

Veterinary Orthopedic Society 38th Annual Conference Abstracts

March 5th-12th, 2011
Snowmass, Colorado, USA

Part I: Podium Presentations

1 Intraoperative Contamination of the Suction Tip in Clean Orthopedic Surgeries in Dogs and Cats

Medl N¹; Guerrero TG¹; Hölzle L²; Montavon PM¹

(1)Small Animal Surgery, Vetsuisse Faculty, University Zurich, Zurich, Switzerland, (2)Institute of Veterinary Bacteriology, Vetsuisse Faculty, University Zurich

Introduction: The objectives of this study were to determine the contamination of the suction tip in three different operating modes, its time-dependence, and to give a description of the bacteria found. Our hypotheses were that continuous suction would be inferior to the intermittent mode and a chlorhexidine bath would further decrease contamination rates and that this contamination rate would increase with prolonged surgical time.

Materials and Methods: Clean surgeries (n=75) were assigned to one of three groups: (1) continuous suction, (2) intermittent suction or (3) chlorhexidine-bath intermittent suction. Samples of the suction tip were taken and submitted for bacterial culture at 0, 20, 60 minutes and at the end of surgery. A control suction was operated in every surgery. Samples were taken at the end of surgery simultaneously with a swab from the surgical wound. A Fisher's exact test was used to analyze data P = 0.05 was considered significant.

Results: Aerobic contamination rate of the suction tip was 45.3%, with significant higher contamination rates for the continuous suction group (64%) compared to the intermittent group (24%, $P_{1-2}=003$). The chlorhexidine-bath was not proven superior. Wound contamination ranged from 4% to 8%. The organisms cultured were identical to those found in the positive suction tips during the same surgery. In surgeries lasting longer than 60 minutes contamination rates doubled. Bacterial culture mainly revealed coagulase-negative *Staphylococci*.

Discussion/Conclusion: Intermittent suction was superior to continuous suction. Changing the suction tip appears advisable at 60 minutes. Cultures revealed bacteria that are associated with the normal skin flora.

Acknowledgments: Nothing to disclose.

2 Effects of Intra-Articular Tiludronate on Synovial Fluid Parameters and Joint Health in Horses: A Pilot Study

Duesterdieck-Zellmer K; Gorman EM; Moneta L

College of Veterinary Medicine, Oregon State University, Corvallis, OR

Introduction: Tiludronate may have beneficial effects on horses' osteoarthritic joints. Despite no data about safety or efficacy of intra-articularly administered tiludronate, veterinarians are injecting it into horses' joints. In vitro data on equine articular cartilage explants showed lower concentrations of tiludronate ameliorating proteoglycan loss and decreasing chondrocyte apoptosis, whereas high concentrations had detrimental effects. This study's purpose was to determine short-term safety of a low dose of intra-articularly administered tiludronate in horses.

Materials and Methods: Four horses without front limb lameness and clinically and radiographically normal carpal joints were injected with tiludronate (0.17 mg) into one randomly assigned middle carpal joint. The contralateral joint was injected with 1 ml NaCl. Horses underwent physical and lameness exams throughout the study. Joint fluid from both carpal joints was sampled prior to injections and 5 minutes, 24 and 48 hours, 7 and 14 days later. Synovial nucleated, differential cell count and total protein concentration was determined. Data were analyzed by ANOVA ($p < 0.05$).

Results: No negative effects of tiludronate were found. All horses showed moderate effusion of both middle carpal joints 1–3 days post injection. No lameness or positive flexion tests associated with the carpal joints were noted. Synovial fluid parameters did not differ between tiludronate treated and control joints.

Discussion/Conclusion: Intra-articular injection of a low dose of tiludronate into horses' middle carpal joints did not have any short-term detrimental effects and is likely safe to be administered at this dose in similarly sized joints of horses.

Acknowledgments: The study was funded via intramural funding.

3 Complementary Use of Extracorporeal Shock Wave Therapy on Elbow Osteoarthritis in Dogs

Millis DL; Drum M; Whitlock D

Small Animal Clinical Sciences, University of Tennessee College of Veterinary Medicine, Knoxville, TN

Introduction: New modalities to manage OA are regularly promoted, but there is little objective evidence of efficacy for many modalities. Extracorporeal shock wave therapy (ESWT) has been used to treat OA in animals. The purpose of the study reported here was to evaluate the efficacy of ESWT in the management of canine elbow OA. We hypothesized that ESWT would have a positive effect on clinical parameters of lameness.

Materials and Methods: Fifteen skeletally mature dogs with elbow OA were evaluated. Dogs were randomly assigned to a treated or sham treatment group. Evaluations included subjective gait evaluations at a trot and walk; comfortable range of motion measurements; and determination of ground reaction forces at a trot. ESWT treatments were administered on days 0 and 14. Joints received 500 pulses using a 5 mm probe, with the pulses divided and applied equally to joint capsule insertion points. The energy flux density used was 0.13mJ/mm². Dogs were evaluated on days 0, 14, and 28.

Results: ESWT resulted in a 3.3% increase in peak vertical force compared with a decrease of 5.4% in sham treated dogs ($P < 0.01$). Mean lameness scores improved at the walk with ESWT (2.1 ± 0.3 to 1.7 ± 0.3) versus deterioration with sham treatment (2.0 ± 0.4 to 2.2 ± 0.5) ($P < 0.01$).

Discussion/Conclusion: ESWT is a relatively new modality to treat OA. The improvement in peak vertical force and lameness scores are similar to what might be expected with NSAIDs. ESWT appears to be an efficacious addition to the multimodal approach to managing OA of the elbow.

Acknowledgments: This study received funding from PulseVet, Inc.

4 A Prospective Evaluation of the Effect of Extracorporeal Shock Wave Therapy on Patellar Ligament Desmitis following Tibial Plateau Leveling Osteotomy

Gallagher AD¹; Cross AR²; Sepulveda G²

(1)Florida Veterinary Referral Center, Estero, FL, (2)Georgia Veterinary Specialists, Atlanta, GA

Introduction: Inflammation of the patellar ligament has been reported following the tibial plateau leveling osteotomy (TPLO) procedure. Extracorporeal shock wave therapy (ESWT) is a relatively new treatment for various musculoskeletal conditions, including tendon and ligament injuries.

Materials and Methods: All patients underwent a TPLO. Pre and postoperatively at 4, 6, and 8 weeks, the affected stifle was examined radiographically and ultrasonographically. At 4 and 6 weeks postoperative, dogs in the treatment group were briefly anesthetized with propofol (4–6 mg/kg IV to effect) and treated with ESWT. The patellar ligament thickness on lateral view was measured at 1/4, 1/2, 3/4 the distance from origin to insertion. Ultrasound was used to evaluate patellar ligament disruption and peri-ligament edema.

Results: There was significant difference in thickness ($p=0.0264$) only at the distal point; therefore, only this point was used to measure difference between the control and treatment groups. A significant difference between groups was reached at 6 and 8 weeks ($p=0.0059$ and $p=0.0095$, respectively) postoperatively.

Discussion/Conclusion: Patellar ligament thickening is a common radiographic finding following TPLO and is presumed to represent patellar ligament desmitis. Our finding of tendon thickening being most severe distally is consistent with that of previous studies. Possible mechanisms of action of ESWT include stimulation of tissue neovascularization, transforming growth factor beta (TGF- β), insulin like growth factor I (IGF-I), and bone morphogenetic protein 2 (BMP-2) synthesis. Based on the results of this study, ESWT decreases the radiographic signs of patellar ligament desmitis and should be considered as a viable treatment option.

Acknowledgments: None

5 Primary Repair of the Anterior Cruciate Ligament using a Bio-Active Scaffold in a Mature Ovine Model: A Preliminary Study

Murray MM¹; Vavken P¹; Palmer RH²; Proffen BL¹; Fleming BA³; Ryan SD²

(1)Department of Orthopaedic Surgery, Children's Hospital Boston-Harvard Medical School, Boston, MA, (2)Small Ruminant Comparative Orthopaedics Laboratory, Dept of Clinical Sciences, College of Veterinary Medicine & Biomedical Science; Colorado State University, Fort Collins, CO, (3)Bioengineering Labs; Rhode Island Hospital, Warren Alpert Medical School of Brown University, Providence, RI

Introduction: Gold standard treatments for anterior cruciate ligament (ACL) injuries in human and canine patients are not ideal in terms of complication rates, rehabilitation duration and incidence of osteoarthritis. Ideal treatment would restore normal knee kinematics via preservation of the ACL's complex insertion site anatomy and proprioceptive function. Thus, new ACL treatments using tissue-engineering concepts to regenerate injured regions of the ACL are of interest for human and canine patients. Recent work suggests that primary ACL repair enhanced by bioactive scaffold placement in the wound can stimulate functional ACL healing in immature animals. The hypothesis of this study was progressive ACL healing would occur in a mature ovine model.

