

## Veterinary Orthopedic Society 37th Annual Conference Abstracts

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### Part II

#### 42 Radiographic Evaluation of Proximal Radial Head Rotation/Subluxation in Surgically Managed Patients with Angular Limb Deformities

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**Introduction:** A: to evaluate cases of angular limb deformity ALD, record the prevalence of proximal radial rotation/subluxation RS and corection, B: illustrate a method for evaluation of the proximal radial position via CT in vivo.

**Materials and Methods:** A: The radiographs of 14 dogs with ALD were reviewed for proximal radial RS. Classifications were: 0 normal, 1 mild RS, 2 RS. B: CT was performed on 3 normal dogs, one in both pronation and supination. On transverse slices lines were drawn: A across the widest part of the humeral condyles bisecting the collateral ligament insertions. B following the anatomical axis of the humerus, C tangential to the cranial cortex of the radius across the fovea. D bisecting the cranial eminence of the ulnar notch and the medial eminence of the abductor pollicis longus groove. These 4 lines were superimposed and the angles between lines measured: Proximal radius to humeral condyles PRHC, distal radius to humeral condyles DRHA and humeral shaft and olecranon to humeral condyles HAHC.

**Results:** A: Of the 14 cases 11 had radial head RS. Surgery was performed on 12 cases. Pre-operatively, 3 patients were designated grade 0, 5 grade 1 and 4 grade 2. Post-operatively 7 patients were designated grade 0, 3 grade 1, and 2 grade 2. Statistical improvement was seen in dogs that with either grade 1 or 2 RS pre-op mean grade 0.96 compared with their post operative grades, mean grade 0.56,  $P < 0.02$ . B: PRHC 164° DRHC 163° HAHC 93° PRHC Supination/pronation 165°/143°, Supination/pronation DRHC 163°/147°.

**Discussion/Conclusion:** A: Patients with ALD often demonstrate radial head RS. Improvement in RS was seen in clinical cases using subjective means of evaluation. CT has the potential to more accurately evaluate these changes.

**Acknowledgments:** This study did not receive any financial support, the authors have no proprietary interests.

#### 43 Prevalence of Incomplete Ossification of the Humeral Condyle in the Limb Opposite Humeral Condylar Fracture: 14 Dogs

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**Introduction:** Incomplete ossification of the humeral condyle (IOHC) has been suggested to be a primary cause for humeral condylar fracture (HCF) in the adult dog. The objectives of this study were to determine the frequency of IOHC in the leg opposite unilateral, atraumatic HCF in mature dogs and determine the sensitivity of radiographs as a diagnostic tool for IOHC.

**Materials and Methods:** Computed tomography and radiographs were obtained for both elbows of 14 dogs presenting with unilateral HCF. The images were evaluated by two radiologists and the prevalence of IOHC in the limb opposite HCF was identified. Sensitivity and specificity of radiographic diagnosis of IOHC was determined using CT as the diagnostic gold standard.

**Results:** IOHC was present in 6/14 dogs but IOHC was incomplete in 3/6 affected dogs. Plane radiographs had a sensitivity of 83% and specificity of

100%. The Kappa coefficient between radiologists for radiographic examination was 0.714. Of the Spaniel breeds 4/8 had IOHC in the limb opposite HCF. Biopsies of the intercondylar region of HCF were consistent with fibrosis nonunion.

**Discussion/Conclusion:** CT evaluation is more sensitive than radiographs for diagnosis of IOHC, particularly when assessing partial or incomplete IOHC. However, the sensitivity of radiographic diagnosis is very good and should be adequate in most cases. Clinical suspicion of IOHC in the limb opposite unilateral HCF should be present; however overall prevalence may not be as high as previously reported.

**Acknowledgments:** Funding was provided in part by the University of Minnesota Companion Animal Fund.

#### 44 Care-Giver Placebo Effect in Dogs with Osteoarthritis

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**Introduction:** Subjective measures such as owner questionnaires are commonly used and while useful, they add *bias*. That bias is called the care-giver placebo effect. In uncontrolled studies the bias may inflate or deflate the perceived effect of treatment thereby causing unwarranted changes in clinical practice. The objective of this study was to document the care-giver placebo effect in dogs with lameness from OA.

**Materials and Methods:** The was a prospective, randomized, placebo-controlled study of dogs with >grade 2 lameness from OA. Lameness was defined as improved, or worse, if GRFs increased, or decreased, by 5% on at least 2 of 3 post-intervention exams. Owner survey and veterinary exam were compared to GRF. An owner/veterinarian had a correct response on a questionnaire if they stated the dog was improved and they correctly matched any of the GRF changes or if they stated the dog had not changed and there was no change. An observer had a care-giver placebo response if they stated the dog was improved and the dog had not improved or had worsened.

**Results:** 12.1% of the dogs had lameness that had improved and 8.6% had lameness that had worsened. For the owner question addressing quality of life, 56.9% of responses were placebo responses. For the owner question addressing lameness, 53.4% of responses were placebo responses. For the veterinary exam, lameness and pain were underestimated 51.7% of the time and underestimated 15.5% of the time.

**Discussion/Conclusion:** The care-giver placebo effect is important because treatments may be perceived as more effective than reality and can lead to increased patient morbidity, financial and time burden on the care-giver, and diverts resources from research into treatments that may benefit the patient. Studies with control groups may mitigate the care-giver placebo effect.

**Acknowledgments:** Novartis Animal Health provided the data for this study.

#### 45 The Use of Delayed Gadolinium Enhanced Magnetic Resonance Imaging and T2 Mapping to Evaluate Articular Cartilage in the Canine Elbow

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**Introduction:** Currently available diagnostic tools to evaluate articular cartilage lack the sensitivity and objectivity to measure early degenerative changes. Two techniques using MRI have been developed to detect changes in the biology of articular cartilage: delayed gadolinium-enhanced MRI of cartilage (dGEMRIC) and T2 mapping. Both techniques have been validated and are being used to study the degenerative and adaptive nature of articular cartilage in humans, but no such study has been done in canines.

**Materials and Methods:** This study evaluated the articular cartilage in the region of the medial coronoid process (MCP) of six healthy research dogs free of clinical

cally detectable orthopedic disease using both MRI techniques. Force plate gait analysis was done prior to anesthesia. Histology and proteoglycan (PG) content of the MCP were used to confirm normal articular cartilage post mortem.

**Results:** Five dogs had histologically normal cartilage. PG content in these dogs were similar to previously reported PG content in normal articular cartilage. Both dGEMRIC indexes and T2 values fell into a range similar to what is seen in normal cartilage in other species.

**Discussion/Conclusion:** T2 mapping and dGEMRIC scores for normal cartilage in the elbow of the dog can be reproducibly generated using a 3T MRI. These techniques can be used as objective outcome measures for clinical studies in dogs with conditions associated with the development of osteoarthritis.

**Acknowledgments:** none

#### 46 BioScaffold Device Reduces Pain and Lameness in Dogs with Osteoarthritis

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**Introduction:** It is well accepted that current pharmaceutical management of canine osteoarthritis has substantial limitations. A new medical device (bioscaffold) has been recently developed that is non-immunogenic and structurally resembles tertiary embryonic connective tissue. Cells infiltrating the bioscaffold up-regulate numerous tissue repair factors which induce fetal like repair mechanisms consistent with tissue regeneration. It was hypothesized the bioscaffold would alleviate clinical signs of osteoarthritis owing to its structural properties and comprehensive effects on infiltrating cells.

**Materials and Methods:** This was a 90-day historically controlled study in nine dogs (20 joints) with medically refractory osteoarthritis of the coxofemoral and/or cubital joints. Each patient received a single bioscaffold implant and was evaluated at baseline and Days 30, 60 and 90 using a standardized orthopedic visual analog scale for lameness, range of motion, and pain. Patients were evaluated at the same time-points by owners using a standardized visual analog scale for disability.

