dual energy X-ray absorptiometry analysis (DXA).

MATERIALS AND METHODS

Twenty adult dogs with radiographically confirmed CHD were selected for the study. All dogs entered into the study were screened with a complete physical and lameness exam, CBC, serum chemistry profile, UA, and thyroid profile, force plate analysis (peak vertical force and impulse at a trot), hip radiographs, back-fat ultrasound measurements, and total body composition analysis using DXA. Subject inclusion criteria were dogs 1-12 years of age with an estimated ideal body weight ranges 20-40 kg, no other concurrent orthopedic disease, previous orthopedic surgery, or medical conditions, lameness scores of mild to moderate, radiographic evidence of secondary OA due to chronic hip dysplasia, and percent body fat $\geq 30\%$. All dogs were divided into two groups; group 1 = body weight maintained (control), group 2 = weight loss. All dogs entered into the study underwent baseline physical exams, lameness exams, blood work and urinalysis, force plate and DXA analysis at time 0. All dogs were rechecked at time = 3, 6 months as at time =0 with the exception of blood work and urinalysis performed only at time = 6. Two different veterinarians performed physical and lameness exams and were blinded to each others findings. Group 1 dogs were fed a maintenance diet during the study period. Group 2 dogs were fed a reducing diet during the study period. Ideal body weights for group 2 dogs were calculated from percent body fat baseline data obtained from DXA analysis. Dogs were weighed weekly and the owners recorded weekly weights, food intake, and activity levels. Owners were also asked to evaluate their dog for lameness as well. Data analysis was performed using a repeated measures ANOVA. Differences between groups were determined using a Tukey-Kramer Multiple Comparison Test post hoc. Significance was set at $P \leq 0.05$ for all statistical testing.

RESULTS

Currently 7 dogs are in group 1 and 9 dogs are in group 2. Preliminary results indicate that weight reduction can be correlated to DXA assessments of lean-body mass and body fat. Preliminary results regarding force-plate data and clinical scores will be discussed in detail during abstract presentation.

CONCLUSION

DXA analysis can be used to correlate body mass changes in dogs during weight reduction.

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Femur fractures associated with canine total hip replacement

W.D. Liska

INTRODUCTION

Numerous potential complications such as luxation, infection, aseptic loosening, sciatic neuropraxia, patella luxation, and pulmonary thromboembolism can arise when performing canine total hip replacement (THR) surgery.¹ Femur fractures have been recognized but have not been described in detail in the veterinary literature. Biomechanical forces that are normally dissipated over the entire length of the bone are concentrated at the end of rigid implants. Periprostheses fractures can occur due to concentration of forces due to differences in modules of elasticity between implants, cement, and bone. Fractures can also result from propagation of fissures, known or unknown, created during surgery.

The incidence of femur fractures, whether primary or secondary to fissures, in canine THR patients is unknown. A study was undertaken to identify possible reasons, incidence, treatment options, and outcome of this serious complication.

MATERIAL AND METHODS

The medical records and radiographs of 19 dogs with 21 femur fractures associated with total hip replacements at Gulf Coast Veterinary Surgery between 1989 and 2002 were reviewed. The same surgeon using the same technique and same BioMedtrix Modular Hip Replacement System performed 18 (out of a total of 648 THR's) of the 19 original THR surgeries. One original THR was performed elsewhere but with the same technique and system.

Multiple parameters were evaluated including time intervals between THR and fracture, fracture location, fracture orientation, treatment methods, fracture healing, implant integrity, and limb function. Radiographic exams and client interview follow-up continues during the study (range 300 minimum to 1734 days) or until death (8 dogs).

RESULTS

Ten different breeds were represented with dogs averaging 77.2 pounds (range 49 – 104). There were 8 females and 11 males with an average age of 7 years 5 months at the time of THR surgery. Fractures occurred intraoperatively, immediately postoperatively during radiography, after revision surgery, after explantation, and as long as 2196 days post-THR. 19/21 fractures were displaced at the time of presentation and 2 were non-displaced. One of the latter 2 fractures displaced shortly after presentation. Two dogs had two fractures at different locations post-THR.

Four fractures followed THR when fissures created were known at the time of surgery. Nine dogs were observed falling at the time of fracture and 2 were running at full speed. One dog was hit-by-car and one was in a car during an accident. One dog sustained a fracture while unattended in the back yard for an extended period of time. There was no known "event" connected to the fracture in only 1 dog. Five of the 19 dogs had previous injuries involving the proximal femur pre-THR.

Fractures were long oblique or spiral in 16/19 femurs. The cement also fractured at or beyond the tip of the stem in 8/18 femurs. Surgical stabilization was performed in 17/19 displaced fractures. Fourteen fractures were repaired first time using plate and screw fixation with 8/14 repairs augmented with cerclage wires. All fractures went on to union (except one 16 year old dog that was euthanized at the time of fracture and one dog that died of unrelated causes prior to healing). Fourteen unions were anatomical and 4 had mild angular deformity. Union took 6 – 10 weeks in 15 femurs. One delayed union plated 172 days post-fracture united by day 250. The bone-cement interface and implant integrity was intact in all unions.

DISCUSSION

Femur fractures occurred at a rate of about 2.8% (18/648) in this group. Intraoperative femur fractures occurred in 83 / 3566 (2.3%) in a human study. In that study, the incidence was higher in females with uncemented components in patients that had had previous surgery on the ipsilateral hip and in revision surgery.² The dogs were middle aged at 7.5 years and slightly overweight (mean body score 6.3). There was no breed or sex predilection. About 30% (6/20) of the fractures occurred within one week after surgery but one occurred 6 years post-THR with aseptic loosening. There is an increased likelihood of periprosthetic femur

fractures due to the increasing number of THR's performed on both young highly active dogs as well as old dogs with brittle bone secondary to severe chronic degenerative joint disease. There is a similar pattern in the more active, aging human population with fractures occurring 2:1 females: males at an average of 77 years and averaging 7.6 years after primary arthroplasty.³

There is an inherent risk of driving a large femoral component into a smaller or tight fitting medullary canal. Fractures can easily go unrecognized, displaced fractures from propagated fissures can occur at a later date, and non-displaced longitudinal fissures may heal. Marked periosteal new bone formation and/or adverse effects on the bone-cement (or bone-implant) interface may be the result in those fractures that do not proceed to catastrophic failure with displacement requiring fixation.⁴

Abnormal bone that is sclerotic, brittle, or thin secondary to previous surgery, end-stage degenerative joint disease, osteoporosis, or aseptic loosening is at higher risk of fracture. Analysis of risk factors should be taken into account during preoperative planning to help reduce the incidence of this severe complication. Normal bone can fracture during excessive load, such as trauma, when stress is concentrated at the tip of the femoral stem. The fractures extended through the vicinity of the tip of the femoral stem and in 39%, the cement also fractured exposing the component.

If the THR components are stable, immediate open reduction internal fixation with plate and screws yields excellent results with anatomical union expected within 10 weeks. Return to normal function is expected without disruption of the bone-cement interface or integrity of the THR components. Better clinical results in postoperative mobility are also achieved in humans with plate osteosynthesis compared to other methods following periprosthetic femoral fractures.⁵

Cerclage wires can be used to augment the plate and screws but cerclage wire fixation alone is not recommended. Revision surgery with component and cement replacement, in addition of plate and screw fixation, should be considered if aseptic loosening is present at the time of fracture. Conservative management is not recommended as a primary option in treating these fractures due to subsequent angular deformity even though the fractures may unite using this approach.

CONCLUSION

When femur fractures occur in THR patients, the fractures should be repaired immediately using plate and screw fixation. If long fissures in the femur are created while reaming the femoral canal during THR procedures, the forces on the fissures should be neutralized to reduce the possibility of fractures. Analysis of risk factors should be taken into account during preoperative planning to help reduce the incidence of this complication. With proper treatment, femur fractures associated with THR will go on to successful anatomical union and the integrity of the implant system can be maintained.

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Pulmonary thromboembolism associated with canine total hip replacement

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INTRODUCTION

Canine total hip replacement (THR) is a commonly performed procedure used to resolve pain and dysfunction secondary to coxofemoral arthritis. The procedure establishes a pain free joint with normal function. Complications can arise including luxation, infection, aseptic loosening, femur fracture, sciatic neuropraxia, and patella luxation. Death associated with the procedure is very rare. A potential non-anesthesia cause for death is pulmonary thromboembolism (PTE). This investigation was conducted to evaluate the incidence of PTE and to report the risk and significance.

MATERIAL AND METHODS

Complications that arose in a series of 648 consecutive THR procedures were reviewed. The 648 THRs were performed on 372 (138 bilateral THRs) clinical canine patients by the same surgeon over 10 years (1992-2002) with a minimum of 3 months follow-up. The BioMedtrix modular implant system and HowMedica PMMA in dough form were used in all cases. Pulmonary scintigraphy was performed on 30 consecutive dogs 48 hours post-THR. The lung perfusion scans were performed 5 minutes after 99mTc-MAA injection. The segmental ventilation perfusion defects (SVPDs) observed were classified according to the PIOPED criteria. Radiographs (left lateral, right lateral, and ventro-dorsal projections) were taken immediately postoperatively and at the time of the lung scans. Transesophageal and intercostal ultrasonography looking at the right atrium, right ventricle, and pulmonary outflow tract was performed on 10 consecutive dogs intraoperatively during the time of femoral component stem insertion.

RESULTS

One (0.15%) fatality occurred due to PTE in the series of 648 cases. Symptoms, including cyanosis and respiratory distress, were evident prompting the patient's lung scan. The dog had multiple segmental ventilation perfusion defects evident on static lung scan images 36 hours postoperatively. The 99mTc-MAA perfusion lung scan 5 minutes after intravenous injection demonstrated minimal perfusion (nearly total occlusion) to the right cranial and middle lobes. Several segmental filling defects were evident in the right caudal lobe and there was decreased perfusion in the left cranial lobe. The findings in the latter 2 lobes were classified as moderately severe segmental PTE. The dog died 48 hours after surgery.

The lung perfusion scans on the 30 asymptomatic dogs demonstrated some degree of SVPDs 82% of the time and were classified as severe 32% of the time. No particular lung lobe was more prone to SVPDs. Patchy "mulberry" appearing defects indicative of fat embolization were most common. The size, location, and number of SVPDs were variable. None of the dogs had any abnormal pulmonary clinical signs and no pulmonary radiographic abnormalities were evident.

Ultrasonography revealed visible evidence of embolism in 8 of the 10 dogs evaluated. The emboli were observed entering the heart within 5-10 seconds after insertion of the femoral stem into the cement in the femoral canal. The emboli had the appearance of air bubbles in 2/8 and tissue particles in 6/8. No emboli were observed in 2/10 dogs. Air bubbles entering the right atrium became "trapped" in the dorsal aspect of the chamber. The air in the atrium could be dislodged forming multiple small bubbles by aggressively shaking the thorax. Pneumodislodgement resulted in embolization to the pulmonary vasculature. The pneumoembolus was observed in the right atrium for more than 8 minutes in one dog. The tissue particles entering the heart varied in appearance from a homogeneous "snow storm" to a "hail" of multiple variable sized globules. Embolism lasted a variable time but was typically over within 45 seconds. The tissue particle emboli were of variable size, intensity, and duration.

DISCUSSION

Air present in cancellous bone has one place to go (into the venous circulation) when air locked by PMMA. Intrusion of cement under pressure into cancellous bone during stem insertion forces the air into the venous circulation. The small volume of air is dramatic to observe ultrasonographically but is apparently rarely of any consequence. Fat, bone marrow, and intravascular coagulation (clots) can all contribute to embolism and PTE during and after total hip replacement. Fat microemboli larger in diameter than the smallest pul-

monary vasculature can deform, squeeze through the capillaries, and enter the systemic circulation within minutes or hours after surgery. Bone marrow, clots, and fat also have the potential to act as a nidus for thrombus formation. Heparinization to decrease the incidence of clot formation could be considered. There does not appear to be adequate indication to do so, and it was not done in any dogs in this group. Prophylactic measures that may help minimize the severity of embolemia and PTE include copious lavage of the cancellous bone/cement interface. Intra- and postoperative fluid therapy to maintain normovolemia may also be helpful. Controlling cancellous bone and intramedullary pressure could theoretically affect the severity of the embolemia.

The source of all embolemia is unclear. It is more likely to originate in cancellous bone in the proximal femur than from the endosteum of the mid-diaphyseal medullary canal. Pressurization of cement during femoral stem implant insertion results in embolemia of a "snow storm" or "hail" of echogenic particles in the right heart. Fortunately, most dogs are apparently able to recover spontaneously as evidenced by the extremely low mortality rate even though the morbidity is high. The complication should be taken seriously since one dog died of PTE, even though there was only one death in a group of 648 consecutive cases. The exact incidence of mortality is still unknown.

Local analgesic effect of ketamine in the abaxial sesamoid block in the horse

J. López-Sanromán, J. Cruz, M. Santos, R. Mazzini, Tabanera, F. Tendillo

INTRODUCTION

Ketamine is a dissociative anesthetic agent widely used in veterinary practice. Ketamine appears to have both central nervous system action and local anesthetic properties. Weber et al. in 1975 were able to produce a "ring block" of the fingers in volunteers. Also in humans, subcutaneous ketamine infiltration had local analgesic effects in both healthy and hyperalgesic skin. In animals, it has also been used epidurally to produce perineal analgesia in horses, and epidural anesthesia in dogs. N-methyl-D-aspartate (NMDA) channel blockade appears to be the primary mechanism of the anesthetic action of ketamine. In previous studies of local effects of different agents in horses, an abaxial sesamoid block/radiant heat/hof withdrawal model has been used. In this report we will describe the results of the analgesic effects of ketamine in the horse using the abaxial sesamoid block model.

MATERIAL AND METHODS

The heat lamp/hof withdrawal model described by Kamerling et al. in 1985 was selected to analyse the effects. This model has been employed by other authors using radiant heat as a noxious thermal stimulus. The experimental protocol was approved by the University Animal Use Committee. A total of 36 mature healthy horses were used in this study. A routine clinical examination was performed in all selected horses to ensure that all the animals were sound and clinically free of lameness. One week before each experiment, an abaxial sesamoid block with 5 mL of 2% mepivacaine was performed in all horses as a positive control, to rule out aberrant nerve supplies in the distal limb of the animals. Horses were then randomly assigned to four groups. In group one (negative control group), an abaxial sesamoid block with 5 mL of saline was performed in one randomly selected front leg. In groups two, three and four, an abaxial sesamoid block with 5 mL of 1%, 2% and 3% ketamine was performed also in one randomly selected front leg, respectively. Before each block, the hof withdrawal reflex latency (time between lamp illumination and withdrawal of the hof) was determined. After the block, local analgesic effects were determined using the heat lamp at 2 and 5 minutes after the injection and the every five minutes for a total period of one hour.

RESULTS

After the administration of 5 mL of diluted ketamine, there were significant differences between basal and ketamine values from 2 to 10 minutes after injection of 1% and 2% ketamine, and from 2 to 15 minutes after injection of 3% ketamine. Additionally, there were significant differences between control (saline) and ketamine values at every time point from 2 to 10 minutes after 1% and 2% ketamine injection and from 2 to 15 minutes after 3% ketamine injection. Saline injection did not result in analgesia in any of the subjects. There were not significant differences between ketamine groups at every time point.

CONCLUSIONS

This study shows that abaxial sesamoid nerve block with ketamine ensures an adequate analgesia with an onset of action of 2 minutes and a maximal duration of 15 minutes.

Tendon transfer after brachial plexus injury in 4 dogs and 2 cats

D. Lorinson, K. Größlinger

INTRODUCTION

The study describes a tendon transfer procedure and clinical outcome in four client owned dogs and two cats after brachial plexus injury.

MATERIALS AND METHODS

From 1996-2001 four dogs and two cats were referred to our hospital for evaluation of forelimb lameness and neurological deficits. All animals had a history of trauma 3 to 6 weeks ago. Upon neurological examination in all of our animals muscle atrophy of the extensor muscle of the elbow, carpus and digits was detected. The flexor muscle of the same joints seemed according to clinical and electromyography exam functional. The patients occasionally bore a little weight on the affected limbs but always with the foot folded under. Skin sensation was reduced over the dorsal aspect of the foot and absent on the dorsal and lateral aspects of the forearm. The elbow joint was not dropped but the placing reflexes were lost. There was no evidence of a Horner syndrome and ipsilateral panniculus reflex was present in all patients. Electromyography was performed in all patients and was consistent with the testing reflexes and skin sensations. No abnormalities were found on survey radiographs all joints had normal range of motion. Relocation of the biceps brachii muscle was performed. The muscle is liberated through a medial approach of the humerus. Both tendons are cut close to their insertion. This necessitates separation of the extensor carpi radialis and brachioradialis muscle. The biceps muscle is pulled free. Care should be taken not to damage the neurovascular structures in this region. Through the same wound incision the olecranon is exposed. The periosteum on its caudomedial aspect is incised and elevated. With the elbow joint in extended position, the biceps tendons are sutured to the elevated periosteum, using interrupted sutures of 3/0 nylon. The second procedure at the same time was a relocation of the flexor carpi radialis muscle. An incision is made from the craniomedial aspect of the forearm. Medially the flexor carpi radialis muscle was isolated for most of its length. On the lateral side the common digital extensor muscle is similarly exposed. The flexor tendon is transected below the carpal joint and is drawn obliquely across the forearm either between radius and extensor carpi radialis muscle or between cephalic vein and extensor carpi radialis, to lie along the common extensor. A side to side anastomosis using interrupted sutures of 3/0 nylon was done. The carpus and elbow were extended and splinted for two weeks. After that physical therapy had been performed.

RESULTS

Two dogs and one cat have been able to support weight with only minimal flipping over of their carpus and skin-excoriation of the digits within eight to twelve weeks postoperativ. Over the next six month gait improved gradually but the affected legs were weaker. The owners were satisfied with the locomotory ability of there animals and no further treatment was needed. In one dog and one cat only little improvement was seen after six months. Those animals were able to support weight on the affected leg. The elbow joint did not collapse but active extention of their carpal joint did not occur. Skin-excoriation over the carpus and digits has been managed conservatively other surgical treatment was denied. One dog was lost for follow up.

CONCLUSION

The success of this techniques depends largely on an accurate assessment of the extent of the injury. The muscle being transferred must have a functional nerve supply so they may replace or support the function of the paralysed muscle. In selected cases tendon transfer after brachial plexus injury in dogs and cats can be a useful procedure. Physical therapy is as needed as a devoted owner. The results in this carefully chosen case series, though not perfect, were satisfactory.

Biomechanical properties of the canine shoulder joint

J. Maierl, D. Eller, P. Böttcher, S. Hecht, U. Matis, H.-G. Liebich

The canine shoulder joint is generally considered a congruent spherical joint. Only few references give the information that the humeral head is ovoid. A number of consequences result from this geometry. One of which is the fact that a very high number of joints from adult animals show a defect of the articular cartilage in the caudal third of the humeral head. These lesions varied from a slight roughening to a complete loss of the articular cartilage.

In order to demonstrate the physiological morphology we investigated anatomical preparation of healthy shoulder joints by CT. With the resulting datasets it was possible to visualize the subchondral bone density as a feature reflecting the high long-term loading of the joint. Furthermore – as the specimens were scanned exarticulated – we could establish the topographical distribution of cartilage thickness, as well. Split line patterns were performed in decalcified samples in order to visualize a preferential orientation of collagen fibres in the subchondral bone. This is the morphological correlate of repeated bending stress in bone. In-vitro contact studies were performed at the “standing” angle with a special silicone and pressure sensitive film (Fuji prescale film).

The glenoid cavity typically displays a higher subchondral bone density in comparison to the humeral head. Maximal bone density can be found close to the lateral margin and in the caudal half of the *cavitas glenoidalis*. In the humeral head maximal density is typically located in the caudal third extending towards the intertubercular groove immediately adjacent to the major tubercle.

Topographical distribution of the cartilage thickness is almost completely complementary to the distribution of subchondral bone density. Maximal cartilage thickness can be found in the cranial part of the glenoid cavity which supports the supraglenoid tubercle. In the humeral head there is high cartilage thickness (up to 1mm) in the very caudal part of the humeral head and in the cranial part close to the sulcus intertubercularis. Cartilage thickness is very low in the caudal part of the head where bone density is high.

The split line pattern in the glenoid cavity reflects bending stress in the cranio-caudal direction as well as to the medial edge which is projecting cranio-medially. In the humeral head no specific orientation of the subchondral collagen fibres can be detected which is typical for convex articular surfaces as they do not experience bending stress.

Contact studies reveal articular contact in the caudal as well as in the cranial part of the joint surface. Pressure is highest in these areas as well.

The major conclusion which can be drawn from the reported findings is the fact that the canine shoulder joint is incongruent. This incongruity leads to heavy loading of the caudal aspect of the humeral causing subchondral bone to reach maximal density. This again is followed by destruction of the articular cartilage due to overloading. The biological significance of this major incongruity is currently not known.

AO spinal implants for canine Wobbler syndrome

U. Matis

Several *traction-mobilization* techniques have been successfully used to treat dogs with Wobbler syndrome, particularly those with disk degeneration and subsequent hypertrophy of the annulus fibrosus. These methods include a screw and double washer technique, the use of an interbody polymethylmethacrylate plug, polyvinylidene spinal plates, Steinmann pins plus methylmethacrylate bone cement and Harrington rods. Disadvantages encompass the possibility of implants entering the spinal canal, insufficient stabilization requiring external support, implant failure and increased stress at the adjacent interspaces encouraging second lesions ("domino effect"). Most of these disadvantages can be overcome by using the Syncage-C and Cervical Spine Locking Plate (CSLP) designed by the AO for the treatment of cervical spine instabilities in humans.

PROCEDURE

The patient is positioned in dorsal recumbency with the thorax and neck elevated and extended over a rolled fleece or rigid vacuum type of apparatus and secured to the table in order to prevent lateral motion. Free access to a C-arm is provided. The use of an image intensifier is very helpful to visualize the cervical spine in a lateral view while preparing the intervertebral space and placing the implants. With the front limbs positioned caudally, the proximal metaphyses of both humeri are easily accessible for cancellous bone harvesting.

Following ventral exposure, the collapsed intervertebral disk space is fenestrated and distracted using a *Casper distractor*. Distraction of the segment is essential for relieving spinal cord and nerve root compression by stretching the annulus fibrosus and widening the foramina. It also provides good access to the intervertebral space for subsequent removal of remaining disk material and optimum preparation of the endplates. The cartilaginous layer is carefully removed from the vertebral endplates, which is important for the vascular supply to the bone graft. Excessive cleaning, however, should be avoided, because the cortical bone beneath the cartilaginous layer increases the resistance of implant subsidence in the adjacent vertebrae.

Curved and wedge shaped cages in four different sizes (4.5, 5.5, 7.0 and 8.5 mm) are available to match the individual anatomy and preparation of the cranial endplate. Both Syncages facilitate the restoration of the natural disk space and normal lordosis. Prior to implantation, any osteophytes have to be removed from the intervertebral space to achieve complete decompression of the neural structures.

Colour-coded trial implants are used to determine the type and size of the appropriate Syncage. A special holder is screwed to the trial so that the cranial side of the holder matches the cranial side of the trial implant. With the segment fully distracted, the trial implant must fit tightly and accurately between the endplates in order to maximize segment stability through tension in the longitudinal ligament and the annulus fibrosus. Finally, the corresponding *Syncage-C* is selected, mounted on the holder, packed with autogenous cancellous bone and inserted into the distracted segment. If necessary, the implant is slightly hammered into the disk space. The space around the implant should also be filled with additional bone material.

Before removing distractor and holder, the position of the cage in relation to the vertebral bodies is verified under the image intensifier.

In dogs too small for accepting Syncages, a polymethylmethacrylate plug may be used as an intervertebral spacer. Here, preparation of the endplates includes a few drill holes to increase the bone-cement interface.

In both techniques, internal fixation should be supplemented by using a *Cervical Spine Locking Plate (CSLP)*. This H-shaped plate comes in two sizes and different lengths from 24 to 92 millimeters. It is fixed to the vertebrae using converging monocortical expansion head screws. When choosing the suitable plate size, it should be borne in mind that the intervertebral disks of the neck region a slightly inclined from ventrocaudal to dorsocranial. The screws should remain completely in the vertebral body and not penetrate the intervertebral disks. An effective instrument set ensures reliable placement. Temporary fixation pins prevent plate movement during drilling and screw insertion. The expansion mechanism of a special self-holding drill guide locks the plate and enables safe drilling in the correct direction. Drill bits with a safety stop are used to avoid penetration of the spinal canal. The expansion head screw system locks the monocortical screws at a determined angle in the plate hole.

Up to now, five dogs of 20 to 53 kg body weight have been treated for dynamic degenerative disk disease at C5-6 and/or C6-7 using AO/ASIF cervical spine implants. In the first dog, the neurologic status deteriorated 3 days after surgery. Traction-fixation had been performed using the Syncage-C alone. The cage broke

and migrated causing recurrence of instability. The implant was replaced and supplemented with the Cervical Spine Locking Plate, which resulted in quick recovery. The other four dogs were primarily stabilized using the Cervical Spine Locking Plate, three in combination with a Syncage-C and one with a bone cement plug. Although further experience is needed, preliminary results are encouraging and support the use of the AO/ASIF cervical spine systems for treatment of the canine Wobbler syndrome. External support is not necessary to maintain stability and postoperative morbidity is minimal. Reliability and safety justify the comparably high implant costs.

Clinical experience and long-term results of the cemented biomécanique hip

U. Matis, I. Holz

INTRODUCTION

Since the introduction of the cemented hip joint endoprosthesis in veterinary medicine, many reports have been published describing the different types of prostheses and their successful application in the dog. However, only very few statistics included a systematic evaluation of radiographic follow-up examinations. In particular, there has always been a clear lack of well-documented long-term controls, which are a basic prerequisite for substantiated long-term prognosis.

MATERIALS AND METHODS

In a retrospective study performed at the Surgical Clinic of the Faculty of Veterinary Medicine at the Munich Ludwig-Maximilians-University, data on 479 Biomécanique prostheses, which had been implanted in 369 dogs (110 [23%] of these patients had bilateral arthroplasty) was evaluated. All operations were carried out by the same surgeon with the dogs under general anaesthesia using inhalation agents and controlled respiration. The surgical technique used was a modification of the method described by Hohn et al. (1983) using Refobacin-Palacos® (Merck, Darmstadt, Germany) bone cement. PMMA was finger-packed into the acetabular bed and injected into the femoral shaft. After the medullary cavity had been flushed and cleared of blood and debris, a urine catheter was placed into the femoral canal during injection of the bone cement.

Follow-up examinations were performed between 6 weeks and 10 years postoperatively (average 3 years) and were repeated once or even more times in many patients. Of the total of 479 arthroplasties, 356 prostheses (95.7%) were re-evaluated 6 weeks after surgery, 105 (28.2%) after 6 months, 162 (43.6%) after 1 year, 106 (28.5%) after 2 years, 58 (15.6%) after 3 years, 64 (17.2%) after 4 years, 44 (11.8%) after 5 years, 12 (3.2%) after 6 years, 3 (0.8%) after 7 years, 4 (1.1%) after 8 years, 1 (0.3%) after 9 years and 1 (0.3%) after 10 years.

The *clinical examination* included assessment of pain on passive movement of the limb, muscle atrophy, maximum passive extension of the hip, stance and contralateral lameness. Owner reports were added to the clinical findings and summarized as a functional result.

Radiographic assessment of the position of the *acetabular component* and the stem of the prosthesis as well as the bone-cement and cement-implant interfaces was performed by comparing post-operative radiographs with those taken at the time of re-examination. For assessment of the bone-cement interface of the acetabular cup, the zonal division according to DeLee and Charnley (1976) was used. Radiolucencies at the bone-cement interface identified immediately after surgery were attributed to the cementing technique. Radiolucent lines that were progressive, particularly those involving all three zones, were considered as relevant loosening and predisposition for acetabular migration. For assessment of the *stem prosthesis*, the proximal femoral region as visualized on ventrodorsal radiographs was divided into seven zones according to Gruen et al. (1979). Radiographic findings indicative of implant loosening included cement fractures, subsidence of the stem as well as radiolucent areas between implant and cement and bone and cement, respectively.

RESULTS

Functional results obtained with the Biomécanique total hip system were good to excellent in 97% of the cases, i.e. the condition had improved compared to the preoperative state and lameness had either resolved completely or was reduced to infrequent episodes. In the remaining 3% of the patients, permanent complaints had either persisted or were caused by postoperative complications. Ninety-seven percent of the dog owners were very satisfied with the outcome of the surgery and declared they would consent to this procedure again at any time.

The main complication observed in 4% of the prostheses was aseptic loosening, with a slightly higher incidence in the acetabulum (2.5%) than in the shaft (1.5%). The second most frequent complication was infection (1.7%) followed by luxation (1.5%) and femoral fractures (0.8%). Other problems observed included transient neurapraxia and patellar luxation. Forty of the 44 complications (90.9%) were resolved complete-

ly by revision surgery. In one dog, conservative treatment alone achieved satisfactory correction, while this was not possible in another patient. Two dogs were euthanized at their owners' request.

To date, long-term results of 65 implanted Biomécanique prostheses with an observation period between five and ten years are available. Neither significantly increased lameness frequency nor markedly elevated numbers of radiolucencies indicative of implant loosening were reported in these follow-up examinations. Although radiolucencies were seen in a total of 77% of prostheses, only 4% of these had caused a clinically relevant loosening of the implant.