Materials and Methods: Eight skeletally mature sheep underwent complete unilateral ACL transection followed by primary repair with a non-absorbable femorotibial stent suture and placement of a bio-scaffold in the ACL gap. After 3 and 6 months, four animals at each time point were euthanized and AP knee laxity and structural properties of the repaired ACL were determined.

Results: Structural properties (yield load, maximum load and stiffness) of the healing ACL were relatively low three months after surgery, but all increased significantly by six months, to levels similar to that reported for ovine ACL reconstruction (the current gold standard) at that time point.

Discussion/Conclusion: Primary ACL repair using a bioscaffold is feasible and further study is warranted.

Acknowledgments: This study was funded by NIH RO1 AR052772.

6 Minimally Invasive Synovium Harvest for Potential Use in Meniscal Tissue Engineering

Warnock J; Baltzer W; Duesterdieck-Zellmer K; Ott J

Clinical Sciences, Oregon State University College of Veterinary Medicine, Corvallis, OR

Introduction: Meniscal injury is a common cause of painful knee arthritis in dogs. Tissue engineering is a new strategy for treating avascular meniscal injury or total meniscal loss. The purpose of this study was to determine if minimally invasive synovium harvest can produce viable cell cultures that can form meniscus-like ECM, with the long term goal of producing autologous meniscal fibrocartilage in vitro.

Materials and Methods: Synovium was arthroscopically harvested from 12 dogs with naturally occurring cranial cruciate ligament deficiency ("AS") and obtained from 6 dogs with patellar luxation via arthrotomy ("AR"). Cells were treated with a chondrogenic growth factor protocol. Relative expression of SOX-9, collagen type I and II, and aggrecan were determined using real-time RT-PCR; glycosaminoglycan (GAG) and hydroxyproline content were measured. Immunohistochemistry for collagen I and II was performed.

Results: Synovium was able to pass through an arthroscopic tissue shaver with high viability and required less ex vivo processing time. A lower cell yield occurred in AS, however these cells were able to synthesize micromass tissues containing collagen I, II and small amounts of GAG. AR and AS cells expressed evidence of a chondrogenic lineage shift via expression of SOX-9, aggrecan, and collagen II. Differences in ECM synthesis and cell proliferation time could not be detected between AR and AS.

Discussion/Conclusion: This surgical method may be useful for facile access to synovial mesenchymal progenitor cells for meniscal tissue engineering.

Acknowledgments: None.

7 Synovial Bioscaffolds for Potential Use In Meniscal Tissue Engineering

Warnock J; Duesterdieck-Zellmer K; Baltzer W; Ott J

Clinical Sciences, Oregon State University College of Veterinary Medicine, Corvallis, OR

Introduction: Meniscal injury is a common cause of painful knee arthritis in dogs. Tissue engineering is a new strategy for treating avascular meniscal injury or total meniscal loss. The purpose of this study is to investigate in vitro synthesis of tensioned sheets of cultured synoviocytes (tensioned synoviocyte constructs "TSC"), with the long-term goal of creating living, fibrocartilaginous surgical scaffolds.

Materials and Methods: TSC and spontaneous synovial micromasses ("SM") were synthesized from cultured synoviocytes harvested from 6 normal and 14 arthritic stifles. To measure meniscal-like matrix constituents, glycosaminoglycan (GAG) and hydroxyproline content were measured. Histologic analysis was performed using Toluidine Blue and immunohistochemistry (IHC) for collagen I, II, and smooth muscle actin (α SMA). Cell viability was assessed using Ethidium homodimer and Calcein AM.

Results: Tension increased tissue collagen and GAG content in normal and arthritic TSC versus SM; normal TSC had higher GAG content than arthritic TSC. TSC had moderate localized, regional staining for GAG; SM showed faint regional staining for GAG. IHC showed strong immunoreactivity for collagen I and α SMA, with crenulated collagen sheets in SM and longitudinally oriented collagen bands in TSC. Collagen II showed localized, moderate immunoreactivity in TSC and mild reactivity in SM. Cell viability was highest in TSC versus SM.

Discussion/Conclusion: This culture method is a viable model for in vitro meniscal tissue engineering studies, but further study is warranted to determine if TSC can be applied to repair or replacement of damaged menisci.

Acknowledgments: None.

8 Short Term Temporal Alterations in the Magnetic Resonance Signal Occur in Primary Lesions Identified in the Deep Digital Flexor Tendon in the Equine Digit

Clegg PD; Talbot A; Milner P

Dept of Musculoskeletal Biology, University of Liverpool, Neston, United Kingdom

Introduction: Primary lesions of the deep digital flexor tendon (DDFT) within the equine digit are an important cause of lameness diagnosed using magnetic resonance imaging (MR) but the alteration in MR appearance of these lesions over time has not been documented. We determined whether the MR appearance of different primary DDFT lesions alters with time and whether lesion type is a determinant of these changes.

Materials and Methods: Cases were included that had lameness attributable to a primary lesion involving the DDFT in the digit diagnosed on MRI. Age, breed and lameness level of the cases were recorded. Lesions were typed and lesion volumes and intensities were quantified. Follow-up examinations and measurements were repeated at 3 and 6-month periods.

Results: Thirty horses were identified as having a primary DDFT lesion. Lesion distribution included: parasagittal splits (13), dorsal border lesions (11) and core lesions (6). No association was found between degree of lameness and lesion

type. There was a trend for horses with core lesions to be older. Dorsal border lesions alone showed statistically significant reduction both in volume and ratio-metric intensity (initial scan: $0.18 \pm 0.04 \text{ cm}^3$; 4.06 ± 0.46), at 3 months ($0.11 \pm 0.03 \text{ cm}^3$; 2.98 ± 0.22 $p < 0.05$) and 6 months ($0.05 \pm 0.01 \text{ cm}^3$; 2.00 ± 0.19 $p < 0.01$ & $p < 0.05$). Overall lameness scores improved during the study period and was lesion independent.

Discussion/Conclusion: Dorsal border lesions show evidence of significant reduction in both volume and intensity whereas parasagittal splits and core lesions do not. Lesion typing may be important in predicting lesion behaviour using MR imaging.

Acknowledgments: S. Sidwell for data analysis.

9 Comparison of Clinically Relevant Platelet-Rich Plasma Methods and Acellular Bone Marrow Preparations on Equine Digital Flexor Tenocytes in vitro

Hraha TH; Doremus KM; McIlwraith CW; Frisbie DD

Clinical Sciences, Colorado State University, Fort Collins, CO

Introduction: Degenerative tendon disease is a common clinical problem. Despite advances in therapies, injuries continue to lead to morbidity. Growth factors, which modulate the repair process, are playing an increasingly important role in the local treatment of orthopaedic disease. Novel therapeutics, including platelet-rich plasma (PRP) and acellular bone marrow aspirate (ABMA), have been described clinically; however comparisons to differentiate their effects on tenocytes or direct comparisons are lacking. Our goal was to compare the three most clinically relevant platelet-rich plasma products: Autologous Conditioned Plasma (ACP)[®], Fibrivet[®] and fPRP[®] and ABMA to a plasma control.

Materials and Methods: Each of the tested products was assessed for the ability to concentrate platelets, WBCs, and a number of growth factor concentrations (IGF-1, TGF- β , and PDGF-BB). The effect of each product on tenocyte proliferation and matrix production (hydroxylproline) was also assessed after a 72-hour period. All methods were commercially available.

Results: Only fPRP[®] significantly increased the platelet concentration and IGF-1, TGF- β and PDGF-BB concentrations when compared to controls. When the effects of the various methods were measured on tenocytes only ACP increased the cell proliferation and matrix (hydroxylproline) when compared to controls. It is noteworthy that fPRP[®] increased cell proliferation and ABMA matrix production in tenocytes when compared to controls.

Discussion/Conclusion: The side-by-side comparison of various clinical treatments suggested there were significant differences between them. When the effect on the tenocyte is taken into account ACP[®] may have some of the most beneficial properties as tested.

Acknowledgments: Funding was provided by the American Quarter Horse Foundation.