**Results:** The bioscaffold implant resulted in statistically significant clinical improvements in lameness ( $p=0.004$ ), range of motion ( $p=0.001$ ), pain ( $p<0.001$ ), and owner assessments ( $p<0.001$ ) with no dissipation of effect at 90 days.

**Discussion/Conclusion:** We conclude this new implant should be a consideration for management of musculoskeletal disorders of the joint. Further studies are warranted to examine the duration of effect and comparison to other modalities.

**Acknowledgments:** N/A

#### 47 Can Goniometry Be Used to Detect the Presence of Lameness in Dogs with Chronic Elbow Osteoarthritis?

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**Introduction:** The purpose of the present study was to assess if elbow joint range of motion (ROM) is useful in diagnosing lameness in dogs with chronic elbow osteoarthritis (OA).

**Materials and Methods:** Twenty-one client owned dogs with documented OA and 6 dogs without evidence of OA were evaluated. Ground reaction forces were determined for each dog at a trot. Goniometric measurements of comfortable ROM of the elbow were made in non-sedated dogs. Total ROM was calculated by subtracting flexion from extension. ROM and ground reaction force data were compared between groups using t test, and median test when applicable. The usefulness of goniometric measurements in diagnosing lameness in dogs with chronic elbow OA was assessed, along with the agreement between ROM and peak vertical force in diagnosing lameness.

**Results:** ROM and ground reaction forces were significantly different between groups with normal dogs having greater ROM and peak vertical force (PVF).

There were no significant differences in diagnostic accuracy between PVF and any of the ROM values. All tests to assess agreement between PVF and ROM measurements in this population showed statistically significant and substantial agreement in diagnosing lameness.

**Discussion/Conclusion:** Goniometric ROM measurements of the elbow may provide a useful tool to determine lameness in dogs with chronic elbow arthritis. Goniometry is cost effective, easily learned and provides the clinician with objective data which may be useful when subtle lameness exists and force plate analysis is not available.

**Acknowledgments:** N/A

#### 48 Pharmacokinetics of Intra-Articular Methylprednisolone Acetate and Endogenous Hydrocortisone Suppression in Exercising Horses

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**Introduction:** The purpose of the study was to determine the pharmacokinetics of IA administered Methylprednisolone Acetate (MPA) and associated hydrocortisone (HYD) suppression in exercising horses following IA administration of MPA in two (low dose of 100mg) or three (high dose 200 mg) different joints to mimic clinical use.

**Materials and Methods:** Five fit horses were subjected to an exercise program on the treadmill and injected intrasynovially with two different doses of MPA into different joints. Plasma and urine MP and HYD were measured by HPLC method. Non-compartmental pharmacokinetic parameter estimates were generated in WinNonlin (v. 5.2, Pharsight Corp.)

**Results:** New reference ranges of MP for exercising horses, with more sensitive detection methods, and multiple joint administration of 100mg or 200mg MPA were generated. For the 100 mg dose, plasma MP  $C_{max}$  was 5.07 ng/ml,  $T_{max}$  12 hrs, and  $T_{last}$  168 hrs. For the 200 mg dose, plasma MP  $C_{max}$  was 5.63 ng/ml,  $T_{max}$  13.2 hrs, and  $T_{last}$  384 hrs. In Protocol B, the MPA dose was doubled, but less than 2-fold increases in  $C_{max}$  and AUC were observed, indicating nonlinear pharmacokinetics of MP after IA administration of MPA within the evaluated dose range. HYD in plasma decreased to below detection values within 12 hours and remained suppressed for at least 36 hrs indicating profound, predictable HYD suppression with either dose.

**Discussion/Conclusion:** Our reference values will provide new parameters for the development of steroid drug detection and withdrawal recommendations in sport horses. Plasma is as effective as urine in setting detection limits. Our study used sensitive assays, conditioned exercising horses, and drug distribution among multiple joints. Plasma HYD concentration can accurately serve as a nonspecific steroid-screening.

**Acknowledgments:** We would like to thank Emily Falk, Carissa Norquest and Dr Elijah Hothem for professional assistance and Pfizer and USEF for funding the study.

#### 49 Equine Specific Protein Expression in Autologous Conditioned Serum: A Comparison of Two Commercial Methods (IRAP<sup>®</sup> and IRAP II<sup>®</sup>)

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**Introduction:** Joint disease, specifically osteoarthritis (OA), is one of the most prevalent and debilitating conditions affecting horses. Autologous conditioned serum (ACS), commercially available as IRAP<sup>®</sup> and IRAP II<sup>®</sup>, is a therapy for OA, venous blood is incubated with medical-grade borosilicate beads for 24 hours, after which the ACS is harvested. It has previously been reported that this process serves to both physically and chemically stimulate the production of inflammatory and anti-inflammatory cytokines, resulting in higher concentrations in the

isolated serum. ACS has been reported to be beneficial in the treatment of osteoarthritis and rheumatoid arthritis as well as muscle, tendon and ligament injuries in humans, in addition to osteoarthritis in horses. The objective of this study was to determine levels of inflammatory and anti-inflammatory cytokines in equine whole blood incubated with the IRAP and IRAP II compared to levels found in baseline serum.

**Materials and Methods:** Whole blood drawn into an IRAP<sup>a</sup> syringe, IRAP II<sup>b</sup> centrifuge tube or serum tube. IRAP and IRAP II were processed and baseline serum and ACS were aliquoted and stored. Cytokine concentrations were measured.

**Results:** Differences were seen comparing baseline serum to ACS independent of processing system (IRAP and IRAP II). In addition, an increase in beneficial cytokines with no significant increase in detrimental cytokines was observed with IRAP II.

**Discussion/Conclusion:** These results in equine ACS are different when compared to the human data, underscoring the need for species specific studies.

a. Dechra, Orthogen Veterinary, Dusseldorf, Germany

b. Arthrex, Inc. Bonita Springs, FL

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## Poster Presentations

### 50 Effects of Agility Exercise on Urinary Eicosanoid Metabolite Excretion in Dogs

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**Introduction:** Exercise induces an inflammatory response that alters eicosanoid production in humans and horses. The purpose of this study was to determine the effects of agility exercise on eicosanoid production in dogs and whether skill level has any effect.

**Materials and Methods:** Competing agility dogs were examined and their skill level recorded, n=15. Each dog ran a course 3 times (5' rest between runs) consisting of 15 obstacles. Prior to, immediately- and 4 hours- following exercise urine was collected. Urine thromboxane B2 (TXB2), 6-keto prostaglandin F1a (PGF1a, prostacyclin), prostaglandin E2 metabolites (13,14-dihydro-15-keto-prostaglandin A2 and 13,14-dihydro-15-keto-prostaglandin E2), and 13,14-dihydro-15-keto-prostaglandin F2a were determined using a competitive enzyme immunoassay and standardized by division with urine creatinine (CR, mg/dl, competitive enzyme immunoassay).

**Results:** Urinary TBX2 tripled following exercise (mean  $\pm$  SEM, pre 4.56, post 11.76, 4 hour post 14.91 pg/ml/mg/dl CR, 1-way ANOVA, P=0.005) with a significant increase in masters dogs (pre 4.55  $\pm$  0.62, post 8.35  $\pm$  1.06, 4 hour post 15.27  $\pm$  2.76, P=0.0097) but not in novice or intermediates (P>0.05, 1-way ANOVA). The other eicosanoids were not affected by exercise (1-way ANOVA, P>0.05).

**Discussion/Conclusion:** Increased TXB2 production without concomitant increase in prostaglandin E2 or PGF1a has not been reported in dogs. The dogs with the greatest skill level (and fastest run time) had a significantly greater increase in TXB2. Future research to determine why improved performance is associated with increased TXB2 production is warranted.