DISCUSSION

Compared with a previous retrospective study, in which 149 dogs with 199 Canine Richards II prostheses were evaluated using the same criteria (Kosfeld 1996), the incidence of complications decreased from 18.6% to 9.2%. This may partly be attributed to the increased experience of the surgeon and partly to the greater versatility of the Biomécanique system. The titanium shaft of the Biomécanique prosthesis did not reveal a higher risk of aseptic loosening. Its design facilitates centralization of the stem, which is one of the recommended measures to prevent aseptic loosening. No fatigue fractures of the Biomécanique stem occurred, as had been the case in 1.6% of Canine Richards II prostheses. Thanks to the wide range of sizes available, Biomécanique prostheses could be implanted in dogs with body weights from 8 to 70 kilograms. As the modular design of this implant system allows individual selection of stem and head size as well as neck length, the rate of luxation could be reduced to 1.5% compared to the 2.7% observed in patients that had received the Canine Richards II prosthesis. As far as long-term results are concerned, the aseptic loosening rate in the patients of the present study was slightly higher, while lameness frequency was reduced compared to cases with uncemented PCA prostheses reported by DeYoung et al. (1992) and Marcellin-Little et al. (1999).

CONCLUSIONS

The Biomécanique prosthesis can be unreservedly recommended for total hip arthroplasties in dogs. With the reservation of the reduced number of long-term controlled hip joint endoprostheses, life-long fail-safe functioning can be assumed provided that the implant is well integrated during the first 12 months. Versatility, material and design of the implant as well as cementing technique and the experience of the surgeon represent the most critical features for a successful outcome of the cemented hip joint endoprosthesis.

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Infraspinatus Bursal Ossification (IBO) in eight dogs

W.M. McKee, C. May, C. Macias

A variety of soft tissue injuries in or around the shoulder are associated with lameness in dogs. This study concerns lameness associated with ossified bodies in the infraspinatus bursa.

Eight dogs (all Labrador retrievers) presented between October 1995 and July 2000 with thoracic limb lameness localised to the shoulder. Focal pain on direct pressure over the tendon of insertion of infraspinatus was noted in four out of nine affected shoulders. Radiography included medio-lateral and caudo-cranial views (fifteen shoulders) and abnormalities were documented in all fifteen, with changes most evident on the caudo-cranial view. A single mineralised mass was recognised in 12 shoulders and multiple masses were recognised in three. There was sclerosis of the adjacent humeral bone in all cases. Positive contrast arthrography was performed in three affected joints and was normal in all three. Synovial fluid was analysed from five affected joints (colour, viscosity, volume and cytology) and was within reference parameters in all five cases. Arthroscopic evaluation was performed in three affected joints and revealed partial medial glenohumeral ligament rupture in two and signs of bicipital tenosynovitis in one.

Four out of nine affected shoulders were treated with intra-articular injection of long-acting methylprednisolone acetate (60-90mg) and four were treated with rest and NSAID. Two of the NSAID treated dogs were subsequently operated on and one dog was managed surgically as the primary treatment. Surgery was by a standard cranio-lateral approach to the shoulder and infraspinatus tendon of insertion. A single mineralised body was found in the infraspinatus bursa attached to the wall of the bursa and with adhesions to the infraspinatus tendon in two cases and multiple mineralised bodies were found in one case. Histological examination (with thanks to Dr Irene McCandlish, of IDEXX laboratories) revealed primarily bone with irregular areas of cartilage and dense connective tissue. Follow-up ranged from two to 32 months (mean 13.9 months). Of the four cases treated with intra-articular methylprednisolone, lameness resolved in two and the remaining two showed an improvement in lameness. Of the four cases treated with rest and NSAIDS, lameness resolved in one and improved in one. The lameness showed no change in two and these were subsequently treated surgically. In total, three cases were treated surgically with improvement of lameness in all three, but resolution of lameness in none.

IBO appears to be an uncommon condition in dogs. Focal pain on palpation of the tendon of insertion of infraspinatus is a useful clinical finding and the caudo-cranial radiographic view of the shoulder is important in the diagnosis. Some (possibly all) lame dogs have concomitant shoulder pathology (3/3 on arthroscopy). The observation of radiographic evidence of lesions in shoulders not showing lameness suggests that IBO may be asymptomatic and that concomitant shoulder pathology may be a cause of lameness. The focal pain response on direct palpation (4/9 cases) and improvement following surgical removal of mineralised bodies in three cases suggests that the IBO may be a cause of lameness.

Genetic manipulation of the synoviocyte in the treatment of OA

C.W. McIlwraith

Using an established model of equine osteoarthritis that mimics clinical osteoarthritis, the therapeutic effects resulting from intra-articular overexpression of the equine interleukin-1 receptor antagonist gene through adenoviral mediated gene transfer were investigated. The study consisted of three parts:

1. Constructing an adenoviral vector expressing equine IL-1Ra DNA (Ad-EqIL-1Ra);
2. Testing the utility of this vector and its anti-IL-1 activity *in vitro*;
3. Determining a safe and potentially efficient dose of the vector *in vivo* using normal equine joints;
4. Testing the vector *in vivo* using an established equine OA model.

This investigation had several novel features including the use of an autologous gene and the assessment of improvement using clinical, as well as laboratory, criteria.

In the *in vitro* study, a dose-dependant increase in media concentrations of IL-1Ra was demonstrated 48 hours after transduction of equine synoviocytes with that same Ad-EqIL-1Ra at 0, 1, 10 and 100 MOI reaching a peak concentration of 39 ng/10⁶ cells at 100 MOI. In the *in vivo* dose titration study, intra-articular injection of the Ad-EqIL-1Ra vector in normal equine joints led to a dose-dependant increase in the concentration of IL-1Ra in synovial fluid aspirates. Maximum duration of IL-1Ra production (28 days) occurred with 10 and 20x10¹⁰ particles per joint. The highest Ad-EqIL-1Ra concentration (50x10¹⁰ particles per joint) produced a marked, acute synovial fluid leucocytosis.

In the *in vivo* study, the equine OA model utilizing a chip fragment, burring and exercise in the midcarpal joint was used. Seventy days after the induction of OA, and 56 days following IA administration of Ad-EqIL-1Ra, significant improvement in clinical lameness was observed in treated compared to untreated horses. IL-1Ra concentration was significantly increased in the synovial fluids of transduced joints on days 7, 14 and 21 after induction (21, 28 and 35 days after lesion creation). At post-mortem, control OA-induced joints contained some levels of pathologic change in the form of partial or full thickness articular cartilage erosions, and these changes were not present in transduced joints. The induced osteoarthritis also reduced the glycosaminoglycan staining in the articular cartilage, and this effect was also reversed by treatment with the EqIL-1Ra gene.

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Lateral corpectomy as surgical treatment of ventral thoracolumbar disk hernia. Study of 42 cases

P. Meheust, C. Carozzo, P. Moissonnier, M. Helliard

OBJECTIVE

Study the long-term clinical and radiographical results of surgical treatment of ventral thoraco-lumbar medullary compression by lateral corpectomy.

STUDY DESIGN

Retrospective study

ANIMALS

42 dogs operated by lateral corpectomy. They all suffered of a thoracolumbar disc protrusion, appearing in a ventral position during myelography examination. The hernias were either of Hansen type I or Hansen type II

METHOD

All the operated dogs were clinically evaluated and classified in stages (1 - 5) according to the observed neurological symptoms. The medullary decompression was realized by lateral corpectomy. It consists of the osteotomy of the dorsal third of the vertebral bodies neighboring the herniated disk. A clinical and radiographical follow-up was done for a minimum period of 6 months.

RESULTS

T12-13 is the most concerned disk (n=16). The myelography showed that 30% of the hernia cases were strictly ventral, i.e in the median plane. In the other cases, it was very slightly lateral while remaining on the vertebral floor. The surgical investigation showed that only 15% of hernias were contained. At the term of a minimum post-operating period of 6 months, 92% of dogs presented an improvement of their clinical state. No complication (instability, infection...) or recurrence on the operating site was noted.

CONCLUSION

The lateral corpectomy is a technique allowing to treat ventral thoracolumbar herniated disk efficiently, whether contained or not contained. Compare to hemilaminectomy, it allow an easier approach and a better visualization of the herniated disk, a better control of hemorrhage of epidural veins, a most complete removal of the herniated discal material with an ease and a safety which do not offer the other techniques.

Surgical arthrodesis of cervical instability

B. P. Meij

Cervical instability or caudal cervical spondylomyelopathy (CCME) causing wobbler syndrome is a condition of large and giant breeds, e.g., Dobermann, Great Dane, Basset Hound, Rottweiler, Mastiff, and other breeds. Animals are affected while growing in their first year (Great Dane, Basset Hound, Dobermann) or as middle age to older animals (Dobermann, Rottweiler, and other breeds). A variety of lesions have been described. Anatomic abnormalities include stenosis of the cranial aperture of the cervical vertebral canal, vertebral body deformation, and asymmetry of the articular facets. Degenerative lesions include fibrinoid disc degeneration and protrusion (Hansen type II disc degeneration), ligamentous hypertrophy, and joint capsule proliferation. Anatomic abnormalities predominate in the younger dogs while degenerative lesions predominate in older animals. Wobbler syndrome is characterized by posterior paresis and ataxia, proprioceptive deficits, forelimb lameness and mild cervical pain. Diagnostic work up includes cervical radiographs in the anesthetized animal with stress views (flexion, extension, and linear distraction and compression) after injection of a radiographic contrast agent in the cisterna magna (myelography). The aim of the myelogram is to determine the exact localization of the spinal cord compression and to assess whether the compressive lesion is static or dynamic in nature.

Surgical treatment is the most common treatment for cervical instability, however, a course of exercise reduction for 2 to 4 weeks, the use of a chest harness, and the administration of non-steroidal anti-inflammatory drugs or corticosteroids often lead to temporary improvement.

The two goals of neurosurgery in wobbler syndrome are 1) to decompress a compressive lesion and 2) to stabilize a cervical instability. Several surgical techniques have been devised to provide decompression, stability or both. The number of procedures devised and their lack of universal acceptance demonstrate the range of possible lesions and the less than ideal results of any single procedure. The attempt to stabilize a cervical vertebral junction, that is, by nature, highly flexible seems to be a paradox and may well explain the high rate of surgical failures and complications.

There are three methods (each with its modifications) to surgically treat wobbler syndrome in the dog: 1) ventral decompression, 2) ventral distraction and stabilization, and 3) dorsal decompression. The outcome of the myelographic examination usually determines which technique may be chosen as the best option for surgical treatment.

1) *Ventral decompression* ('ventral slot') is mainly indicated in static, ventral lesions (type I or II disc herniation), fusion of the vertebrae is promoted by packing cancellous bone around the slot site. A modification on the ventral slot technique is the inverted cone decompression technique in which less dorsal cortical bone shelf is removed than in the classical ventral slot technique.

2) *Ventral distraction and stabilization*. The main indication for this method of treatment is one or multiple dynamic ventral compressive spinal cord lesion(s), e.g. cervical instability, type II disc degeneration, and dorsal longitudinal ligamentous hypertrophy. The techniques that have been used share the same principle, i.e., linear distraction of cervical vertebral bodies resulting in decompression at the site of the dynamic lesion and (temporary) fixation of the vertebral bodies allowing fusion to take place which is promoted by cancellous or corticocancellous bone grafts. Various surgical techniques have been developed over the last two decades, some of them have been abandoned again because of surgical failure or complications. The techniques that have been used are: distraction with a cylindrical cortical allograft kept in place with a plastic Lubra plate, distraction with Steinmann pins or screws and fixation with a polymethyl methacrylate (PMMA) or bone cement bridge, Harrington rod distraction device, screw and washer technique, and the modified distraction-stabilization technique using an interbody PMMA plug. Arthrodesis of the cervical vertebrae is promoted by packing cancellous bone, harvested from the proximal humerus, on the ventral surface of the affected cervical junction.

3) *Dorsal decompression* is indicated in static or dynamic dorsal compressive spinal cord lesions, e.g., osteophytes around articular facets or interarcuate ligamentous hypertrophy. Techniques include (continuous) dorsal laminectomy, and dorsal stabilization techniques with wire or lag screw fixation of the articular facets. At the Utrecht University follow up was available in 20 dogs (18 Dobermanns and 2 Great Danes) that have been surgically treated for wobbler syndrome. The surgical procedures that were used were Lubra plate and cortical graft (2 dogs), Steinmann pins and PMMA bridge (3 dogs), Harrington rod distraction device (4 dogs), ventral decompression ('ventral slot', 3 dogs), dorsal (hemi)laminectomy (1 dog), and screw and washer (7 dogs). The Lubra plate and Harrington rod techniques had a high rate of surgical implant failure and

the procedures were abandoned. The ventral decompression technique for wobblers syndrome resulted in neurological worsening in 2 of 3 dogs. Clinical and neurological stabilization or improvement was seen with the Steinmann pin and PMMA technique (2 out of 3 dogs), the screw and washer technique (5 out of 7 dogs) and following dorsal laminectomy in a Great Dane. Complete surgical arthrodesis of the cervical vertebrae was only observed with the screw and washer technique although in time the end plates of the vertebral bodies collapsed on the washer.

Nerve sheath tumors

B.P. Meij, L.N. Frost-Christensen

Nerve sheath tumors (NSTs) have a low incidence in dogs and most commonly involve the peripheral nerves of the brachial plexus. NSTs are benign or malignant mesenchymal tumors and they originate from periaxonal schwann cells (schwannoma) and fibroblasts (neurofibroma/neurofibrosarcoma). Due to its mesenchymal origin the terminology for NSTs is diverse and a wide range of names has been used in the literature, e.g., neurinoma, schwannoma, neurofibroma, neuro(fibro)sarcoma, neurilemmoma, neurogenic sarcoma, neurofibromatosis. Currently the most widely used name is nerve sheath tumor. On histological examination NSTs exhibit Antoni A and B patterns; the former (Antoni A) comprises compact spindle cells arranged in interlacing fascicles and palisades (whorls), whereas the latter (Antoni B) is less cellular, consisting of spindle cells arranged loosely and supported by edematous matrix. NSTs may occur in every large or small nerve in the body but will only receive attention from the orthopedic surgeon or the neurosurgeon when the spinal cord, cauda equina or main peripheral nerves of limbs are involved. Although most NSTs grow outside the dura mater (extradural) they may extend along the pathways of the nerve roots into the intervertebral foramen. Once inside the spinal canal they may develop an intradural-extramedullary component or even an intradural-intramedullary component. Clinical signs include severe, unexplained, and intractable pain, limb lameness, monoparesis, ataxia and proprioceptive deficits. Early diagnosis and an aggressive surgical protocol maximize the possibility for complete tumor resection sparing the limb. NSTs have a high rate of recurrence, and the overall prognosis is considered poor.

At the Utrecht University eight dogs with a nerve sheath tumor were seen in which the diagnosis of NST was confirmed by imaging or histological examination of the surgical specimen. The dogs (German Shepherd, English Cocker Spaniel, Bouvier, Irish Terrier, Labrador Retriever and 3 Golden Retrievers) ranged in age from 14 months to 10 years and were referred for limb lameness, monoparesis, severe muscle atrophy, and (periodic) severe limb or axillary pain unresponsive to medical treatment. Pain was eventually localized in the upper cervical area (1 dog), in the lower cervical area and axillary region (4 dogs), in the lower back region (1 dog), and in the distal limb (2 dogs). Electromyography was performed in 4 dogs and showed denervation potentials of the muscles of the affected limb. In all dogs radiography was not diagnostic or inconclusive.

Computed tomography (CT) was performed in 5 dogs, magnetic resonance imaging (MRI) in 2 dogs, and ultrasonography in 2 dogs. CT revealed a brachial plexus tumor at C6-C7-T1 in 3 dogs, an intradural-extramedullary tumor component of a NST at C6 in 1 dog, and lumbosacral disc disease together with a right spinal nerve root S1 tumor in 1 dog. MRI revealed an intradural-extramedullary tumor component of a left paravertebral NST at C1-C2 in an Irish Terrier. Ultrasonographic examination revealed an elongated tumor along the trajectory of the tibial nerve at the medioplantar aspect of the talocrural joint in an English Cocker Spaniel. Ultrasonographic examination and MRI revealed an elongated tumor along the trajectory of the median nerve at the mediopalmar aspect of the carpus in a Labrador Retriever.

The Irish Terrier with a NST at level C1-C2 and two dogs with a brachial plexus tumor were euthanized at the request of the owner. Five dogs underwent surgical exploration and tumor resection sparing the limb. Histopathological examination of surgical specimens revealed a schwannoma (spinal cord, brachial plexus), a low-malignant neurofibrosarcoma (S1 nerve root, median nerve) and a myxosarcoma (tibial nerve). Follow up examination showed a recurrence in 3 dogs at 2 to 5 months after surgery. Two dogs (C6 spinal cord NST and S1 nerve root NST) were euthanized at the time of recurrence. The Labrador Retriever with a median NST was successfully re-operated. Two dogs with a brachial plexus NST and a tibial NST went into full remission. The dogs that underwent resection of NSTs of median nerve and tibial nerve at distal limb showed no significant neurological deficits following surgery due to overlapping innervation of other peripheral limb nerves.

Introduction to small animal veterinary physical therapy

D.L. Millis

Physical therapy in human patients is common and well accepted. Until recently, there has been little study of physical therapy of animals. Advances in human physical therapy have allowed us to adapt some of the techniques and procedures to small animals.

The age and physical condition of the patient, the surgical condition, concurrent injuries, owner compliance, and the training and expertise of the rehabilitation team affect the rehabilitation protocol. Whenever possible, preemptive pain management should be instituted so patients are comfortable during rehabilitation.

STRETCHING AND RANGE OF MOTION EXERCISES

It is critical to reestablish full range of motion (ROM) as soon after injury as possible. Animals may have permanent loss of motion by two weeks after surgery, which limits an animal's functional ability in the future. Proper technique is vital because aggressive ROM exercises result in pain, reflex inhibition, delayed use of limb, joint fibrosis, and a stiffer joint. The key is to stretch and realign soft tissues and collagen over time, not to rip and tear tissues. ROM therapy is important for any joint surgery and in young dogs with physeal fractures.

CRYOTHERAPY

Cryotherapy is important following acute injuries or in the postoperative period to decrease blood flow, pain, swelling, inflammation, hemorrhage, and metabolic activity. Cryotherapy is applied for 72-96 hours, for 15-20 minutes, every 4-6 hours following injury. It may also be beneficial for chronic conditions. Ice packs, commercial cold water circulating units, or commercial cold packs may be used with or without concurrent compression.

HEAT

After 72-96 hours, heat may be applied to increase blood flow, tissue extensibility, and general relaxation, and to decrease pain, muscle spasms, and joint stiffness. Superficial heat penetrates 1-2 cm and may be applied using commercial hot packs, or warm moistened towels. Apply moist or dry heat for 10 min prior to a session. Be cautious in applying heat to areas with reduced sensation, or in non-ambulatory animals. Heat may increase swelling if used too early.

Therapeutic ultrasound is useful in heating tissues up to 5 cm in depth. 3.3 MHz transducers are effective for heating more superficial tissues, while 1 MHz is used for deeper tissues. Ultrasound may also increase collagen deposition and wound breaking strength.

NEUROMUSCULAR ELECTRICAL STIMULATION

Neuromuscular electrical stimulation (NMES) has a wide variety of benefits including increasing muscle strength and joint range of motion, decreasing edema and pain, promoting wound healing, and restoring function. Pulsed alternating current, low frequency units are the most widely used for therapeutic applications. Early use of NMES may attenuate muscle atrophy following surgical procedures. A muzzle should be applied prior to initiating NMES. Tranquilization may also be necessary. Treatment should be administered under the supervision of trained personnel. Muscle groups may be contracted sequentially or together (co-contraction). Muscles are generally treated for 10-20 minutes, 3-7 x/week.

REHABILITATIVE EXERCISES

The goals of therapeutic exercises are to improve active pain-free range of motion, improve use of limb, reduce lameness, improve muscle mass and muscle strength, improve daily function, and help prevent further injury.

Standing exercises are performed for animals with bilateral pelvic and neurologic injuries. Place the dog with all four feet squarely underneath, then support the affected body part with a towel or sling to support the body and allow some weight-bearing. When the dog slowly collapses, pull it back up, then repeat the exercise. Start with 10-15 repetitions bid-tid, and gradually increase to 5 minutes per session.

Slow walks are perhaps the most important exercise in the early post-op period. The walks must be at a

speed to encourage weight-bearing; if the dog is walked too fast, they will carry the limb. Behavior modification to encourage limb use is important.

Climbing stairs is useful to improve power in the rear limb extensors. Stair climbing may start if the repair is stable and the dog is consistently using the limb at a walk with progressively decreasing lameness. The dog must begin slowly climbing stairs to encourage proper use of the rear limbs, as opposed to simply carrying the limb while climbing stairs.

Treadmill activity is very useful in rehabilitation. Most dogs trained to a leash readily take to treadmill walking. A variety of treadmills are available for dog use. A harness is useful to help support the dog. Side fences, a variable speed control, timer, and the ability to change the incline of the surface are other useful features. Treadmills are useful for patterning gait, and encouraging early use of a limb. The ground moving underneath the dog often encourages a nonweight-bearing dog to begin using limb. Treadmills help reduce the stress and pain of limb movement in some conditions, such as extension of the hips or knees.

Dancing and wheelbarrowing are techniques to increase weightbearing and stress on the rear and fore limbs, respectively. Muzzle dogs prior to exercise. The forelimbs are lifted off the ground for dancing, and the rear limbs are lifted for wheelbarrowing. Dogs with normal proprioception will naturally move the limbs as the animal "dances" or wheelbarrows. Dogs may also perform these exercises going up and down inclines.

Sit-to-stand exercises help strengthen hip and stifle extensors. Attention should be paid to sitting and standing straight, with no leaning to one side, and the dog should sit squarely on its haunches. It may be easier to back the dog into a corner, with the affected limb next to a wall so that the limb cannot slide out. Start with 5-10 reps sid-bid, and work up to 15 reps tid-qid.

Cavaletti rails are poles which are spaced apart on the ground at a low height. They are useful to help dogs lengthen their stride, flex their joints, and regain appropriate proprioception. Begin with walking and progress to trotting. The rails may be raised to encourage greater active flexion and extension of joints, and the distance between the rails may be altered.

Carts and sleds may be used to pull weights. Harnesses should be well padded and comfortable. The position of the head and neck are important in determining whether a dog pulls the weight forward with the forelimbs or the hind limbs. Dogs may also perform chronic "weight lifting" by wearing a canine backpack filled with weights or by wearing leg weights.

Controlled ball playing is an effective form of therapeutic exercise. Ball playing should begin on a relatively short leash to avoid explosive activity in the early rehabilitation period, followed by graduation to an enclosed area, such as a run. As the animal nears full return to function, off-leash activity may be performed in a field free of irregular surfaces.

AQUATIC THERAPY

Aquatic therapy is excellent for improving muscle strength and joint mobility in a nonweight-bearing environment. Bathtubs, whirlpools, swimming pools, ponds, or lakes may be used. Some dogs do not tolerate swimming and there is some risk in damaging tissues if the animal thrashes. Underwater treadmills allow muscle strengthening, gait patterning, and enhanced cardiovascular fitness in a buoyant environment to reduce weight-bearing stress on bones and joints. Be aware that many patients are not well-conditioned and they may be able to tolerate only 2-5 minutes of swimming when starting an aquatic program.

SUMMARY

Optimal protocols for postoperative rehabilitation in animals are unknown. This exciting new area of patient management has the potential to improve outcomes, increase patient quality of life, and enhance owner satisfaction and enjoyment of their companions. It should be goal of every veterinary team to provide some form of rehabilitation for injured or surgical patients.

REFERENCES AVAILABLE FROM THE AUTHOR.

Bone and lean tissue changes following cranial cruciate ligament transection and stifle stabilization

D. Millis, D. Francis, M. Stevens, S. Barnett

A previous cranial cruciate ligament (CCL) transection-stifle stabilization model indicated that 1/3 of muscle mass is lost following surgery, followed by a slight recovery between 5 and 10 weeks. Little information exists regarding changes in bone after stifle surgery. The purpose of this study was to quantify the changes in bone following CCL transection and stifle stabilization.

METHODS

The first part of this study evaluated changes in the proximal, midshaft, and distal tibia following CCL transection and immediate stabilization of the stifle. Dual-energy X-ray absorptiometry was used to determine bone density (BD), bone mineral content (BMC), and bone area of the limb undergoing surgery and the contralateral nonsurgical limb. Data were collected prior to surgery, and 5 and 10 weeks after surgery.

The second part of this study evaluated BMC and lean tissue mass of the entire affected surgery limb and the contralateral nonsurgical limb prior to surgery and 2, 4, 6, and 8 weeks after surgery.

RESULTS

BD and BMC decreased 12-15% in the proximal and distal tibia of the affected limb, and increased 2-5% in the contralateral tibia. Changes in the midshaft tibia were less pronounced, with bone loss of 4-7% occurring. Changes were noted within the first 5 weeks.

In part 2 of the study, limb BMC of the affected limb was unchanged in the first 2 weeks, but sharply decreased between weeks 2 and 4, followed by continued but slowed bone loss through week 8. Lean tissue mass decreased immediately after surgery, with peak loss at 4 weeks, followed by a gradual recovery of mass. BMC and lean tissue mass of the contralateral limb began to increase 4 weeks after surgery.

CONCLUSION

The pattern and rate of bone loss differs from that of lean tissue mass, with changes in bone being delayed by 2 weeks as compared with changes in lean tissue. Bone loss continues for 8-10 weeks, while muscle mass begins to recover by 4-6 weeks. Knowledge of the time course of these changes may allow development of strategies to prevent these potentially deleterious changes.

Clinical application of Zurich Cementless - canine total hip prosthesis

P.M. Montavon, S. Tepic

A new cementless total hip prosthesis, Zurich Cementless, was developed at the University of Zurich. The most important characteristics of the Zurich Cementless is avoidance of the coupling effect of the medial and lateral femoral cortices, and stress shielding due to compliance mismatch. The stem is fastened to the medial cortex with screws. This instantly provides a stable fixation, which approximates the normal physiological stress distribution on the proximal femur. It allows bone remodeling around the screws. The initial fixation of the cup is attained by a press fit insertion. The porous design of the cup allows fluid convection and its fixation by osseointegration. A Multicentric Study involving centers in America, Asia and Europe is underway to obtain reliable, comparative clinical results and information to improve the surgical procedure, instruments, and implants.

MATERIALS AND METHODS

Experimental and clinical testing resulted in the latest design of implants of different sizes and adequate surgical instruments for surgical implantation. Transparencies as template on radiographs allow preoperative planning for the proper size of implants. The hip joint is approached from a craniolateral incision. Biplanar osteotomy reaching the level of the lesser trochanter distally allows resection of the femoral head and neck. Preparation of the proximal femur including the area of the intertrochanteric fossa is made with different reamers and broaches acting as template for the stem. Preparation of the acetabulum is the most challenging part of the procedure. Removal of the subchondral sclerotic bone and uniform preparation of the cavity is made with reamers of progressive sizes, beginning at the original ventral border of the acetabulum. The existing caudal and cranial acetabular rims are preserved. The hemispheric cup is then positioned. It is impacted insuring that the caudal and cranial equator areas are covered with bone. Protruding pelvic osteophytes are removed and the level of femoral neck resection is controlled to facilitate later reduction of the prosthesis. The femoral component is fixed into the guide and inserted into the proximal femur with desired anteversion. Access holes in the lateral and then screw holes in the medial cortex are drilled. Screws are placed into the femoral stem holes beginning proximally and proceeding distally. A femoral head and neck of desired length is impacted on the stem. The prosthesis is reduced. Stability of the hip prosthesis is tested and improved with intraoperative changes, if necessary. The surgical wound is reconstructed. Templates assist in evaluating the position of the acetabular cup possible on postoperative radiographs.

RESULTS

The range of motion of the prosthesis is greater than that of the natural hip. The surgical technique is reproducible. The time required is less than 2 hours. Ideally 3 persons are needed. Patients recover a normal gait within 4–8 weeks. This technique is well suited for dogs 8–10 months of age. The number of complication as part of the Multicentric Study has been decreasing. The learning curve needing less than 20 cases was reported to be steep. A series of over 400 cases operated with the latest generation of implant designs showed early complications in 17 cases (rate of <5%): 8 luxations occurred and 6 acetabular cups were dislodged from their fixation on the pelvis mostly caused by inadequate implantation. Femoral fractures occurred in 3 patients. The revision proved to be successful in all but one case. Bacterial cultures done at the end of surgical revision were positive on 3 patients requiring long-term antibacterial medications. Evaluation of the results of the Multicentric Study will be reported at a later date. The contribution of active participants with useful suggestions to the Multicentric Study, results in invaluable improvement of techniques for canine total hip replacement.

LITERATURE REFERENCES AVAILABLE UPON REQUEST TO THE AUTHORS.

Stenosing tendosynovitis of the abductor pollicis longus muscle

S. Grundmann, P.M. Montavon

INTRODUCTION

Chronic lameness of the forelimb in dogs with a firm swelling at the medial aspect of the antebrachioacarpal joint can be caused by a tendosynovitis of the abductor pollicis longus muscle (APL). Extensive friction causes fibrotic thickening of the tendon sheath associated with pain and functional impairment. The primary cause of the disease may be overstraining of the tendon, which then leads to inflammation. Proliferation of bony structures impairing free gliding movement of the tendon is present in all chronic cases. This condition has been diagnosed in 22 cases and treated in 10 patients between 1995 and 2000 at the University of Zurich.