10 Correlation of Foot Balance and Deep Digital Flexor Tendon Lesion Location on Magnetic Resonance Imaging

Gindlesperger B¹; Stewart AA²; Stewart MC²

(1)Southern Pines Equine Associates, Vass, NC, (2)Veterinary Clinical Medicine, University of Illinois, Urbana, IL

Introduction: The purpose of this study was to determine if the location of DDFT lesion identified on MRI corresponded with a medial to lateral and dorsal to palmar imbalance of the distal limb. We hypothesize that the DDFT lesion will be located on the long side of imbalanced limbs and that dorsal to palmar imbalance will be present in limbs with DDFT lesions.

Materials and Methods: Medical records, radiographs, and MRI for horses between July 2007 and September 2009 that blocked out to the digit were reviewed. Radiographs and MRI were reviewed to see if there was a correlation between imbalance and DDFT injury. Statistics were performed using a Fisher Exact Test with a $P < 0.05$ considered significant.

Results: There is a significant correlation between the long side of an imbalanced limb and location of DDFT lesion. A negative palmar angle was present in all limbs with DDFT lesion, supporting both hypotheses of the study.

Discussion/Conclusion: These results suggest that horses with a long toe, low heel, and medial to lateral foot imbalance are predisposed to DDF tendon injury on the long side of medial to lateral imbalance. Further studies with larger case numbers are warranted to verify these findings.

Acknowledgments: None.

11 Evaluation of the Effect of Distal Femoral Elevation on Radiographic Measurement of the Anatomic Lateral Distal Femoral Angle (aLDFA)

Jackson GM; Wendelburg KL

Animal Specialty Group, Inc, Los Angeles, CA

Introduction: Anatomic aLDFA should be measured from a true craniocaudal femoral radiograph. Positioning for this projection can be difficult, with typical malpositioning having distal femoral elevation. This study assessed the effect of increasing distal femoral elevation on the measurement of distal femoral varus. Additionally it evaluated reliability of reported femoral anatomic landmarks.

Materials and Methods: Paired femurs from seven canine cadavers were dissected free of soft tissues and positioned in a custom frame. The distal end of the frame was elevated in 5° increments from 0° to 45° with craniocaudal radiographs obtained at each position. Femoral varus was measured from the radiograph of each femur at each elevation. Statistical comparison of measured values was performed and radiographs were evaluated for anatomic markers of positioning.

Results: There was significant increase in measured aLDFA at all elevations greater than 5° when compared to 0° elevation. The mean value for aLDFA increased from 92.3° at 0° elevation to 95.0° at 45° elevation. The femoral trochlear ridges and walls of the intercondylar fossa were the most useful landmarks to assess positioning, though the fabellae may also be beneficial. The lesser trochanter and nutrient foramen were less useful landmarks.

Discussion/Conclusion: Elevation of the distal femur had a significant effect on measured aLDFA at elevations greater than 5°. Appropriate positioning is crucial during evaluation of femoral varus. Positioning techniques, such as the flexed caudocranial (CdCr) position, and evaluation of anatomic landmarks should be used to ensure that appropriate radiographic positioning is obtained.

Acknowledgments: None.

12 Radiographic Measurement of the Femoral Axes, Joint Angles, and Varus Angle in Orthopedically Normal Small Breed Dogs and Small Breed Dogs with Medial Patellar Luxation

Fasanella FJ¹; Horstman CL²; Mason DR²; Sawyer MJ¹; Tomlinson JL³

(1)Department of Surgery, Las Vegas Veterinary Referral Center, Las Vegas, NV,

(2)Las Vegas Veterinary Referral Center, Las Vegas, NV, (3)Comparative Orthopaedic Laboratory, University of Missouri, Columbia, MO

Introduction: The purpose of this study was to determine the femoral anatomic, mechanical, and femoral varus angle (FVA) in two populations of small breed dogs, those with and without MPL and if there are differences in the angles between the two populations. It was hypothesized that previously described measuring modalities could be applied to small breed dogs and that a difference would exist between dogs with and without patella luxation.

Materials and Methods: Frontal plane radiographs of canine femora were obtained in dogs with and without medial patella luxation. Radiographs were used to determine femoral anatomic and femoral mechanical axes, proximal and distal joint reference lines, the intersecting angles of each [aLPFA, aLDFA, mLPFA, mLDFA (anatomic and mechanical, lateral proximal and lateral distal femoral angles, respectively)], and FVA.

Results: Thirteen femora with MPL and 16 normal femora met the inclusion criteria. All limbs evaluated with MPL were grade III. Mean \pm SD reference ranges for the normal and MPL groups were established. No significant differences existed between the normal and MPL groups.

Discussion/Conclusion: The radiographic methodology established reference ranges have been established in orthopedically normal small breed dogs and those with MPL. No differences existed between femora with and without MPL.

Acknowledgments: All funding for this study was provided by Las Vegas Veterinary Referral Center.

13 A Novel Means of Evaluating Radial Torsion using Conventional Radiography

Maquire PJ; Petkov EP; Lesser AS

Small Animal Surgery, New York Veterinary Specialty Center, Farmingdale, NY

Introduction: Use of a radiopaque marker (RM) affixed to the limb provides a reference point on two-dimensional conventional radiographs. This reference can be used to quantify radial torsion.

Materials and Methods: A cadaveric radius was imaged as it was rotated 360 degrees along its long axis providing reference images. An RM was affixed to 4 cadaveric antebrachii: proximal mediolateral followed by distal mediolateral radial radiographs were taken. The length of the RM was measured on the radiographs. These measurements were entered into a trigonometric formula and radial rotation calculated. Computed tomography was used to measure radial torsion of the specimens using an accepted technique. Procurvatum, valgus and rotation were induced in the specimens before repeating the above imaging.

Results: The calculated torsion utilizing the RM was within 10 degrees of the results obtained using CT, both before and after induced angulation. Insufficient radiographic landmarks are present in the proximal radius to justify use of a craniocaudal view to assess radial torsion. The lateral view demonstrated more easily identified landmarks.

Discussion/Conclusion: Radial torsion can be quantified using the RM technique with reasonable accuracy, including cases with significant angulations. Evaluation of radial head rotation or subluxation should not be performed using craniocaudal radiographs alone.

Acknowledgments: Medical imaging software, B&M DICOM PACS VET. Viewer was provided by B&M Services, Bulgaria.

14 The Effect of Configuration and Radiographic Positioning on Measurements of Deformity Magnitude in a Dog with a Complex Antebrachial Growth Deformity: Comparison between Radiographic and 3D Computer Modeling Measurements

Nikolaou C¹; Fitzpatrick N¹; Isaza Saldarriaga JF²; Correa Velez S²; Waville V¹; Ash K¹; Ochoa J¹

(1)Fitzpatrick Referrals, Surrey, United Kingdom, (2)Department of Product Design Engineering – Grupo de Investigación en Bioingeniería, EAFIT-CES Universities Medellín, Medellín, Colombia

Introduction: Our aim was to establish the mathematical relationship between radiographically measured torsion and frontal plane antebrachial growth deformities (ABGD) and to compare with those derived from a 3D computer model.

Materials and Methods: Direct digital radiographs and CT scans of the forelimbs of a 23kg dog with bilateral ABGD were acquired 3D reconstructions were created from the CT scans and parametric surfaces exported to SolidWorks 2009. The lateral distal radial angle (LDRA) and distal caudal radial angle (DCRA) were measured on both. A transverse cut of the radius was performed at the intersection point of the anatomical axes and the frontal plane deformity was measured following: 1) rotation of the distal radial segment, 2) alteration of the procurvatum angle, 3) rotation of the limb around the humeral axis with: (a) unchanged procurvatum, (b) procurvatum 20°, (c) procurvatum 0°, (d) procurvatum equal

valgus angle, 4) rotation of the limb around the transcondylar axis. Valgus angle measurements were correlated using curve estimation regression analysis.

Results: Radiographically measured valgus was 8.83°, LDRA 89.81°, procurvatum 10.38°, DCRA 86.3° and the same deformities measured on the 3D model were 29°, 100.4°, 19.39°, and 96.6°. Radial torsion and procurvatum did not affect measurements of valgus on the 3D model.

Discussion/Conclusion: Radiographic measurements of frontal plane deformity differed significantly from measurements on the 3D model and therefore the model was more accurate for pre-operative planning. Rotation around the humeral axis had a significant and predictable effect on the measurements of valgus deformity.