**Acknowledgments:** There was no proprietary interest in this study. Intramural departmental funds were used for supplies.

### 51 Agility Exercise Induces Oxidant Stress in Dogs

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**Introduction:** In humans, intense exercise induces acute oxidant stress with resultant increase in F2 isoprostane production; the result of interaction between reactive oxygen species and arachidonic acid in cell membranes. The purpose of the study was to determine the effects of agility exercise on dogs of different skill levels with respect to 15F2t isoprostane (ISO) excretion in urine.

**Materials and Methods:** Actively competing agility dogs were examined and their competitive level recorded, n=13. Each dog ran a course 3 times (5 minute rest between runs) consisting of 15 obstacles. Prior to, immediately and 4 hours following exercise, urine was collected. ISO was determined using competitive enzyme immunoassay following pre-treatment with  $\beta$ glucuronidase (pg/mL) and standardized by division with urine creatinine (CR, competitive enzyme immunoassay).

**Results:** Urinary ISO increased significantly following agility exercise (mean  $\pm$  SEM, pre 14.50  $\pm$  1.45, post 20.55  $\pm$  3.54 and 4 hour post 18.82  $\pm$  1.43, one-way ANOVA, P=0.0092), however, it was not affected by the dogs' skill level, P>0.05.

**Discussion/Conclusion:** Dogs participating in agility exercise undergo significant oxidant stress that has not resolved within 4 hours of exercise. Determination of the time needed for excretion levels to return to pre-exercise levels is warranted to further characterize the type of oxidant stress these dogs experience and to determine optimum rest periods between trials.

**Acknowledgments:** There was no proprietary interest in this study. Intramural departmental funds were used for laboratory assay supplies.

### 52 Structural Properties of Synthetic Bone Models Compared to Native Canine Bone

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**Introduction:** Synthetic materials used for biomechanical testing reduce specimen numbers and costs, eliminate handling issues and potential specimen degradation, and have unlimited availability. Synthetic bone models were hypothesized to compare favorably to native canine bone.

**Materials and Methods:** Three sizes of polyoxymethylene (POM) and two sizes of short fiber-filled epoxy (SFE) hollow cylinders of varying outside diameter and wall thickness were evaluated in acute 3-point bending to failure. A 1-way ANOVA with post hoc Tukey HSD was used to compare elastic modulus, maximal stress and yield stress to published results of Greyhound and Pit Bull femur, humerus and tibia.<sup>1</sup> Significance was set at P<0.05.

**Results:** The POMs did not perform similarly to the majority of native canine bones, nor did they fail by fracture. The SFEs performed similarly to the native canine bones and failed similarly by fracture; the 3-mm SFE was most similar to the wide range of native bones in all 3 parameters tested.

**Discussion/Conclusion:** All synthetic bone models had minimal variability. All native bones had wide variability. The disparate breeds had a reported significantly greater stiffness in Greyhound bones and significantly greater energy absorption to failure in Pit Bull bones;<sup>1</sup> however, the structural properties of the 3-mm SFEs mirrored the majority of the native diaphyseal long bones. The 3-mm SFE can be reasonably proposed for use as a substitute for native canine bone for biomechanical testing.

1. Kemp TJ, Bachus KN, Narn JA et al. Functional trade-offs in the limb bones of dogs selected for running versus fighting. *J Exper Biol* 208:3475–3482, 2005\*

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\* Dr. David Carrier (senior author) provided raw study data

### 53 Biomechanical Testing of the 3.5 mm SOP Bone Plate Using a Delrin Rod Gap Model with Four Different Screw Configurations

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**Introduction:** A new locking veterinary orthopedic implant, the SOP plate, has recently become available and follows the trend of biological fixation. Initial studies of the 3.5-mm SOP plate have evaluated strength and stiffness in four-point bending. The purpose of this study was to evaluate and compare the mechanical properties of the 14-hole, 3.5-mm SOP plate using four different screw configurations in a Delrin rod gap model during axial loading.

**Materials and Methods:** Twelve SOP constructs were created using four different screw configurations (3 constructs / group). Each construct underwent eccentric axial loading to failure. Max load, work, yield point, and stiffness were measured and compared for all constructs.

**Results:** Significant differences for max load and yield were recorded between Groups 2 and 4. Groups 3 and 4 were significantly stiffer than Groups 1 and 2. Differences between Groups 3 and 4 and between Groups 1 and 2 were not significantly different from each other in max load, work, yield, or stiffness.

**Discussion/Conclusion:** Construct stiffness decreased as screw holes adjacent to the fracture site are omitted in eccentric axial loading. Application of a screw in the 5<sup>th</sup> and 10<sup>th</sup> screw holes was the major factor in determining if stiffness was significant. The stiffness of the SOP construct can be increased in eccentric axial loading by filling the screw holes adjacent to the fracture.

**Acknowledgments:** The authors wish to thank Orthomed UK Ltd, Halifax, West Yorkshire, UK for donation of the SOP plates and screws to this experiment.

### 54 Biomechanical Testing of the 3.5 mm SOP Bone Plate Using a Delrin Rod Gap Model with the Plate at Increasing Distances from the Bone Model

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**Introduction:** It has been shown that increasing the distance of the locking compression plate (LCP) from the bone decreases construct stability. Biomechanical testing of the SOP plate with respect to the applied distance from the bone has not been performed. The purpose of this study was to compare the mechanical properties of the 14-hole, 3.5-mm SOP plate in a simulated comminuted fracture with the plate placed at increasing distances from a Delrin rod.

**Materials and Methods:** Twelve SOP constructs were applied at increasing distances from a simulated bone model and tested to failure in eccentric axial loading. The results were compared to a control group of 14-hole LC-DCPs. Max load, work, and stiffness was measured for all constructs.

**Results:** The SOP plate applied at 0mm and at 2 mm required significantly higher loads before plastic deformation was reached when compared to all other groups. No significant differences were noted in stiffness between the LC-DCP and the SOP plate at 0mm or 2mm or between the SOP plate at 5 mm and 10mm.

**Discussion/Conclusion:** Significant decreases in max load occurred for the SOP construct as the plate was moved farther from the bone. When an SOP plate is used at a distance greater than 2mm from the bone there will be increased displacement which may result in an unstable fracture or compromised healing.

**Acknowledgments:** The authors wish to thank Orthomed UK Ltd, Halifax, West Yorkshire, UK for donation of the SOP plates and screws to conduct this experiment.

### 55 Twelve Week Radiographic and Histomorphometric Analysis of Biomedtrix Canine Biological Fixation Acetabular Cups

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**Introduction:** This study evaluated bone ingrowth into acetabular components of the BioMedtrix Biological Fixation (BFX) at 12 weeks after implantation and determined whether a difference existed in four separate regions of the cup.

**Materials and Methods:** Six hounds received a cementless total hip replacement using a BFX acetabular cup and a modified BFX femoral component. Twelve weeks post-operatively, all dogs were euthanized. Radiographs were assessed for implant position and bone remodelling in 3 zones (cranial, medial and caudal). Acetabuli were fixed and embedded in plastic. From each acetabulum a 75–100 µm thick horizontal section was made to assess cranial, medial and caudal regions. A mid body vertical section was made for the dorsal region. Sections were stained with toluidine blue. The bone fraction in the pores coating the implants Vv(Bone-Pores) was estimated using 25µm<sup>2</sup> computerized point counting. Data was expressed as a mean and standard deviation for each region and further evaluated using an ANOVA and Tukey comparison test.