DIAGNOSIS

Mostly large breed dogs of varying ages, without history of direct trauma, were affected. All of them showed lameness of different degrees, most severe after rest and exacerbated by vigorous exercise. Consistently, the affected limbs showed a firm swelling medial to the antebrachioacarpal joint. The carpus had various degrees of restricted mobility and was painful in passive flexion in all cases. Radiographic changes are seen with chronicity of the disease. Soft tissue swelling and bone proliferations were present at the dorsomedial aspect of the styloid process of the radius in the area of the fibro-osseous canal of the APL. Severity of these findings did not correlate with the clinical signs. Centesis and ultrasonic examination have not been helpful so far.

THERAPY

An injection of corticosteroids was given initially in the tendon sheath of the APL. The mediolateral radius above the swelling clipped and aseptically prepared. A 24-gauge needle advanced proximally underneath the palpable tendon groove along the tendon sheath. Methylprednisolone acetate 0.5ml (20 mg) injected and the area of infiltration massaged. The carpus was immobilized with a splint for three weeks. In the absence of clinical improvement, the treatment was repeated. Without improvement during the first three weeks, or with unsatisfactory result after a second treatment, surgical release of the tendon was performed. The APL arises as a strong triangular muscle on the lateral surface of ulna, interosseous membrane and radius. The terminal tendon is enclosed in a synovial sheath, crosses the tendon of the extensor carpi radialis muscle and passes the medial sulcus of the radius under the straight part of medial collateral ligament. Finally, the tendon inserts medially on the basis of metacarpal I, in presence of a sesamoid bone. The patient was placed in lateral recumbent position for surgery. Through a longitudinal skin incision over the styloid process of the radius the tendon of the APL was exposed. The thickened synovial sheath was incised longitudinally in order to visualize the tendon. Fibrous and osseous tissue reactions were extensively excised until a free gliding movement of the tendon was achieved. A modified Robert Jones bandage was applied for five days post-operatively, and activity was restricted to leash walks for three weeks.

CONCLUSIONS

Dogs with acute symptoms can be treated successfully with local steroid injection and immobilization. Complete resolution of signs in chronic cases can be achieved by extensive resection of the affected tendon sheath and surrounding connective tissue fibrosis. There are cases where lameness does not disappear completely.

LITERATURE REFERENCES AVAILABLE UPON REQUEST TO THE AUTHORS.

Advancement of the tibial tuberosity for the treatment of cranial cruciate deficient canine stifle

P.M. Montavon, D.M. Damur, S. Tepic

INTRODUCTION

The introduction of biomechanical considerations has influenced the treatment of cranial cruciate deficient stifles in dogs. Recent techniques modify the basic joint geometry in an attempt to neutralize the tibiofemoral shear force, which appears to be responsible for the overload of the cranial cruciate ligament. The better long-term prognosis offered by the slower postoperative progression of arthrosis in comparison to previous techniques is considered as a clinical success by a majority of surgeons. Conformational malalignment entities have also been evidenced and surgical limb realignment is indicated in these clinical cases. The procedure presented here consists in advancing the tibial tuberosity, in order to position the patellar ligament perpendicularly to the tibial plateau, thereby reducing to zero the tibiofemoral shear force and easing the function of the deficient cranial cruciate. The lesser invasive technique reduces operative time and perioperative morbidity. Respecting the normal range of flexion of the stifle should make a meniscal release, hence a loss of intraarticular caudal support, not necessary. Decreased retropatellar pressure could alleviate the sulcus chondromalacia present in about 30% of the cases.

These advantages should improve the short and long-time results of the surgical treatment of cranial cruciate deficient stifle.

PREOPERATIVE PLANNING

Mediolateral radiographs of the stifle in extension, avoiding the cranial drawer phenomenon in the presence of total rupture of the cranial cruciate ligament are necessary to figure out the angle necessary to bring the patellar ligament perpendicularly to the tibial plateau. The patellar ligament is represented by its cranial border, the orientation of the tibial plateau by a line passing through both tibial origins of the cranial and caudal cruciate ligaments.

SURGICAL TECHNIQUE

Arthroscopy or medial arthrotomy are performed in case of total cranial cruciate ligament rupture to explore the stifle joint and treat eventual meniscal lesions. Transverse osteotomy of the tibial tuberosity is carried through its distal extremity to the cranial borders of the menisci. A bone spacing structure of desired size is inserted into the distracted osteotomy in order to advance the tibial tuberosity, giving its new position to the patellar ligament. The tibial tuberosity is fixed to the tibia with a tension band. The wound is closed in appositional manner after mobilizing the edges in order to cover the implants.

RESULTS

Failure to maintain the advancement of the patellar ligament has been encountered, resulting from excessive tension and compression forces for the internal fixation repair. In all other cases, clinical results are satisfactory as documented by force plate gait analysis. No additional postoperative meniscal damages have been observed at this date. The results are encouraging and the technique will be further developed.

LITERATURE REFERENCES AVAILABLE UPON REQUEST TO THE AUTHORS.

Cartilage engineering using cell and growth factor composites

A.J. Nixon

CARTILAGE REPAIR

Facilitation of cartilage repair falls into one of two categories; 1) repair by stimulation of pluripotential cells from the subarticular level or 2) transplantation of cartilage, osteochondral grafts, or chondrocytes from remote regions. Only the latter category will be discussed here.

Transplantation Resurfacing. *Chondrocyte Transplantation.* Free chondrocyte transplantation to cartilage defects can be expected to fail. However, implantation in various vehicles to stabilize chondrocytes and allow cell mitosis and matrix production has developed into a viable tissue-engineering industry. Research and clinical data describe the successful use of autogenous and allograft chondrocytes applied in various vehicles to improve cartilage repair in animals and man. Allograft chondrocytes provoke few immune responses due to the barrier provided by the surrounding matrix, and are initially protected by the fixation vehicle. Research in large animal models supports the use of fibrin glue for stabilization and nutrition of transplanted chondrocytes. The tissue response in 15 mm full-thickness defects is superior to non-grafted controls and the self-polymerizing material can be applied arthroscopically to fill irregularities in the subchondral bone. Furthermore, the same vehicle can provide a depot for anabolic agents such as IGF-I applied simultaneously.

Stromal Stem Cells. Stem-cells are a possible autogenous non-chondrocytic cell source that have been shown to improve cartilage healing in experimental animals. Sources include periosteum, muscle and bone-marrow. However, bone-marrow stem cells are tedious to culture, and accumulation of sufficient numbers to graft large articular defects can take up to a month; an unacceptable delay in repair of acute injuries. Moreover, the yield from mature patients (representing the majority of the surgery caseload) is reduced over yields from immature animals, making the accumulation of sufficient cells for grafting age-dependent but generally very slow. Methods to accelerate proliferation and chondrogenesis stand to make significant improvements in the utilization of stem cells for articular repair.

Growth Factors. Slow-release delivery of IGF-I within a cartilage defect, to facilitate matrix production in local and transplanted chondrocytes, provides a mechanism for enhanced cartilage repair. Elution studies of IGF-I from fibrin indicate maximally stimulatory levels of IGF-I (greater than 50 ng/ml) remain for a minimum of 3 weeks following an initial loading dose of 25 µg. *In vivo* evaluation of a self-polymerizing fibrin vehicle loaded with 25 µg IGF-I, injected into cartilage lesions in the femoropatellar joints and examined 6 months after implant, showed an improved cell population with more cartilage-like architecture. Other studies using injected combinations of IGF-I and pentosan polysulfate show attenuation of the symptoms of synovitis in OA models in sheep. In general IGF-I seems to have better application in combination with chondrocyte or mesenchymal stem cell grafts, where more complete cartilage repair develops. Experimental evaluation of repairs 8 months following implantation of a mixture of chondrocytes and 25 µg IGF-I in stifle defects of 8 horses, showed a considerably improved joint surface with 58% type II collagen and better neo-cartilage integration at the defect edges. Other potential growth stimulatory agents include BMP2 and BMP7, both of which have shown major cartilage enhancing properties. Recently, use of growth factor gene therapy programs have opened a way for more persistent delivery of IGF-I, BMP's or TGF-β to articular lesions. Adenoviral and retroviral vectors have been used to deliver IGF-I, TGF-β, and BMP-7 in various *in vitro* and *in vivo* trials. Effective transfection of synovial cells and chondrocytes with IGF-I has been documented *in vitro*, and several months of IGF-I production result from direct intra-articular injection of Ad.IGF-I in animal studies. Generally, *in vivo* cartilage repair studies with Ad.IGF-I and Ad.BMP7 transduced chondrocytes show advanced early hyaline cartilage formation and less dramatic differences long-term.

Results of surgical management of Wobbler syndrome

A.J. Nixon

OVERVIEW

Cervical intervertebral fusion is indicated for horses with cervical compressive myelopathy, recalcitrant neck pain, and horses with lameness due to compressive radiculopathy, associated with inflammation of the synovial structures and pressure on the neural outflow at C5-6, C6-7, and C7-T1.

MIDCERVICAL COMPRESSIVE DISORDERS

Surgical fusion of the midcervical vertebrae is technically more simple than the caudal cervical vertebrae. Single level fusions can be accomplished using a 22 mm long stainless steel implant without any additional fixation devices. Where double-level fusion of the midcervical vertebra is required, the implants are additionally stabilized with polyvinylidene (Lubra®) plate secured with several cancellous screws. This is particularly important due to the increased stress of multiple-level fusion. The ideal candidate for surgery is a single-level compression, recent onset, and a grade 2 or less in severity. Myelographic examination is important to define clear single-level cases. Controversy and impact on results come with additional compressed sites. Recent retrospective analysis of the guidelines for myelographic compression compared to histological evaluation, indicate a tendency to false positives, based on the fifty percent reduction of dorsal contrast column criterion. However, it is more appropriate to fuse all affected levels, than to leave a questionable intervertebral junction, which may develop more severe compression after fusion of the adjacent intervertebral junction. Fifty-five percent of horses having intervertebral fusion go on to neurologic normalcy. Recovery following surgery can take as long as fourteen months, and results are improved by early training exercises, which in many cases includes breaking to ride and the use of reining exercises.

CAUDAL CERVICAL FUSION

Intervertebral fusion of the lower cervical junctions is more technically demanding, especially at C7-T1. Because of the natural propensity for extension of the caudal cervical vertebra in the standing animal, all implants in the caudal cervical region are secured with additional fixation devices, including lubra plates and screws, or newer implants with attached threads. Fusion at C6-7 is the most common site, although fusion of both C5-6 and C6-7 is frequent. Recovery is generally slow, however, the regression and bony arthritic change, including osteophytes and lamina thickenings at the C6-7 and C5-6 junctions is often complete. Sixty-five percent of horses with cervical fusion in the lower vertebra have recovered normal neurological status. Improved recovery is often related to the more definitive diagnosis at this level, compared to mid-cervical vertebra, where there are often several suspicious sites. Two horses out of 17 C6-7 intervertebral fusions fractured a small portion of the caudal perimeter of C6, and this resulted in increased neck pain, but eventual fusion and recovery of neurological capabilities in both. Fusion for cervical radiculopathy has been done in six horses, four of which recovered from the lameness. Two horses were improved but lameness did not completely resolve.

The role of DDFT tendinitis in navicular syndrome - a CT perspective

M. Nowak

From an anatomical point of view, the definition of navicular syndrome is divided in three parts:

1. the navicular bone
2. the navicular bursa
3. the deep digital flexor tendon.(DDFT)

A differentiation between these three parts was difficult to achieve for clinicians in the past. With the help and combination of intra-articular and intrabursal anaesthesia, scintigraphy, ultrasonography and computed-tomography, it is now possible to define the navicular bone, navicular bursa or DDFT as the single source of pain. This is desirable because therapy, time of convalescence and prognosis are different for each of the three parts.

The soft tissue structures in the hoof capsule are important for palmar heel pain but most difficult to diagnose as the site of a lesion in navicular syndrome. Pain originating in the navicular bursa is easily detected by intrabursal anaesthesia, whereas the DDFT and the surrounding structures in the hoof are other possible sites of pain that are not visible and can not be palpated. Indirect methods for the detection of pain originating in the DDFT in the palmar region of the hoof, like nerve blocks and extension-tests, are unspecific.

Busoni and Denoix (1999) first described the use of ultrasonography to present images of the DDFT in the palmar region of the hoof capsule via a transcutaneous solear access over the frog. But a continuous and complete imaging of the DDFT in its total length and width (without artefacts) is difficult to achieve.

The difficulties in imaging of the DDFT in the hoof capsule with ultrasonography, stresses the value of computed-tomography as an important diagnostic tool for the differentiation of pain arising from the DDFT in navicular syndrome.

High quality computed tomographic images of the normal DDFT from the distal aspect of the proximal phalanx down to the insertion of the DDFT at the distal phalanx, can generally be obtained as described by Tietje et.al. in 2001. Subjective criteria like shape, contour and structure as well as objective measures like density and distance in length and width were determined in the normal tendon and compared to horses with tendon abnormalities. The density of the DDFT was assessed at three sites in 10 transversal planes, the depth was determined at three locations in palmar to dorsal and the width in medial to lateral direction. The mean values for density amounted to 106,8 HU (sd 12,7HU), for the depth 5,04 mm (sd 0.66mm) and for the width to 35.05 mm (sd 2,99mm). Significant differences were demonstrated between planes as well as within planes comparing measurements by statistical analysis, thus demonstrating that the data predominantly follow distinct rules. Within the transversal plane, from the distal to the proximal aspect of the navicular bone, lowest values for density were found in the axial ROI, with significantly lower values for depth axially. Also a distal to proximal increase in values for depth and a decrease for width were noted. Apart from determining standard values, CT images of pathological DDFT were shown and a comparison to ultrasonographic images and post mortem findings was made. Measured values found in regions with pathological lesions were evaluated by referring to the mean of standard values plus/minus two standard deviations. The importance and high value of computed tomography in imaging the distal aspect of the DDFT was not only confirmed by comparing different images by means of subjective criteria but also by objectively collected data for density and distance. The significance of these findings has previously been questioned (Denoix, 1994), but was confirmed by ultrasonographic studies and post mortem examinations in this study. Pathological examination confirmed that tendinitis results in a reduction in density as measured by computed tomography, and that this imaging technique can be used in conjunction with defined reference ranges to objectively diagnose tendinitis.

Nevertheless there are limitations for CT. Some areas of interest to clinicians, can not be clearly detected

by computed tomographic images. This involves abnormalities of:

1. the fibrous -cartilaginous part of the tendon
2. the digital annular ligament around the DDFT
3. the ligament attachment to P2.

Since we have determined the standard values of the DDFT in CT – images, we have been collecting data from horses with tendinitis of the distal part of the DDFT. Tietje et.al. (unpublished) examined 47 horses. Clinical examination, diagnostic local anaesthesia, ultrasonography of the distal pastern region and radiography were performed to localise the site of lameness to the palmar region of the hoof. In CT, evidence of tendinitis was taken to be a mean DDFT density value (plus/minus 2 standard deviations) below the normal range as described above.

26 cases had evidence of tendinitis, in some cases even severe lesions, without palpable or visible swelling. The density reduction of the diseased tendons was between 2 and 68 HU. The length of the lesions measured from 10mm to 100mm, the size ranged from 4% to 100% of the total cross section of the affected tendon. In 25 cases, shape as well as length and width were measured outside the reference values. Five horses had severe radiographic navicular bone changes, 10 showed moderate alterations with low grade palmar surface defects and in 4 cases we detected mild changes without defects but with rough or undulating palmar surface contour. Ultrasonographic changes in the distal pastern region were definitely found in 14 cases and were suggestive in 10. Compared to CT density values, all lesions were below the reference ranges. In all cases with lesions of the DDFT over a longer distance, the centre of the lowest density range was detected in the most distal part. In 41 cases the main defect of the DDFT was localised to the navicular area. Defects were shown five times only in the medial branch, in 19 cases only in the lateral branch and in 13 horses in both parts. In 10 cases separate defects were detected in the medial and lateral branches. In 17 of 22 cases, the lesion was localised to the dorsal aspect of DDFT, in 25 cases the lesion involved the complete depth.

Beside the lesions of the DDFT, further soft tissue abnormalities were found in CT images in 40 cases, involving effusion of the navicular bursa and the distal tendon sheath and thickening of the digital annular ligament.

The significance of distal deep digital flexor tendinitis as a differential diagnosis for the navicular syndrome is illustrated by the fact that 17 of the horses had tendinitis at the level of the navicular bone without radiographic bone changes, penetrating wounds or abnormalities on palpation of the pastern region. Therefore, the difficulties in obtaining images of soft tissue structures within the hoof capsule make computed tomography an important diagnostic tool for diseases in this region, especially when navicular syndrome is being considered.

Furthermore, follow-up examinations documented an increase in density in the healing phase, changes in tendon shape and peritendinous alterations such as thickening of the digital annular ligament and adhesions of the navicular bursa

Synovial chondrocalcin as a cartilage metabolic marker in canine osteoarthritis in its early stage

M. Okumura, A. Omachi, T. Kadosawa, T. Fujinaga

The objective of this paper is to evaluate the clinical significance of measurement of synovial chondrocalcin (C-peptide of procollagen type II) as a cartilage metabolic marker to recognize the pathophysiology of canine osteoarthritis (OA) in its early stage.

The canine OA of the left stifle joint was induced by arthroscopic transection of anterior cruciate ligament (ACL) in 5 healthy beagles. Conventional radiographs and computed tomographs (CT) were investigated on day 0, 7, 14, 28, 42, 56, 70 and 84. The concentrations of sulfated glycosaminoglycans (s-GAG) and chondrocalcin in synovial fluid, which was collected on day 0, 3, 7, 14, 28, 42, 56, 70 and 84, was measured by dimethylmethylene blue dye-binding assay and sandwich-enzyme linked immunosorbent assay, respectively. The dogs were euthanized 84 days after surgery, then gross and histologic examinations were performed. Gross and histological findings revealed that the experimental transection of ACL induced early stage of OA in left stifle joints in all animals. The concentration of s-GAG in synovial fluid collected from the affected joints significantly decreased from day 3 to day 14. The concentration of chondrocalcin in synovial fluid of the affected joint was significantly increased on day 7. Osteophyte formation in conventional radiography was found 42 days after surgery, while new bone formation in CT images was identified 14 days after surgery.

These results indicate that CT images are superior for the detection of bonny lesion in canine OA at its early stage to conventional radiography. Before these morphological changes in the joint were found in CT images, the significant changes of the concentrations of s-GAG and chondrocalcin were found. It is therefore suggested that the cartilage metabolic markers are of value to detect the pathology in the arthritic joint before the changes were found in diagnostic imaging.

Incomplete ossification of the caudal glenoid

M. Olivieri, A. Piras, A. Vezzoni, D. Marcellin, E. Ciliberto, B. Peirone

INTRODUCTION

The presence of an accessory ossification center in the caudal glenoid is occasionally found in some growing medium to large breed dogs. Its existence had been already described in the veterinary literature⁽¹⁾. A preliminary study was reported where incomplete ossification of the caudal glenoid (IOCG) was recognized as cause of lameness in a few cases⁽²⁾.

In the present work 25 cases with shoulder lameness and IOCG are presented. History, physical examination, radiographic findings, synovial fluid analysis, bone scintigraphy and arthroscopy were collected. In many of these cases IOCG was discovered to be the primary cause of shoulder lameness. In these dogs arthroscopic removal of the ossification center allowed a fast and complete recovery. In other cases IOCG was associated to other problems: OCD, partial tear of the biceps tendon, shoulder instability. In these cases, recovery was correlated to the resolution of the associated condition.

Histology confirmed that the accessory ossification center did not fuse to the remaining part of the glenoid.

MATERIALS AND METHODS

The records of dogs submitted to shoulder arthroscopy at the Malpensa and Cremona Veterinary Clinic and at the Veterinary Hospital of the University of Turin from September 1995 to June 2002 were reviewed. 25 cases affected by IOCG were selected.

History, physical examination, radiographic findings, synovial fluid analysis, bone scintigraphy, diagnostic and operative arthroscopy, histopathology and clinical outcome were reviewed.

RESULTS

IOCG was found in 7 different breeds: 9 Rottweilers (4 bilateral cases), 4 Labrador, 2 German Shepherd, 2 Border Collie, 1 Russian Terrier (bilateral case), 1 Dobermann and 1 English Bulldog. There were 11 males and 9 females. Their age ranged from 8 months to 10 years. In only 2 cases there was a history of minor trauma. Duration of lameness was variable, ranging from one week to one year.

At physical examination most of the dogs showed pain at shoulder joint manipulation, mainly in flexion. In one case medio-lateral instability was detected under general anesthesia. In two cases pain response on palpation of the shoulder joint was doubtful and nuclear scintigraphy was used to localize the origin of the orthopedic problem.

All the radiographic examinations showed lack of fusion of the accessory ossification center on the caudal border of the glenoid cavity.

Other radiographic findings were OCD (3 cases), calcification of the supraspinatus tendon (3 cases), of the biceps tendon (2 cases) and initial DJD (2 cases).

The synovial fluid analysis was always inflammatory, from mild to severe.

Shoulder arthroscopies always showed synovitis, very mild in some recent cases, and much more severe in chronic cases or in cases associated to other lesions.

In all the cases, on the posterior margin of the glenoid a mobile osteochondral fragment was identified. It was attached by fibrous adhesions to the caudal glenoid and was arthroscopically removed. For this purpose, the fragment was mobilized with a probe and a banana knife, and then removed with crocodile forceps.

Additional arthroscopic findings were:

8 ipearthrophic synovitis (treated by synovectomy).

3 partial lesions of the medial collateral ligament: 2 cases with about 20% of the fibers damaged and 1 case with about 70% of the fibers damaged (treated with a shaver)

3 OCD lesions (treated by removing the flap).

1 partial tear of the biceps tendon (treated by trimming and shaving the damaged fibers).

Histology was done in 4 cases: the ossification centers had the features of osteochondral fragments that had not united to the glenoid.

In 18 cases where the only lesion was IOCG the dogs were free of lameness or pain on manipulation of the shoulder joint within 1 or 2 weeks, including the bilateral cases. The same results were obtained in the 3 cases with associated OCD lesions, but in 2-4 weeks.

In the 3 cases with associated partial tears of the medial collateral ligament, the 2 dogs with 20% of the fibers damaged were free of lameness within 1 month. The third case had about 70% of the fibers damaged. This

dog was improved but still lame after moderate exercise.

The dog with associated partial tear of the biceps tendon was free of lameness within 1 month.

DISCUSSION

In the shoulder joint of some medium – large breed dogs, an accessory caudal glenoid ossification center is occasionally seen. In the recent past it was considered a “normal finding”⁽³⁾. Our clinical experience suggests that IOCG can cause forelimb lameness either by itself or in association with other lesions of the shoulder joint.

History, clinical signs, physical and radiographic examinations and synovial fluid analysis were sufficient to formulate a diagnosis of shoulder lameness and to consider IOCG the possible cause of it. In two cases nuclear scintigraphy was necessary to confirm that the shoulder was the origin of the orthopedic problem. Definitive diagnosis could be done by arthroscopy, palpating and moving with a probe the unfused fragment and ruling out all the other conditions that cause shoulder lameness in dog. In our experience, concomitant conditions were detected and treated at the same time in 7 dogs. In these cases whether or not they were the primary cause of lameness is difficult to assert.

The clinical signs in 24 out of 25 dogs disappeared within 1-4 weeks. Residual lameness due to shoulder instability was present in the last case.

In light of the histologic findings it appears that the caudal glenoid in these dogs represent an ununited accessory ossification center. Also osteochondrosis can be an additional etiology in specific cases. Histology of our cases with associated OCD lesion is in progress.

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Lateral humeral condylar fractures in dogs by Kirschner wire fixation

B. Peirone, E. Ciliberto, E. Mancarella, G. Pisani

INTRODUCTION

Lateral humeral condylar fractures are commonly encountered in small animal practice. Although these fractures can occur in dogs of any age or size, they seem to occur most frequently in young, small breed canines⁽²⁾. Compression fixation of lateral condylar fractures using a lag screw technique is generally the preferred therapy. Because of the small size and soft bone of some of these animals, however, repair with a bone screw may not be the best choice⁽²⁾. An alternative technique, based on the insertion of two or three Kirschner wires has been proposed⁽¹⁾. The authors report their experience on the use of this technique.

MATERIALS AND METHODS

Between December 1998 and August 2001, eight dogs with lateral humeral condylar fractures were treated at the Veterinary Hospital of the University of Turin. The age of the animals ranged from two to five months and had weights between 1.5 to 12 kg. The dogs were all different breeds and in all cases, fracture was caused by a traumatic event. Standard radiographic examination of the suffering elbow joint showed the presence of a lateral condylar fracture. Under general anaesthesia and in lateral recumbence on the opposite side, a cranio-lateral procedure to the elbow joint was performed. Subsequently, the fracture was reduced and compressed by applying point reduction forceps (Synthes, Paoli, PA). Two or three Kirschner wires were inserted from the lateral epicondyle to the medial condyle with a divergent direction between them such that they crossed each other on the medial condyle. Lastly, an anti-rotational Kirschner wire was inserted diagonally from the lateral epicondyle to the medial cortex of the humerus. After closure, radiographic examination was performed and a padded bandage was applied for five days. Restriction of physical activity was recommended for one month. All animals underwent clinical and radiographic examination until complete bone healing was achieved.

RESULTS

In all subjects, satisfactory functional recovery of the joint was observed and the fractures healed in six/eight weeks. Implants were removed in four out of eight dogs. In two subjects, mobilisation and migration of a Kirschner wire was observed at four and five weeks following surgical intervention, respectively.

CONCLUSION

The objective of articular fracture treatment is anatomic reduction and rigid fixation in order to obtain primary bone healing, thus permitting complete functional recovery of the joint. In young animals, the bone of the condylar region is weak and the insertion of a transcondylar lag screw may not achieve the desired compressive effect. Furthermore, considering the small dimension of condyles in juvenile small breed dogs, it is not always easy to insert correctly the screw. This technique allows for suitable stability and compression of the fracture, it is simple to perform and minimally invasive. The eventual incorrect insertion of a wire can be easily corrected without serious articular damage. Furthermore, both clinical and radiographic results are satisfactory.

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Flexural deformity of the carpus in dogs: a retrospective study of 15 cases

M. Petazzoni, C.M. Mortellaro

AIM OF THE WORK

To evaluate 15 clinical cases of carpal flexural deformity (CFD) in puppies. Authors also propose a grading of the disease based upon severity of clinical signs.

INTRODUCTION

The carpal flexural deformity is a musculotendineous disease affecting young puppies of several medium, large and giant breeds. This condition is caused by a contracture of the flexor carpi ulnaris but its etiology is still unknown.

MATERIALS AND METHODS

Medical records of 15 dogs affected by CFD, diagnosed between 1997 and 2002, were evaluated. All the dogs had been presented for a front-limb lameness and a definitive diagnosis of CFD was based on clinical signs (weight-bearing on the lateropalmar surfaces of the digits, different degrees of varus deviation of the hand and/or carpal hyperflexion). A grading was established based on severity of clinical signs. Grade one = mild deformity: the dog is weight-bearing on the lateropalmar surfaces of the digits without any deviation in varus and/or procurvatus of the carpus; grade two = moderate deformity: varus deviation of the carpus with slight flexion of the carpus; grade three = severe deformity: obvious carpal hyperflexion associated with different degrees of varus deviation and weight-bearing on the lateropalmar surfaces of the digits.

RESULTS

Twelve breeds were included in this survey: Shar-pei, Dalmatian, Dobermann pinscher, Dogo Argentino, Dogue de Bordeaux, American staff. terrier, Golden retriever, Pitbull, Rottweiler, Boxer, Bulldog and a mixed breed. The two Dogue de Bordeaux and the two American Staffordshire terriers came from the same litter. Ten out of 15 dogs were male (66.6%) and 5 were female (33.3%); mean age at presentation was 9.5 weeks (range 6 - 12). Thirteen dogs were bilaterally affected (86.6%) and in two dogs the condition was unilateral (13.4%). Six out of 15 (40%) had a first degree contracture, 2 out of 15 (13.3%) a second degree and 7 out of 15 (46.6%) a third degree contracture. Thirteen puppies (100%) recovered spontaneously with rest in 2-8 weeks (mean 4,5) while two dogs needed a Robert Jones bandage (see Table). Conservative management was effective in all the puppies and no recurrences were reported.

CONCLUSION

Several breeds can be affected by CFD. Clinical presentation allows, more often than not, a definitive diagnosis. Since activity worsens clinical signs, it is obvious that exercise must be restricted. In this context it is advisable to prevent puppies from climbing stairs in order to avoid an accident because puppies can easily stumble. The disease, which is always self-limiting, has a favourable prognosis and usually a short course. Surgical therapy is never required even in the most severe deformity while recovery, that is directly proportional to the degree of the disease, comes with time.