Acknowledgments: No external financial support

15 True Spherical Dome Osteotomy using a Novel Blade Design in a Dog with an Antebrachial Growth Deformity: Planning and Execution of Technique

Fitzpatrick N¹; Nikolaou C¹; Ochoa J¹; Isaza Saldarriaga JF²; Correa Velez S²; Ash K¹; Waville V¹; Szanto Z³

(1)Fitzpatrick Referrals, Surrey, United Kingdom, (2)Department of Product Design Engineering – Grupo de Investigación en Bioingeniería, EAFIT-CES Universities Medellín, Medellín, Colombia, (3)Twin Falls Veterinary Clinic and Hospital, Twin Falls, ID

Introduction: Dome osteotomies in literature to date have constituted cylindrical or crescentic cuts. We aimed to describe the application of a new dome blade design and trigonometric principles for execution of true spherical osteotomy (TSO) in antebrachial growth deformities.

Materials and Methods: A dome blade was used to create osteotomies in plastic bone models, the surfaces of which were laser-scanned and trigonometric calculations were applied to align the epicentre (O) of the blade with the midpoint of the model in frontal and sagittal planes (MP_{fg}). Complex ABGD in a dog was assessed using CORA methodology applied to radiographic images and a 3D model reconstructed from CT scans. Trigonometric formulas for execution of a TSO were applied.

Results: Blade orientation prevented translation at the osteotomy site in frontal and sagittal planes after correction of torsion. Preoperative FPA radiographically was 13° valgus, whereas FPA on the 3D model was 0°. Postoperative FPA radiographically was 5° varus.

Discussion/Conclusion: Discrepancy between true FPA and that measured radiographically was attributable to radiographic distortion due to rotation. The angulation correction axis (ACA) of a TSO is located at O, and therefore separated from the osteotomy by the sphere radius. To avoid translation of the bone axes when a TSO is employed to correct a torsional deformity, the ACA should pass through the CORA on the midline of MP_{fg} rather than any CORA on the bisector line of the deformity. This constitutes a new rule specifically pertinent to dome osteotomies.

Acknowledgments: No external financial support.

16 Capital Physeal Fracture as an Indication for Canine Total Hip Replacement

Kalis RH¹; Liska WD²; Jankovits DA³

(1)Angell Animal Medical Center, Boston, MA, (2)Gulf Coast Veterinary Specialists, Houston, TX, (3)Animal Specialty Group, Los Angeles, CA

Introduction: Capital physeal fracture (CPF) is a common injury for dogs and cats. The objective of this study was to evaluate outcomes of (CPF) treated with total hip replacement (THR).

Materials and Methods: A retrospective phase II nonrandomized efficacy study was conducted on 21 dogs and 4 cats (27 THR). The medical records and radiographs of dogs and cats with CPF treated with total hip replacement from 1991 – 2009 were reviewed. Data collected from the physical examination, radiographs, thigh circumference (TC), force plate gait analysis, and an owner questionnaire at a minimum of 6 months after surgery were documented.

Results: The patient signalment and interval between CPF and THR had no clinical correlation with post-THR outcome. Owner questionnaires showed patients improved post-THR with minimal or no lameness in all. TC and force plate gait analysis examined in the y-axis (cranial-caudal brake and propel) and z-axis (vertical – peak and impulse) in all patients showed no statistically significant difference between the THR limb and the normal contralateral limb.

Discussion/Conclusion: THR limbs compared to the normal contralateral limb showed no statistically significant differences in any subjective or objective parameters. THR should be considered a viable treatment option for CPF.

Acknowledgments: There was no financial support for this study.

17 The Treatment of Femoral Capital Physeal Fractures using Total Hip Replacement in Dogs

Pugliese LC¹; Dyce J¹; Johnson KA²; Kowaleski MP³

(1)College of Veterinary Medicine, The Ohio State University, Columbus, OH, (2)Department of Clinical Sciences, Faculty of Veterinary Science University of Sydney, Sydney, Australia, (3)Department of Clinical Sciences, Tufts University Cummings School of Veterinary Medicine, North Grafton, MA

Introduction: Femoral capital physeal fractures (FCPF) occur infrequently in young dogs most commonly secondarily to trauma. Total hip replacement (THR) has been recommended as a surgical treatment method but there have not been clinical studies evaluating this method. The aim of this retrospective study was to detail the THR surgical outcome and present findings specific to FCPF in dogs comparing surgical time, patient age, and complications to a control group of THR cases.

Materials and Methods: Cases were identified from a THR database. Statistical analysis using unpaired T-tests and Chi-squared analysis was performed on the data collected.

Results: Fifteen clinical cases of FCPF were matched to 15 THR cases presented for evaluation of bilateral hip dysplasia. Statistically significant differences were noted in surgical time ($p=0.049$), but not for age ($p=0.07$) and body weight ($p=0.7$). Radiographic findings pre-operatively showed consistent sclerotic changes in the femoral neck and remodeling with a chronic malunion of the physis. The post-operative radiographic review revealed that femoral implant positioning tended to be caudoproximal to craniodistal with a complication rate of 33.3% compared to a hospital rate of 11.2%.

Discussion/Conclusion: The sclerotic changes noted in the femoral neck made preparation of the femoral canal difficult, increasing surgical time and complication rate. The malalignment of the femoral stem is unique to FCPF. THR is a valid method of addressing FCPF in dogs, however these cases provide specific challenges in proximal femoral bone quality, stem placement, and preparation of the femoral canal.

Acknowledgments: Special thanks to Kim Penrod, RVT, Celia Ruckel, and Bobbi Schmidt.

18 Comparison of Osteotomy Proximity Between the Helica Hip and BFX Total Hip Arthroplasty Systems

Franklin SP¹; Feyerabend NP¹; Franklin AL¹; Hayashi K²; Hurt RJ²; Cook JL

(1)Comparative Orthopaedic Laboratory, University of Missouri, Columbia, MO, (2)Surgical and Radiological Sciences, School of Veterinary Medicine, University of California, Davis, Davis, CA

Introduction: One of the purported advantages of the Helica total hip arthroplasty system is that it preserves more proximal femoral bone stock. We hypothesized that osteotomies made in conjunction with implantation of the Helica hip femoral implant are significantly more proximal than osteotomies used in conjunction with implantation of the BFX femoral implant.

Materials and Methods: Immediate post-operative cranial-caudal radiographs of 34 femurs were evaluated to assess the level of the osteotomy used with 17 Helica femoral stems and 17 BFX femoral implants. The level of the osteotomy was evaluated by comparing it to the most distal extent of the intertrochanteric

fossa. A Mann-Whitney Rank Sum test was performed to determine whether there was a significant difference between the two groups.

Results: Osteotomies made in conjunction with the Helica hip arthroplasty system were significantly more proximal than those made in conjunction with the BFX THA system ($p=0.001$).

Discussion/Conclusion: The data support the hypothesis that osteotomies made in conjunction with the Helica hip THA system are consistently more proximal than those made with the BFX and therefore preserve more proximal femoral bone stock. This may be an advantage when placing an implant in a young patient in whom revision may be needed in the future.

Acknowledgments: None.

19 Prevalence of Coxofemoral Osteoarthritis in Geriatric Dogs with Minimal Hip Joint Laxity

McDonald-Lynch MB¹; Karbe GT¹; Ferguson R²; Biery DN¹; Gregor TP¹; McKelvie PJ¹; Smith GK¹

(1)Department of Clinical Studies, School of Veterinary Medicine, University of Pennsylvania, Philadelphia, PA, (2)Monash Veterinary Clinic, Victoria 3166, Australia

Introduction: The diagnosis of canine hip dysplasia (CHD) is based on radiographic osteoarthritis (OA) and/or subluxation. It is believed that hip OA occurring later in life is primary OA not related to CHD. This study aimed to investigate the prevalence of primary hip OA by examining geriatric dogs, both Greyhounds and non-Greyhounds, at low risk of CHD.

Materials and Methods: Older Greyhounds ($N=41$) were recruited for hip evaluation; non-Greyhounds from the PennHIP database ($N=67$) were matched to the Greyhounds by age, weight, and hip laxity ($DI<0.35$). One radiologist performed all subjective hip evaluations. Joint laxity was measured by distraction index.

Results: Mean Greyhound and non-Greyhound age was 9.59 and 7.55yrs, weight 29.47 and 30.11kg, and DI 0.235 and 0.286, respectively. Greyhound DI was <0.3 in 22/25 dogs; non-Greyhound DI was <0.3 in 33/67 dogs. No Greyhounds showed radiographic OA; 4/67 non-Greyhounds exhibited radiographic OA, all with $DI=0.29$. Mean DI of dogs with OA was significantly greater than those without. There were no significant differences in prevalence of OA between groups.