**Results:** There were no radiographic signs of implant migration, loosening, resorptive or productive bone remodelling. The mean Vv(Bone-Pores) of all dogs at 12 weeks post operatively was (0.514 ± 0.112). The mean Vv(Bone-Pores) of the cranial, medial, caudal and dorsal zone was 0.510 (sd 0.128), 0.375 (sd 0.219), 0.566 (sd 0.155) and 0.600 (sd 0.194) respectively. There was no significant difference (p=0.168) between the mean Vv(Bone-Pores) of the different zones.

**Discussion/Conclusion:** Despite substantial regional differences, there was no statistical difference between the different regions. This was most likely due to the limited number of animals in the study and the large individual variation. Radiographic changes were not supportive of histological remodelling. Although not directly comparable, these results compare favourably to studies investigating bone in-growth into other canine porous acetabular cups.

**Acknowledgments:** Partially funded by Indiana 21st Century Research and Technology Fund.

### 56 Evaluation of Strength at the Pin-Acrylic Interface Using Variably Treated External Skeletal Fixator Pins

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**Introduction:** The benefits of acrylic connecting columns with the use of external skeletal fixation (ESF) have been demonstrated. The pin-acrylic interface is critically important to the stability of the ESF construct. Therefore, our objective was to measure pullout force to failure and shear strength at the pin-acrylic interface for variably treated 1/8" ESF pins.

**Materials and Methods:** One-eighth inch diameter, intramedullary pins were used for each of five treatment groups: polished, unpolished, three notched, five notched, and machine knurled. Each pin was seated into a 2 cm diameter acrylic connecting bar and tested in pullout force to failure. Extraction force of 1/8" positive profile intramedullary pins from two cadaveric tibias was documented and compared to the above groups.

**Results:** Knurled pin ends were found to be strongest in pullout and shear, followed by 5 notched, 3 notched, unpolished, and polished pins, respectively (p < 0.05). Mean extraction force from bone (1,529 N) was found to be similar to that of the 5 notched pin group (1,509 N). Mode of failure was consistent within groups. Fracture of the acrylic column was only seen with knurled pin ends.

**Discussion/Conclusion:** Acrylic-pin interface loosening can attenuate the stability of ESF and increase patient morbidity. The establishment of a stronger acrylic-pin interface could be beneficial in cases of decreased owner compliance, large patients, and anticipated delayed union.

**Acknowledgments:** Imex Veterinary Inc. Jorgensen Laboratories

### 57 A Comparison of the Osteogenic Potential of Canine Bone Marrow and Adipose Tissue Derived Mesenchymal Stem Cells and Effects of Oxygen on Proliferation

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**Introduction:** The osteogenic potential and proliferative capacity of canine MSCs from bone marrow and adipose tissue have not been directly compared. In this study osteogenesis and proliferation of canine MSCs derived from BM and AT from the same animal were compared. In addition, we evaluated the effects of oxygen on proliferative capacity.

**Materials and Methods:** Paired BM and AT derived-MSCs were cultured at 1%, 5% and 21% oxygen tension and subcultured every 7 days. Cells were divided into control and osteogenic groups. 4 paired samples were cultured in osteogenic media without dexamethasone, 3 paired samples were cultured in osteogenic media containing dexamethasone. Cells were stained with 0.5% Alizarin Red solution to observe calcium deposition and therefore bone formation on Days 1, 7, and 14.

**Results:** AT derived MSCs proliferate at a significantly faster rate than BM derived MSCs, and senesce more slowly. Lowering oxygen tension to 5% did not enhance proliferation. Culture in 1% oxygen tension significantly decreased cell proliferation in both groups. All osteogenic groups showed positive Alizarin Red (AR) staining from Day 7 compared to the control groups. The osteogenic potential of canine MSCs were variable.

**Discussion/Conclusion:** The osteogenic potential of MSCs from BM and AT was highly variable but AT derived-MSCs expanded more quickly and showed good osteogenic potential. Taking this into consideration, this study suggests that canine AT derived-MSCs might be more suitable for use in a clinical situation.

**Acknowledgments:** This research was funded by a private grant from Dick and Carolyn Randall.

### 58 Screw Loosening Six Weeks After Triple Pelvic Osteotomy: Comparison of Pre-Tapped with Self-Tapping 3.5 Mm Cortical Screws

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**Introduction:** Screw loosening is a common post-operative complication in triple pelvic osteotomy (TPO) surgery for dogs with hip dysplasia. Several factors have been suggested to influence screw loosening. We investigated the difference between pre-tapped and self-tapping 3.5 mm cortical bone screws and hypothesised that pre-tapped screws would show more screw loosening.

**Materials and Methods:** The radiographic records of two groups of dogs that had undergone a unilateral TPO procedure were reviewed retrospectively. In the first group (n=30) only pre-tapped screws were used, and in the second group (n=32) only self-tapping screws were used, for stabilisation of a standard Slocum TPO plate. The effects of age, gender, weight, side, rotation angle, sacral purchase and screw type on screw loosening were examined.

**Results:** In the pre-tapped group a total of 42 (23%) screws loosened in 22 (73%) dogs. The median screw loosening per loose screw was 3.2mm. In the self-tapping group a total of 28 (14%) screws loosened in 15 (44%) dogs, with a median screw loosening per loose screw of 2.2mm. Screw loosening was significantly more prevalent with pre-tapped than self-tapping screws. Other variables (age, gender, weight, side, rotation angle, sacral purchase) were non-significant.

**Discussion/Conclusion:** In TPO surgery screw loosening is less prevalent if 3.5 mm self-tapping screws are used in comparison to 3.5 mm pre-tapped screws.

**Acknowledgments:** No financial support and no proprietary interest

### 59 Triple Pelvic Osteotomy in Dogs Under 12 Kg in Weight: Technical Feasibility and Short-Term Radiographic and Clinical Complications in Fourteen Hips

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**Introduction:** Triple pelvic osteotomy (TPO) is a well-accepted method for treating hip dysplasia in young large-breed dogs. Small-breed dogs present less often with hip dysplasia, and if it is operated on a femoral head and neck excision will usually be performed. We investigated whether dogs under 12 kg could be successfully operated on with a TPO procedure.

**Materials and Methods:** Fourteen hips of ten dogs weighing 12kg or less were operated on with a standard three-incision TPO technique. A four- or five-hole 2.7 mm Synthes DCP with 2.7 mm self-tapping screws was used. The plate was angulated according to the pre-surgical measured angle of reduction.

**Results:** Follow-up showed that all the operated hips functioned clinically well. Femoral overlap improved in all cases (pre-op median 21%, post-op median 77%). No minor wound complications occurred and all osteotomies healed well. Screw loosening was observed in nine out of 59 screws (15 %) and one screw broke.

**Discussion/Conclusion:** TPO with a 2.7 mm DCP plate can be successfully performed in small-breed dogs with hip dysplasia and offered as an alternative to femoral head and neck excision.

**Acknowledgments:** No financial and no proprietary interest

### 60 Inhibition of Pro-Inflammatory Cytokine Expression and Prostaglandin E2 Production by Avocado Soybean Unsaponifiables and Chondroitin Sulfate

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**Introduction:** Osteoarthritis (OA) in humans and animals is characterized by cartilage degradation, immobility, and chronic joint pain. Pain receptors within the joint can be activated by TNF- $\alpha$ , IL-1 $\beta$  and PGE<sub>2</sub>, which are produced by macrophage and fibroblast-like cells in the synovial membrane. We activated human THP-1 and mouse RAW cells, two monocyte/macrophage-like cell lines, and analyzed inflammatory cytokine gene expression and PGE<sub>2</sub> production. We also determined whether avocado soybean unsaponifiables (ASU) and chondroitin sulfate (CS) will inhibit activation.