BREED	sex	age (weeks)	side	course (weeks)	degree	therapy
SHAR-PEI	M	10	bil	2	1	REST
SHAR-PEI	F	9	bil	6	3	REST
DALMATIAN	F	9	bil	2	3	Robert Jones
DOBERMANN	M	12	right	2	1	REST
DOGO ARGENTINO	M	9	bil	2	1	REST
DOGUE DE BORDEAUX	F	12	bil	2	1	REST
DOGUE DE BORDEAUX	M	12	bil	3	2	REST
AM STAFF TERRIER	M	7	bil	8	3	REST
AM STAFF TERRIER	F	7	bil	8	3	REST
GOLDEN RETRIEVER	M	12	left	2	1	REST
PITBULL	M	6	bil	8	3	REST
ROTTWEILER	M	12	bil	2	1	REST
BOXER	F	8	bil	8	2	Robert Jones after 2 weeks
MIXED BOXER X AMSTAFF	M	8	bil	6	3	REST
BULLDOG	M	12	bil	6	3	REST

Customized single hook plate for fractures of metacarpal/tarsal bones in racing greyhounds

A. Piras, M. Olivieri

Fractures of the left V, right II and III metacarpal/tarsal bones are considered stress fractures due to repetitive cyclic loading. In highly comminute fractures of the shaft, in proximity of the head can be difficult to place in such a small area a minimum of two screws without interfering with the joint space or with fracture lines. A single hook VC plate 1.5/2.0 mm have been customized to overcome the problem. The original AO/ASIF hook plate and customized hook plates have been used in dogs to stabilize inter-trochanteric variation osteotomies and to treat a variety of fractures and osteotomies. A Veterinary Cuttable plate was customized following the indications published by other Authors, the main variation was that a single long hook was left next to the distal hole. The inclination of the hook was approximately 85 degrees and the position either left or right was chosen according to the fracture shape and fissures location. The plate was pre-contoured using as a model the X-ray of the opposite metacarpal/tarsal and was cut at appropriate length. Eleven fractures in 9 Racing Greyhounds have been treated during a period of 12 months using this technique. The fracture was exposed with a standard approach, after elevation of the extensor T., the plate was applied in a bridging fashion according to the principles of biological osteosynthesis. No attempts were made to reconstruct anatomically the multiple fragments; the normal length and bone alignment were achieved with minimal manipulations of the fragments. A minimum amount of 1.5 or and 2.0 screws were applied. A synthetic cast or a reinforced bandage was applied according to each case for 4/5 weeks. Plates were removed between the 7th and 16th week, training started at 8 weeks after plate removal. In most cases dogs returned to race between 12 and 16 weeks after plate removal. The simplicity of the application and its versatility together with the very encouraging early results make this implant modification an interesting technique.

Scintigraphic Changes Associated with Complicated Canine Total Hip Replacement

B.A. Poteet, W.L. Liska

INTRODUCTION AND PURPOSE

Three phase (arterial, blood pool and bone phases) and single phase (bone phase only) bone scans were performed on multiple dogs having complications that were felt to be associated with previous total hip replacement (THR). ⁶⁷Gallium was used in one patient in an effort to increase the specificity of the scan findings. The purpose of the study was 1) to determine if bone scans were of benefit in diagnosing complications associated with THR, 2) to assess if 3 phase bone scans add specificity to the diagnosis compared to single phase bone scans, and 3) evaluate if bone scanning can differentiate implant loosening from implant infection.

MATERIALS AND METHODS

A large field of view gamma camera and dedicated computer was used to acquire the dynamic (arterial phase), static blood pool (venous phase) and bone phase images after bolus injections of ^{99m}Tc-MDP. The radiopharmaceutical dose ranged from 10 to 30 mCi (370 - 1110 MBq) depending on the animal's size. Dynamic phase images were acquired at 2 sec/frame for 30 frames (one minute) followed by 500k static images of the coxofemoral joints at 3-5 minutes. Static 500k bone phase images were acquired at 3 hours post-injection. The gallium scan images were obtained at 24 hours, 48 hours and 72 hours post-administration. All dogs were under general anesthesia for all scans. Radiographs of pelvis and proximal femurs were also obtained in all cases.

FINDINGS

Bone scans appear to be of benefit in diagnosing complications associated with THR in dogs. Bone scanning is a highly sensitive modality to assess bony turnover, which may be associated with loosening and infection. The 3 phase bone scan adds specificity and can often differentiate a loosened implant from an infected implant. Three phase bone scans also appear to be of benefit in diagnosing infection when the accompanying radiographs are equivocal. Diffuse, marked uptake around the entire implant, on all 3 phases is seen with sepsis, while focal, marked uptake seen at the distal caudal portion of the femoral implant stem suggests aseptic loosening.

Modified Stout multiple loop interdental wiring and dental acrylic for repair of mandibular fractures

C.W. Probst

Mandibular fractures result from trauma (e.g., automobile accidents, dog bites, gunshot wounds, etc.) and these patients are often presented as emergencies. The sight of blood or a drooping jaw often upsets the animal's owners and the animal is often very agitated because of the fracture. Despite the temptation to begin immediate treatment of the mandibular fracture(s), the animal should be examined carefully for other, possibly life-threatening, injuries (e.g., shock, pneumothorax, diaphragmatic hernia, traumatic myocarditis, etc.). Once any life-threatening injuries have been addressed, one may begin treatment of the mandibular fracture(s).

RELEVANT MANDIBULAR ANATOMY

It is important to have a general understanding of the relevant mandibular anatomy in order to avoid further trauma to important mandibular structures. The mandibular foramen is located on the lingual side of the mandible and is caudal to the third molar. The mandibular alveolar artery, a branch of the maxillary artery, enters the mandible via the mandibular foramen and supplies the roots of the teeth and the mandibular bone itself. The mandibular alveolar artery then gives rise to the mental arteries with exit the mandible via the anterior, middle and posterior mental foramen. The mental arteries supply the anterior portion of the jaw. In addition to vascular structures, important nerves pass through the mandibular and mental foramen. The mandibular alveolar nerve, which arises from the mandibular branch of the trigeminal nerve, provides sensory branches to the teeth. It then gives rise to the mental nerves that supply sensation to the skin ventral to the incisor teeth. When formulating a plan to repair a mandibular fracture, one should consider these important structures so as not to cause further trauma to them.

TREATMENT

Many different techniques have been described for treatment of mandibular fractures including: intramedullary pin, orthopedic wire, external fixators, acrylic external fixators, and bone plates and screws. While these various treatments have advantages and disadvantages, I have found that I achieve better results with more conservative management than with more aggressive management. Regardless of the method of repair that is chosen, one must strive to achieve good dental occlusion post operatively. Delivering inhalant anesthetic via an endotracheal tube placed through a pharyngostomy incision avoids having the tube pass through the mouth. This allows the surgeon to check the dental occlusion as needed throughout the operation.

I prefer to use a combination of interdental wiring reinforced with an acrylic splint whenever possible. This technique uses a modification of the Stout multiple loop wire that is reinforced with dental acrylic. It is easy to perform, does not damage important mandibular structures, and is inexpensive to perform because it does not require specialized equipment or expensive implants. This procedure requires that there be at least one, preferably two, intact teeth on either side of the fracture and that there is no missing bone. Therefore good fracture reduction is possible. In addition, this technique is best used for fractures that occur rostral to the first molar.

Small gauge orthopedic wire (22 or 24 gauge) is used to create the Stout multiple loop. I modify the traditional technique by placing the wire twists on the lingual side of the mandible rather than on the buccal side. One end of a length of orthopedic wire is passed around the caudal margin of the caudal tooth chosen to anchor the wire. The wire is passed through the gum (from the buccal to the lingual side) beneath the crown of the tooth and superficial to the mandibular bone. Sufficient length of wire is pulled through so that it will lay along the lingual margin of the teeth and reach the most rostral anchor tooth. The other end of the wire is then passed around the rostral margin of the tooth (from buccal to lingual side) beneath the crown. A short loop is created on the lingual side such that the first strand of wire is captured within the loop. The end of the wire is then passed back to the buccal side beneath the crown of the caudal margin of the next rostral tooth. This procedure is repeated until the rostral most anchor tooth is reached. The two free ends of the wire are twisted together. The fracture is then carefully reduced and the wire tightened. The ends of the wire and each loop must be tightened alternately so as to maintain relatively even tension on all aspects of the wire.

Once the wire has been tightened, the acrylic splint can be applied. I use a product called "Jet Repair Acrylic" (Lang Dental Manufacturing Co. Inc., Wheeling, Illinois, 60090) that is available through most dental supply companies. A thin layer of acrylic powder is sprayed on the lingual surface of gum around the wire loops. Then a few drops of the liquid monomer are dripped onto the powder. The acrylic is then allowed to harden somewhat (2 - 4 minutes). Then another thin layer of powder is sprayed over the first layer and more liquid monomer is dripped onto the powder. This layer is allowed to bond to the first and harden. This process is repeated until the loops are completed encased with acrylic. (The reason for applying the acrylic in multiple thin layers is to minimize the heat produced by the curing process.) Any sharp edges of the acrylic splint may be trimmed with bone ronguers.

POST-OPERATIVE CARE

Regardless of the method of fracture repair, the post-operative care will be similar. The animal should not be allowed to eat hard food or chew on anything hard until the fracture has healed. It may be necessary to have the owner make a gruel by mixing water with the animal's food. If intra-oral implants have been used, it is helpful to have the clients try to rinse the animal's mouth several times daily with a dilute chlorhexidine solution or water. It may also be necessary to apply a tape muzzle for the first several weeks after surgery depending upon the degree of fracture stabilization.

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Block recession arthroplasty

C.W. Probst

Patellar luxation is a common cause of rear leg lameness in dogs. Medial patellar luxation (MPL) is far more common than lateral luxation in all breeds, representing about 80% of the cases. Bilateral disease is common although one stifle is usually worse than the other is. Proper surgical management of this disease often results in a favorable outcome and client satisfaction. Most of the patients seen in our practice require some form of femoral trochleoplasty to deepen the groove in which the patella rides. We have found the block recession trochleoplasty to provide several advantages of previously described techniques. It preserves the articular cartilage of the femoral trochlea, it preserves a greater surface area of articular cartilage, and there is no narrowing of the proximal trochlea so the patella remains in contact with the femoral trochlea even when the stifle is extended.

SURGICAL TECHNIQUE

The patient is anesthetized and the affected limb(s) is/are clipped from the hock to the hip and prepped for aseptic surgery. The patient is placed in dorsal recumbency on the operating table such that its rear legs hang off the end of the operating table. The limb(s) are given a final aseptic scrub and then draped for surgery. The most severely affected limb is operated first. A lateral arthrotomy to the stifle is performed. One may choose to make the skin incision on the medial side of the stifle for cosmetic purposes. Once the arthrotomy is complete the patella is luxated medially and the joint is inspected. The cruciate ligaments and menisci are evaluated. The trochlear ridges (especially the medial trochlear ridge) are inspected for cartilage erosions caused by the luxating patella. In addition, the trochlear side of the patella is evaluated for cartilage erosion. The femoral trochlea is usually shallow and requires deepening.

The proposed width of the new trochlear groove is determined by examining the width of the patella and making sure the new groove will accommodate it. The first cut through the articular cartilage is made on either the medial or lateral femoral trochlear ridge. The position of this cut (i.e., in a lateral or medial direction) is determined by the width of the proposed new trochlear groove. The cuts into the bone are made with a thin blade saw (i.e., power reciprocating saw, power oscillating saw, or hand held hobby saw). The first cut is made from the proximal extent of the articular cartilage and continues distally to the level of the origin of the caudal cruciate ligament. While the surface of the femoral trochlear ridge is convex, it is important to make the depth of the cut a straight line between its origin and ending. The second cut is made parallel to the first and on the opposite side of the trochlea. Again, the distance between the two cuts should accommodate the width of the patella. The third cut is the most challenging and may be made either with an osteotome or long, thin blade oscillating saw. When using an osteotome, it is ideal to choose an osteotome that is as wide as the distance between the two saw cuts and one that has a very thin blade. If an oscillating saw is used, the arc of the oscillating blade should not be wider than the distance between the two parallel saw cuts. The third cut may be commenced either at the distal end or the proximal end of the two other saw cuts. The surgeon must visualize the plane of this cut as a straight plane between the origin and ending of the other two cut. Therefore one must "aim" carefully when making the third cut so that the osteotome or saw blade exits at the correct place (i.e., the opposite end of the two parallel saw cuts). The "block" of subchondral bone covered with articular cartilage is removed from the femur and wrapped in saline soaked gauze sponge and placed in a safe location (i.e., where it will not be accidentally discarded) on the instrument table. Additional subchondral bone must be removed from the depth of the femoral trochlea before replacing the block. This may be done using an osteotome and mallet to "shave" thin slivers of bone from the depth of the trochlea, or done with the oscillating saw. These slivers of cancellous bone are placed in a saline moistened gauze sponge for use later. After removing about 1-mm of bone, the block can be replaced into its position and the degree of recession determined. If more deepening is required, the block is removed and additional bone slivers are removed. Once the appropriate depth has been achieved the block is repositioned. The bone removed by the saw from the original two cuts may leave the block a little unstable. If so, slivers of cancellous bone can be wedged into to one of the cuts to greatly improve the stability of the block.

Once the trochleoplasty has been finished, any additional procedures (e.g., tibial tubercle transposition, resection of a portion of the lateral joint capsule, etc.) may be performed. The arthrotomy is then closed in a standard manner. The incision is covered with a sterile dressing and a padded bandage is applied to the limb. The patient is usually discharged from the hospital the day following surgery. The bandage can be

removed in seven to ten days. The dog's activity should be restricted to leash walks for eight weeks after surgery.

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The tibial plateau angle in labrador retrievers with normal and cranial cruciate deficient stifles

U. Reif, C. Probst

INTRODUCTION

Although there is wide agreement regarding the pathogenesis and morphogenesis of secondary degenerative changes resulting from transection of the CrCL, the primary cause leading to CrCL rupture in dogs is controversial. It has been hypothesized, that the tibial plateau slope of the canine tibia is one of several factors leading to cranial tibial thrust in the stifle during weight bearing. Conformational abnormalities such as an inappropriately increased slope of the tibial plateau have been theorized to cause increased stress in the CrCL, ultimately leading to ligament rupture. Cadaver studies showed a close relation between the magnitude of the tibial plateau angle (TPA) and the amount of cranial tibial thrust generated by axial tibial loading. The objective of this study was to investigate the correlation between the tibial plateau angle and the incidence of cranial cruciate ligament rupture in the Labrador Retriever. A hypothesis was formulated, that dogs suffering from CrCL rupture have a significantly greater TPA than dogs with normal stifle joints.

MATERIALS AND METHODS

Stifle joints of normal Labrador retrievers and those suffering from CrCL rupture were radiographed and their TPA determined. The normal group consisted of 39 purebred Labrador retrievers presented for reasons unrelated to CrCL rupture. All these dogs had no current or past history of orthopedic problems, and were at least 8 years of age. If radiographic evaluation of the stifle revealed signs of degenerative joint disease, the individual was excluded from the study. The CrCL rupture group consisted of 42 purebred Labrador retrievers with surgically confirmed CrCL rupture. For radiographic evaluation the dogs were in lateral recumbency with the stifle and the hock joint at approximately 90° of flexion. The radiographs were repeated until superimposition of the tibial condyles was achieved. One observer measured all TPA's four times and the mean value for each dog was calculated. To compare the TPA of normal dogs and dogs with CrCL rupture, a t-test for independent samples was used. The mean TPA, the standard deviation, and the range were reported for both groups. Values of $P < 0.05$ were considered significant.

RESULTS

The mean age (\pm SD, range) for the normal group was 10.0 years (\pm 1.8, 8.0-14.6) and the mean age (\pm SD, range) for the CrCL rupture group was 5.4 years (\pm 2.8, 0.8-9.4). The mean TPA (\pm SD, range) in the normal group was 23.6° (\pm 3.5, 14.7-29.3) and the mean TPA (\pm SD, range) in the CrCL rupture group was 23.5° (\pm 3.1, 18.5-30.3). There was no significant difference between the two groups ($P=0.97$).

DISCUSSION

Positioning of the tibia during radiography can influence the TPA measured on lateral radiographs. To decrease variation due to positioning, the radiographs were evaluated for superimposition of the medial and lateral tibial plateau. Measurement of the TPA is subject to intra- and interobserver variation. Therefore one observer measured all TPA's and the mean of four measurements determined the TPA. In addition to individual TPA variation, breeds differ in their skeletal conformation and may also differ in their breed specific TPA. Consequently only purebred Labrador retrievers were included in the study. Finally, it is difficult to identify a control group of normal individuals not likely to suffer from CrCL rupture. Reviewing the age of onset of CrCL rupture in Labrador retrievers at the Veterinary Teaching Hospital of the Michigan State University between 1995 and 2000 showed that only 6% were eight years or older. All dogs in the normal group were at least eight years of age and free of clinical and radiographic signs of CrCL rupture and therefore unlikely to suffer from CrCL rupture.

CONCLUSION

Our hypothesis, that dogs suffering from CrCL rupture have a significantly greater TPA than dogs with normal stifle joints, was rejected. Although individual variation in the TPA was similar in both groups and ranged from 15 to 30°, increased TPA measurements did not predispose Labrador retrievers for CrCL rupture.

Influence of limb positioning and observation method on the measurement of the tibial plateau angle

U. Reif, L. Dejardin, C. Probst, C. DeCamp, G. Flo, A. Johnson

INTRODUCTION

The tibial plateau angle (TPA) has been evaluated in several clinical and basic science research studies and measurement of the TPA is an essential part of Tibial Plateau Leveling Osteotomy. In order to level the tibial plateau, its angle with respect to the functional axis of the tibia must be determined. Evaluation of the medial tibial plateau anatomy using two-dimensional radiography is problematic and may be affected by radiographic and observation methods. The objectives of this study were to evaluate the effect of limb positioning on the radiographic tibial plateau angle (R-TPA) and to evaluate variation between two different tibial plateau angle measurement techniques. A hypothesis was formulated, that limb position influences the radiographic appearance of the tibial plateau and therefore influences the TPA measured on lateral radiographs.

MATERIALS AND METHODS

Study design: Five cadaver hind legs from large breed dogs, free of orthopedic conditions, were used for this study. They were mounted on a platform, which was freely movable in a plane parallel to the radiology table and rested on a base containing the radiographic cassette. The leg was positioned in lateral recumbency with the stifle and hock joint at approximately 90° simulating a tabletop technique. True lateral positioning was defined by superimposition of the femoral and tibial condyles. Radiographs were repeated while the specimen platform was relocated in 5 cm increments in a proximal, distal, caudal and cranial direction. In total, 25 radiographs of each specimen were taken. This simulated internal and external rotation, abduction and adduction of the tibia as the true lateral position diverted away from the central beam of the x-ray machine. After dissection of all the soft tissue structures surrounding the tibia the anatomical tibial plateau angle (A-TPA) was determined.

Methods of R-TPA determination: Six observers determined the R-TPA on 25 radiographs of 5 dogs. For method A the long axis of the tibia was determined by the midpoint between the two apices of the tibial intercondylar eminences and the center of the talus. The medial tibial plateau was determined by its most cranial and most caudal margin. For method B the long axis of the tibia was determined as described before and then a line tangential to the tibial plateau was drawn at the point of intersection between the long axis of the tibia and the tibial plateau. The measurements were digitally scanned and the TPA between the perpendicular to the long tibial axis and the medial tibial plateau were determined using image measurement software.

Methods of A-TPA determination: To determine the long tibial axis the dissected specimen was secured in an SK-system external fixator frame. Two Kirschner wires defined the cranial and caudal margins of the tibial plateau. The specimen was digitally photographed and the anatomical TPA was determined using image measurement software.

Statistical analysis: Data were analyzed by means of ANOVA. Statistical significance was set at $P < 0.5$.

RESULTS

The maximal difference of the mean R-TPA due to positioning was 3.6° for method A and 5.7° for method B. The R-TPA significantly decreased in both methods as the limb was positioned from cranial-proximal to caudal-distal with respect to the x-ray beam. The radiographic mean (\pm SD) R-TPA in the true lateral positions was 24.9° (\pm 3.0) when measured with method A, and 24.6° (\pm 2.7) when measured with method B. The true lateral position had a p-value of 0.98 and therefore no significant difference between A-TPA and R-TPA could be detected. In the peripheral positions, however, the p-values were < 0.05 indicating that the R-TPA was significantly different from the A-TPA.

CONCLUSION

True lateral positioning of the tibia defined by radiographic superimposition of the femoral and tibial condyles should be used for TPA determination to avoid over and underestimation of the TPA. When possible the tibial plateau should be determined by its cranial and caudal margin.

Rational choice of antibiotics in musculoskeletal infections in the horse

C.M. Riggs

Antimicrobial therapy is often pivotal to the successful treatment of musculoskeletal infections. In order to achieve optimal results it is essential to use appropriate antibacterial agents in the most effective manner. There is a large array of antimicrobial drugs, both on- and off-label, available for use in the horse and selection of the correct agent(s) can be a daunting task. Selection and usage of a particular agent or combination of agents should be based on sound principles, outlined below:

- Confirmation that an infectious organism is the cause of the disease
- Sensitivity spectrum of the bacteria involved
 - Based on either:
 - culture and sensitivity testing of samples from the individual case, or
 - prior knowledge of the bacteria most likely to be involved (which will depend on the tissues involved and mode of contamination) and likely sensitivity spectrum of those bacteria (which will vary between geographical locations)
- Potential for the antibiotic to achieve therapeutic concentrations at the site of infection and remain active in the microenvironment of the diseased tissues
 - Affected by:
 - the tissues involved
 - the extent of concurrent disease in infected and surrounding tissues (determined by the degree of trauma and/or chronicity of the infection and hence the disruption of blood supply and degree of fibrosis)
 - the presence of any abscesses, especially where they cannot all be drained by surgical means
 - the cellular location of the bacteria (intra- or extra-cellular)
- The relative risk of side-effects from the use of a particular agent
 - Direct: toxic effects of the drug (e.g. increased risk of nephrotoxicity caused by aminoglycosides in dehydrated or neonatal animals)
 - Indirect: precipitating secondary bacterial overgrowth of pathogens elsewhere (e.g. colitis)
- The need for and potential benefits of different antibacterial agents when used in combination
- The need for bactericidal or bacteristatic agents
 - Age and immune status of the animal
- The dosage regime least likely to induce bacterial resistance
- The practicality of the dosage regime required and ease of administration
- The cost of the antimicrobial treatment

Sesamoid disease

G.M. Robins

Damage to metacarpal-phalangeal palmar sesamoid bones, particularly numbers 2 and 7, is a well-recognized problem in many breeds particularly racing greyhounds, Rottweilers, Labradors and Bull Terriers. Although the incidence of clinical disease is increasing, many dogs have an asymptomatic form of the condition. Affected individuals are usually under one year of age and are presented because of persistent forelimb lameness. There is no history of trauma and a physical examination reveals no consistent finding which may render these sesamoids liable to injury. The affected joint(s) is usually thickened, painful and flexion of the joint reduced. In some cases there is an obvious synovial effusion. Radiographs of the feet reveal fractures of the sesamoid bone(s) and degenerative joint disease. There may be soft-tissue calcification adjacent to the sesamoid bone and periosteal proliferation in the adjacent bones.

The clinical significance of sesamoid disease was tested in an Australian survey of 55 young Rottweilers. Twenty-one dogs developed lameness during the study and 12 of these the lameness was attributable directly to sesamoid disease. Treatment in 9 dogs involved rest alone and in 6 of these the lameness resolved within 6 weeks. The other 3 dogs treated by rest alone remained intermittently lame. The final 3 lame dogs were treated by surgical excision of the affected sesamoid and the lameness resolved in all three. It was concluded that sesamoid disease commonly occurs in young Rottweilers but only occasionally causes clinically significant lameness.

The aetiology and pathogenesis of sesamoid disease was studied by histological examination of sesamoid bones from both affected and normal Rottweilers. Chronically affected sesamoids showed a histological appearance typical of a fracture healing by fibrous union with fibrous callus and variable amounts of cartilage deposition, necrotic bone and new bone formation in the fracture sites. Examination of sesamoids known to be acutely fractured and in two cases in which pain in the joint was associated with a radiographically intact sesamoid, revealed avascular necrosis of the entire sesamoid bone and marrow tissue. These findings suggest that avascular necrosis may be a contributing factor behind the high incidence of sesamoid fragmentation in Rottweilers.

Sesamoid disease remains one of the major differential causes of lameness in young large rapidly growing dogs.

Achilles tendon injuries

G.M. Robins

Achilles tendon injuries are common and they have been the subject of renewed interest because of the increased incidence of chronic injuries diagnosed in large breeds of dogs, particularly in Dobermans. Meutstege (1991) classified Achilles tendon injuries. In Type 1 injuries there is complete disruption of the entire tendon usually as the result of trauma. The outcome is maximal flexion of the hock when the stifle is extended. The separated tendon ends are palpable through the skin. In some cases a skin laceration may be evident, indicative of external trauma. Type 2 injuries show a variable degree of increased hock flexion with stifle extension and are the result of only partial disruption of the tendon. Type 2 injuries can be further subclassified into Type 2a, where there is incomplete separation between the gastrocnemius muscle and the tendon. Type 2b where there is total disruption of the tendon, but the paratenon is still intact. Type 2c where the tendons of the gastrocnemius muscle and the semitendinosus, biceps femoris and gracilis muscles are torn from the attachment to the tuber calcanei, leaving the superficial flexor tendon component intact.

Type 2c injuries result in a characteristic hyperflexion of the toes during weight bearing. The increased amount of hock flexion caused by the disrupted gastrocnemius tendon results in increased tension within the superficial flexor tendon.

Type 3; these injuries may represent an earlier stage of type 2c. The distal end of the gastrocnemius tendon is thickened, as is the fibular tarsal bone. These changes may represent small tears in the tendon and enthesitis. Radiographically there may be evidence of soft tissue swelling, with calcification or bone fragmentation and changes to the size and shape of the tuber calcanei. It is the type 2c and type 3 injuries that are recognised commonly in Dobermans.

A type of Achilles tendon injury not covered in this classification is associated with luxation of the superficial digital flexor tendon. The tendon usually luxated laterally and is associated with a characteristic lameness. There appears to be an increased incidence in Shetland sheep dogs and collies.

The treatment of type 2c Achilles tendon injuries will be discussed and will include techniques for reducing the tension in the tendon and the need to perform a tendon repair.

Computer-assisted preoperative planning for optimization of placement of external skeletal fixators on the antebrachium of dogs

G.L. Rovesti, D.J. Marcellin-Little, A. Cannavale, C. Passaro

Careful preoperative planning is mandatory before placement of an external skeletal fixator on the antebrachium of dogs, because potential damage to vessels and nerves during insertion of pins or K-wires may occur. Also, functional impairment of the limb may occur after frame placement if muscles and tendons are inappropriately transfixed, or if the frame interferes with anatomic structures. The aim of this study was to develop an interactive multimedia software aimed at enhancing preoperative planning and to evaluate the results of the use of this software.

A multimedia interactive software was produced in cooperation with a specialized medical 3D computer graphics company. Axial sections of the antebrachium of five normal dogs were obtained by Magnetic Resonance Imaging (MRI). Each limb was divided in 20 equal portions, the most proximal and the most distal ones being at the level of the elbow and the radio-carpal joints, respectively. Each section was reviewed to positively identify vessels and nerves of surgical relevance. These neurovascular structures were enhanced for better visualization. A mediolateral (ML) radiographic projection of a radius and ulna was used as a reference for selecting the level of the desired section in the first interface. Moving the pointer proximally or distally would activate various axial MRI corresponding to these sections. Once the section was selected, a second interface could be activated. That interface included a small window showing the original MRI section, a small window showing the actual level on the ML radiographic projection for orientation, and a larger window with the MRI section with enhanced neurovascular structures. Suggested corridors for pins and wire insertion were shown graphically. Three-D models of frame constructs for fracture treatment were provided, and the user can rotate them in any direction and zoom on details. A 3D model of the forearm with reconstruction of vessels and nerves of surgical relevance was also available, with and without external fixators in place, to better appreciate relationships between anatomical structures, and between anatomical structures and frame construct. A resident in surgery with no prior experience using external fixation as a primary surgeon was asked to apply six unilateral biplanar and six circular external fixator frames for stabilization of bilateral diaphyseal antebrachial fractures of six fresh dog cadavers, for a total of twelve applications. She was allowed to study the multimedia interactive software for one week, and was then asked to apply the frames following the software suggestions for wire and pin insertion. She was allowed to consult a laptop computer while operating, and to select the section of the desired level of fixation showing the suggested corridors for wire and pin insertion. After application, the frames were removed, leaving wires and pins in place, and soft tissues around them were dissected, checking for transfixation of any vessels and nerves.

Damage to neurovascular structures was not observed on the operated limbs. The resident felt more confident in performing the surgery than she did before the use of the software. She had been already assisted in some clinical procedures, but nevertheless appreciated the possibility to see video clips of insertion at the desired level of fixation just before doing it. The axial atlas with suggestions for wire and pin insertion and 3D models with and without the frame in place were considered most helpful to help understand 3D frame configuration and relationships between anatomical structures and frame.

The theoretical principles and clinical application of external fixators are described in several textbooks. It is not always easy, however, to visualize and clinically apply the principles described in these textbooks, especially when one has a limited clinical experience. This is due in part to the fact that frames should follow specific geometric rules that differ between patients. Also, the 3D visualization of frames may be difficult to achieve. Advanced graphic support is generally unavailable in standard textbooks, and interactive multimedia texts are just appearing in the medical literature. An interactive multimedia software that allows the surgeon to see the frame in any direction and to move it as it was in her/his hands may be potentially beneficial for a better understanding of the construct and its relationship with adjacent anatomical structure. The twelve frame applications performed by a resident in surgery in this study were completed with mechanically sound frames that did not damage the neurovascular structures. Further trials could be performed to evaluate the benefits of this interactive multimedia software for the management of fractures and limb deformities in clinical cases.

Skeletal traction in veterinary traumatology: a two year experience

G.L. Rovesti, B. Peirone

INTRODUCTION

The use of skeletal traction for fracture reduction is a necessity in the treatment of veterinary traumatology. Analogous to human medicine, techniques have recently been developed for traction of appendicular skeletal fractures. The scope of the present report was to evaluate the clinical applications of such skeletal traction.

MATERIALS AND METHODS

Between February 2000 and January 2002, 25 dogs affected with fractures were treated with skeletal traction before or during osteosynthesis (group A). For each animal, relative data were recorded including location, circumference of treated area, time between trauma and surgical intervention, and mode of traction. Postoperative radiographs were evaluated by assessment of stump contact and axial realignment of the areas under treatment.