Discussion/Conclusion: There was minimal radiographic osteoarthritis in this population of geriatric dogs with low risk of osteoarthritis secondary to laxity. The osteoarthritis observed in the 4 non-Greyhounds occurred in dogs with DI between 0.29 and 0.35. We conclude from the results of this study, combined with the lifespan study, that the vast majority of hip OA in the dog is attributable to hip laxity and is therefore secondary to CHD.

Acknowledgments: Australian Greyhound Veterinary Association for financially supporting this study.

20 Applications of Evidence-Based Medicine: Systematic Review of the Literature describing Surgical Treatments for Canine Hip Dysplasia

Bergh MS¹; Budsberg SC²

(1)Department of Veterinary Clinical Sciences, Iowa State University College of Veterinary Medicine, Ames, IA, (2)University of Georgia, Athens, GA

Introduction: Numerous surgical treatments have been described to treat pain caused by canine hip dysplasia (CHD). The aim of this study was to systematically review scientific literature in an evidence-based approach to determine whether data exists to support the idea that one or more surgical procedures allows for a consistent return to normal clinical function in dogs with CHD.

Materials and Methods: A broad bibliographic search was performed through April 2010. Studies were included if they were peer-reviewed, published in English, evaluated naturally occurring CHD, and if they had ≥ 6 months post-operative follow-up. Studies were compared and evaluated with regard to study design, surgical technique, short and long-term follow-up, and level of evidence classification.

Results: 436 manuscripts were initially identified; 59 met the inclusion criteria. Only one study provided level I evidence, 6 provided level II evidence, 9 provided level III evidence, and 43 provided level IV evidence relative to the study question. Twenty-one studies were prospective in nature. The most common outcome measurements were visual gait observation, radiography, and orthopedic examination. Juvenile pubic symphysiodesis (JPS) and total hip replacement (THR) had the strongest evidence to support their clinical efficacy.

Discussion/Conclusion: Despite a large number of publications describing outcome after surgical treatments for CHD, few provided high quality evidence. The current evidence suggests that JPS and THR may be surgical treatments that will consistently allow a return to normal function for dogs with hip dysplasia. Additional prospective, randomized, blinded, placebo-controlled studies are needed to evaluate these treatments further.

Acknowledgments: None.

21 Assessment and Validation of Magnification in Digital Radiology

Read RL¹; Wallace AD¹; Perry JA¹; Duncan CG²; Duerr FD¹

(1)Aspen Meadow Veterinary Specialists, Longmont, CO, (2)Clinical sciences, Colorado State University, Fort Collins, CO

Introduction: The accuracy of on-screen measurement tools associated with digital radiography has not been completely evaluated in veterinary medicine. The goal of this study was to evaluate interobserver variability and to quantify the degree of magnification error with different distances between the calibration marker and object of interest.

Materials and Methods: Measurements of a 155mm Steinmann pin were performed using a 25.4 mm calibration ball (OrthoMark™) and a software program (VetPACSOOrthoPlan™). Measurements were taken by a surgeon, resident, intern and a technician using three calibration methods (no, automatic, and manual calibration). Measurements were recorded as the orientation of the calibration ball and pin were changed in both vertical and horizontal increments simulating a clinical setting.

Results: There was no statistically significant difference between observer measurements. There was a statistically significant difference between calibration methods with manual calibration being the most accurate. There was no statistically significant difference for manual calibration when the ball moved horizontally but there were statistically significant differences when moving vertically. Magnification increased by 1.56% (SD+/-0.36%) for every 1/2" the ball was below the object and decreased by 1.29% (SD+/-0.21%) for every 1/2" the ball was above the pin with manual calibration.

Discussion/Conclusion: Observer level of experience did not affect calibration. Manual calibration is recommended to achieve most accurate measurements. Ideally, the calibration ball is placed at the same level as the object to be measured. Expected magnification error is greater if the calibration object is below the object to be measured.

Acknowledgments: The authors kindly thank RolleSolutions Inc. for donating the OrthoMark™ for use in our study.

22 Comparison of Imaging Modalities for Diagnosis and Treatment Decision Making for Shoulder Osteochondrosis in Dogs

Wall CR¹; Cook CR²; Cook JL²

(1)Large Animal Clinical Sciences, Texas A&M University, College Station, TX, (2)Comparative Orthopaedic Laboratory University of Missouri, Columbia, MO

Introduction: The shoulder is the most commonly affect joint of canine osteochondrosis (OC). Advanced imaging modalities are becoming more commonplace in veterinary medicine. Our purpose was to prospectively compared radiographs, ultrasonography (US) and MRI with respect to diagnostic accuracy of canine shoulder OC.

Materials and Methods: This was a prospective clinical study. Under sedation radiographs and an US the shoulders were obtained. An MRI of both shoulders was performed, immediately followed by surgery where the OC lesion was characterized by an ACVS diplomate. The primary investigator evaluated all images from each modality while remaining blinded to the surgical findings (the gold standard). Statistical analysis included a Pearson Product Moment, Spearman Rank Order test, positive and negative likelihood ratios, odds ratios, sensitivity, specificity, and positive and negative predictive values.

Results: The measurements of the lesion by the various imaging modalities had strong, significant correlations when compared to the arthroscopic findings. Overall, MRI was the most accurate modality, with the strongest correlations to the arthroscopic findings.

Discussion/Conclusion: The findings of this study outline the potential advantages and disadvantages of these imaging modalities enabling the clinician to more objectively choose the most effective imaging modality or modalities for comprehensive and accurate diagnosis of canine shoulder OC.

Acknowledgments: The Hohn-Johnson Research Award funded this study.

23 Predictive Value of Radiographs, Dual Energy Xray Absorptiometry, Computed Tomography and Microcomputed Tomography to Determine Local Cancellous Bone Quality of the Proximal Femur

Townsend KL¹; Motta T¹; Samii V¹; Hart RE²; Dyce J¹; Allen MJ¹

(1)Veterinary Clinical Sciences, (2)Department of Biomedical Engineering, The Ohio State University, Columbus, OH,

Introduction: Proximal femoral bone quality and quantity are two important variables to provide long-term stability in cementless total hip arthroplasty (THA). The specific aims of this study is to determine the feasibility of using non-invasive imaging to predict the quality, quantity and mechanical properties of cancellous bone in the canine proximal femur.

Materials and Methods: Ten cadaveric canine femora were used. Radiographs were taken, along with DEXA scans and quantitative CT. Bone Mineral Content (BMC) and Bone Mineral Density (BMD) were measured from DEXA scans and qCT, and radiographs were scored. Cores of cancellous bone were harvested from the proximal femur. High-resolution micro computed tomography (uCT) was performed to assess bone microstructure (fractional bone volume BV/TV, polar moment of inertia). Direct mechanical testing of the bone core was performed to assess bone strength (break load, stiffness, energy at break). Regression analysis was used to compare the biomechanical parameters with the imaging modalities.

Results: Micro CT values (BV/TV and AMI) had the best predictor of mechanical properties of cancellous bone in the proximal femur, while clinical imaging modalities such as radiographs, DEXA BMD and BMC and qCT had only mild correlation with predicting bone strength.

Discussion/Conclusion: uCT has the best predictor of bone strength, suggesting that bone architecture plays a significant role in determining bone strength. CT, DEXA and radiographs all showed only mild correlation of bone strength, indicating that clinical parameters are not useful in predicting proximal femoral bone strength.

Acknowledgments: The OSU Canine Research Fund for Funding for this study.

24 Magnetic Resonance Imaging Findings In Horses with Septic Arthritis

Easley J¹; Brokken M²; Zubrod C³; Garrett K⁴; Holmes S⁵; Morton A¹

(1)Large Animal Clinical Sciences, University of Florida, Gainesville, FL, (2)Cleveland Equine Clinic, Ravenna, OH, (3)Oakridge Equine Hospital, Edmond, OK, (4)Rood and Riddle Equine Hospital, Lexington, KY, (5) Small Animal Clinical Sciences, University of Georgia, Athens, GA

Introduction: Magnetic resonance findings of septic arthritis in horses have not been described.

Materials and Methods: Fourteen horses with septic arthritis that underwent high-field (15 Tesla) MR examination were included in a retrospective manner. Septic arthritis was diagnosed based on historical and clinical findings, synovial fluid analyses and culture, radiographic, ultrasonographic, and arthroscopic findings and histopathological findings. Horses were included if two or more of these criteria were positive. MR examinations were performed under general anesthesia on the affected limb and the contralateral limb for comparison when available MR images were evaluated in a blinded-fashion.