**Materials and Methods:** Cells were pretreated with control media alone, ASU (ASU®-NMX1000 8.3  $\mu$ g/ml), CS (TRH122®, 20  $\mu$ g/ml), or the ASU (8.3  $\mu$ g/ml) and CS (20 $\mu$ g/ml) combination, and then activated with LPS (10 ng/ml) or IL-1 $\beta$  (10 ng/ml) and TNF- $\alpha$  (1 ng/ml). Cells were incubated for 1 or 24 hrs to measure cytokine transcripts or PGE<sub>2</sub> production.

**Results:** Cytokine or LPS activation upregulated IL-1 $\beta$  and TNF- $\alpha$  gene expression and PGE<sub>2</sub> production. Pretreatment with ASU or CS alone marginally reduced cytokine expression and PGE<sub>2</sub> production however, the combination drastically reduced activation and NF- $\kappa$ B translocation.

**Discussion/Conclusion:** Activated synoviocyte surrogates express inflammatory mediators. Expression is suppressed by the ASU-CS combination more effectively than by each individual agent alone. This observation suggests that the ASU-CS combination may reduce pain in both humans and animals.

**Acknowledgments:** Research supported by Nutramax Laboratories, Inc.

### 61 Effect of Tibial Tuberosity Advancement On the Contact Mechanics and the Alignment of the Patellofemoral Joint

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**Introduction:** The purpose of this study was to evaluate the effect of TTA on patellofemoral contact mechanics and kinematics. We hypothesized that TTA, while restoring normal femorotibial and patellofemoral alignment, would reduce retropatellar pressure when compared to CrCL-intact

**Materials and Methods:** Nine canine stifles were used. A sham TTA was performed in each leg and a pressure sensor was fixed in the patellofemoral joint before mounting the legs in the testing apparatus. Measurements were taken, under load before and after CrCL transection (CrCLD), and after TTA. Contact area, peak and mean contact pressure, and total force were acquired. Radiographs were taken at each condition. The femorotibial and patellofemoral alignments were measured using a two-dimensional computer digitization technique.

**Results:** A significant cranio-proximal tibial displacement and increase in patellar tilt were found in the CrCLD joints. Both femorotibial and patellofemoral alignments were restored after TTA. Contact areas and peak pressure did not vary between conditions. Mean pressure and total force measured in the CrCLD and TTA conditions were significantly lower than in the control. No differences were found between CrCLD and TTA conditions.

**Discussion/Conclusion:** Abnormal patellofemoral biomechanics after CrCL rupture may predispose to osteoarthritis. TTA restored the normal femorotibial and patellofemoral alignment, and reduced the retropatellar forces by about 20%. Further studies are needed to evaluate if this reduced retropatellar pressure may have a clinical effect.

**Acknowledgments:** Study funded by the University of Zurich

### 62 A Biomechanical Comparison of Three Hybrid Linear-Circular Fixator Constructs

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**Introduction:** Hybrid linear-circular fixation has been described for fracture management and correction of limb deformities dogs and cats. Little information is available regarding the mechanical properties of these systems. The purpose of this study was to determine the stiffness properties of three hybrid fixator constructs loaded in axial compression, cranial-caudal bending, medial-lateral bending and torsion.

**Materials and Methods:** Three hybrid constructs (X, Y, & Z) were tested. All constructs utilized two tensioned olive wires bolted to a single, 66 mm, incomplete (5/8) ring to stabilize the distal bone segment. All constructs also utilized a medially-positioned, primary hybrid rod and three fixation pins to stabilize the longer, proximal bone segment. Constructs Y and Z also utilized a secondary diagonally placed hybrid rod. In constructs X & Y fixation pins were inserted in a single plane while in construct Z fixation pins were inserted in two planes. Eight replicates of each construct were tested using an MTS. Each construct was tested for 10 cycles for each of the 4 modes of loading. Load/displacement data was collected for all tests. Stiffness data were analyzed using an ANOVA with a post hoc bonferroni correction (p value < 0.05).

**Results:** Significant differences were noted in stiffness between the following constructs. Axial loading: X & Y and X & Z. Cranial-caudal bending: X & Z. Medial-lateral bending: None. Torsion: X & Z and Y & Z.

**Discussion/Conclusion:** Incorporation of biplanar linear fixation elements as well as the addition of a secondary hybrid rod improved construct stiffness in several modes of loading. This study provides a base for further studies evaluating hybrid linear-circular fixator biomechanics.

**Acknowledgments:** Authors have no financial interest in and received no reimbursement from companies that produced products used in this study. Thanks to IMEX Veterinary, Inc. for financial support of this project.

### 63 The Effect of A Bisphosphonate On Healing of Experimental Stress Fractures in the Rat

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**Introduction:** Bisphosphonates (BPs) are potent inhibitors of osteoclasts and bone resorption. The aim of this study was to determine the effect of the BP Risedronate on fracture remodelling and woven bone callus formation in the rat ulna loading (RUL) model of stress fractures.

**Materials and Methods:** Stress fractures were created by cyclical loading of the ulna in 135 adult female Wistar rats. Rats were treated daily with oral saline, or risedronate at 0.1mg/kg or 1.0 mg/kg. Histomorphometry was performed on one toluidine blue-stained section from each bone at a standard level along the fracture.

**Results:** Daily, oral treatment with risedronate at a high dose rate caused significant reductions in the amount of resorption and formation occurring as part of the remodelling along the stress fracture line. Woven bone was rapidly produced in the first 2 weeks after loading and there were no significant differences in woven bone parameters between treated and control groups at any time-point.

**Discussion/Conclusion:** We used the RUL model to demonstrate that daily risedronate treatment at a high dose impaired stress fracture remodelling up to 10 weeks after loading. The low dose did not have a significant effect on remodelling of the stress fracture line at 6 and 10 weeks after loading. Woven bone formation and consolidation were not affected by the low or high doses of risedronate suggesting that this part of the repair process of a stress fracture will not be negatively affected by risedronate, even if treatment was continued after a stress fracture was sustained.

**Acknowledgments:** NHMRC

### 64 Radiographic Quantitative Assessment of Cranial Tibial Subluxation Before and After Tibial Plateau Leveling Osteotomy

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**Introduction:** The purpose of this study was to determine whether the distance between the cranial cruciate ligament (CrCL) origin and insertion (CrCLd) could be used to detect cranial tibial subluxation in stifles over a range of motion and after treatment with tibial plateau leveling osteotomy (TPLO).

**Materials and Methods:** Eight pelvic limbs from adult dogs were used. Mediolateral radiographs of the stifle were obtained through a full range of motion at 15° increments. Radio-opaque markers were then placed at the CrCL origin and insertion. Radiographs of each specimen were repeated, before and after CrCL transection, with and without TPLO. Following CrCL transection, radiographs were obtained before and after inducing cranial tibial subluxation. Inter-observer variability in CrCLd without fiduciary beads was assessed by using intraclass correlation. Radiographs with fiduciary markers were used to assess the effect of CrCL status, subluxation, flexion angle, and TPLO on CrCLd; comparisons were made with ANOVA.

**Results:** Interobserver agreement was strong, with intraclass correlation coefficient of 0.859. CrCLd at a stifle angle of 120° was marginally longer (< 1 mm) than at 90°. Otherwise, there was no effect of flexion angle on CrCLd, indicating

stifle isometry. Cranial tibial subluxation caused 25–40% increase in CrCLD. TPLO had no effect on CrCLD, regardless of CrCL status or stifle subluxation. **Discussion/Conclusion:** Cranial tibial subluxation in stifles affected by complete CrCL insufficiency is reliably detectable on radiographs by comparing CrCLD on neutral and stress radiography, regardless of whether TPLO has been performed, and at any flexion angle.

**Acknowledgments:** This project was funded by Intramural College of Veterinary Medicine University of Florida Resident Grant, 2008.