Success was evaluated according to the following parameters:

- excellent: stump contact 100%; absence of axial deviations
- good: stump contact between 50% and 100%; and/or axial deviation not $>10^\circ$
- sufficient: stump contact between 10% and 50%; and/or axial deviation not $>30^\circ$
- insufficient: stump contact $<10\%$; and/or axial deviation $>30^\circ$

The control group (B) was composed of 20 canines affected by fractures in which no traction was applied. For this group, the above criteria were also used to evaluate the time necessary for intervention and the success of the procedure, considering postoperative stump contact and realignment. This data was compared with the group of animals receiving traction (group A).

RESULTS

The average age of the dogs treated with traction was 3.5 years (range 0.5 to 9 years) with an average weight of 23.5 kg (range 5 to 45 kg). The time interval between the trauma and surgical intervention averaged 6 days, ranging from 1 to 28 days. The circumference of the treated anatomical sectors (e.g., thigh, forearm) was 25 cm (range 12 to 44 cm). The fractures were distributed as follows: 3 humerus, 9 radius-ulna, 8 femur, and 5 tibia. The maximum tension applied averaged 18.4 kg (range 8 to 25 kg), while the average time of application was 49 minutes (range 15 to 150 min). In group A, the time required for surgical intervention averaged 154 min and in group B averaged 188 min. In the former group, postoperative radiographic evaluation was excellent in 22 cases (88%) and good in three cases (12%). In the latter group, recovery was excellent in 14 cases (70%), good in three cases (25%), and sufficient in one case (5%).

CONCLUSION

According to the present study, the factor having the greatest influence on the weight and duration required to obtain fracture reduction was the time interval between trauma and surgical intervention (and not limb circumference or muscular mass). Considering stump contact and postoperative realignment, the clinical results obtained in group A were superior to those observed in the control group, particularly so in fractures treated with linear external fixtures. A significant reduction in the time required for surgical intervention was also observed. Relative to group A, skeletal preoperative traction permitted an adequate realignment and simplified the application of osteosynthesis, reducing the manipulation of tissues: this facilitated an *open but don't touch* (OBDT) approach. No physical damage was apparent following the application of tractive techniques.

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Injuries of the biceps tendon in dogs

M. Sager, J. Assheuer

INTRODUCTION

More recently disease of the biceps tendon is seen as a clinical entity. Only the acute and complete tear of the tendon can be differentiated by clinical examination of the different stages of inflammation and degeneration of the tendon itself and the surrounding tissue, the tendon sheath, the intertubercular ligament and the surface of the sulcus intertubercularis. The availability of modern imaging modalities like ultrasonography and magnetic resonance imaging for small animal practitioners provides more detailed information about localization, extent and type of injury. These information's could be very helpful for the decision for the most adequate therapy and a better prognosis.

In our own caseload of patients with shoulder lameness referred for MRI-examination injuries of the biceps tendon have a incidence of about 75 percent.

MATERIAL AND METHODS

A total of 24 patients with a history of chronic shoulder lameness and biceps tendon injuries diagnosed by MR were studied for the following findings: tendovaginitis (common in all), degeneration of the tendon, old tear, sulcus abnormalities, labrum injuries and the criteria of body weight, onset of lameness by the history and subluxation of the joint diagnosed by clinical examination. The mean age of the group was 6,0 years, the body weight had a range from 7 to 62 kg with a mean of 28,5 kg.

MR imaging was performed in the three recommended planes in reference to the anatomical structure of the joint parallel and perpendicular to the glenoid and sagittal. We prefer the examination by STIR-sequence, followed by a GE (gradient echo) sequence, T1-weighted, out of phase. Inflamed and reactive tissue is best depicted by use of a gadolinium contrast medium intravenously.

RESULTS

In the total of 24 patients with the sign of tendovaginitis by MRI examination, degeneration was present in 10, old tear in 7, sulcus abnormalities in 10 and labrum injuries in 5 patients. Subluxation by clinical criteria was found in 6 patients. 50% of the cases with degeneration showed a partial or complete old tear of the tendon. In all cases with clinical subluxation sulcus abnormalities are depicted by MRI.

The time interval of lameness before examination was in mean 5,7 month for all cases. Patients with tears of the tendon and sulcus abnormalities had a longer period of lameness of 7,9 and 7,2 month. The period was shortest by concomitant labrum injuries (5,3 month) and degeneration of the tendon (5,5 month).

The body mass was highest in the group with tears of the tendon (41,2 kg) by a mean of all patients from 28,5 kg. In the groups with sulcus abnormalities and subluxation we found breeds with lower body mass (21,3 kg and 18,3 kg). Labrum injuries were found in one case of a small dog (14,0 kg) with all other patients over the body weight of 30 kg. By exception of 2 dogs all patients are older than 5 years.

DISCUSSION

Subluxation of the shoulder joint in smaller breeds causes injury of the biceps tendon associated with sulcus abnormalities by lateral stressing of the tendon. Degeneration of the tendon may be the follow of a tear by a traumatic event. In other cases the tear could be secondary to a lower strength of the tendon by degeneration.

For therapy of the biceps tendon there is a conservative and a surgical option. Labrum injuries and unstable joints needs to be treated surgical. Cases with tendovaginitis and adhesions to the intertubercular ligament revealed by MRI examination are in our experience also an indication for surgical intervention.

SUMMARY

By MRI examination of the shoulder joint injuries of the biceps tendon, the joint capsule and the sulcus intertubercularis were sufficiently revealed. A detailed and profound diagnosis helps to make a decision for conservative or surgical treatment.

Fixation of radioulnar fractures in toy breed dogs with biodegradable sr-pla plates and metal screws – preliminary results

A. Saikku-Bäckström, J. Rähä, RM Tulamo, T. Välimaa

Fixation of fractures with biodegradable implants has many advantages compared with traditional metallic implants. The absorbable implant preserves adequate fixation during fracture healing and then, as it is absorbed slowly, it gradually shifts stresses over to the healing bone, thus preventing osteoporosis and stimulating both bone growth and remodelling. There is also no need for an implant removal operation. Implants made of self-reinforced (SR) polylactic acid (PLA) have been successfully used in osteotomies of the femoral diaphysis in both rabbits and sheep^[1,2]. Fixation of radioulnar fractures in toy breed dogs has many potential problems when metallic plates are used. The high bending modulus of metal compared to bone easily results in osteoporosis that makes it difficult to estimate appropriate time for plate removal. Refractures after plate removal are not uncommon in toy breed dogs. The aim of this study was to investigate if biodegradable plates could be used in radioulnar fractures of toy breed dogs and if they could prevent the osteoporosis so commonly associated with metallic fixation.

Eleven (11) toy breed dogs under 6 kilograms (1,6 – 6 kg) with traumatic radioulnar fractures were operated on. Seven (7) had distal radioulnar fractures and four (4) had mid diaphyseal radioulnar fractures. 2 pomeranians, 2 Italian greyhounds, 2 toy poodles, 1 kleinspitz, 1 medium poodle, 1 bichon bolognese, 1 Moscow miniature terrier and 1 Italian greyhound- miniature pinscher-mix were included. Six (6) dogs were between 4-12 months of age and five (5) dogs were between 1-6 years of age. The plates were made of a self-reinforced (SR) poly-L/D-lactic acid stereocopolymer with a L/D isomere ratio of 70/30. The dimensions of the mid diaphyseal plates were 50-70 mm x 7 mm and of the triangular shaped distal fracture plates were 35-55 mm x 7 mm. The plates had no holes. AO metallic miniscrews with diameter of 1,5-2,0 mm were used. Isoflurane anesthesia was used and pain was managed with meloxicam and buprenorfin. Standard surgical techniques were used. The proper sites for screwholes were marked on the plate and the desired size of plate was estimated. The plate was then trimmed with scissors and the cut edges were smoothed with a coarse file. Screwholes were drilled in the plate with the same drill that was used for the bone. In 6 cases, two plates were used at the fracture site in a sandwichplate fashion to gain more stiffness. A cancellous bone graft was taken from ipsilateral humerus in all but one case. A light splint was used after the operation until bridging callus was noted. The splints were changed every 2 weeks and removed usually after 6 weeks, range 2-9 weeks.

Fracture healing was achieved in 10 cases within 3-12 weeks. Evaluation of fracture healing was favoured by the radiolucency of the SR-PLA plates. In most cases the fracture line had disappeared between the 6- and 9-week controls. No signs of osteoporosis were seen in any radiographs. No malpositions or functional problems of the leg were seen. There was one case with plate failure that was noted at the 4-week control. The plate had failed transversally at the fracture site. Three dogs developed skin abrasions from the splints but all recovered quickly after splint removal.

In conclusion, the absorbable SR-PLA plates can be used together with metallic screws in radioulnar fractures of toy breed dogs. Use of these plates seems to prevent osteoporosis, as is expected when the elasticity modulus of the SR-PLA plate is close to that of bone. A sandwichplate technique on all cases could have prevented one case from refracturing and would also have lowered the need for splinting. The long-term follow-up of these promising results is in progress.

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Soft tissue pathology in horses with navicular syndrome – MRI results

M. Schramme, S. Dyson, R. Murray, M. Branch

In the author's clinic, MRI is performed with the horses under general anaesthesia and the limbs under scrutiny positioned in the isocentre of a short bore, flared end 1.5 Tesla GE Signa Echospeed magnet. A human extremity radiofrequency coil is placed around the foot to be imaged. Sandbags are placed on the limbs in order to reduce movement associated with respiration. Images are obtained in sagittal, transverse and dorsal planes and include 3 dimensional (3D) T2* gradient echo (GRE), spoiled gradient echo (SPGR), fat saturated 3D T2* GRE and short inversion recovery (STIR) sequences. Both forefeet are examined routinely and a complete examination requires approximately 90 minutes anaesthesia time. It is important to remember that MRI is not a screening tool like nuclear scintigraphy, but an imaging technique limited to a specific anatomical area. Its results merely supplement those of a comprehensive clinical, radiographic and scintigraphic examination. MRI has allowed us to make specific diagnoses in the foot that could not have been made using other imaging techniques. It is important to include these new specific conditions in the list of differential diagnoses of foot lameness in the horse. In our experience, MRI of the foot has been particularly useful in the recognition of abnormally high signal (fluid) in the soft tissue structures of the foot, the recognition of abnormally high signal in the spongiosa of the navicular bone (bone oedema), and the recognition of abnormal signal in articular cartilage and subchondral bone. In 18 horses with unilateral or bilateral foot lameness without radiological or ultrasonographic abnormalities examined using MRI at the Animal Health Trust in 2001, 7 had primary lesions of the DDFT, 2 had abnormalities of the DIP joint cartilage and subchondral bone, 7 had primary abnormalities of the navicular bone, and 2 had multiple lesions associated with the distal insertion of the DDFT on the distal phalanx, the impar ligament the navicular bone and the DIP joint.

At the time of writing this abstract, obvious lesions of the DDFT that were considered the primary cause of lameness have been encountered in 12 horses. These lesions were usually restricted to either the medial or lateral lobe, or rarely occurred in both lobes. Only in one horse was the lesion restricted to the level of insertion of the DDFT to the flexor surface of the distal phalanx. In 6 horses DDFT lesions were identified as 'core lesions', in 6 horses as a 'sagittal full thickness split', in 1 horse as a 'dorsal border erosion', and in one horse as an 'enthesiopathy'. The lesions varied in length between 1.3 and 7.0 cm. Lesions commonly extended along the proximodistal length of the navicular bursa, but were occasionally restricted to the distal insertion of the DDFT, or extended up into the pastern region. Histological examination has shown that the presence of abnormally high signal in the DDFT is associated with collagen necrosis, matrix liquefaction and hyalinisation (unpublished data).

Retrospective analysis of the response to regional analgesic techniques of the first 10 horses diagnosed with DDF tendinitis in the foot, revealed that only 5 horses improved more than 75% to a palmar digital nerve block, 2 improved less than 50% and 3 did not improve at all. All horses improved more than 75% to an abaxial sesamoid nerve block. All horses in which intra-articular analgesia of the DIP joint was performed (9) improved more than 75%, but only 6 of 8 horses in which intrabursal analgesia of the navicular bursa was performed improved more than 75%.

The results indicate that MRI is a very sensitive tool for detection of injury to tendons and ligaments, especially in areas like the foot, that remain difficult to access ultrasonographically.

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Magnetic resonance imaging of the canine shoulder and elbow joint

S. Schuller, J. Maierl, H.-G. Liebich

Magnetic resonance imaging (MRI) is well established for detecting cartilage lesions in human medicine. Its value has been recognized in early detection and diagnosis, in determining prognosis and follow-up of lesions as well as in the postoperative evaluation of osteochondral disorders. MRI is an upcoming technique in veterinary medicine and is gaining in importance as a non-invasive method.

We compared different sequences to determine parameters that maximize positive contrast between hyaline cartilage and fluid and adjacent tissues such as the subchondral bone. With the most optimal sequence 26 joints of seven cadaveric dogs were scanned and compared with anatomical sections.

Imaging was performed with a 1,0-T magnet (Siemens Magnetom Impact Expert) and a extremity coil. Joints were scanned in the axial plane. We used a slice thickness of 2mm, pixel size 0,31 x 0,31mm, a matrix of 512² and FOV of 160mm. Different sequence were compared. Articular cartilage was best delineated by the fat-suppressed Flash 3D images, we favoured a flip angle of 60°. These parameters were used to study the shoulder and elbow joints with and without cartilage defects. Eight joints were healthy when inspected anatomically (control group).

With FS FLASH 3D normal hyaline cartilage showed a high signal intensity. Joint fluid, fat and subchondral bone emitted a low signal. In the shoulder joint deep and intermediate cartilage lesions could easily be diagnosed and could be correlated with the findings in the anatomical sections. Superficial lesions could not always be identified reliably in the MRI images. The most common lesion was a superficial to intermediate chondral defect which was found in the posterior third of the humeral head.

In the elbow joints with opposing articular surfaces in contact there was almost a single line representing both articular cartilages. In most cases however it was possible to see the hypointense signal line of the joint fluid. Better results for delineating cartilage surfaces were shown in the transverse plane. Chondral lesions could not be diagnosed, but we found an erroneously interpreted hyaline cartilage defect. In the anatomical sections lesions were detected at the typical sites: medial part of the condylus humeri, proc. coronoideus medialis and medial area of fovea capitis radii. The low sensitivity of MRI when it comes to detecting cartilage lesions in the elbow and shoulder joint (small superficial lesions) can be explained by the relatively low spatial resolution of the MR images (pixel spacing 0,31x0,31 mm) in comparison to the cartilage thickness (maximum 1mm).

In conclusion, fat-suppressed 3D FLASH imaging shows a high chondral contrast to joint fluid and subchondral bone and is useful for detecting defects in the hyaline cartilage of the shoulder, but not in the elbow joint.

Sequence	TR	TE	FA
Flash 3D	25	11	30
Flash 3D	24	11	25
Flash 3D FS	50	11	60
Flash 3D FS	50	11	30
Dess 3D (Acq 2)	28	9	40
Fisp 3D	22	10	25
Fisp 3D MTC	33	10	25

Current research in the pathophysiology of elbow dysplasia

K.S. Schulz, D. Mason, I. Holsworth, H. Pooya

The underlying pathophysiology of FCP has yet to be determined. Theories include osteochondrosis (OC), radio-ulnar incongruence, radio-humeral incongruence, and structural insufficiency of the region. Several of these factors may simultaneously contribute to the pathophysiology of the disease. Current research into the pathophysiology of elbow dysplasia has included determination of the role of the ulna in transarticular loading. The ulna has a large contact surface and results suggest that the medial coronoid shares load transfer with the radial head at close to 50% each. Several investigators have proposed that fracture of the MCP occurs because of overloading. Abnormalities of joint shape or congruence may lead to altered transarticular pressures and increased loading of the coronoid region. Radiography has been routinely cited as a means of evaluating radio-ulnar incongruence in association with FCP. An evaluation of nine dogs with elbow dysplasia correlated radiographic and gross findings of incongruence. There was a high correlation between gross findings of incongruence and radiographic interpretation of incongruence. This is in contrast to a more recent study that demonstrated poor agreement on subjective determination of elbow joint congruity when the x-ray beam was not centered on the joint or when the joint was placed in extreme flexion or extension. Another recent study demonstrated very poor consistency between radiologists in their ability to differentiate canine elbow joints with and without step defects between the proximal articular surfaces of the radius and ulna. The relatively low specificity demonstrated in this study suggested a tendency for radiologists to incorrectly report radio-ulnar step defects when none existed. More recent studies are investigating the ability of CT to measure radio-ulnar incongruence. Incongruence between the trochlear notch of the ulna and the trochlea of the humerus has been proposed as a cause of increased loading of the coronoid process. Details of this proposed mechanism have not been elucidated and the normal incongruence of the canine elbow joint must be considered. One study used computer-aided analysis of radiographs to evaluate the congruity of the trochlear notch in normal Rhodesian ridgebacks as compared to Bernese mountain dogs with varying grades of arthritis presumably secondary to FCP. Retrospective evaluation of 409 medio-lateral radiographs and 68 craniocaudal radiographs from an unreported number of Bernese mountain dogs was compared to complete, prospective radiographic evaluation of 50 normal Rhodesian ridgebacks. The authors reported that the Bernese mountain dogs had a tendency towards large humeral condyles and ellipsoid trochlear notches as compared to the Rhodesian ridgebacks. They also reported that the degree of incongruence correlated with the degree of arthritis.

Topical treatment of cartilage defects

K. Schulz

Focal osteoarthritic lesions occur in all cases of OCD, are frequent in cases of elbow dysplasia and are less frequently identified in cruciate disease, shoulder instability or articular trauma. The cause for these lesions in elbow dysplasia remains unknown; however, the lesions are typical for those associated with increased transarticular pressure due either to joint incongruence or malalignment. Intra-articular arthroscopic management of cartilage defects has been routinely recommended in human arthritis treatment although the long term benefits remain in question. If the underlying cause has been eliminated as in cases of acute trauma or loose body abrasion then it is possible that arthroscopic treatment of the arthritic lesions may aid in reformation of a low friction surface of fibrocartilage. If however the underlying cause of the bone and cartilage damage is not eliminated, the disease process will be perpetuated and it is much less likely that the lesions will heal adequately.

Numerous scales have been reported for the grading of gross arthritic lesions and one will be shown. After the lesions have been assessed by the surgeon he or she must decide whether arthroscopic debridement and treatment will aid in the healing of the joint or potentially contribute to degeneration. It has been well demonstrated that partial thickness cartilage lesions which do not penetrate the tide mark do not heal as readily as those that do penetrate the mark. By removing partial thickness cartilage lesions, the surgeon is assuming that their manipulation will contribute to the healing of the area by temporarily increasing the severity of the defect.

Management of articular cartilage lesions is based on the concept that providing blood with mesenchymal stem cell precursors access to the lesion encourages healing by formation of fibrocartilage. Several methods have been described to achieve this. Abrasion arthroplasty involves uniform removal of subchondral bone until bleeding is achieved. This can be accomplished in the canine elbow by use of either a curette or burr attachment on a small joint shaver. The shaver is usually more rapid and efficient and generally just as accurate. Another method of treatment for grade IV lesions is microfracture. In this technique numerous microcracks are created in the subchondral bone plate to allow bleeding at the lesion surface. Microfracture awls are available for small joint arthroscopic use. Alternatively, a small microfracture pick may be created by bending the end of a 0.035 or 0.045 inch K-wire to about a 45-degree angle. The wire is then secured into a Jacobs chuck. A final technique described for management of these lesions is forage in which small holes are drilled in the subchondral bone. In humans and horses this technique has reportedly led to the formation of cystic lesions.

Topical treatment of cartilage defects is most easily achieved by arthroscopy because of the magnification and access to all joint surfaces. Palpation of lesions using a right angle probe may be performed through an instrument cannula; however most power shavers and micropicks will not fit easily through a small joint cannula. Visually evaluate and palpate areas of cartilage damage and note the size and severity of the lesion. Debridement of Grade I lesions with chondromalacia is up to the discretion of the surgeon. Small areas of grade II fibrillation in the absence of other lesions also may be left undisturbed. Larger areas of Grade II cartilage disease can be treated similar to Grade III lesions at the discretion of the surgeon. Grade III lesions are areas of full thickness fibrillation. Use a curette or burr to remove the diseased cartilage while being careful not to damage any of the surrounding more normal cartilage. The resulting subchondral bone bed is then treated identically to Grade IV lesions. Grade IV cartilage damage is full thickness loss of cartilage and exposure and, in some cases, eburnation of the subchondral bone. They are treated with abrasion or microfracture until adequate bleeding occurs.

To perform abrasion arthroplasty, insert a hand burr or preferentially a power shaver burr through the instrument portal. Either method will produce significant bone debris that can clog the egress portal and impede visualization, therefore it is important to monitor and maintain the flow of fluid through the joint during this procedure. Spin the burr to remove subchondral bone over the area of the lesion. Check for resulting bleeding frequently by stopping inflow of fluid and ensuring adequate outflow to decrease the pressure in the joint. When bleeding is observed diffusely from the lesion bed, lavage the joint to remove the remaining bone debris and close routinely.

To perform microfracture, insert an appropriately angled micropick into the joint and press the tip against the subchondral bone surface. Have an assistant tap the pick handle once or twice. The pick should be held securely to avoid gouging the surface and adjacent healthy cartilage. Apply the micropick diffusely across the diseased area and check for resulting bleeding frequently by stopping inflow of fluid and ensuring ade-

quate outflow. When bleeding is observed diffusely from the lesion bed, lavage the joint to remove the remaining bone debris and close routinely.

Producing diffuse effective bleeding varies in difficulty between joints. Combining abrasion and microfracture may help increase subchondral bleeding. In cases of eburnation it may be difficult or impossible to get significant bleeding with these techniques.

Postoperative management will include life long medical management in most cases. Treatment includes control of body weight and exercise level in combination with NSAID and chondroprotective medications and physical therapy.

The efficacy of arthroscopic treatment in management of osteoarthritis of focal cartilage defects is unknown. It is likely to have much greater efficacy when combined with medical management, physical therapy, and weight control. Severe cases may be unresponsive and many cases may require additional surgical intervention including corrective osteotomies, arthrodesis, or joint replacement.

Future treatments may include osteochondral autogenous transfers, cartilage culture and autograft, stem cell technology, and gene therapy. Currently these procedures are cost prohibitive. In addition, all of these procedures are likely to be unsuccessful in environments of destructive mechanics such as elbow dysplasia and hip dysplasia. It is a prerequisite that the loading environment of the joint be corrected if healing of the articular surface is to be achieved.

Mechanics of the canine femur with two types of hip replacement stems: finite element analysis

R. Shahar, L. Banks Sills, R. Eliasy

INTRODUCTION

In the intact femur stress is distributed over the entire cross-section of the bone. The natural stress distribution in the femur is significantly altered after total hip replacement, due to the manner in which the load is transferred from the prosthesis to the femur. After surgery, loads are placed both on the implant and on the bone. These forces are transferred through compression and shear across the cement-bone and cement-implant interfaces. This leads to high interface stresses, and reduced bone stresses (stress shielding). The long-term performance of total hip replacement components in humans, and in particular that of the femoral stem, has been the subject of intense investigations. Such studies are lacking in dogs. This study examined the stresses that develop in the stems of cemented THR and Zurich cementless hip, as well as in the cement and in the femur.

METHODS

Femora were harvested from a mature German Sheppard dog. One type of femoral stem was placed in each of the femora. Serial transverse computed tomography scans were obtained of both femur-implant units. The geometries of both units were extracted by applying image processing software, and three-dimensional finite element models were created with Nastran[®] pre-processor. Numerical values for boundary conditions (muscle forces and joint reaction forces) were obtained from a biomechanical analysis of the canine femur previously published by the authors. Perfect bonding was assumed between the cement and the bone/implant (cemented model), and between the screws and bone/implant (Zurich cementless model). Finite element analysis yielded the stresses, strains and deformations in both models during three-legged stance. Stresses were compared with stresses determined in a finite element model of the intact canine femur.

RESULTS

The effective stress distribution in the distal half of the femur for both systems was quite similar, and also quite similar to that in the intact femur. However, in the proximal half of the femur, significant differences were found. Stresses in the proximo-medial cortex of the femur with the Zurich cementless model were found to be much higher than those found in the femur with the cemented model, and both models resulted in femoral stresses lower than those in the intact femur. In the cemented model, maximum effective stress in the cement layer was found to occur in the disto-medial area, reaching 50.4MPa. In the Zurich cementless model maximal stresses occurred in the proximo-lateral aspect of the implant, near the junction between the most proximal screw and the body of the implant, and reached 98.8 MPa.

DISCUSSION

The results of this study quantify the differences in stress distribution that occur in the femur after total hip replacement. While stress shielding is shown to occur with both methods investigated, the cemented hip is associated with more severe stress shielding. Maximal Effective stress and peak principal stresses in the Zurich implant reach 104.6 and 188 MPa respectively, significantly lower than the yield tensile stress of titanium which is 885 MPa, or the fatigue endurance limit of titanium (515MPa). The safety margin seems adequate, although it must be remembered that stresses were calculated for forces generated at a slow walk, and high impact activity will result in much higher forces. The cement mantle in the cemented stem is considered the weakest link in long-term endurance of cemented prostheses. It is assumed that loosening of prostheses occurs because of excessive stresses that develop in the bone-cement and implant-cement interfaces. Such excessive stresses may lead to fatigue fracture of the cement mantle, or failure of the cement-bone bond. The results of this study suggest that peak shear stresses in the cement occur in the inner proximo-medial and outer disto-medial aspects of the cement. However both are below the reported shear endurance limit of PMMA.

Three dimensional biomechanical model of the canine knee

R. Shahar, J. Milgram

INTRODUCTION

The canine knee is a complex, three-dimensional structure, which consists of the tibio-femoral and patello-femoral joints. Many mathematical models of the human knee have been developed in order to study the complex behavior of the various structural components of the knee, such as the forces occurring in the cruciate ligaments. However, similar models of the canine knee have not been described, and the nature of the complex translation-rotation movement of the femur relative to the tibia, and the forces which develop in the knee ligaments and between articulating surfaces, have not been elucidated. The purpose of this study was to develop a comprehensive, three-dimensional mathematical model of the canine knee.

METHODS

The right hind limb was harvested from a mature, healthy large breed dog that had been euthanised at a local shelter due to dog population control regulations. Following careful dissection, morphometric data of all muscles of the hind leg (physiologic cross-section area, muscle weight, fiber length and fiber angle of pennation) were obtained. Coordinates of origin and insertion (in coordinate systems embedded in the appropriate bones) were obtained for each muscle, as well as all the ligament groups that stabilize the knee. The coordinates of fifty to one hundred evenly distributed points located on each of the six articulating surfaces of the knee (medial femoral and tibial condyle, lateral femoral and tibial condyle, patellar surface and femoral trochlea) were also determined. An anatomic, three-dimensional, mathematical model of the knee was developed, by combining and modifying the basic assumptions made in the models described by Wisman et al (1980), Yamaguchi and Zajac (1989) and Beynonn et al (1996). All articular surfaces were approximated by 4th order polynomials. All bones and joint cartilages were assumed to be non-deformable, and the forces in the knee ligaments were described as second order functions of ligament strain. Contact forces between the appropriate articular surfaces were constrained to be collinear, and perpendicular to their respective surfaces. A system of 28 non-linear equations with 28 unknowns resulted, which described the quasi-static equilibrium of the knee for a given knee flexion angle. This system of equations was solved by applying a least squares algorithm (MATLAB[®] software, optimization toolbox).

RESULTS

Analysis of this model allows the evaluation of a variety of physiological parameters associated with the function of the knee. These parameters include the knee joint reaction forces (acting on the articular surfaces of the medial and lateral femoral condyles and the patello-femoral reaction force). In addition, it allows the determination of the location of the tibio-femoral points of contact, and thereby the description of the complex translation and rotation of the femur relative to the tibia during walking. It also yields the forces in the quadriceps muscle group and in the patellar ligament, and in the cruciate ligaments and collateral ligaments, which stabilize the knee, and the angles of internal/external rotation and abduction/adduction of the femur. Finally, by appropriate modification of the geometric input data, the model can be used to evaluate the biomechanical consequences of a simulated TPLO surgical procedure.

DISCUSSION

This model is the first comprehensive, three-dimensional biomechanical model of the canine knee. Analysis of this model not only serves as a powerful tool for understanding the biomechanics of the normal knee, but can also be used in the evaluation of the effects of a variety of common pathological conditions, such as rupture of the cranial cruciate ligament, and patellar luxation. In addition, it can be used to evaluate the effect of surgical techniques such as TPLO. TPLO, a recently introduced technique for the treatment of rupture of the cranial cruciate ligament, is claimed to restore functional knee stability by eliminating the cranially oriented force generated during weight bearing. This conclusion was based upon a simple, two-dimensional analysis of the forces affecting the stifle. However, it can only be rigorously tested by a combination of in-vivo and in-vitro experiments, combined with parametric analyses of a more comprehensive model, such as the one described here.

Does claw – trimming provoke an endurable effect on claw quality?

J. Huber, Ch. Stanek, J. Troxler

Routine claw trimming is accepted as the most important prophylactic measure in preventing claw diseases. Surprisingly, little is known about a quantified long term effect on repeated claw trimming procedures on the herd claw status.