Results: The MR findings were as follows: 13/14 cases (93%) had joint effusion, synovial proliferation, and "bone edema" like lesions in subchondral bone and marrow, 9/14 (64%) had joint capsule thickening, 8/14 (57%) had soft tissue edema and evidence of subchondral bone damage, 6/14 (43%) had full thickness articular cartilage defects with various sizes and depths of cartilage erosion and fibrin deposition within the joint space. Intravenous gadolinium administration was performed in 5 of 14 cases.

Discussion/Conclusion: The MR findings of septic arthritis in horses in this study are consistent with those reported in humans. MR imaging may allow earlier and more accurate diagnosis of septic arthritis in horses, especially in cases where clinical diagnosis is challenging. It also provides additional information not afforded by traditional diagnostics that may influence and enhance treatment and provide more accurate prognosis.

Acknowledgments: None.

25 Retrieval Analysis of Cemented Canine Tibial Implants: Implications for Surgical Technique and Implant Design

Allen MJ¹; Miller MA²; Khorasani MS²; Townsend KL¹; Mann KA²

(1)Veterinary Clinical Sciences, The Ohio State University, Columbus, OH, (2)Orthopedic Surgery, SUNY Upstate Medical University, Syracuse, NY

Introduction: The long-term performance of canine total knee replacement (TKR) implants is currently unknown. The aim of this study was to characterize the structure and mechanical properties of the implant-cement-bone interfaces in cemented canine tibial components. We hypothesized that (1) interface micromotion would be similar to that in human TKR, and (2) there would be differences in the structure of the cement mantle in dogs versus humans.

Materials and Methods: Tibial components were retrieved from 5 dogs one year following cemented TKR 5mm-thick sagittal sections through the medial and lateral articular surfaces were radiographed, stained and the implant-cement and cement-bone interfaces characterized by light microscopy. Axial loads were then applied and micromotion quantified using digital image correlation. Comparisons were made against four human cemented retrieval specimens.

Results: Cement-bone interdigitation was good to excellent along the keel but variable beneath the implant. Cement cracks were commonly seen adjacent to the sharp cornered laser undercuts in the UHMWPE. Micromotion was similar in canine and human retrievals. There was greater micromotion on the lateral side compared to the medial side ($p=0.004$).

Discussion/Conclusion: Cement interdigitation is impeded by the higher density of canine subchondral bone. Keyholes should be used to improve cement access into the proximal tibia. The clinical significance of cement cracking is unclear, but design changes to the fixation surface of the UHMWPE implant could improve cement mantle integrity and promote long-term stable fixation.

Acknowledgments: Implants provided by BioMedtrix LLC.

26 The Effect of Tibial Tuberosity Advancement and Meniscal Release on Stability of the Cranial Cruciate Deficient Stifle throughout Stance Phase – Mark S. Bloomberg Resident Research Award

Butler JR¹; Syrcle JA¹; McLaughlin RM¹; Elder SH²

(1)College of Veterinary Medicine, (2)Department of Agriculture and Biological Engineering, Mississippi State University, Mississippi State, MS

Introduction: Tibial tuberosity advancement (TTA), while commonly used to treat cranial cruciate (CrCL) deficient stifles, has been reported to result in a high rate of subsequent meniscal injury and progressive osteoarthritis following surgery. In this study, stifle stability following TTA was evaluated throughout the stance phase to investigate possible causes for postoperative complications.

Materials and Methods: 18 cadaveric pelvic limbs were evaluated under the following treatment conditions: intact CrCL, deficient CrCL, TTA-treated (CrCL deficient + TTA), and meniscal release (TTA treated + meniscal release). Limbs were loaded with 30% bodyweight and a hinge plate was used to advance the tibial tuberosity to a patellar tendon angle (PTA) of 90° relative to the tibial plateau at 135° of stifle flexion. The limbs were evaluated in early, middle and late stance using electromagnetic tracking sensors to determine cranial tibial thrust and tibial axial rotation.

Results: Transection of the CrCL resulted in significant cranial tibial thrust during early, middle, and late stance ($P<0.0001$) and internal rotation during early ($P=0.049$) and middle stance ($P=0.0006$). TTA successfully eliminated cranial tibial thrust in early, middle, and late stance ($p<0.0001$) but was unsuccessful in normalizing axial rotation in middle stance ($P=0.030$). Meniscal release had no effect on stifle stability when performed in conjunction with TTA.

Discussion/Conclusion: TTA effectively eliminated cranial tibial thrust throughout stance when performed as described. TTA did not consistently normalize axial rotation although the magnitude of axial rotation was small and of questionable clinical significance. Further research is warranted to evaluate the biomechanical effects of TTA when using the femorotibial tangent as a reference in surgical planning and under additional loading conditions such as further extension of the stifle joint or activity other than straight-line walking.

Acknowledgments: This project was funded by an internal research grant from the College of Veterinary Medicine, Mississippi State University.

27 Contact Mechanics of Normal Dog Elbows: An ex vivo Study – Mark S. Bloomberg Resident Research Award

Cuddy LC; Pozzi A; Lewis DD; Kim SE; Conrad BP; Horodyski MB; Banks S; Fitzpatrick N

Comparative Orthopaedics and Biomechanics Laboratory, University of Florida, Gainesville, FL

Introduction: Antebrachial rotation has been implicated in the development of medial coronoid disease. Ex vivo contact mechanics of normal dog elbows have been investigated at one pose using qualitative methods. The purpose of this investigation was to determine the effects of antebrachial rotation at three elbow flexion angles on the contact mechanics of normal dog elbows.

Materials and Methods: Unpaired thoracic limbs were harvested from 18 dogs (mean body weight 282 kg). Digital pressure sensors measured contact area, mean contact pressure and peak contact pressure in the medial and lateral elbow compartments with the limb under 200 N axial load. Each specimen was tested at each flexion angle (115°, 135°, 155°) with the antebrachium in neutral, 28° supination and 16° pronation. Repeated measures analysis of variance with Bonferroni post-hoc correction was used for statistical comparison, with $p = 0.05$ considered statistically significant.

Results: Contact area was significantly higher in the lateral (58–64%) compared with the medial (36–42%) compartment. There was no significant difference in mean or peak contact pressure between compartments. Antebrachial rotation decreased contact area and increased mean contact pressure in both compartments. Elbow flexion increased mean and peak contact pressure in both compartments, with corresponding decreases in elbow extension.

Discussion/Conclusion: Contact mechanics of normal dog elbows significantly alter with changes in elbow pose. This model may be used for future investigation of altered elbow biomechanics in pathologic states and effects of surgical procedures.

Acknowledgments: Funded by University of Florida College of Veterinary Medicine Faculty Research Grant.

28 Effect of Articular Design on Mediolateral Constraint and Stability of Two Unlinked Canine Total Elbow Prostheses – Mark S. Bloomberg Resident Research Award

Guillou RP¹; Demianiuk RM¹; DeJardin LM¹; Beckett C²; Haut RC²

(1)College of Veterinary Medicine, (2)College of Osteopathic Medicine, Michigan State University, East Lansing, MI

Introduction: Short and long term stability of the unlinked, semi-constrained IOWA and TATE prostheses is influenced by their articular congruity. While a less congruent design spares bone/implant interfaces from deleterious stresses, it may impair prosthetic stability. To optimize osteointegration, a low congruity TATE-2 profile was recently released; however optimal prosthesis constraint is unknown. Our purpose was to compare IOWA and TATE behavior under mediolateral translation. We hypothesized that constraint and stability would be greatest in IOWA and lowest in TATE-2 profiles.

Materials and Methods: Four prostheses per group were tested in mediolateral translation. Loading conditions mimicked those of a trotting 40kg dog in mid-stance. Stiffness (a reflection of prosthetic constraint) and maximum resistive force (an indication of prosthetic intrinsic stability) were statistically analyzed ($p < 0.05$).

Results: Compared to IOWA and TATE-1, TATE-2 stiffness was at least 30 and 20 times smaller, respectively ($p < 0.001$). Regardless of direction, IOWA maximum resistive force was 30% and 100% greater than TATE-1 and TATE-2, respectively ($p < 0.001$). Similarly, TATE-1 resistive force was ~50% greater than TATE-2 in both directions ($p < 0.001$).

Discussion/Conclusion: Despite IOWA greater intrinsic stability, the reported 10% postoperative luxation suggests that collateral desmotomy during implantation offsets the potential benefit of congruent designs. Conversely, the conservative TATE implantation may explain the lack of postoperative luxation with less congruent TATE profiles. Reducing TATE-2 congruity significantly decreased prosthetic constraint. Theoretically, this could spare bone/implant interfaces from deleterious shear stresses that may subsequently enhance bone ingrowth and long-term stability.