## 65 Biomechanical Comparison of Laminar Spinal Stabilisation and Ventral Vertebral Body Plating at the L1-L2 Segment – an In-Vitro Study

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**Introduction:** Several techniques have been described to stabilize the spine, most of them acting on the ventral vertebral body. The purpose of this study was to compare the ventral vertebral plating with laminar stabilisation, which acts as a tension band on the dorsal lamina. The approach for implant placement for laminar stabilisation has previously been determined via a cadaver CT study.

**Materials and Methods:** Spinal segments from Th13 to L3 from 18 canine cadavers were divided into two groups (laminar and vertebral). A veterinary reconstruction plate was used for stabilisation in both groups and testing was performed using a four point bending test in flexion and extension. To set a reference, first testing was performed with intact unplated spines to determine the nominal range of motion (ROM). Spines were then destabilised by creating a defect in the intervertebral disc (incision of the annulus from ventral) and plated either laminar or vertebral. Testing was performed with same settings as before and compared to the nominal motion values.

**Results:** ROM was significantly lower with laminar plating (74,10±8,48%) compared to vertebral plating (111,52±12,50%), suggesting an increased stiffness.

**Discussion/Conclusion:** These in vitro results suggest that laminar stabilisation provides an increased stiffness compared to vertebral plating.

**Acknowledgments:** No disclosures.

## 66 Pilot Hole Diameter and Tapping Affects Insertional Torque and Pullout Strength of 4.0mm Cancellous Bone Screws

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**Introduction:** Recommendation for placement of 4.0mm screws is to drill a 2.5mm pilot hole (PH) and tap with a 4.0mm tap. Our purpose was to evaluate PH diameter and tapping on insertional torque and axial pullout strength of 4.0mm screws. Our hypotheses were: (1) axial pullout strength of 4.0mm screws would be greater when a 2.0mm PH was used compared to a 2.5mm PH, and (2) tapping would decrease insertional torque, without reducing axial pullout strength, of 4.0mm screws.

**Materials and Methods:** Cancellous bone blocks were assigned to one of five groups designated (screw size/pilot hole/tap size): 1 (3.5/2.5/3.5), 2 (4.0/2.5/4.0), 3 (4.0/2.5/none), 4 (4.0/2.0/4.0), 5 (4.0/2.0/none). 70mm screws were inserted using a torque recording screwdriver to find maximum insertional torque (MIT). The screws were extracted at a rate of 5mm/min until failure. The ultimate strength to failure (USF) was determined. Mean ±SD for MIT and USF were calculated. Data was analyzed using a mixed model ANOVA with significance at p<0.05.

**Results:** Mean ± SD for MIT (Nm) and USF (N) were: 1: 0.21±0.05, 1373.02±67.74; 2: 0.56±0.07, 1660.91±97.75; 3: 0.74±0.08, 1799.56±102.73; 4: 0.67±0.04, 1754.41±48.7; 5: 0.93±0.03, 1767±30.93. MIT

was significantly different among all groups. USF was not significantly different between groups 3, 4, and 5. USF for groups 3,4,5 was significantly greater than groups 1 and 2 and group 2 was significantly greater than group 1.

**Discussion/Conclusion:** 4.0mm screws inserted into tapped or untapped 2.0mm PH's, or untapped 2.5mm PH's had significantly greater USF than 4.0mm screws inserted according to the AO guideline. Tapping of 2.0 PH's did not significantly reduce USF but reduced MIT. Insertion of 4.0mm screws into tapped 2.0mm PH's provides greater USF with an acceptable increase in MIT compared to the recommended tapped 2.5mm hole.

**Acknowledgments:** This study was funded by the authors.

## 67 Synoviocytes Protect Cartilage from the Effects of Injury

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**Introduction:** The purpose of this study is to determine the molecular mechanisms by which cartilage responds to injury in the presence of synoviocytes to provide direction for the development of biomarkers to diagnose and therapeutics to prevent or treat OA.

**Materials and Methods:** Full thickness cartilage samples, either injured by compressive load or left as uninjured controls, were cultured with and without passage 3 synoviocytes. Cartilage samples were collected at day 1 to determine changes in chondrocyte gene expression for aggrecan, cyclooxygenase 2 and matrix metalloproteinases (MMP)-1,13, and at day 32 to determine histologic changes such as chondrocyte cell death and chondrocyte cluster formation.

**Results:** Gene expression analysis indicated a trend toward reduced gene expression levels in injured co-culture samples compared to injured samples, however at this point the only significant difference was with MMP-1 expression (p<0.002), n=2, further investigation is underway. Histologic analysis shows significant reductions in chondrocyte cluster formation (p<0.0004) and cluster size with injured co-culture samples compared to injured (p<0.003)

**Discussion/Conclusion:** In this study we show that culturing of injured cartilage in the presence of synoviocytes significantly alters the activity of chondrocytes when compared to injured cartilage cultured alone. The results from histologic evaluation and preliminary mRNA expression data collectively suggest that synoviocytes innately down regulate chondrocyte activities in injured cartilage resulting in a reduced histologic pathology. We will extend these studies to determine early molecular markers indicative of OA progression in response to injury, and design therapeutics to enhance the existing beneficial effects of synoviocytes on injured cartilage.

**Acknowledgments:** discretionary funds, Dr Wayne McIlwraith, Colorado State University.

## 68 In-Vitro Comparison of Proximal Ulnar Osteotomy and Distal Ulnar Osteotomy with Release of the Interosseous Ligament in a Canine Model

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**Introduction:** Proximal ulnar osteotomy is a common procedure utilized to treat elbow dysplasia. The purpose of this study was to determine if distal ulnar osteotomy with release of the interosseous ligament provides equivalent proximal displacement of the proximal ulna when compared to proximal ulnar osteotomy. **Materials and Methods:** Twenty cadaveric Beagle antebrachii were disarticulated at the elbow joint and randomly assigned to one of two groups. A distraction force of approximately 170 Newton's was applied to the proximal ulna with the distal limb secured in the materials testing system (MTS) and displacement of the proximal ulnar segment was recorded following each treatment. Group A was tested without treatment (NOTX), followed by an oblique proximal ulnar

osteotomy (PUO). Group B limbs were tested with a distal ulnar osteotomy (DUO) followed by a release of the interosseous ligament (DOLR).

**Results:** No displacement at the radioulnar joint was observed in the NOTX group. Mean displacement for the PUO was 1.68mm, while the DOLR group had a mean displacement of 1.94mm. There was no significant difference in displacement between the PUO and DOLR groups.

**Discussion/Conclusion:** In the study population there was no significant difference in the displacement of the proximal ulnar segment following distal ulnar osteotomy with interosseous ligament release compared to conventional ulnar osteotomy. Given the morbidity associated with proximal ulnar osteotomy, distal osteotomy with release of the interosseous ligament may be an alternative method of addressing joint incongruity in adult dogs.

**Acknowledgments:** No acknowledgments

## 69 Precision and Repeatability of a Custom Made Pointer Device for the Determination of Virtual Landmarks for Canine 3D Kinematic

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**Introduction:** Placement of makers on anatomical landmarks represents a large source of error in 3D-kinematics. We tested the accuracy and precision of a custom made pointer and compared it to conventional skin markers in dogs.

**Materials and Methods:** The pointer was assessed by pointing at the surface of a spherical object of known dimensions and position in space. Secondly, the elbow joint axis was marked in 12 cadavers using with a Steinmann pin and markers. The ability to locate the lateral landmark of this elbow axis was compared between the pointer and skin-mounted marker. The distance between experimental and true locations was compared between the 2 methods.

**Results:** A sphere was mathematically fitted through 29 collected points on the surface of the object. Center, diameter and volume overlap of the fitted sphere were compared to that of the object. A 0.729mm bias was found indicating good accuracy. Residual values were small indicating good precision. The average distances between the true and estimated elbow landmark were 9.55mm  $\pm$  4.20 and 9.32mm  $\pm$  3.28 for the pointer and the marker respectively. No significant differences were observed between the two methods.