Austrian agricultural economy with a comparatively small herd size is turning from a tied stall system with regulated pasture access in the summer months to a loose housing system with varying access to pasture. In a field study in the province of Salzburg, 5 farms with a tie-stall system were compared with 5 farms with a loose housing system. Farms with evident changes of the management system were not included in this study. On each farm about 50% of the cows were randomly selected, with a total of 185 cows included at the beginning of the study. Every cow underwent an orthopaedic examination and a routine claw trimming using the dutch method during the months January to March 1998, with a follow up claw trimming 6 months later and a last claw trimming 12 months later. Claw trimming and recordings were carried out by the first author personally. Claw status was expressed numerically using the classification by BOSMAN et al. (1989) and modified by STANEK (1994), putting more weight on clinically relevant changes like sole ulcers. This system allows to express the variety of pathological and semipathological conditions on all main claws within one figure. A low figure is indicating a good condition of the claws. Median claw score values, minimal and maximal values at the various points are depicted in Table 1.

	Tied stall	Tied stall	Tied stall	Loose housing	Loose housing	Loose housing
Claw trimming period # / n cows	I/81	II/75	III/65	I/83	II/82	III/68
Minimum	0	5	5	3	5	3
Maximum	105	136	67	87	88	65
Median	27	29	27	37	31,5	25

Analyzing the extensive data material, the following conclusions can be drawn: The claw score was higher in the loose house systems compared with tie stalls. The individual claw score showed a higher variation in the tie stall system at examination I, the worst individual scores were recorded in tie stall systems. At the end of the pasture season the claw score decreased in both systems, as did the individual variation. In the following stall season the score increased again, the claw situation worsened again. The claw score showed a significant decrease during the examination period in the loose housing group, whilst in the tie stall group this score remained stable. Claw trimming proved successful in improving the claw condition in loose house systems, whilst in tie stalls the claw score remained at the same level. One explanation is the different approach to the claw trimming necessity prior to this study, as it was found in farmers using the tie stall system.

An update on diagnosis and treatment of septic arthritis in cattle

A. Steiner, C. Spring, M. Zulauf

DIAGNOSIS OF SEPTIC ARTHRITIS

Cytological analysis of synovial fluid:

In a recent retrospective cohort study on 130 cattle with arthritis, synovial fluid characteristics were compared between cattle with septic and aseptic arthritis, respectively.¹ Cattle with septic arthritis had significantly higher numbers of total nucleated cell counts (TNCC), polymorphonuclear (PMN) cells and total protein (TP) as compared to cattle with aseptic arthritis. The percentage of PMN cells was significantly higher in cattle with septic arthritis. Cut-off values for joint sepsis were suggested at TP > 45g/L, TNCC > 25 x 10⁹ cells/L, PMN cells > 20 x 10⁹ cells/L, and percentage of PMN cells > 80%.

Microbial analysis of synovial fluid in cattle with septic arthritis: Comparison of culturing with and without preincubation for 24 hours in blood culture medium:

Synovial samples harvested from 31 cattle with septic arthritis within a 2-year period at the Food animal clinic, University of Berne, were analyzed. After arthrocentesis, 2ml of synovial fluid each were subjected to direct microbial culturing and cytological examination and analysis of TP concentration. Five to ten ml were aseptically injected into a blood culture medium, kept for at least 24 hours at room temperature and subsequently subjected to routine microbial culturing. Joint sepsis was diagnosed, using clinical criteria and the results of synovial cytology and TP concentration according to the results of Rohde et al.¹ Bacterial growth was found in 19 of 31 cases (61%). Identical results with both techniques - direct culturing and preincubation for ≥24 hours in blood culture medium - were found in 23 cases (74%). In 7 samples (23%), bacterial growth was found after preincubation, but not at direct culturing. In one sample (3%), bacterial growth was found at direct culturing, but not after preincubation. History revealed antimicrobial pretreatment in 19 cases (61%). Surprisingly, antimicrobial pretreatment did not have any effect on microbial growth in culture: Relative distribution of samples with and without bacterial growth were identical in the group with antimicrobial pretreatment as compared to the group without antimicrobial pretreatment.

STRATEGIES FOR TREATMENT OF SEPTIC ARTHRITIS

Review:

Surgical treatment, including arthrotomy, debridement, synovectomy and removal of necrotic bone,² carpal arthrodesis with or without carpal bone resection,³ and facilitated ankylosis of the distal interphalangeal joint^{4,5} were successfully used for treatment of chronic septic arthritis in cattle. Conservative treatment consisting of intramuscular and intra-articular antimicrobial treatment were less successful.² Arthroscopic lavage, synovectomy and curettage, and intraarticular administration of gentamicin-impregnated collagen sponges were proposed as a less invasive alternative to arthrotomy.⁶⁻⁸

Retrospective analysis of 31 cases with septic arthritis:

In a case series of 31 cattle with septic arthritis treated by arthroscopic lavage, synovectomy and curettage, intra-articular administration of a gentamicin-impregnated collagen sponges, and intravenous administration of sodium penicillin, 25 cases were treated successfully (81%). From the 6 cases that were euthanatized after treatment, the stifle joint was affected in 3 cases, the tibiotarsal joint in 2 cases and the metacarpophalangeal joint in 1 case. Anatomically complex joints with multiple joint pouches seem to have the less favorable prognosis than joints with a less complex anatomy.

Outlook, future developments:

For specific veterinary use, the need for registered antimicrobial delivery systems does exist. Development of new drug delivery systems, using PLA carriers and antimicrobial agents with a broad gram negative as well as gram positive spectrum is currently being proposed.

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EN.REFLIST

Evaluation of a novel non-toxic rigid polymer as connecting bar in external skeletal fixators

C.K. Störk, P. Canivet, A. Baidak, M. Balligand

INTRODUCTION

The purpose of this study was (1) to investigate relevant mechanical characteristics of a non-toxic, low-cost, rigid polymer, and (2) to compare the mechanical structural properties of a full frame External Skeletal Fixator (ESF) with either rigid polymer (RP) connecting bars, polymethylmethacrylate (PMMA) connecting bars, or stainless steel (SS) clamps and connecting bars. The authors hypothesized, that 20 mm diameter RP columns used as connecting bars in a ESF type II configuration compare favorably to PMMA and SS in mechanical performance.

MATERIAL AND METHODS

Differential scanning calorimetry was performed to determine composition of the polymer. The elastic modulus in traction was determined. Internal porosity of the HPP column was assessed measuring total number of pores, average pore size, and total pore area per cross section of 6 polished non-adjacent cross-sections using appropriate digital equipment. Mechanical properties were assessed using an in vitro fracture bone model with a bilateral uniplanar ESF (Type II) similar to previously described protocols. Identical ESF were built with connecting bars using RP (n = 8), PMMA (Technovit; n = 8), and SS connecting bars and clamps (Meynard System; n = 3). Nondestructive mechanical tests were performed in uni-axial compression (AC) and cranio-caudal (CC) four-point bending, as well as fatigue AC. Composite stiffness for each specimen and for each loading mode was calculated from 6 replicate measures using the slope of the load displacement curve at small displacements. Three RP ESF were subject to a compression-compression fatigue test loading the specimen from 70 to 700 N in a fully reversing sinusoidal mode at a frequency of 1.5 Hz. The tests were discontinued after 150.000 cycles, which likely corresponds to at least 7 weeks of ambulation of a convalescent patient.

RESULTS

Mean internal porosity of RP was determined 0.59%. RP, PMMA, and SS ESF specimens yielded composite stiffness values (Mean±SD) of 227±15, 381±30 and 394±9 N/mm in AC, and of 35±2, 24±2, and 15±0 N/mm in CC, respectively. Intra- and inter-specimen variation in AC were 0.9% and 6.6% for HPP, 1.4% and 7.7% for PMMA, and 1.1% and 2.2% for SS, respectively. For each loading mode differences between groups were highly significant (p<0.001), with the exception of PMMA and SS in AC.

DISCUSSION/CONCLUSION

In contrast to PMMA, the thermoplastic has no contact-toxicity, does not release any noxious fumes and can be handled without gloves. RP is a versatile, non-toxic, satisfactorily rigid, fatigue resistant and low-cost material that can be used for connecting bars in ESF. RP connecting bars in an ESF are a reliable, inexpensive option for the veterinary surgeon.

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Biomechanics of the canine hip joint

S. Tepic

The basic ball-and-socket anatomy of the canine hip joint allows all three degrees of rotational freedom: flexion/extension, abduction/adduction, and internal/external rotation. Normal hip joints, with weight bearing capacity of several times body weight, provide for durable, extremely low friction articulations, taking millions, to tens of millions of movement and loading cycles annually, for a decade or longer. Much has been said, with little justification, about relatively reduced mechanical demand on the hip joint in quadrupeds vs. human – dogs need, and use the load bearing capacity of their hips to no lesser extent than we do.

All of the performance we expect, and frequently get, in a natural articulation is possible only due to its constant maintenance. Our analytical skills are still rather modest in modeling even the mechanics of these complex bearings, never mind the biological processes of keeping them in a steady-state condition in face of constant degradation of all of its elements. We thus generally opt for describing what we can address by standard tools of mechanics, and then venture to use less precise notions of “bio” to hint at modes of, for example, failure.

There are several layers of analysis required to arrive at a description of a functioning joint. At the first level there is kinematics and external loading of the complete joint. The usual approach is to observe the body in motion – state of the art technology allows for real time kinematic data acquisition and display of a number of tagged body segments¹. Aside from the important issues of skeleton vs. soft tissue kinematics, the process of observing the body in motion is conceptually simple, if technically involved.

Determination of joint loads has been approached both experimentally and analytically, and in the most productive way, by combining the two. Experimental determination has been carried out by special hip replacement components, instrumented to measure the internal loading in the joint and transmitting the information out of the body. Several projects^{2,3,4,5}, starting as early as sixties and some still in progress, have taken on the technological challenges of this approach and have ultimately given us some solid reference (for both human and dog) to gauge our analytical efforts against. These analyses are usually also based on experimental inputs: on one side, of the kinematics data (and the inertial properties of the body segments), on the other side, of the ground reaction force measured during kinematic data acquisition. Application of the straightforward Newtonian dynamic analysis of the body segments, will then lead to sequential calculations of internal total reactions between the body segments, starting with the ground reaction. Total joint reactions comprise both: the internal joint forces and the resultant muscle actions around them. Since muscles can exert only tension, one would need six of them to control three degrees of rotational freedom at the hip joint. In reality, there is almost a factor five redundancy. What are all these muscles for, and how to calculate what they should be doing? This presents one of the major puzzles in biomechanics⁶. Data from direct measurements of joint forces suggest even a bigger problem – there is always a degree of muscle co-contraction, i.e. not only that we cannot figure out how to appropriate the minimum required actions (those needed for the observed movement) to different muscles, but there is an apparent waste of muscle action, squeezing the joint together and causing no external effect⁷.

Co-contraction has a fundamental role in providing stiffness across the joints (i.e. a resistance to a change in angulation), which also appears to be the basic principle of physiological control of joint kinematics⁸ – position of the joint is determined by pre-setting the stiffness of the agonist and antagonist muscles, rather than, e.g., their length. In general, learned movements require less co-contraction, while those performed in the unknown environment, or requiring higher precision, call for more of it.

Redundancy of the muscles is usually dealt with by introducing some criterion of optimality, allowing computational algorithms to select the ones most appropriate to reduce the value of the cost function. Since this approach cannot even start to address the issues of all-important co-contraction, its results should be taken with appropriate caution. Issues, such as those of muscle activity and joint loading⁹, debated in the human hip biomechanics during the last decades are certainly of relevance for the canine hip – details may vary, but the nature of the problems at this level of analysis is very similar. And so it is at the next level down – understanding how the joint works as a low friction bearing.

Comparisons with technical bearings were generally unproductive – cartilage, as it turns out, has no companion in the man made bearings. Significant confusion in this area of research persists for decades¹⁰, and probably only a very careful reader could learn that the “mystery” of joint lubrication resides in the ability of opposing cartilage layers to effectively seal off the articulation and allow for a much reduced loss of fluid from the cartilage layers during high load phases, while opening the seal for imbibing during reduced load

phases (including the day/night cycle). A synovial joint is more of a valve than a bearing¹¹. Hence, degradation of the sealing efficacy, which, once again, is amazingly high in comparison to anything man-made, may be an important component in degenerative joint disease. Among other manifestations of reduced joint space sealing, there will be a rise in friction, and as a consequence of it, a rise in the temperature inside and in the surrounding of cartilage layers¹². While this temperature rise may be a transduction signal for the control of chondrocyte metabolic activity in healthy state, it may also drive the pathological processes once outside the normal range. Joints degenerated to the extent of complete, if focal, loss of cartilage, resulting in direct bone-on-bone contact must in fact get extremely hot with even a moderate activity.

Such insights should be useful in modeling and thus understanding the process of joint lubrication, maintenance and degradation, but the impact of it all at the clinical level is, and is likely to remain minimal. Joints in dogs will most likely continue to degenerate at rates similar to those observed today, and for years to come, little else other than perhaps a wider use of total joint replacement is likely to make an impact in the clinical treatment of canine hip disease.

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Biomechanics of the stifle joint

S. Tepic, D. Damur, P. M. Montavon

High incidence of the cranial cruciate ligament (ACL) deficiency in dogs, clinical success and widespread, if belated, acceptance of the tibial plateau leveling osteotomy (TPLO) proposed by Slocum^{1,2,3} have stirred and reinvigorated small animal veterinary orthopedics in an unparalleled way. Treating a stifle joint rendered unstable due to a failed ligament by a surgical intervention aimed at modifying basic joint geometry was a unique and uniquely successful proposal. Intuitively, a steeper inclination of the tibial plateau is a causative factor, and Slocum's surgical intervention aims to not only render the joint stable, but to in fact eliminate the prime suspect for the ligament failure. This was a departure from the conventional approaches to solving the problem by ligament reconstruction, augmentation, or replacement by a surrogate. Implied rationale for these very different management options is the presumed etiology of the cruciate ligament failure: trauma vs. gradual deterioration due to a functionally ill-conditioned stifle joint.

Ultimately, it was the superior clinical performance of the dogs treated by Slocum's TPLO, which has made it the preferred choice for the treatment of ACL deficiency. In comparison to extracapsular ligament augmentation, which remains in the repertoire of most surgeons, TPLO shows a slower progression of arthritis⁴, and hence a better long-term prognosis.

TPLO concept was born out of Slocum's appreciation for the tibial thrust test introduced by Henderson and Milton⁵ and was a more radical corrective intervention than his cranial closing wedge osteotomy⁶. It also appears that the tibial thrust test was the primary basis for determination of the angle of correction deemed appropriate for a TPLO. Yet, as will be discussed in this presentation, the outcome of the test is dependent on the way in which the test load is applied to the paw. Loading the paw with a pure moment, which is usually instructed and most surgeons seem to practice, results in the loading of the stifle joint with a total joint force nearly parallel to the Achilles' tendon, which in turn is approximately parallel to the "functional axis" of the tibia, as defined by Slocum. In order to neutralize the cranial thrust so produced, the plateau should be perpendicular to the Achilles' tendon. However, in its functional use of the limb, the dog is not loading its paw with a moment, but with a force. If the paw is loaded by a force, the stifle total force is nearly parallel to the patellar ligament. In which case, by the same argument, the correction should aim for making the plateau perpendicular to the patellar ligament. In both cases a certain degree of over-correction is warranted to provide a margin of safety in a joint with a ruptured or threatened ligament.

There are thus two possibilities to put up for analysis and discussion: (1) tibial plateau perpendicular to Achilles' tendon; (2) tibial plateau perpendicular to patellar ligament. There is an angle of approximately 15 degrees between the Achilles' tendon and the patellar ligament (with the stifle in extension). In both cases, one can attempt to influence either the plateau or the tendon/ligament. Slocum's TPLO turns the plateau, orienting it with respect to Achilles' tendon. A cranial closing wedge osteotomy, abandoned by Slocum, has been reinvented and is also practiced, and advocated as an alternative way to tilt the plateau, wherein in fact it mostly turns the Achilles' tendon. TPLO can of course be performed with a smaller angle of correction aiming at perpendicularity to the patellar ligament. The fourth possibility, that of correcting the angle of the patellar ligament, is well known in orthopedics, but to our knowledge has not been used for ACL deficiency. And yet, it may be the simplest procedure to perform, with major benefits expected in terms of reduced morbidity and improved short and long-term performance.

Slocum's publications have in fact laid out basic mechanics of the stifle, but rather arbitrarily, he decided that the tibia is a simple axially loaded truss. Determination of true joint forces, in spite of many decades of research in biomechanics, remains an illusive task, mostly for the problems of muscle redundancy and co-contraction. The latter has subtle and difficult to objectively assess functional / physiological causes. The arguments presented here are based on greatly simplified mechanics of the stifle, and should be used only for sorting out different possibilities when contemplating surgical interventions. Yet the need to perform them is such that we cannot wait to figure it all out. And for the benefit of many dogs and his fellow surgeons treating them, it is good that Slocum did not wait either. His insistence on the strictest adherence to the rules for execution of TPLO has perhaps prevented variations which otherwise might have suggested that the corrective angle is excessive. For that we have only anecdotal evidence. Yet one of the main drawbacks of TPLO may be caused by the excessive angle of correction: the most obvious, and generally overlooked fact is that the joint congruity is drastically changed by placing it on an average into 25 degrees of extra flexion. It may well be that the medial meniscal release is mandated by its impingement caused not by the tibial thrust (which should be well compensated), but by artificially increased flexion of the joint itself.

If the total stifle joint force is in fact oriented by about 15 degrees more cranial than presumed by Slocum, the evidence for the causative role of the increased tibial plateau angle becomes even more convincing. Morris and Lipowitz⁷ have measured this angle to be about 18 degrees in controls and about 24 degrees in dogs with failed ACL. If the reference is shifted by some 15 degrees, this would suggest 3 degrees in controls and 9 degrees in failed ACL cases. Instead of a 30% increased load responsible for the failure, we would be looking at a 300% percent increased load. And if the functional reference of true relevance is the angle of the patellar ligament, instead of a tibial axis, we may find a further cause for ACL failure in the formation of the tibial tuberosity. A steeper slope of the plateau and/or a less cranially prominent tibial tuberosity will increase tension in the cranial cruciate ligament, and may consequently predispose for its injury. Surgical management of the cranial cruciate deficiency could then rationally involve a reduction of the slope of the plateau and/or a cranial advancement of the tibial tuberosity.

If only a crude approximation to the true biomechanical status of an active musculato-skeletal linkage, simple static analysis of the stifle joint may prove its utility in at least three ways: (i) by guiding the search for underlying causes of the unusually high incidence of the cranial cruciate ligament deficiency; (ii) by providing more precise, and rationally based, means of determining the parameters for the currently practiced surgical interventions; (iii) by inspiring new management procedures.

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Hormonal influences of distraction osteogenesis

L.F.H. Theyse

The role of growth factors in tissue proliferation, differentiation, and healing has attracted increasing interest during recent years. This field of interests has developed into the discipline of tissue engineering, focussing on *in vitro* production of specific tissues for clinical application. Bone healing and osteoporosis have been studied extensively in the past including bone metabolism, histological, and radiographic research. The discovery of the importance of growth factors on bone growth and bone healing has had a major impact on research in both orthopaedic, reconstructive, and spinal surgery. Distraction osteogenesis (DO) plays a pivotal role in these studies. DO is the *de novo* production of bone in an osteotomy zone under controlled distraction. DO is characterized by a latency period, a distraction phase, and a consolidation phase. Under ideal circumstances intramembranous osteogenesis will occur implicating direct bone formation. Under less favourable conditions a combination of intramembranous and endochondral with an intermediate cartilaginous stage will take place. DO is an ideal basic research model to identify and study the cascade of growth factors influencing bone formation. From a clinical point of view the interest in the growth factors is instigated by the fact that bone consolidation after limb lengthening procedures in human patients takes a vast amount of time and accelerating bone healing of the distraction zone would be a great benefit. Presently several groups of growth factors are distinguished including the transforming growth factor beta's (TGF- β 's), insuline-like growth factors (IGF-1 and IGF-2), bone morphogenetic proteins (BMPs), and fibroblast growth factors (FGFs). The several growth factors have their specific receptors on the cell surface. In the TGF- β -superfamily intracellular down-stream effects are transmitted to the target genes by Smad proteins. Although the importance of the TGF- β 's during DO has been presented in several studies the exact molecular cascade by which TGF- β_1 and TGF- β_2 exerts their effect is still unclear. Although TGF- β is up-regulated in the early phases of DO, several studies on local administration of TGF- β showed no positive effect on bone formation. IGFs especially IGF-1 play an important role in DO and are found throughout the entire period of bone formation. Studies using recombinant growth hormone (rGH) in combination with DO showed an accelerated consolidation phase supposed to be mediated by an increase in the local and systemic concentration of IGF-1. The effect of the IGFs is modulated by IGF-binding proteins (IGF-BPs). BMPs can induce new bone formation and determine the differentiation pathways of uncommitted mesenchymal cells. BMP-2 has been shown not only to stimulate bone healing, but also to enhance early bone consolidation in DO. The FGFs are potent regulators of proliferation and differentiation. FGF is intensely present in the distracted region during DO. Local infusion with FGF in the distraction zone stimulated bone formation and shortened the consolidation phase.

Although our understanding of the role of growth factors in regulating bone formation has increased considerably much has to be unravelled about the complex interactions between formation and resorption. The ultimate goal is to develop new therapies to enhance bone formation and bone healing.

Canine total stifle arthroplasty

T.M. Turner

Canine total stifle arthroplasty (TSA) has proved to be a successful reconstructive procedure which has been used extensively as a research model in our laboratory, and to a limited degree in clinical veterinary practice. The complex mechanics of the stifle poses considerable difficulties for design of the articulating joint configuration in regard to joint kinematics and the long-term fixation of the prosthetic components to the host bone. Unlike hip joint replacement, a prosthetic stifle device consists of a resurfacing arthroplasty. As a result, components may be subjected to considerable shear and rotational forces during joint function. An unconstrained total condylar type prosthesis was designed specifically for the canine stifle to study issues regarding long-term integrity of the prosthetic interface including the effect of component design, micromotion, wear debris, implant-bone interface defects, and bone remodeling. Experience with over 90 implantations indicates that the surgical procedure and canine prosthetic device can restore the stifle to clinically normal motion and limb function. Long-term fixation of the components to bone has been achieved and maintained using either cementless fixation via bone ingrowth into a metallic porous coated surface, or by cement fixation using polymethylmethacrylate.

Clinical conditions resulting in pain or chronic instability treatable with TSA are: severe degenerative osteoarthritis; chronic instability; severe joint fracture; articular fracture malunion; and selected bone neoplasia. In general, TSA can be considered for non-infective conditions which are untreatable by conventional methods and for which arthrodesis of the stifle is a consideration. Contraindications for TSA are joint infections, neurological deficits of the limb and joint neoplasia.

The canine total stifle prosthesis consists of a femoral total condylar component, a tibial tray, and a UHMW polyethylene insert for articulation with the femoral component. The rectangular Ti6Al4V tibial tray has an undersurface flat pad of c.p. Ti fiber metal porous composite with either no pegs or 4 porous coated pegs. Screws for adjuvant fixation may be placed through holes in a flat tray or through cannulated pegs in the component. The CoCr or Ti alloy femoral components have fiber metal pads attached to the internal faces for bone ingrowth.

Clinically dogs exhibited full weight bearing by 6 weeks postoperative and normal function thereafter. Stifles have exhibited a range of motion within 10 degrees of the contralateral joint, and normal alignment. Radiographically, component porous surfaces were in direct contact with the underlying bone with minimal radiolucencies. Current generation TSA demonstrated greater bone ingrowth extent 90.3% and consistency of volume fraction 22.5% than previously reported.² A relationship study of interface micromotion, bone ingrowth, and screw fixation identified that amount and distribution of bone ingrowth was dependent on initial tibial tray stability.³

Research studies and evaluation of long term clinical cases demonstrated that the canine total stifle arthroplasty restored normal clinical canine stifle function. Histological analysis of retrieved clinical implants in service for 2 years showed extensive incorporation of bone and porous coating attesting to secure long-term implant fixation. Future considerations focus on implant design sizing and wear.

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Practical applications of tissue engineering in small animals

T.M. Turner

Skeletal tissue engineering employs biological and engineering technology to restore, replace, maintain or enhance cellular function and formation of various tissues. Orthopedically, this has encompassed bone and cartilage but supportive tissues such as ligaments and tendons are also under investigation. Although extensive research studies are in evaluation, practical application of these technologies has progressed slowly. Application of tissue engineering aims to replace or augment tissues that have been removed or that have become deficient through surgery or disease. These novel therapeutic treatments are accomplished by the interactions between biodegradable scaffolds, growth factors, and cells. Clinical usage of these treatments may involve one or a combination of these modalities.

Orthopedic tissue scaffolds can be biological or synthetic. Some ideal scaffold characteristics are an osteoconductive surface, rapid incorporation to the host bone, minimal inflammatory response, allow for three dimension cellular growth, rapid resorbability with cellular replacement, or conversely maintain long term structural integrity with cellular incorporation, and provide excellent biocompatibility over time. These scaffolds can be implanted alone to allow for naïve cellular infiltration or combined with cells, growth factors or drugs for local delivery. Combination scaffolds may use more than one synthetic material or mix biological and synthetic materials. Biological graft materials can be obtained as autograft, allografts bulk or particulate, or processed allograft such as demineralized bone matrix. Synthetic graft materials are commonly ceramic based such as, calcium phosphates, calcium carbonates, or calcium sulfate. Various formulations of these materials are available, for example hydroxyapatite/tricalcium phosphate in different percent combinations i.e. 60HA/40TCP or 80HA/20TCP, can evoke a different remodeling response. Polymeric scaffolds, in particular polylactic acid based materials (PLA, PLGA) and polycarbonates can provide similar function but are not in clinical use as great as ceramics. Growth factors can be generated locally through cell transplants or by delivering the growth factor in a graft scaffold for local release. Our laboratory has studied TGFbeta and BMP showing dramatic enhancement of the amount of bone developing in a defect. These factors can result in up regulation of naïve osteoblastic or stem cells, recruit additional bone cells, or stimulate cell division. Successful cell transplants require a viable environment in order for the cells to survive, proliferate, and differentiate into bone. Osteoblasts or mesenchymal stem cells (MSC) transplants can be obtained as mixed with autograft, as bone marrow aspirate, or engineered in vitro or expanded from cellular aspirates ex vivo to use as isolated graft material or seeded into synthetic graft material.

The same principles can be applied to tissue engineered cartilage transplantation. Cartilage graft material can be obtained as local or distant autograft, allograft or expansion of naïve cartilage by tissue engineering technology. These are in active clinical useage in human orthopedics but minimally in veterinary orthopedics. Site selection and preparation is critical to graft survivability. Other musculoskeletal engineered tissues, tendons and ligaments, are under active research but not as clinically applicable.

Management of fracture fixation failure

T.M. Turner

Critical evaluation of cases is important in determining the success or failure of a fixation treatment. Fixation failures are in reality most commonly due to errors in technique, which inevitably lead to loss of bone purchase by the device and subsequently implant stability. We can categorize technical errors as failure to apply the principles of internal fixation, failure of the implant, failure of the bone, or failure of the patient. Whether screw, plate, pin, wire, or external fixator is used, the correct principles for application of any of the devices must be adhered to for a successful fixation. Failure of screw fixation may be due to: infection, improper preparation of the screw hole, incorrect size, incorrect insertion angle, loss of initial purchase, or the fragments not anatomically aligned at screw insertion. Options that may be utilized if there is a failure to obtain purchase with the screw are: (1) to redirect the screw insertion angle, (2) use a larger screw size, (3) use a different bone site to achieve similar fixation in bone, or (4) application of bone cement into the hole. Plate application errors are due to inappropriate selection of the proper plate function, incorrect anatomic bone site, failure to span a sufficient length of bone, and failure to securely fix the plate to proximal and distal bone ends. Failure to obtain proper plate contour to the bone surface will result in malalignment, impaired joint and limb function and possible impaired bone healing. Delayed unions are due to poor vascularity, poor fracture fragment stability, deficient bone stock or progressive instability. Most metal implant failure is due principally to poor application, incorrect size selection of the implant, damage to the implant during the process of application, or a manufacturing defect. A decreased bone healing response places greater demands on the implant thus if the fracture does not heal the implant may eventually fail. Improving the bone osteogenic response with graft can eliminate this potential. Failure can result due to qualitative and quantitative issues of the bone. Underlying conditions or disease states locally or systemically can result in decreased bone mineralization leading to poor purchase of the implant. Local issues that can affect bone quality are infection, trauma, and disuse osteoporosis. Systemically, metabolic conditions can lead to loss of bone mineral. Additional fixation methods or technology or bone graft may be required to supplement these deficient states. Failure of the bone can result from undetected fissures and fragmentation, which can lead to poor implant purchase. Failure of fixation may also be related to the patient. In general, these are due to overuse of the limb prior to healing of the fracture. Instructions to the owner should specifically detail the amount of space and activity level that the pet is permitted. These actions will help to diminish this potential cause for failure. Overall, the majority of failures of osteosynthesis are preventable with attention to technical details, methodology of implant fixation, appropriate surgical decisions and the application of bone graft.

Tarsal luxations in cats

R. Vannini

Injuries of the tarsal joint are common in cats. A complete luxation of the talocrural joint is a severe form of tarsal injury that is occasionally seen. The talocrural joint is a tight hinge joint, stabilized primarily by strong ligaments.