Acknowledgments: Michigan State University Companion Animal Fund and BioMedtrix LLC.

29 Axial Stiffness of Incomplete and Complete Single Ring Circular External Skeletal Fixator Constructs – Mark S. Bloomberg Resident Research Award

Hudson C¹; Lewis DD¹; Pozzi A¹; Horodyski MB²

(1)Small Animal Clinical Sciences, University of Florida, Small Animal Hospital, Gainesville, FL, (2)Department of Orthopaedics and Rehabilitation, College of Medicine, University of Florida, Gainesville, FL

Introduction: Circular external skeletal fixators often incorporate incomplete rings when juxta-articular ring placement has the potential to interfere with joint range of motion. The purpose of this study was to evaluate axial stiffness of single ring constructs. We hypothesized that complete ring constructs would display greater axial stiffness than incomplete ring constructs and that stiffness would be positively correlated with increasing wire tension.

Materials and Methods: Single ring constructs were constructed using 5/8 and complete rings (50, 66, 84, 118 mm), and 4 wire tensions (0, 30, 60, and 90 kg). Constructs were axially loaded in an MTS. Stiffness was calculated from construct load displacement curves.

Results: Complete ring constructs were stiffer than 5/8 ring constructs overall. Smaller rings were stiffer than larger rings. Increasing wire tension to 60 kg increased construct stiffness in 5/8 ring constructs. Tensioning to 90 kg resulted in construct failure in 50, 66, and 84 mm rings.

Discussion/Conclusion: Mechanical performance of 5/8 ring constructs improved when tensioned to 60 kg but does not match that of complete rings. We recommend tensioning larger (84, 118 mm) incomplete rings in clinical patients. **Acknowledgments:** IMEX Veterinary Inc. provided materials free of charge for this study.

30 Biomechanical Comparison of Three Standard and Five Locking Plates with Four-Point Bending to Failure – Mark S. Bloomberg Resident Research Award

Blake CA¹; Boudrieau RJ¹; Torrance BS¹; Tacvorian EK²; Cabassu J¹; Gaudette GR²; Kowaleski MP

(1)Department of Clinical Sciences, Tufts University Cummings School of Veterinary Medicine, North Grafton, MA, (2)Biomedical Engineering, Worcester Polytechnic Institute, Worcester, MA

Introduction: Evolution of internal fixation has led to development of many locking bone plate systems. This study compared biomechanical properties of standard plates and recently designed locking plates in bending. We hypothesized the SOP™ to have the highest stiffness and strength and those composed of titanium (Ti) to have the lowest.

Materials and Methods: DCP®, stainless steel (SS) LC-DCP®, Ti LC-DCP®, LCP®, ALPS 10 and 11, SOP™ and Fixin plates were evaluated with rigid extension segments and again with a validated bone model simulating a comminuted fracture. Bending stiffness, bending structural stiffness and bending strength were compared: 1-way ANOVA with post-hoc Tukey ($P < 0.05$).

Results: Bending stiffness and structural stiffness of the SOP™ was significantly greater than all other plates, and the Ti LC-DCP®, ALPS 10 and Fixin significantly less than the remaining plates. The SOP™ was significantly stronger than all other plates; however, the remaining plates did not follow a similar pattern. None of these characteristics were maintained when compared as constructs.

Discussion/Conclusion: These data suggest that the plate/screw/bone interface affects the biomechanical properties of the differing implant designs. Our hypothesis was not supported because no consistent differences were found between the various constructs. Due to differing plate construct properties, identical approaches to fracture management and plate application cannot be applied.

Acknowledgments: Implants and financial support provided by: Kyon, Zürich, Switzerland; Orthomed, Halifax, West Yorkshire, UK; Synthes Vet, Paoli, PA, USA; TraumaVet SRL, Rivolito, Italy.

31 Biomechanical Changes of the Equine Carpus after Removal of the Second Metacarpal Bone – Mark S. Bloomberg Resident Research Award

Amend KS¹; Baxter GM¹; Hubert JD¹; Kawcak CE¹; Santoni BG²; McGilvray KC²; Rao S¹

(1)Department of Clinical Sciences, (2)Department of Mechanical Engineering, Colorado State University, Fort Collins, CO

Introduction: Little is known about what role that the small metacarpal bones play in the biomechanical stability of the carpus. The goal of this study was to quantify the changes in biomechanical forces within the carpus after removal of 50, 80, and 100% of the second metacarpal bone (MCII). It was hypothesized that removing more than two-thirds of MCII would change the torsional and compressive loading of the carpus resulting in displacement of the second, third and radiocarpal carpal bones.

Materials and Methods: Sixteen cadaveric equine forelimbs were tested in a servo-hydraulic material testing machine. Stereophotometric techniques using reflective triads placed in the carpal bones, metacarpal bones and radius were

used to evaluate each individual bone's kinematic motion during loading cycles. Samples were loaded in compression and compression+torsion in the intact limb and after removing 50, 80 and 100% of MCII. Load-displacement (compression) and torque-angle (torsion) curves were constructed for each test. The slope of the linear (elastic) portion of each curve was used to determine compressive and compression+torsional stiffness of the carpus.

Results: A significant decrease in compressive+torsional stiffness was found only after 100% removal of MCII. Removing 80% of MCII had little effect. Compressive stiffness of the carpus did not change after MCII removal.

Discussion/Conclusion: The most significant biomechanical alteration was found when MCII was removed completely and the limb loaded in both compression and torsion.

Acknowledgments: This project was funded by the ACVS Resident-in-Training Grant.

32 Comparison of the Mechanical Behaviors of Locked and Non-Locked Plate/Screw Fixation Applied to Experimentally Induced Rotational Osteotomies in Canine Iliac – Mark S. Bloomberg Resident Research Award

Case JB¹; Dean C²; Wilson D¹; Knudsen J¹; James SP²; Palmer R¹

(1)Clinical Sciences, College of Veterinary Medicine, (2) Mechanical Engineering, Colorado State University, Fort Collins, CO

Introduction: Pelvic fractures account for 20–30% of fractures in dogs and osteotomies like the triple pelvic osteotomy (TPO) procedure are commonly performed for treatment of canine hip dysplasia (CHD). Premature loss of fixation is common. Our purpose was to compare the mechanical behaviors of two locked versions and one non-locked version of 20° plate/screw fixation applied to rotational osteotomies in canine ilia under the conditions of static and cyclic loading of the acetabula.

Materials and Methods: Comparison #1 – Non-Locked screws 20° TPO (NL-20) construct vs. Locked Parallel screws 20° TPO (LP-20) construct. Comparison #2 – LP-20 construct vs. Locked Diverging screws 20° TPO (LD-20) construct. Stiffness, screw loosening, osteotomy gap displacement, yield load, yield displacement, maximum load, load to failure, and failure mode were determined.

Results: Screw loosening was significantly more frequent for NL-20 versus LP-20 ($p=0.01$) and for LD-20 versus LP-20 constructs ($p=0.02$). The relative risk for screw loosening with NL-20 constructs versus LP-20 constructs was 1.4 (95% CI=1.1–1.8). The relative risk for screw loosening with LD-20 versus LP-20 was 1.6 (95% CI=1.1–2.2). Yield load was significantly greater for LP-20 versus NL-20 and LD-20 constructs ($p=0.04$, $p=0.03$), respectively.

Discussion/Conclusion: Screw loosening was significantly reduced and yield loads were significantly larger for LP-20 plate/screw construct. Use of LP-20 plate/screw fixation for triple pelvic osteotomy should reduce the incidence of screw loosening and plastic deformation in the early postoperative period compared to NL-20 and LD-20 constructs.

Acknowledgments: New Generation Devices provided implants.

33 Canine Common Calcaneal Tendon Augmentation with Degradable Mesh: A Biomechanical Study

Murphy SM¹; Kuhlman S²; Dowdell T¹

(1)West Vet Emergency and Specialty Center, Boise, ID, (2)Boise State University, Center for Orthopedic and Biomechanics, Boise, ID

Introduction: Our aim was to evaluate a synthetic degradable mesh (Artelon® Vastra Frolunda, Sweden) in distal calcaneal tendon repair.

Materials and Methods: Eight paired cadaveric tendons were randomly assigned to receive mesh or suture repair alone. Non-augmented repair consisted of two distal locking loop sutures and a proximal modified three-loop pulley placed in the tendon and calcaneus. For the augmented group, mesh was secured to the tendon and calcaneus then same repair performed. Specimens were cycled at 10N before load to failure at 25 mm/min with synchronized video to evaluate

gap formation. Statistical analysis was performed using a two-tailed Student's t-Test ($p<0.05$).