**Discussion/Conclusion:** The pointer proved to be accurate and reliable for localizing virtual points and was at least equivalent to skin mounted markers for the detection of anatomical landmarks in the dog. It should prove useful in the localization of anatomical landmarks for kinematic analysis.

**Acknowledgments:** The authors acknowledge Pet Trust from the Ontario Veterinary College for providing funding for this study.

## 70 Effects of Antebrachial Torsion On the Measurement of Frontal Plane Angulation: A Cadaveric Radiographic Analysis

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**Introduction:** Antebrachial deformities frequently present with valgus and external torsion. Radiography is necessary despite torsion altering the appearance of concurrent deformities. The purposes of this study were to quantify the effect of antebrachial torsion on the miscalculation of valgus and assess a radiographic method to resolve miscalculations.

**Materials and Methods:** A hinged circular external fixator with attached goniometer was applied to the distal radius of a canine cadaver prior to osteotomizing at the hinge level. Valgus was induced in 5° increments (from 0° to 45°), and external rotation in 15° increments (from 0° to 60°) radiographing each combination. Observed radiographic valgus (ORV) was measured and differences between the true valgus (TV) and the ORV were calculated to result in artifactual

valgus (AV) values. The study was repeated with rotational repositioning to match the induced torsion to assess for improved measurement accuracy.

**Results:** Both 0° and 15° torsional iterations possessed mean AV values < 5° for every valgus increment. Torsion of >30° resulted in AV values >5°. Rotationally re-positioning the limb resulted in the 30° torsional group having AV <5° for TV values of 0°-20°, the 45° torsional group having AV <5° for TV values between 0°-15°, and the 60° torsional group having AV <5° TV values of 0°-10°.

**Discussion/Conclusion:** Increasing antebrachial torsion interferes with accurate measurement of valgus. Torsion in excess of 15° results in radiographic artifacts greater than 5°. Rotationally re-positioning the limb allows the accurate calculation of more valgus/torsion combinations, but still results in miscalculations of more advanced rotation/angulation deformities.

**Acknowledgments:** This study was financially supported by the Comparative Orthopaedic Laboratory, University of Missouri.

## 71 Radiographic Localization and Isometry of the Origin of the Canine Cranial Cruciate Ligament

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**Introduction:** The purpose of this study was: (1) to radiographically define the anatomic origin of the CrCL as translated to the lateral femoral condyle (CrCL-LC); (2) to correlate the CrCL-LC to radiographic and anatomic landmarks for the consistent identification of the CrCL-LC; (3) to compare the isometry of the CrCL-LC to the lateral fabella. Our hypothesis was that the CrCL-LC would provide a more isometric point than the lateral fabella.

**Materials and Methods:** Lead markers were placed in the origin of the CrCL, the lateral fabella, and proximal tibia in 12 canine cadaveric stifles. CrCL-LC was defined as the intersection of lines connecting the proximal/distal and cranial/caudal markers. The CrCL-LC was correlated to the radiodense shadow of the intercondylar notch roof (Blumensaat's line) and a line from the long digital extensor fossa to the lateral fabella (LDE-LF). Measurements from CrCL-LC and lateral fabella were made to each of the tibial markers (TM) using lateral radiographs of each limb at five joint angles. The mean percent change in length from each femoral point to each TM was determined. Differences were compared using a mixed model ANOVA.

**Results:** The CrCL-LC was consistently located in the caudal 1/3 of Blumensaat's line and LDE-LF. There was no significant difference in isometry for the CrCL-LC and lateral fabella at TMs 1, 2, 5, 6, or 7. At TMs 3, 8, and 9, the CrCL-LC was significantly ( $p < 0.05$ ) more isometric.

**Discussion/Conclusion:** The CrCL-LC can be consistently located using radiographic and anatomic landmarks. While the CrCL-LC was significantly more isometric than the lateral fabella at three TMs, the most isometric point for both the CrCL-LC and the lateral fabella is the most cranial and proximal TM.

**Acknowledgments:** No disclosures or acknowledgments

## 72 Mechanical Testing of Orthopedic Suture Materials Used for Extra-Articular Stabilization of Canine Cruciate Ligament-Deficient Stifles

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**Introduction:** Canine cruciate ligament (CrCL) injury in the dog is one of the most prevalent orthopedic diseases seen by veterinarians. The objective of this study was to compare the mechanical properties of 4 orthopedic suture materials commonly used for CrCL deficient stifle surgery.

**Materials and Methods:** The materials tested were 80-lb test monofilament nylon leader material, FiberTape®, FiberWire®, and Xgen OrthoFiber. Five samples of each suture were tested for load to failure and cyclic fatigue between 70N and 150N using a servohydraulic materials-testing machine. Groups were compared for statistical differences.

**Results:** Mean ultimate load to failure: Xgen Orthofiber (867N) > FiberWire (774N) = FiberTape (725N) > monofilament (403N).

Elongation at failure: FiberTape (6.2mm) = FiberWire (8.7mm) < Xgen Orthofiber (16.5mm).

The load at 3-mm and 5-mm of elongation: FiberTape (344N and 590N) > FiberWire (238N and 417N) = Xgen Orthofiber (210N and 329N) > monofilament (130N and 156N).

Stiffness: FiberTape (105.2 N/mm) > FiberWire (83.1 N/mm) = Xgen Orthofiber (58 N/mm) > (9.7 N/mm).

Elongation during 1000 cycles: Xgen Orthofiber (0.962mm) = FiberTape (0.976mm) < FiberWire (1.32mm) < monofilament (3.75mm).

**Discussion/Conclusion:** The braided suture material outperformed the monofilament. All suture materials tested had "clinical failure" at loads low enough to draw into question the relevance of the performance of any of the tested suture materials. All suture material elongated during cyclic testing and performance was inversely related to stiffness. It is important to look at "clinical failure" of suture material not only mechanical failure as many other studies have represented.

**Acknowledgments:** No funding has been provided for this study.

### 73 Wear Analysis in Retrieved Canine Total Knee Replacement Implants

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**Introduction:** The long-term success of total knee replacement (TKR) can be limited by mechanical wear of the implant. The specific aim of the current study was to document the nature and extent of wear in canine TKR using a cohort of research animals that were implanted with a clinical TKR implant system.

**Materials and Methods:** Ultra-high molecular weight polyethylene (UHMWPE) tibial inserts were retrieved 60 months post-operatively from six purpose-bred hounds that had undergone cementless TKR with a commercial TKR implant. The extent and severity of six different forms of UHMWPE damage (burnishing, scratching, abrasion, pitting, delamination, deformation and embedded debris) were characterized on both medial and lateral articular surfaces using light microscopy, scanning electron microscopy and contact profilometry.

**Results:** Burnishing (polishing), pitting and scratching were seen in all six implants. Wear scores were highest in the central zones on both medial and lateral sides. Wear in the caudal zone was more severe than in the cranial zone. Subsurface cracking and surface delamination were seen in 2 of 6 implants. Profilometry revealed statistically significant increases in average surface roughness (Ra) on the medial side relative to the lateral side of the articulation ( $p=0.05$ ).

**Discussion/Conclusion:** Wear patterns in canine TKR implants were similar to those reported in human TKR retrievals, with evidence of burnishing (reflective of the early "bedding-in" process), pitting, surface scratching and deformation due to cold flow of the polymer. Delamination, a sign of fatigue failure, was uncommon in this series of short-term retrievals. Wear analysis provides important insights into the performance of the UHMWPE surface in TKR. Future studies will focus on long-term performance of the implant and the relationship between implant wear and subsequent implant loosening.