There are two important groups of ligaments in the feline ankle: *The inferior tibiofibular ligaments* fasten the fibula to the tibia and guarantee a very tight but elastic connection between these bones. The broad and strong cranial tibiofibular ligament runs a short distance transversely from the cranial edge of the lateral malleolus to the adjacent lateral surface of the tibia. The weaker caudal tibiofibular ligament joins the lateral malleolus to the posterior tibia. The intraosseous membrane joins the fibula to the tibia proximal to the syndesmosis. *The collateral ligaments* prevent any tilting movement of the talus in the talocrural joint. The medial collateral ligament (MCL) has two main parts: a short and strong tibiotalar and a tibio calcaneal ligament. Both insert on the distomedial aspect of the medial malleolus. The lateral collateral ligament (LCL) consists of two parts as well: a short fibulotalar and a fibulo calcaneal ligament. Several of the stabilizing structures of the ankle need to be injured for a complete luxation of the talocrural joint to occur. Injuries seen in the cat are: rupture or loss of the collateral ligaments, fractures or abrasions of the medial and/or lateral malleolus, fracture of the distal fibula, rupture of the tibiofibular ligaments, fractures of the caudal aspects of the distal tibial margin, tear of the joint capsule, fractures of the talus and damage to the articular cartilage. Usually specific combinations of these injuries are seen. This allows for a classification of tarsal luxation in cats. There are three patterns of injury according to the level of the fibular fracture:

Type A: Infrasyndesmotric luxation: there is a transverse avulsion fracture of the lateral malleolus at or below the level of the ankle joint or a rupture of the LCL. The medial malleolus is avulsed or the MCL ruptured. The tibiofibular ligamentous (TFL) complex is intact. This type is very rare in cats.

Type B: Transsyndesmotric luxation: there is a fracture of the distal fibula just above the ankle joint or passing upwards from the ankle joint. The LCL is intact. The medial malleolus is avulsed or the MCL complex ruptured. The interosseous membrane is intact, the tibiofibular ligament complex is partially disrupted. This type is rare in cats.

Type C: Suprasyndesmotric luxation: there is a shaft fracture of the fibula anywhere between the syndesmosis and the head of the fibula. The medial malleolus is avulsed or the MCL complex ruptured. The tibiofibular ligamentous complex is always disrupted, but the LCL is intact. This is the most common type of luxation seen in cats.

Successful management of talocrural luxation remains a surgical challenge and is dependent of the correct assessment of all injuries. Closed reposition and external coaptation has not been successful. A disrupted joint is highly unstable and difficult to maintain reduced in a closed fashion.

Anatomic reconstruction and stable repair of the tibial part of the talocrural joint is necessary for perfect congruity with the talus and for early weight bearing with successful return to normal activity. Surgical techniques described for the dog are not necessarily useful or applicable for the cat. Due to their size and site of insertion, torn ligaments are difficult to repair anatomically. They are therefore replaced by a non-absorbable suture or wire. The MCL is best replaced with a suture in a figure-8 configuration anchored through small bone tunnels in the medial malleolus and in the medial process of the central tarsal bone. The fractured medial malleolus is often big enough to be reattached by a tension band wire. A wire suture can be used, if the fragment is too small.

If the fibula is fractured above the syndesmosis, it should be reattached to the tibia by a mini lag screw, two divergent pins or a tension band wire. The fibular fracture must be correctly aligned to assure proper position of the malleolus in regard to the joint surface.

The torn joint capsule is sutured. Even so it does not contribute significantly to joint stability, suturing might stimulate fibrosis and stabilization of the joint.

Arthrodesis is indicated if the disruption is associated with severe cartilage loss, complex fractures of the talus or complete loss of the malleolus due to a shearing injury as well in open joint injuries, where infection is likely. Even so the talocrural joint is the high motion joint of the hock, significant motion occurs also at the level of the calcaneal joints. This is primarily due to the Achilles tendon apparatus pulling on the calcaneus. Therefore, if the talocrural joint is damaged, a panarthrodesis with a dorsal plate and screws stabilizing the calcaneus is recommended. Depending the size and weight of the cat a mini-DCP or a cuttable plate can be used.

Closed reduction and external skeletal fixation remains an option if financial restraints of the owner do not allow for better repairs. A rigid ESF may be difficult to apply due to the size of the feline metatarsal bones. Constructing the ESF as a "walking ESF" is a viable solution to circumvent the need to insert strong fixation pins in the small metatarsal bones. The connecting bars of a type II ESF are left long enough to extend beyond the foot. This way the animal walks on the bars instead of the foot.

Postoperatively an external coaptation is recommended to protect all repairs. Splints or soft casts are most commonly used. A "walking ESF" is particularly useful in open shearing injuries, which require daily wound care.

The most common complications seen are instability and low grade infection. Even minimal displacements of the joint fragments will result in incongruity between the talus and the ankle mortice, resulting in secondary traumatic arthritis. Talocrural luxation is a serious injury often leading to DJD, chronic pain and lameness. Prognosis is depending the type of injury, whether the joint is closed or open contaminated and the presence of concomitant injuries such as fractures of the talus or posterior edge of the tibia. The length of post op immobilization has been proposed as an other factor influencing outcome. Early physiotherapy and mobilization appeared to benefit the outcome.

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Radiography and CT of the navicular structures; what can we believe?

F. Verschooten, T. De Clercq, M. Pannekoek

A complete radiographic examination for ND-syndrome includes two dorso-palmar views with the sole of the foot angled on a block at 55° and 65° to the horizontal respectively and one LM or ML view. Two DP views with a different angulation of the foot make it easy to differentiate between affections of the navicular bone (NB) itself and artefacts created mostly by the frog. In a comparison of the palmaroproximal-palmarodistal view of isolated NB to other projections, the contribution of this view to the diagnosis of ND was found to be minimal.

Analysis of the radiographs of a large number of horses with navicular disease and normal horses has led to a proposed classification of important, less important and 'pseudopathological' radiological signs for the diagnosis of navicular disease.

In the lateromedial projection these are:

Important radiographic signs

- osteosclerosis of the medullary cavity
- localised osteoporotic area in the subchondral bone plate and/or in spongiosa
- enlarged silhouette of the NB in either proximodistal or/and dorsopalmar direction
- irregular new bone formation at the margo liber
- uneven thickness of the flexor cortex or thickened cortex
- indistinct anatomical outline of the distal border with or without osteochondral fragments
- calcifications in the soft tissues close to the NB (mostly the result of local corticosteroid injections)

Less important signs

- osteoporosis of the subchondral bone plate (normal thickness)
- thinning of the subchondral bone plate, but normal bone density
- disappearance of the sharp demarcation between the subchondral bone plate and spongiosa
- a sharply delineated new bone formation at the proximal border of the navicular bone

Pseudopathological findings

- a well defined erosion at the sagittal ridge of the NB (synovial fossa)
- well-defined small spur at the proximal border of the facies articularis of the NB

Radiographic signs in the dorsopalmar view are:

Important radiographic signs

- a localized radiolucent area or "cyst" wherever localized in the navicular bone
- extensive new bone formation changing the shape of the navicular bone resulting in an enlarged silhouette
- bone fragments at the distal border, possibly bilateral, especially important when larger than 7mm x 3mm in size and when surrounded by demineralisation in the navicular bone
- irregular trabecular structure (difficult to appreciate)

Less important signs

- canales sesamoidales/synovial fossae at the distal border of the navicular bone ending in well delineated cysts (3-5mm)
- irregular but sharply delineated new bone formation at the proximal border of the NB
- spurring at the lateral or medial side of the NB
- asymmetric shape of the NB

Pseudopathological findings

- canales sesamoidales/synovial fossae in a wide variety of shape and length at the distal border of the NB

The clinical significance of osteochondral fragments at the distal border of the navicular bone (OFNB) is still a matter of debate. In a recent study 9888 radiographs of front feet of 1648 horses were analysed. In 12.4% of all horses OFNB were found: 25% of these horses were sound, 6% were irregular and 69% were lame. In foot lameness osteochondral fragments were found in 17% of the horses. In horses with clinical and radiographic signs of navicular disease, OFNB's were present in 45.5% of the horses.

In our opinion CT does not reveal important findings in navicular disease when compared to radiography.

Diagnosis and management of bacterial osteitis and sequestration in large animals

F. Verschooten

Bacterial osteitis refers to an infection of bone. Post traumatic bone sequestration often occurs in horses, especially at the level of the metatarsal bones (40% of all cases). During the last 20 years bone sequestration was observed in 135 horses. Extensive wounds and subsequent contamination are responsible for infection of the superficial layer of the compact bone. Sequestration is not induced by direct aseptic traumatic insults or surgical interruption of the periosteal vasculature. Experimental surgery has indicated the paramount importance of infection in post traumatic sequestration. Within 2 weeks after trauma and often even earlier on, infection of bone turns out into sequestration of small or large thin chips of bone (in more than 50% of all cases).

Radiography is quite effective in deciding whether resorption of the sequestrum is going on or not.

Hematogenic infection of bone and sequestration is less common and occurs most often in the growing animal. In the literature, surgery is advocated to treat these conditions. However, it is found that sequestrers are often spontaneously resorbed if simply treated by systemic antibiotics and local wound management. Large sequestrers may disappear completely within 3 to 6 weeks. Not only was spontaneous resorption observed at the level of the metatarsal bone, but in other areas of the body as well (the mandibula, the tibia, the distal phalanx, the radius). Therefore bone sequestration should not be considered as emergency surgery but treated conservatively at first. Conservative treatment means administration of antibiotics and oral corticosteroids making "osteoclastic surgery" possible. A large number of sequestrers were successfully treated in this way.

Bacterial osteitis is rare in cattle contrary to hematogenous or post traumatic osteomyelitis. Bone sequestrers of the compacta are much larger in cattle than in horses, mostly the entire thickness of the cortex being involved. In the bovine, spontaneous resorption of sequestrers is unusual and surgery is mostly the treatment of choice.

A generalised infection of an entire long bone is extremely rare in cattle and in horses.

Non-traumatic Cranial Cruciate Ligament injures

A. Vezzoni, M. Demaria, A. Corbari, A. Cirila

INTRODUCTION

Injures of the Cranial Cruciate Ligament (CrCL) of the stifle are a common clinical finding in dogs of any breed, age and weight. CrCL injures are consisting of partial tears and of complete rupture. Partial tears are associated to short term and self limiting acute lameness, evolving in chronic grade 1 lameness, usually underestimated and leading to complete rupture after a variable time. The cranial tibial thrust associated to the tibial slope and the weight bearing forces has been demonstrated to be responsible of the continuous stress on the damaged ligament leading to its complete rupture.

CrCL complete rupture is clinically associated to acute grade 3 lameness and can be a consequence of a chronic tear or it can be associated to a recent acute trauma, usually consisting of stifle hyperextension and internal rotation, the same condition leading to traumatic partial tears when of less amount.

When CrCL complete rupture is a evolution of partial tears the radiographic findings at time of diagnosis are consisting of chronic signs including osteophytes on the femoral troclear ridges, on the distal poles of patella and on the tibial plateau, periarticular soft tissue swelling and infrapatellar increased density. When complete rupture is a consequence of acute trauma the immediate radiographic examination of the affected knee shows only periarticular soft tissue swelling and increased density of the infrapatellar triangle without any osteophyte. Clinical observation that several dogs have CrCL partial tears in both knees at the same time, even if with different degrees of severity, and that several dogs presented for acute CrCL complete rupture have partial tears in the opposite knee indicates that CrCL injures are not always associated to a trauma and that in predisposed dogs they can be a consequence of a biomechanical imbalance of the forces acting on the knee joint causing a continuous stress on the CrCL. Traumatic and non-traumatic CrCL injures can be differentiated by investigating the opposite knee too with physical and radiographic examination every time a diagnosis of CrCL lesion is performed. Traumatic injures should show the opposite knee as normal, while the non-traumatic ones should show signs of chronic inflammation and degenerative joint signs.

MATERIALS AND METHODS

A prospective study of 251 consecutive dogs treated for CrCL failure was performed. Data collection included all relevant findings regarding patient signalment, history, radiographic aspects of both knee joint at the time of diagnosis and the surgical findings. Radiographic data included a thorough evaluation of the knee joint for acute and chronic inflammation signs, using low dose exposure to visualize periarticular soft tissues too, and a stressed position to evidence and measure the tibial compression test. The tibial slope was measured according to the indications described by Slocum. Pictures of dogs in standing position were taken, with adhesive marks on throcanter, lateral femoral condyle and lateral tibial malleolus to calculate the knee angle at rest in standing position. Dogs with both knee joints simultaneously affected, even with different degrees of severity, were listed as affected by non-traumatic CrCL injures, unless a sure history of trauma was reported. Dogs with the opposite knee joint normal at the time of diagnosis were listed as affected by traumatic CrCL injures. A correlation was study between traumatic and non-traumatic CrCL injures according to breed, sex, age, weight, tibial slope and knee angle. According to the surgical findings and to the amount of tibial compression test the partial tears or complete rupture were recorded.

RESULTS

Of the 251 examined dogs with CrCL failure, 178 (70.9%) were considered as non-traumatic and 73 (29.1%) as traumatic.

Of the 178 dogs with non-traumatic CrCL failure, 95 (53.4%) were male and 83 (46.6%) were female, in 20 dogs (11.2%) the surgical finding was a partial tear and in 158 (88.8%) a complete rupture, the median body weight was 45.3 kg (range from 11 kg to 103 kg), the median age was 3.2 years (range from 8 months to 10.5 years), the median tibial slope was 22° (range from 18° to 30°), the median knee angle in standing position was 138° (range from 130° to 150°). Of the 73 dogs with traumatic CrCL failure, 44 (60.3%) were male and 29 (39.7%) were female, in 12 dogs (16.4%) the surgical finding was a partial tear and in 61 dogs (83.6%) a complete rupture, the median body weight was 33.2 kg (range from 4.5 to 70), the median age was 5 years (range from 1 to 11 years), the median tibial slope was 22.5° (range from 16° to 28°), the median knee angle in standing position was 128° (range from 116° to 136°). Concerning breed distribution in the two groups,



Example of affected opposite knee



Example of normal opposite knee joint with signs of inflammation

in the non-traumatic CrCL injures group with 178 dogs, breeds represented with 10 or more dogs were: Rottweiler (27 dogs, 15.2%), Boxer (19 dogs, 10.7%), Newfoundland (16 dogs, 8.9%), Dogue de Bordeaux (15 dogs, 8.4%), Great Dane (15 dogs, 8.4%), English Bulldog (13 dogs, 7.3%), Corso (12 dogs, 6.7%), Dobermann (10 dogs, 5.6%), representing totally 130 dogs, 73% of this group. In the traumatic CrCL injures group with 73 dogs, most breeds were represented without a significant individual incidence (range from 1.7% to 5.5%), with the exception of the following breeds with 5 or more dogs: Rottweilers (15 dogs, 20.1%), Labrador (10 dogs, 13.7%), German Shepherd (7 dogs, 9.6%) and hunting breeds including Pointer, English Setter, Drahathar, (10 dogs, 13.7%).

The incidence of traumatic and non-traumatic CrCL injures in each breed, with a minimum of 10 dogs evaluated, is shown in the following table:

Breed	Dogs No.	Non-traumatic CrCL injures (dogs No. and %)	Traumatic CrCL injures (dogs No. and %)
Boxer	20	19 - 95.0%	1 - 5.0%
Dobermann	13	10 - 76.9%	3 - 23.1%
Corso	14	12 - 85.7%	2 - 14.3%
Dogue de Bord.	15	15 - 100%	0
English Bulldog	13	13 - 100%	0
German Sheph.	16	9 - 56.2%	7 - 43.8%
Great Dane	16	15 - 93.7%	1 - 6.3%
Labrador	14	4 - 28.6%	10 - 71.4%
Newfoundland	21	16 - 76.2%	5 - 23.8%
Rottweiler	42	27 - 64.3%	15 - 35.7%
Hunting breeds	10	0	10 - 100%

The median of tibial slope in each breeds, with a minimum of 10 dogs evaluated, is shown in the following table, dividing all dogs in two groups, "traumatic" and "non-traumatic" CrCL injures:

Breed	Tibial slope (median value and range values)					
	Non-traumatic CrCL injures			Traumatic CrCL injures		
	No. dogs	median	range	No. dogs	median	range
Boxer	19	21°	19°- 30°	1	21°	-
Dobermann	13	22°	18°- 27°	3	22°	20°- 22°
Corso	12	23°	18°- 27°	2	19°	16°- 21°
Dogue de Bord.	15	25°	19°-29°	0	-	-
English Bulldog	13	25°	20°- 28°	0	-	-
German Sheph.	9	19°	16°- 22°	7	22°	18°- 28°
Great Dane	15	22°	17°- 28°	1	18°	-
Labrador	4	20°	18°- 26°	10	22°	18°- 25°
Newfoundland	16	20°	16°- 30°	5	21°	18°- 25°
Rottweiler	27	21°	16°- 27°	15	22°	18°- 27°
Hunting breeds	0	-	-	10	22°	18°- 26°

The median of knee angle in standing position in each breeds with a minimum of 10 dogs evaluated is shown in the following table, dividing all dogs in two groups, "traumatic" and "non-traumatic" CrCL injures:

Breed	Knee angle in standing position (median value and range values)					
	Non-traumatic CrCL injures			Traumatic CrCL injures		
	No. dogs	median	range	No. dogs	median	range
Boxer	19	138°	134°- 145°	1	128°	-
Dobermann	10	138°	136°- 142°	3	136°	132°- 138°
Corso	12	148°	138°- 154°	2	134°	132°- 136°
Dogue de Bord.	15	150°	147°-154°	0	-	-
English Bulldog	13	150°	134°- 155°	0	-	-
German Sheph.	9	130°	124°- 135°	7	120°	110°- 128°
Great Dane	15	146°	142°- 152°	1	132°	-
Labrador	4	132°	130°- 140°	10	122°	115°- 130°
Newfoundland	16	138°	132°- 142°	5	132°	128°- 132°
Rottweiler	27	140°	135°- 142°	15	130°	126°- 136°
Hunting breeds	0	-	-	10	118°	108°- 126°

DISCUSSION

This study show the evidence that in many dogs of several breeds CrCL injures have a non-traumatic cause, being developed slowly and simultaneously in both knees, even with different degrees of severity. The median age of non-traumatic CrCL injures is lower than in the traumatic group, indicating a breed and individual predisposition to early CrCL injury. Several breeds, like Boxer, English Bulldog, Dogue de Bordeaux, Newfoundland, Great Dane, Dobermann, Corso and Rottweiler show a higher incidence of non-traumatic CrCL injures compared to other breeds; in these most affected breeds the tibial slope is not indicating an anatomical predisposition as their values are in the average of the dogs most affected by traumatic CrCL injures and not by non-traumatic CrCL injures. What appear to be a predisposing factor in the breeds with higher incidence of non-traumatic CrCL injures is the angle of the knee joint in standing position, being wider that in the other breeds, leading to a more straight rear leg. The open angle of the knee enhances the inclined plane effect of the tibial slope and diminishes the opposing pull strength on the tibia



Fig. 1 – Great Dane, M, 3 yrs., 144° knee angle; German Shepherd, F, 4 yrs, 125° knee angle

by the hamstring muscles, leading to a continuous cranial tibial thrust and stress on the CrCL. The consequence of a wider knee angle with a more straight leg is therefore a biomechanical imbalance that could lead to a spontaneous CrCL injures, particularly when associated to high physical activity or to high body weight. In contrary, in breeds without a significant incidence of non-traumatic CrCL injures, the knee angle is closer, with a more angled rear leg, diminishing the effect of the inclined tibial plane which is almost parallel to the ground and enhancing the pull effect of the hamstring muscles, with a perfectly balance biomechanics.

Moreover, the incidence of non-traumatic CrCL injures in breeds that usually have a normal knee angle, like German Shepherds and Labradors, was associated to increased age and body weight of the affected dogs at time of diagnosis; due to the increased weight these dogs showed a wider knee angle and more straight leg compared to the average knee angle of the breed, possibly because keeping a closer knee angle with an increased body weight would cause an excessive muscular tiring. Keeping the knee in a more straight position relieves the muscular effort and the dog is more comfortable, loading his body weigh through a bone to bone more vertical contact, but doing so the cranial tibial thrust is enhanced, favoured by the increased body weight too. Their rear legs assume the position of human legs in standing, wolking and running, with a vertical loading through bones, but in man the tibial slope, which is about 5° to 7°, has no significant cranial tibial thrust, differently to the forces created by the inclined plane of the canine tibial slope. Increased body weight, particularly without a good muscular strength and exercise, is therefore a predisposing factor for non-traumatic CrCL injures in dogs of all breeds. Other factors could play a role predisposing to CrCL injures in some breeds, like the bowlegged conformation which causes stress on the CrCL; nevertheless this conformation does not appear to be determinant for non-traumatic CrCL injures as it is observed in Rottweilers and Labradors both with traumatic and non-traumatic CrCL injures. In these breeds, as in other large breeds, the occurrence of traumatic CrCL injures is associated to very active dog with good muscular mass, enhanced by their bowlegged conformation, while the occurrence of non-traumatic CrCL injures is associated to overweight and inactive dogs with poor muscular mass; this indicates that the muscular tone and strength are essential to balance the high forces acting in their knee, particularly when their conformation leads to straight rear legs.

More extensive studies should be conducted to investigate the biomechanics alterations in the knee joint due to the different morphology in canine breeds and a thorough morphological analysis in breeds predisposed to high incidence of non-traumatic CrCL injures should be performed to evaluate the opportunity to influence the breed standards favouring a more physiological angulation of the rear legs in these breeds. According to Riser's studies, any breed selection going away from the ancestral dog is causing orthopaedic problems, because the anatomy of the dog can not match to the so wider variation we see in canine breeds without resulting in biomechanical and physiological imbalance.

Beacuse CrCL injures of non-traumatic origin have their ethiology in a biomechanical imbalance of the knee joint with enhancement of the cranial tibial thrust, and because the predisposing biomechanical alterations can not be modified, the best treatment in the affected dogs is the alteration of the knee biomechanics by neutralizing the cranial tibial thrust with the tibial plateau levelling osteotomy (TPLO) as proposed by Slocum.

CONCLUSIONS

In this study the evidence that several dogs exhibit CrCL injures without a traumatic cause was demon-

strated, locating predisposing factors in the wider knee angle and straight rear leg conformation of several breeds and in the overweight of every breed. It appears that knee angle and overweight are more important than the anatomical tibial slope itself in causing an excessive cranial tibial thrust in dogs with non-traumatic CrCL injuries. Further studies with kinematic gait analysis on dogs of different breeds are in process to precisely define the knee inclination during walking and weight bearing.

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Pubic symphysiodesis- clinical experiences

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INTRODUCTION

Pubic symphysiodesis (PS) has been described as a technique intended to modify the slope of the acetabular roofs in a more ventral direction during skeletal growth in puppies with signs indicating a predisposition to develop hip dysplasia (HD). Limiting the circumferential growth of the pelvic canal by arresting the pubic symphysis results in bilateral acetabular rotation, improving coxofemoral coverage by the acetabular roofs. This technique, developed in guinea pigs by Mathews and colleagues, has been applied in dogs by Swainson and Dueland and co-workers, describing the use of electrocautery to damage permanently the growth cartilage of pubic symphysis. Pubic symphysiodesis causes also a benign decrease in pelvic inlet area, which is a contraindication for breeding in female dogs, as it is the ethical aspect of limiting or avoiding the manifestation of an inherited disease, both in male and female dogs. Pubic symphysiodesis is performed at an early age, with the most effective results if done at 12 to 18 weeks according to Swainson and Dueland. Indications for pubic symphysiodesis are the presence of Ortolani sign, joint laxity and increased dorsal acetabular rim (DAR) slope in very young puppies, predicting signs of HD development. Finding a positive Ortolani sign in a very young puppy with radiographic evidence of joint incongruity is always indicative of some future development of HD. To assess the clinical efficacy of the procedure and to identify the physical and radiographic findings and the age limits for proper indications and contraindications of PS a prospective study was conducted.

MATERIAL AND METHODS

A prospective study was conducted from January 2001 to December 2001 to examine house hold puppies for early diagnosis of HD at the age from 12 to 24 weeks with the purpose to select candidates for PS, to perform the surgical procedure on a group of them, to treat conservatively an other group as a control group, and to follow up the treated and untreated cases after 2 and 6 months, with the possibility to perform additional surgeries (TPO, DARTHROPLASTY, THR) as indicated after each follow-up. Each puppy was sedated with acepromazine 0.01 mg/kg and atropine 0.003 mg/kg I.M., followed by fentanyl 0.005 mg/kg I.V.; puppies were held in dorsal recumbency with the thorax in a V shaped device, tested for Ortolani signs and the angles of reduction (AR) and of subluxation (AS) were measured with the Canine Electronic Goniometer (Slocum.); a standard ventrodorsal radiographic view, a distraction view and a DAR view were taken, and the radiographic aspects recorded, including: position of the center of the femoral head relative to the DAR, medial in normal hips, the shape of the cranial acetabular rim in the VD view, rounded in normal hips, the distraction index (DI), the slope and the shape of the dorsal rim in the DAR view, keeping as a reference 0° to 7.5° as normal range. Puppies with advanced signs of HD, evidenced by severe femoral head subluxation, deformation and coxa plana were not included in the study. Puppies with signs of femoral head subluxation (center of femoral head lateral or superimposed to dorsal acetabular rim) and positive Ortolani sign were included in the study and treated surgically or conservatively according to owner compliance. Surgical procedure was carried under a routine general inhalant anaesthesia with isoflurane after induction with propofol (6 mg/kg I.V.) and premedication with acepromazine (0.01 mg/kg I.M.) and perioperative antibiotic profilaxis with cefazolin (20 mg/kg IV); the surgical procedure consisted in distal abdominal skin antiseptic preparation, 3 to 4 cm skin incision over the pubic symphysis, subcutaneous sharp and blunt dissection to visualize the insertion of the prepubic tendon on the pubic symphysis; after a short incision of the tendon a wooden spatula was inserted underneath the symphysis to protect intra-abdominal structures, mainly urethra and rectum, from the electrocautery needle. Electrocautery of the cartilaginous pubic symphysis, for a distance of 12 mm to 20 mm from the cranial border, was performed, inserting the needle in its full thickness in several points, 2 mm apart, until the tip of the needle was touching the wooden spatula, for 5 to 8 seconds each time. After each cauterization a saline wash was performed to cool the surrounding tissues. The severed part of the prepubic tendon was sutured to the periosteum of the pubic bone with absorbable synthetic suture and routine subcutaneous and cutaneous suture completed the procedure, being completed in 20 to 30 minutes. Puppies were returned to home the same day. Skin suture was removed a week after and house or box confinement was recommended for 2 months, allowing the dog to walk outside only at a leash, avoiding plays and strenuous activities. For puppies treated conservatively the same recommendations were given. At follow-up at 2 and 6 months each puppy was sedated with acepromazine 0.01 mg/kg and atropine 0.003 mg/kg I.M., followed by fentanyl 0.005 mg/kg I.V. and checked for

Ortolani sign in ventrodorsal recumbency and when positive AR and AS were measured; a standard ventrodorsal radiographs of the hips, to check the position of the femoral heads, and a DAR view, to measure the DAR slope, were taken.

RESULTS

65 puppies were included in the study, the PS surgical procedure was performed in 34 of them and 31 puppies were treated conservatively. The study was completed only in the 54 puppies that returned for follow-up, 28 treated surgically and 26 conservatively. In the 28 surgically treated puppies, median age was 18 weeks (range 12 to 24 weeks), 16 males and 12 females, of the following breeds: 8 Corso, 8 Labrador, 5 German Shepherd, 4 Golden, 1 Rottweiler, 1 Newfoundland and 1 Lagotto. No complication was observed related to surgical procedure, and the behaviour of the treated puppies was reported by owners to be normal since the day after surgery. At follow-up at 2 and 6 months post operatively all puppies could be divided in three groups according to great improvement, some improvement and worsening. In the first group 8 puppies (28.6%) had a great improvement showing negative Ortolani sign, congruent joint with the center of femoral heads medial to dorsal acetabular rim ed improved DAR slope (4° - 5°); in the second group 11 puppies (39.3%) had some improvement, showing Ortolani sign with smaller values of AR and AS, some incongruity, and better DAR slope (4° - 5°); in the third group 9 puppies (32.1) clearly worsened showing increased Ortolani sign, greater femoral head subluxation and rounded lateral margin of DAR. Of the worsened group, 3 puppies were treated with bilateral triple pelvic osteotomy (TPO) after the first follow-up at 2 months after PS and 1 puppy with bilateral Darthroplasty and 2 puppies with bilateral total hip replacement (THR) after the second follow-up at 6 months after PS. All puppies in the worsened group had preoperative AS $> 15^{\circ}$, DI between 0.6 and 1.0 and DAR slope $> 12^{\circ}$, exempt 2 puppies with AS of 5° , DI 0.5 and DAR slope of 8° that did not observe a proper post-operative care, being allowed to run, jump and play. All puppies in the very improved group had preoperative subluxation angles of 5° or less, DI from 0.4 to 0.6 and DAR slope from 5° to 10° . Puppies in the moderately improved group had intermediate values between the other two groups or similar to the first group; in the latter case the post-operative care by the owner was always reported poor with no or little control over the dog. Concerning age correlation to clinical results, in the three groups the age distribution was similar. In the 26 conservatively treated puppies, median age was 16 weeks (range 12 to 24 weeks), 14 males and 12 females, of the following breeds: 6 Corso, 6 Labrador, 6 German Shepherd, 4 Golden, 2 Rottweiler, 2 Newfoundland. At follow-up at 2 and 6 months all puppies could be divided in two groups only, the moderately worsened one and the severely worsened one, and no puppy improved or remained stationary. In the moderately worsened group 14 puppies (53.8%) showed some increase of the Ortolani sign, mainly of the AS, of the femoral head subluxation with the center always lateral to DAR and of the DAR slope, and showing mild to moderate signs of degenerative joint disease (DJD). In the severely worsened group 12 puppies (46.2%) showed high increase of the Ortolani sign, both AR and AS, of the femoral head subluxation with less than one third head coverage by DAR and of the DAR slope with destruction of its lateral border, and showing severe signs of DJD. In the latter group 5 puppies were treated with bilateral TPO after the first follow-up at 2 months, 3 puppies with bilateral Darthroplasty and 1 puppy with bilateral THR after the second follow-up 6 months later.