Results: Load to initiate gap and load at 1 and 9mm gaps were not significantly different (161 vs. 99N, 218 vs. 139N, 433 vs. 220N) between augmented and non-augmented repairs respectively, while ultimate load and load at 3 and 5mm gaps were significant (476 vs. 291N, 296 vs. 196N and 358 vs. 221N). Partial construct failure allowed for evaluation of only 14 and 6 samples at 5 and 9mm gaps, respectively.

Discussion/Conclusion: Mesh augmentation produces an ex vivo repair with higher ultimate load that better resists moderate levels of gap formation. In the clinical scenario, the degradable mesh may improve strength while providing a scaffold for tissue ingrowth but effect on blood supply and tendon healing is unknown. A pilot study has been completed with good long-term results and a multicenter trial is currently underway to evaluate mesh augmentation vs. suture repair alone.

Acknowledgments: Biomedtrix and Artimplant for funding and materials.

34 A Retrospective Study Tears of the Manica Flexoria Treated by Tenoscopic Surgery: 34 Cases

Findley JA; Bladon BM

Donnington Grove Veterinary Surgery, Newbury, United Kingdom

Introduction: Tears of the manica flexoria are the second most frequent cause of non-septic tenosynovitis (Smith and Wright 2006). The prognosis has not been reported.

Materials and Methods: Horses treated for tears of the manica flexoria were identified. The age, breed, and sex of the horse, duration of lameness, affected limb, nerve blocks, effusion, flexion response, and ultrasonographic findings were recorded, as were the surgical findings, annular ligament transection and postoperative performance.

Results: 32 horses underwent surgery on 38 occasions. Six underwent a second surgery, 4 for continuing lameness, and 2 for lameness in another limb; 34 separate cases. All had tendon sheath effusion and in all limb flexion exacerbated lameness ($n=20$). Intrathecal analgesia resulted in > 50% improvement in 80% cases ($n=16$). Ultrasonographic images ($n=26$) revealed a thickened manica flexoria in 6 cases. Cobs (17) and ponies (11) were overrepresented compared to the hospital population, $p=0.02$. 28 (82%) of tears occurred in hindlimbs. Of 32 with follow up, 4 are lame, 2 have reduced exercise level, 26 (84%) have returned to pre-operative use.

Discussion/Conclusion: The prognosis for horses with tears of the manica flexoria following tenoscopic resection was good. Cobs and ponies were more likely to be afflicted. The sensitivity of ultrasonography was low, 23%.

Acknowledgments: None.

35 Mechanical Testing of Lateral Circumfabellar Suture, Tightrope CCL, and SwiveLock Bone Anchor for Extracapsular Stabilization of the Cranial Cruciate Ligament Deficient Stifle in Dogs

Choate CJ; Pozzi A; Lewis DD; Conrad BP; Hudson CC

Department of Small Animal Clinical Sciences, University of Florida College of Veterinary Medicine, Gainesville, FL

Introduction: The purpose of this study was to perform an in vitro mechanical analysis of five methods and materials used clinically for femoral anchorage of extracapsular prostheses for stabilization of cranial cruciate ligament deficient stifles.

Materials and Methods: Fifty femurs were randomly assigned to five treatment categories: single strand of Fiberwire anchored around the fabella, double strands of 36 kg test nylon leader material anchored around the fabella and secured with crimps, single Tightrope, double Tightrope, or 5.5mm SwiveLock with FiberTape. Stress relaxation, creep, stiffness, and load to failure were

measured using a mechanical testing machine. Ten isolated loops of each prosthetic material were subjected to the same mechanical testing procedure.

Results: Circumfabellar Fiberwire had the greatest creep (1.34 ± 0.61 mm) and stress relaxation (106.1 ± 9.4 N) and lowest stiffness (67.8 ± 15.6 N/mm) and load to failure (521.3 ± 19.73 N). Circumfabellar Fiberwire had greater creep and stress relaxation than isolated loops of Fiberwire (0.62 ± 0.30 mm, 82.1 ± 2.2 N). Circumfabellar nylon leader material had greater creep (0.61 ± 0.16 mm) and stress relaxation (77.4 ± 15.0 N) than isolated loops of nylon leader material (0.27 ± 0.02 mm, 49.7 ± 2.2 N). The double Tightrope had the highest load to failure (1356.7 ± 303.6 N).

Discussion/Conclusion: Due to poor mechanical characteristics and knot security, Fiberwire is not recommended for extracapsular stabilization. Circumfabellar anchoring techniques increased the creep and stress relaxation of the femoral preparations, but did not affect the load to failure. Further study is needed to evaluate the long term-effect of the method of femoral attachment on deformation of the stabilization system.

Acknowledgments: Implant materials for this study were provided by Arthrex (Fiberwire, FiberTape, Tightrope CCL systems, and SwiveLock systems) and Securos (nylon leader systems and crimp systems).

36 Single Cycle to Failure in Torsion of 3 Standard and 5 Locking Plate Constructs

Cabassu JB¹; Kowaleski MP¹; Blake CA¹; Shorinko JK²; Gaudette GR²; Boudrieau RJ¹

(1)Small Animal Surgery, Tufts University, North Grafton, MA, (2)Biomedical Engineering, Worcester Polytechnic Institute, Worcester, MA

Introduction: Evolution of internal fixation has led to development of a variety of locking bone plate systems. This study compared biomechanical properties of standard plates and recently designed locking plates in torsion. We hypothesized that titanium (Ti) constructs would have the greatest deformation and SOP™ constructs the greatest strength and stiffness.

Materials and Methods: DCP®, stainless steel (SS) LC-DCP®, Ti LC-DCP®, LCP®, ALPS10 and11, SOP™ and Fixin plates were fixed to a validated bone model simulating a comminuted fracture. Yield torque (strength), yield angle (deformation) and stiffness were compared: 1-way ANOVA with post hoc Tukey tests ($p < 0.05$).

Results: ALPS11 constructs had significantly greater deformation than all constructs except ALPS10. No differences in strength were observed except for the ALPS10 constructs ($< SOP™$, LCP®, DCP® and ALPS11 constructs). No differences in constructs stiffness were observed with SS LC-DCP®, DCP®, LCP® and SOP™ constructs, but all had greater stiffness than all remaining constructs. The ALPS10 construct had lower stiffness than all constructs.

Discussion/Conclusion: Modulus of elasticity of Ti explains the higher deformation and lower stiffness of these systems, with similar results for the Fixin due to its lower cross-sectional area. SOP™ and standard constructs had surprisingly similar biomechanical properties in torsion. Rationale for selecting some of these different implants for fracture repair likely needs to be modified depending upon fracture configuration and implant type chosen.

Acknowledgments: Kyon, Zürich, Switzerland; Orthomed, Halifax, West Yorkshire, UK; Synthes Vet, Paoli, PA, USA; TraumaVet SRL, Rivolito, Italy.

37 The Effect of Minimally Invasive Plating Osteosynthesis and Open Plating Techniques on the Extrasosseous Blood Supply of the Canine Radius

Garofolo SQ; Pozzi A

Department of Small Animal Clinical Sciences, University of Florida, College of Veterinary Medicine, Gainesville, FL

Introduction: This study compared the effects of minimally invasive plating osteosynthesis (MIPO) and an open plating technique (ORIF) on preservation of extrasosseous blood supply of the canine radius using anatomical microdissection.

Materials and Methods: Twelve unpaired limbs were prepared, injected with contrast medium, and then microdissected. Twelve paired limbs were used to compare the two surgical plating techniques; either MIPO or open plating was performed on paired radii. After surgery, the limbs were prepared and injected using the same methodology as normal limbs. Extravasation and periosteal filling was scored and results were compared between the two groups using Wilcoxon matched-pairs signed rank test (significance set at $p < 0.05$).

Results: The ORIF group showed significantly greater extravasation than MIPO specimens ($p = 0.0109$). For each zone, all thoracic limbs in the MIPO group demonstrated significantly greater periosteal filling compared to those in the ORIF group (Zone 1, $p = 0.0369$; Zone 2, $p = 0.0064$; Zone 3, $p = 0.0028$; Zone 4, $p = 0.0036$).

Discussion/Conclusion: All specimens in the MIPO group exhibited superior periosteal filling and vascular integrity compared to the ORIF group. In this cadaveric model, the MIPO technique preserved extrasosseous blood supply of the canine radius to a greater extent than the conventional open plating technique.

Acknowledgments: The authors did not receive any financial compensation for this study.

Part II to follow in the next issue.