**Acknowledgments:** Dr. Susan James, Department of Mechanical Engineering, Colorado State University.

### 74 Title: Evaluation of the Mandible as a Model for Fracture Healing in the Horse Using Micro-CT Analysis

**Authors: Sarrafian TL<sup>1</sup>; Garcia TC<sup>2</sup>; Stover S<sup>2</sup>; Galuppo L<sup>1</sup>**

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**Introduction:** We hypothesized that the mandible could be used as a defect model to test the ability of various regenerative medicine techniques to augment bone healing in horses. The Study aims were to determine feasibility, and intra- and inter-horse variability in bone healing.

**Materials and Methods:** Six research horses were anesthetized and 13.6 mm diameter bilateral, bicortical defects created (core 1). Horses were re-operated at 4 months and a 22 mm core was removed, encompassing the original defect (core 2). Bone volume fraction (BVF) and density of mineralized tissue (BMD) were determined using Micro-CT. A Paired t-test was used to determine if BVF and BMD were different between left and right core 1 and core 2 samples.

**Results:** The mean percent mineralized bone filling of defects at 4 months was  $67\% \pm 16\%$ . No significant intra-horse difference was noted in BVF of either core. There was significant ( $p<0.001$ ) difference in BMD between cores 1 and 2, indicative of reduced bone density in healing defects compared to native bone. Significant difference ( $p=0.022$ ) was found in BMD between left and right core 2 samples.

**Discussion/Conclusion:** Micro-CT evaluation at four months demonstrates that complete healing did not occur. Variations in inter-horse healing were noted, however no significant intra-horse difference in BVF was found. This model is suitable for comparing regenerative products aimed to augment bone healing, without need for termination of study animals.

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### 75 The Mechanical Underpinning of Clinical Failures in a Distal Radius Endoprosthesis Currently Used for Canine Limb Sparing

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**Introduction:** Osteosarcoma is the most commonly occurring bone tumor of the canine skeleton, with the distal radius being the most frequently affected site. Treatments involving massive cortical bone allografts have been largely ineffective, which has motivated the use of limb-sparing endoprostheses. It has been hypothesized that excessive weight is a major contributing factor to the high failure rate (40%) observed clinically for these endoprostheses. A finite element modeling approach was undertaken to determine the mechanical causes for failure of these implants.

**Materials and Methods:** A canine forelimb finite element model was developed using CT scan data. Cartilage was extruded and contact was established in a total of 23 finite sliding contact pairs. Strain and relative interosseous motion in four intact canine forelimbs were determined under a load of 110% BW for model validation. The influence of distal support to the endoprosthesis and the mechanical contribution of the ulna through ulnar pinning were investigated.

**Results:** High von Mises stresses (130 MPa) were observed at the bone-screw interface and high bending stresses (124 MPa) were observed within the radial screws.

**Discussion/Conclusion:** The common causes of failure observed clinically for the 1<sup>st</sup> generation endoprosthesis were screw pullout and screw failure due to shear. Our model predictions are congruous with these findings. The biomechanical contribution of the spacer was insignificant. Addition of distal support to the endoprosthesis is not recommended. Ulnar pinning may be a temporary solution to mitigate the stresses observed.

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## 76 In-Vitro Elution and Antibacterial Activity of Clindamycin, Amikacin, and Vancomycin From R-GEL Polymer

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**Introduction:** Antibiotic impregnated implants have been used to achieve antimicrobial tissue concentrations as much as 20 times the therapeutic level obtained in serum after systemic administration. The objective of this study was to characterize the *in vitro* elution and bioactivity of two formulations of antibiotics in a novel, dissolvable, crosslinked dextran polymer matrix: Formulation 1—amikacin and clindamycin (AC); Formulation 2—amikacin, clindamycin, and vancomycin (ACV).

**Materials and Methods:** Aliquots of the antibiotic impregnated polymer were incubated in PBS buffer for 10 days. The PBS was changed every 24 hours and concentrations of the antibiotics eluted into the saline were quantified. The antimicrobial activity of the eluent from each sampling period was tested for growth inhibition of *Staphylococcus Aureus*.

**Results:** The concentration of amikacin, clindamycin, and vancomycin remained above the breakpoint MIC for a minimum of 9 days. Elution products from both groups demonstrated bioactivity against *S. Aureus* for the entire 10 day study period.

**Discussion/Conclusion:** Amikacin and clindamycin together, or in combination with vancomycin, elute from R-Gel effectively and at gradually decreasing rates for at least 10 days. The antibiotics maintained their bioactivity following polymerization and elution from the R-Gel. Therefore the novel polymer matrix constituting the R-Gel product may be a useful clinical resource for treatment of localized infections.

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## 77 Mechanical Comparison of the 3.5 mm Broad Limited Contact Dynamic Compression Plate and the 3.5 mm Broad Locking Compression Plate

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**Introduction:** The recent availability of 3.5 mm broad locking plates has increased their utility in small animal orthopedics. The objective of this study was to compare the bending properties of the 3.5 mm broad locking compression plate (LCP) to the 3.5 mm broad limited contact dynamic compression plate (LC-DCP) and to analyze the mechanical effect of using threaded plugs in empty screw holes in the LCP.

**Materials and Methods:** The following treatment groups were compared: 3.5 mm broad LC-DCP, 3.5 mm broad LCP, and 3.5 mm broad LCP with threaded

plugs inserted in the four central screw holes. Each plate was subjected to four-point bending. Load-deformation curves were plotted to determine bending stiffness, structural stiffness, and bending strength.

**Results:** The 3.5 mm broad LC-DCP had significantly less bending stiffness ( $p < 0.001$ ), structural stiffness ( $p = 0.002$ ), and bending strength ( $p < 0.001$ ) when compared to the 3.5 mm broad LCP. The addition of threaded plugs did not significantly enhance mechanical parameters in the LCP.

**Discussion/Conclusion:** The 3.5 mm broad LC-DCP achieved 90% of the stiffness and 72% of the strength of the 3.5 mm broad LCP. The addition of threaded inserts into the locking component of four screw holes did not significantly improve the mechanical properties of the locking plate. Although this study provides fundamental material testing data about the 3.5 mm broad LC-DCP and LCP plates, additional investigation using *in vitro* bone construct models would provide better insight into their ultimate performance.

**Acknowledgments:** The implants were provided by Synthes Veterinary Incorporated.

## 78 Elbow Denervation in Dogs: Development of a Surgical Procedure

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**Introduction:** The options to treat DJD-associated elbow pain are limited. Although medical management is the most common treatment modality, side effects can occur. Joint denervation is a surgical technique based on the selective neurotomy of sensory nerve fibers within the peri-capsular region, resulting in permanent or long standing pain relief in some cases. The objective of this study is to develop a surgical technique for denervation of the canine elbow joint capsule.

**Materials and Methods:** Twenty cadavers were used to characterize the innervation to the joint capsule, design and refine the surgical protocol. The final protocol was tested in 10 cadavers (20 normal elbows) and 4 cadavers with bilateral elbow DJD. Protocol testing consisted of histological determination of whether or not nerve tissue had been resected and visual assessment of damage to the parent nerve. The surgical protocol was evaluated in 4 sound hound dogs, assessing the effects on subjective limb use, neurological function and pain on manipulation, %bodyweight distribution (%BW<sub>distrib</sub>) to the operated forelimb and objective sensory threshold testing of sensory dermatomes in the distal limb.

**Results:** The denervation of the elbow was achieved by the neurectomy of 5 sensory branches to the joint capsule. 126/140 resected samples contained nerve tissue. *In vivo* study showed no significant change from baseline for %BW<sub>distrib</sub>, lameness, pain, neurological parameters and sensory thresholds.

**Discussion/Conclusion:** The developed protocol for denervation of the canine elbow appears feasible and does not result in any sensory or motor deficits of the forelimb.

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