DISCUSSION

The selection of puppies included in this study was representing a clinical field condition, with different breeds, different ages, different hip alterations and different owners and housing condition. In puppies with mild to moderate early predictive signs of HD PS was shown to be a effective surgical procedure to halt or reduce its development by improving at different extents the joint congruity and femoral head coverage by the acetabulum; in puppies with severe early predictive signs of HD PS was shown to be completely ineffective in halting the evolution of HD. While early age (12 to 16 weeks) was recommended to have positive results, this study demonstrated that early age is not the determinant factor in predicting the success of the procedure, as it was successful even in puppies 24 weeks old and not successful in puppies 16 weeks old. The age should be early enough to leave a residual growing time to allow the new pelvis orientation. Age is also breed dependant, because in giant breed the residual growing time is longer. The rationale to perform PS at early age (12 to 16 weeks) is because more time of skeletal growing will be available to accomplish the desired correction. Also, at early age puppies that later on would become out of indication for PS, could be still in the range of indications and treated successfully.

Our results showed that severe hip alterations at 12 to 16 weeks were not corrected even by early PS, possibly because the slow process or pelvis orientation was not able to halt the already started subluxation process of the femoral head and the destruction of the lateral border of DAR in the first months following PS in house hold puppies. Different results could be achieved in puppies kept in a cage for 2 months after

PS, but this was not feasible in clinical conditions. The amount of joint laxity, mainly the AS value, and of DAR slope were the key factors in influencing the results of PS in this study, associated to proper post-operative care. The AS is directly correlated to DAR slope and when they are increased the femoral head is pushed dorso-laterally by weight bearing forces acting on the inclined plane of DAR slope. DI was not as useful as AS and DAR values in predicting PS results, possibly because DI is measuring passive joint laxity only, without any correlation to the forces acting into the joint. Same consideration for AR, which is correlated only to the amount of joint laxity; nevertheless AR values over 40° and DI over 0.6 were frequently associated to poor results. The procedure was at different extent effective only when the Ortolani sign was showing AS up to 15° and DAR slope up to 12°, while it was always ineffective when upper values were found. Therefore PS was effective only when moderate hip joint alterations were found, leading to great joint improvement or moderate joint improvement, while it was ineffective when severe hip alterations were found. We considered great joint improvement when the Ortolani sign became negative, the hip joints conformation became normal, with the center of femoral heads medial to dorsal acetabular rim and rounded cranial acetabular border, and DAR slope became 5° or less. We considered a positive result too when the hip joints had some improvement of the preoperative values, because in the control group we always observed a moderate to severe worsening in all puppies. Limiting the indication for PS in puppies with mild to moderate predictive signs of HD only could make the procedure itself questionable, because most dogs could tolerate a mild to moderate HD; nevertheless dogs with normal or near normal hips could have a more active life, fulfilling owner expectations and very active puppies with moderate early HD signs could develop severe HD too, possibly requiring more invasive surgeries later on. In puppies with more severe predictive HD signs at early age (12 to 16 weeks), PS cannot guarantee a positive result; when performed, a follow-up 2 months later should always be done to evaluate the indication for more complex surgeries like TPO, DARTHROPLASTY or THR in the case that PS was not effective in halting HD development. Selection of good candidates for PS requires early evaluation of puppies at 12 to 16 weeks of age, advising it to owners of large breed puppies at time of routine basic vaccination. Later on, when puppies are reaching 20 to 24 weeks of age, only mild cases could be treated, because at that time cases that were mild at 12 to 16 weeks could have worsened in such an extent to be out of indication for PS. In the conservatively treated group we observed that mild signs at 12 to 16 weeks of age became moderate to severe at 24 weeks, indicating a constant progression of the disease; for this reason mild signs at 12 to 16 weeks are always good indication for PS, while the same values at 24 weeks could not necessarily require it, because at that time the puppy is closer to skeletal maturity. The following prognostic table shows the results that could be expected after PS in puppies 12 to 16 weeks old, according to our study:

Table – Prognosis of PS according to pre-operative signs and radiographic data at 12 to 24 wks of age

	Ortolani	AR	AS	Center of fem. head	DI	DAR slope
excellent	positive	20° to 30°	0° to 5°	over DAR to 1 mm lateral	0.4 to 0.6	< 10°
good	positive	30° to 40°	5° to 15°	1.5-2 mm lateral	0.4 to 0.6	10° - 12°
poor	positive	> 40°	> 15°	3 mm or > lateral	> 0.6	> 12°

PS= pubic symphysiodesis; AR= angle of reduction; AS= angle of subluxation; DI= distraction index

Environmental conditions, like nutrition, housing and physical exercise play an important role to influence PS prognosis; overnutrition and excessive free exercise and playing could fasten HD development before PS would produce some effect. In this study we did not see any complication related to the surgical procedure itself; iatrogenic damage to intra-abdominal organs, mainly urethra and rectum, are a potential complication that the surgeon must always consider and avoid. In this study we always applied the same electrocautery setting and modalities, assuming that the procedure itself was correct even in the failed cases because the procedure was the same as the one used in the cases in which we had positive results; applying different electrocautery setting and modalities could lead to negative results that would be questionable to attribute to wrong case selection or to wrong technique.

PS is a surgical procedure that modifies the dog phenotype without leaving sure radiographic evidence that it was performed, on contrary of other techniques like TPO, DARTHROPLASTY and THR, and thus PS has a strong ethical implication. Successfully treated puppy, when adult, could be tested as negative in HD screening, presented in dog shows and sold for breeding. The ethical aspect was discussed deeply with puppy owners to get their understanding and compliance; several puppies (9) were neutered at the same time of PS,

physical contraindication for pregnancy in female dogs was evidenced due to narrowing of the pelvic canal, and genetic contraindication for mating in male and female dogs was underlined. We believe that the dog life-long welfare provided by successful PS would justify this procedure, provided that ethical aspects are well understood.

CONCLUSION

PS is an effective procedure to halt or reduce developing HD in puppies presenting early signs of the disease, like positive Ortolani sign, femoral head subluxation and increased DAR slope. To be effective the procedure should be limited to puppies with mild to moderate signs, detected through routine physical and radiographic examination in predisposed breeds at 12 to 16 weeks of age, and should be coupled with full owner compliance for the proper post-operative care and for ethical aspects of phenotype modification.

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A european perspective on insurance and safety aspects of treating Wobbler syndrome

J.P. Walmsley

Historically there has been some resistance to surgical treatment of wobbler syndrome in horses in the UK. On anecdotal grounds, some veterinary surgeons feel that treated horses may still be uncoordinated enough to be a danger to the public. To the author's knowledge there have never been any accident claims arising from injury to personnel caused by surgically treated wobblers either in Europe or North America and a claim has not been tested in a court of law. Experience suggests that if the horse is still uncoordinated after treatment it is obvious that it is unfit to use and therefore not a risk, but if it has recovered it is safe to ride. With more wobblers being treated successfully the antagonistic view is moderating.

When considering surgery the author carefully advises owners of the potential risk and emphasises their responsibility as owners to ensure that riders using the horse are aware of its history. As a rule we do not advise surgery for jumping horses but many horses have jumped successfully after treatment.

Insurance companies have, in the author's experience, been happy to cover the veterinary costs of surgery and will encourage treatment where appropriate. In some cases they have been saved considerable sums where a loss of use claim has been averted. Horses can be specifically insured for wobbler syndrome, and owners who have taken out this cover will frequently prefer humane destruction to surgery for the horses, especially with untried or poorly bred horses. Among insurers known to the author the safety aspects have not been an issue when offering cover on the grounds that a horse that is still uncoordinated will be unfit to use and therefore no greater risk than a lame horse.

Local delivery systems for the treatment of septic arthritis

J.P. Walmsley

Septic arthritis or synovitis is frequently encountered in equine hospital practice and is most commonly caused by foreign body penetration. The morbidity of this condition is high and the response to treatment unpredictable. The management depends on thorough debridement and lavage of the affected synovial space, and delivery of effective doses of appropriate antibiotics into the affected region. Systemic antibiotic treatment is essential for treating this condition but it is less effective at achieving the required dose in the synovial space than local delivery, and this should be considered when treating septic arthritis or synovitis. There are several methods for local delivery of antibiotic.

Antibiotic impregnated polymethylmethacrylate (PMMA) beads. The delivery of antibiotic in this way depends on the type, the porosity and the surface area of the beads, the vascularity of the tissue, the fluid flow, and the diffusion properties of the antibiotic¹. Gentamicin is the most popular antibiotic but tobramycin, amikacin and ciprofloxacin can be used, though the latter may damage chondrocytes². Ceftriaxone does not elute effectively from PMMA³. Elution of antibiotic is highest on the first day and then decreases. The concentration of antibiotic affects the longevity of the break point susceptibility concentration (BPSC) e.g. 1.2 g of gentamicin in 40 g PMMA can achieve BPSC for 4 days whereas 2 g of gentamicin can extend this to 28 days¹. Beads are available commercially or can be prepared at surgery. They can also be made up in the hospital and gas sterilized. The main disadvantages of the use of PMMA beads is their potential to damage a joint surface and the necessity for removal, which is often rendered more difficult by fibrous tissue reaction.

ANTIBIOTIC IMPREGNATED COLLAGEN

The use of impregnated biodegradable material overcomes the problems of removal and tissue irritation. Gentamicin impregnated collagen sponges are available commercially (Collatamp, Schering Plough) and contain 200 mg gentamicin and 280 mg collagen per 100cm². In the first 24 hours the concentration of gentamicin in a joint is 15x that produced from PMMA beads and still 2x on day 3. After 3 days the level of antibiotic in the joint falls below the BPSC. The collagen is broken down in 8-49 days depending on the tissue vascularity⁴.

CONTINUOUS INFUSION SYSTEMS FOR LAVAGE OR ANTIBIOSIS

More control of the dose and type of antibiotic is obtained using a continuous infusion system. This requires some form of ingress system such as a Jackson Pratt drain or an adapted extension set from an intravenous giving system. This should be tunneled into the synovial space and strict asepsis must be observed when handling the system to reduce the risk of introducing infection. Commercial infusion pumps are available and can be strapped to the horse's limb (Flowline™ Springfusor™, Pacific Medical Supplies Pty Ltd.).

REGIONAL INTRAVENOUS LIMB PERFUSION

This method has been shown to produce high levels of antibiotic both intrasynovially and in the periarticular tissues for up to 24 hours⁵. Local analgesia and sedation is necessary. A tourniquet is applied above the affected structure and an appropriate vein (e.g. palmar/plantar digital, cephalic, saphenous) is catheterized and infused with antibiotic diluted in saline: the tourniquet is removed after 1 hour. 1 g amikacin, 1 g timentin, 10 million iu potassium penicillin and 1 g gentamicin diluted in 20 ml of saline have been used⁶.

REGIONAL INTRAMEDULLARY LIMB PERFUSION

This method is reported to achieve very high levels of antibiotic in the perfused tissues⁷. It is a painful procedure so general anaesthesia is necessary. The limb proximal and distal to the affected site is wrapped with an Esmarch's bandage to exsanguinate the superficial venous system. The long bone just distal to the infection is drilled and an intramedullary bone screw implanted. Infusion of the solution requires considerable pressure. Sixty ml of solution containing 1 g of gentamicin can be used for infusion at a rate of 2ml/min into the proximal third metacarpus for treatment of a carpal infection. MIC antibiotic levels are maintained for approximately 24 hours. The necessity for general anaesthesia is a significant disadvantage.

DIRECT INTRA-ARTICULAR INJECTION

This technique is the simplest method of delivering antibiotics into the affected synovial space. MIC levels of gentamicin are exceeded in a carpal joint for 24 hours with a dose of 150 mg⁸. Empirical doses of 500 mg gentamicin, 250 mg amikacin, 500 mg cefazolin and 500 mg ceftiofur have been used. Arthrocentesis may be contra-indicated in the presence of periarticular infection and repeated arthrocentesis risks introducing infection, traumatising the joint and aggravating the horse.

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Is there a clinical role for bone graft substitutes in equine orthopaedics?

R.D. Welch

Bone grafting in the horse has received little attention within the veterinary literature. This is surprising considering the prolonged healing time typically required for most equine long bone fractures. Prolonged healing time contributes to fatigue failure of orthopaedic implants and the development of laminitis. Therefore, bone grafting may be indicated for most equine long bone fractures, particularly open comminuted fractures.

Harvesting autologous cancellous bone contributes to patient morbidity and surgical time, and has inherent risk including fracture, infection, and increased blood loss. Bone graft quality is never guaranteed and is dependent on the patient, the graft harvest site, graft handling, and time preceding graft placement. Because of these limitations, bone graft substitutes are becoming increasingly popular in human orthopaedics.

The ideal bone graft substitute should have certain inherent attributes including being biocompatible, bioresorbable, osteoconductive, osteoinductive, osteogenic, and easy to apply. Cost will be a primary factor in veterinary orthopaedics. Most of the currently approved human bone graft substitutes feature some of these ideal characteristics; however, none have proven effective in all clinical situations.

Bone graft substitutes typically fit into one of the following categories: ceramics, bone derivatives, composites, natural materials, synthetics, recombinant proteins, cell based, and gene therapies. When selecting the appropriate bone graft substitute material, the biologic and biomechanical features of the anatomic location should be considered. What is expected of the graft substitute; promotion of bone formation or to serve as a mechanical buttress?

Long bone defects regardless of size create stress risers decreasing the overall stability of fracture fixation and contributing to early implant fatigue failure. In such instances, a bone graft substitute should have sufficient structural strength to help augment skeletal fixation while mechanical integrity is restored. Recently, calcium phosphate cements have been developed that are bioresorbable and injectable, while having compressive strengths equal to or exceeding that of cancellous bone. These characteristics may make these cements potentially useful for augmentation of irregular shaped bone voids providing some structural support. Another potential use of these cements may be to support articular tissue grafts for the treatment of subchondral bone cysts.

Osteoinductive proteins (BMP's) will be approved in the near future for certain human indications. These proteins have been shown in numerous animal models to enhance bone healing. To my knowledge, there have been no controlled clinical studies using BMP's in equine fractures. Although these proteins would likely enhance fracture healing in the equine patient, the dosage required may be cost prohibitive in most instances.

As long as there are equine fractures, there will be a clinical need for bone grafting and therefore, bone graft substitutes. There will not likely be a single graft substitute product that will address all clinical situations, but rather a particular product to meet a specific need. It will be the cost, and not the availability, that will ultimately govern when and if such products are used in the equine patient.

Arthroscopic Assisted Tibial Plateau Leveling Osteotomy for Treatment of Partial Cranial Cruciate Ligament Rupture: 41 Cases

W.O. Whitney, B.S. Beale, J. Chandler

Cranial cruciate ligament (CrCL) injury has long been recognized as a common cause of lameness in dogs. Traditionally, the diagnosis was based on palpable instability (cranial drawer). Most clinicians now recognize that partially torn CrCLs are a common cause of lameness and often have no palpable instability. Left untreated, partial tears predictably become complete tears with palpable instability. However, one common misconception is that conservative treatment while waiting for instability to become clinically evident is a sound approach. Based on arthroscopic examination of hundreds of cases with partial CrCL tears, we now recognize that osteoarthritis progresses at a rapid pace despite the fact that the stifle is stable with palpation.

These observations clearly demonstrate a definite need for early diagnosis and intervention.

Tibial Plateau Leveling Osteotomy (TPLO) has become a popular technique for the management of CrCL rupture. The procedure dynamically stabilizes the stifle by negating cranial tibial thrust. Meniscal release procedures are commonly performed at the time of tibial plateau leveling osteotomy as a preventative measure against future medial meniscal tearing. The procedure is generally contemplated when the knee is unstable and the medial meniscus is intact. The efficacy of this procedure and its long-term effect on articular cartilage is currently unknown and the technique is controversial. Some argue that meniscal release renders the meniscus nonfunctional by destroying its hoop-stay mechanism and predisposes to osteoarthritis, while others argue that the incidence of post TPLO meniscal tears is unacceptably high without release. When partial meniscectomy is required for significant naturally occurring tears, release is generally not indicated. Some surgeons prefer prophylactic partial meniscectomy on uninjured menisci to meniscal release. In dogs with partial tears but palpably stable knees, TPLO may save the ligament and maintain joint stability making meniscal release unnecessary. Clinically, we have seen dogs with meniscal release later tear the meniscus, but this incidence is not believed to be high. Good controlled studies are needed to determine the need, efficacy, and induced morbidity associated with this procedure. Release of the medial meniscus can be performed arthroscopically by transecting the caudal meniscotibial ligament or by transversely incising the meniscus caudal to the attachment of the medial collateral ligament. It is not known if either location of release is superior to the other, or if meniscal release is superior or inferior to prophylactic partial ablation.

Arthroscopy has proven to be a reliable, minimally invasive means for early diagnosis of partially torn CrCLs (fig 1).

The purpose of this study was to determine if Tibial Plateau Leveling Osteotomy (TPLO) performed on stable partial CrCL tears could 1) prevent the partial tear from becoming a complete tear 2) prevent the need for meniscal release (by maintaining stability) and 3) prevent future meniscal tears (by maintaining stability).

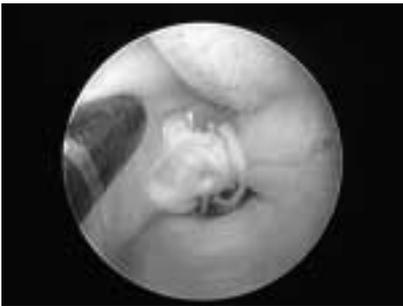


Fig. 1 - Arthroscopic view of a typical partial CrCL tear.

A retrospective study of 252 consecutive cases over a 14 month period (5/01/00-7/31/01) was done. All cases had intraoperative videotape, digital images, and medical records available for evaluation. 169 of 252 (67.1%) were complete tears and excluded. 83 of 252 (32.9%) were partial tears, of which 42 of 83 were palpably unstable in flexion and excluded. The remaining 41 cases were considered palpably stable partial tears and included as the basis of this study. All cases were treated by arthroscopic radiofrequency debridement of torn fibers only and the remaining ligament was left intact. Medial meniscal release was not performed.

Of the 41 "stable partial tears" included in the study, the average age was 4.9 years, the average weight was 38.8 kg, the average pre-op tibial slope was 27.8 degrees, and the average postopera-

tive slope was 7.2 degrees. Pre-existing arthritis was based primarily on periarticular osteophyte formation and arthroscopically graded 0 (none) to 5 (severe) (fig. 2). The average arthritis score was 2.7. Only 10% of the cases had no periarticular osteophyte formation.

Follow-up reevaluation was attempted on all 41 cases (average 11.3 months, range 1.8-21.2 months) and included force plate analysis (n=24), reexamination under general anesthesia (n=32), radiographs (n=33), owner questionnaire (n=38), and second-look arthroscopy (n=19). The most common reason for lack of complete follow-up (ie sedation or anesthesia) was the owner's perception that it was unnecessary due to good outcome. Most second looks were granted when the dogs presented for the second side or when recurrent lameness occurred.

Follow-up (mean 9.9 months, range 1.8-21.2 months) showed no progression of osteoarthritis in 24 or 33 cases (72.7%). 19 of 21 (90.5%) of dogs with normal menisci at time of surgery had no progressive changes. Recheck examination (avg. 11.3 months, range 1.8-21.2 months) revealed that 4 of 32 (12.5%) of the partial tears had become complete, and that 28 of 32 (87.5%) remained stable or had subtle (sometimes equivocal) drawer in flexion only. All 32 had negative cranial tibial compression test. Two possible factors were identified that may contribute to why the 4 partial tears became complete, although it is not known if either is statistically significant: 1) dogs that became complete had more preexisting osteoarthritis (score 3.75/5) and 2) underrotation (avg. 9.5 degrees).

Second-look arthroscopy was performed on 19 dogs (avg. 9.9 months postsurgery). In 15 of 19 (78.9%) the CrCL was intact, the medial meniscus was intact in 14 or 19 (73.7%), and the lateral meniscus was intact in 15 of 19 (78.9%). This is believed to be a very skewed population as only dogs that were having problems or undergoing surgery on the contralateral limb were rescoped.

Force plate analysis was performed on 24 dogs and average of 12.3 months postop (range 3.5-21.3 months). Dogs with a contra lateral complete tear consistently scored better on the partial tear side and only slightly lower than the contra lateral normal limb (fig. 3).

Force plate analysis (N=24 of 41); mean follow-up 12.3 months, range 3.5-21.3 months

Owner questionnaire results (avg. 11.6 months, range 1.8-21.2 months) revealed 30 of 38 (78.9%) owners considered their dog able to function at the same activity level as preinjury (yes or no question). 97.3% of owners said they were pleased with the outcome.

In conclusion, early diagnosis and surgical intervention is strongly advocated when partial CrCL rupture is suspected due to the rapid progression of osteoarthritis. TPLO is effective in slowing the progression of the osteoarthritis and altering the natural course of the disease. In dogs with palpably stable stifles and confirmed partial tears, arthroscopic radiofrequency ablation of the torn fibers only in conjunction with TPLO prevents the CrCL from tearing completely in most cases and medial meniscal release may be unnecessary.

Diagnosis of Partial CrCL Tears

Partial tears can be difficult to diagnose. A heightened index of suspicion is warranted, as many if not most large dogs that have occult rear leg lameness are partial cruciate tears. Joint effusion may or may not be appreciated with palpation. Asymmetrical hyperextensional stifle discomfort is a reliable sign and usually exacerbates lameness. This test can be performed in sedated dog's that are difficult to examine. Flexion may result in a painful response and flexion testing for 20-30 seconds may exacerbate lameness. Most dogs sit with the affected leg extended, with the hock positioned away from the body. Under general anesthesia, close comparison with the contralateral limb often but not always reveals subtle anterior drawer with ill-defined endpoint in flexion but not extension if the anterior medial band is torn. Often the stifle is palpably stable in both flexion and extension. Careful palpation should always be performed under general anesthe-

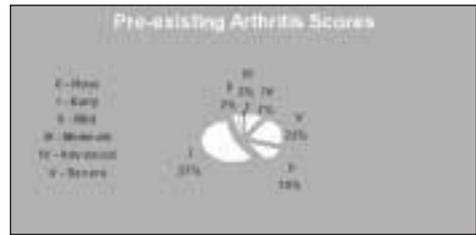


Fig. 2

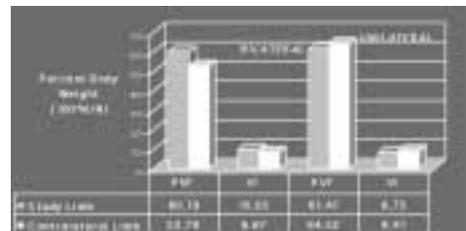


Fig. 3

sia and compared to the contralateral limb.

Radiographs: Most cases of partial and complete rupture can be preliminarily diagnosed radiographically with properly positioned quality radiographs. Radiographs typically demonstrate non-specific changes that are supportive of CrCL rupture. Radiographic diagnosis is based on joint capsular swelling, periarticular osteophyte formation, and occasionally, cranial translation of the tibia.

The first and most subtle radiographic finding in truly acute cases is soft tissue swelling in the caudal joint, seen as an obliteration or caudal deviation of the fat line of the gastrocnemius muscle planes in the popliteal fossa, and loss of the triangular detail of the infrapatellar fat pad (Fig 4-A).

The changes are the same for partial and complete tears. In subacute cases (3-6 weeks), early osteophyte formation may be noted, especially on the proximal and distal poles of the patella and the medial and lateral trochlear ridges of the femur (Fig 4-B). In chronic cases (months), these osteophytes may be quite large and accompanied by similar changes along the medial, lateral, and caudal aspects of the tibia (Fig 4-B).



Fig. 4A



Fig. 4B

The role of bursoscopy in the diagnosis and management of navicular syndrome in horses

C. Wuerfel, B. Hertsch

Navicular disease is a very common disease that has been recognised for a long time. However, there are still difficulties in the diagnosis of this condition, especially when only the soft tissues like the fibrocartilage of the flexor surface of the navicular bone, the deep digital flexor tendon and the interposed bursa are involved.

There are different ways to examine the soft tissues of the navicular region:

1. ultrasound
2. bursoscopy
3. bursography
4. CT and MRI

Wright (1999) used endoscopy of the navicular bursa to diagnose and treat contaminated and septic bursitis. The technique facilitates on the one hand a direct view of the affected tissues and on the other hand bursal lavage, removal of pannus, synovial resection and debridement of lesions.

Tietje et al. (2000) compared the diagnostic value of this technique with the native X-ray examination and with bursography. Their endoscopic findings included synovitis, alterations of the surface of the navicular bone and the deep digital flexor tendon like erosions, adhesions and fibrillation. The bursa itself is a very small area, where the endoscopic overview is limited. This fact might be worsened by pathological processes like adhesions and hypertrophic synovial membranes. In some cases it is not possible to get a satisfactory endoscopic view of the bursa. With the native X-ray examination one is only able to diagnose changes in the bone. It is not possible to visualise early alterations, which are localized in the soft tissues.

Their bursographic results are based on one phenomenon: a distinct line of contrast material juxtaposed to the deep digital flexor tendon is normally separated from the navicular bone by a layer of radio lucent fibrocartilage (Turner 1997).

Tietje evaluated the presentation of the fibrocartilage, the regularity, the thickness and the surface of the line of contrast material and also if contrast material projected into the flexor cortex area. His final results suggest that grave alterations of the soft tissue in the navicular region may be seen during bursoscopy or assumed by bursography, while no changes can be seen with the native X-ray examination. With the help of bursography and bursoscopy it is possible to get further information about the involvement of the deep digital flexor tendon and the bursa navicularis in the navicular syndrome.

A new study about the diagnostic value of the bursography was performed. Front legs of slaughtered horses, which had been removed in the intercarpal joint, were used in this examination. A stationary fine focus x-ray unit was used, enabling a magnified display. The feet were x-rayed in three positions: 0° according to Ox spring, latero-medial and tangential in a 45° angle. Then an iodine contrast material was injected into the bursa navicularis using a palmar approach. Subsequently to the application of contrast medium, x-rays according to Ox spring, latero-medial and tangential, using an angle of 45° and 55°, were taken. After this the navicular region was examined pathomorphologically. The pathomorphological results were divided into four groups according to the severity of the changes and they were compared to the x-ray findings without contrast material and to those supported by contrast media. Bursography was considered of little diagnostic value as it did not lead to a different result concerning the diagnosis of navicular disease in a single front leg. It was remarkable however, that there was a direct correlation between the volume of contrast medium it was possible to apply into the bursa and the severity of navicular disease. It seems logical, that the bursa may become smaller because of fibrous adhesions and degeneration during navicular disease.

Biomechanical comparison of the vetfix system and commonly used ao bone plates

K. Zahn, U. Matis, R. Frei, D. Wunderle, B. Linke, M. Hehli, O. Pohler

INTRODUCTION

The VetFix system is a new implant system developed in 1999 by the AO Institute/Davos for internal fixation of diaphyseal fractures in animals. It may also be described as "Fixateur interne". The system consists of a round stainless steel bar, which is fastened to the bone using special clamps and cortical bone screws. Clamp sizes fit for 2.0, 2.4, 2.7, 3.5 and 4.5/5 mm standard screws. Compatible rods are available in diameters varying between 2, 3, 5 and 8 mm.

AIM OF THE STUDY

It was the purpose of this study to investigate and evaluate the stability of the VetFix system in comparison with clinically proven conventional plates as a basic precondition for its use in fracture repair in the feline and canine patient.

MATERIALS AND METHODS

Eighteen different conventional plates of different types (12 hole) and thickness were divided into four groups and assigned to the four VetFix implant size groups. In a defect model testing set-up, the implants were tested for their applicability for the repair of comminuted fractures. For this purpose they were peripherally fastened to Canevasit® bars placing three screws at each of both ends, with the central region of the implant bridging a gap of the length of four holes. For every plate and VetFix size, twelve implants were tested for their maximum resistance against bending and torsion using a four-point bending test (Instron®, Type 4302) and a torsion test (MTS®, Type 858 Bionix®). Relevant mechanical data were assessed both graphically and mathematically.

RESULTS

During elastic deformation of the VetFix models, clamp-rod connections remained firm and stable and did not move under torsional stress forces. In the group of the 2.0 implants, VetFix, DCP and VCP displayed similar behaviour in the bending and torsion tests. Compared to the 2.4, 2.7 and 3.5 mm screw dimension plates, the VetFix system yielded intermediate results in both types of tests. As far as stiffness is concerned, the 4.5 VetFix showed similar characteristics as the broad 4.5 extension plate but was three times stiffer than the narrow 4.5 DCP.

DISCUSSION

On the basis of the present data, the 2.0 VetFix can be recommended as an alternative to 2.0 DCP and VCP implants. For the 2.7 mm size, the stiffness of the VetFix system lies in between the values given for 2.7 VCP and DCP. Thus, the 2.7 VetFix is a useful implant applicable for selected feline and small canine patients, which fills the gap existing between stiff and flexible implants. In the 3.5 mm implant group, the stability of the VetFix system is absolutely comparable to that of a DCP of the same dimension, rendering the VetFix an alternative to conventional plating.

CONCLUSIONS

On the basis of the evaluation of the obtained test results, the VetFix system can be recommended for clinical use in veterinary orthopaedics. Thanks to its versatility, it may even be superior to conventional implants. Taking into consideration the clinical experience gathered to date and the mechanical data of the tested implants, the VetFix system contributes to help the surgeon choose the ideal implant for each individual fracture patient.

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