



Veterinary Orthopedic Society 39th Annual Conference Abstracts

March 3rd-10th, 2012
Crested Butte, Colorado, USA

Part I

1 Precision, variability, and accuracy of femoral varus measurement using radiographic and computed tomographic imaging in clinically abnormal femora

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Introduction: This study evaluated the precision, variability, and accuracy of aLDFA measurements using radiographic and CT imaging, compared to the reference standard of digital photographs of anatomic specimens, in clinically abnormal femora. Our hypothesis was that CT would be more precise, less variable, and more accurate than radiographs for aLDFA measurement.

Materials and Methods: 20 femora were surgically altered to induce clinically significant femoral varus. Three craniocaudal images of each bone were captured using radiographic, three-dimensional reconstruction of transverse CT images, and digital photographic modalities. aLDFA was measured from each image in triplicate by two observers. Precision was defined as the extent multiple measurements of the same image by the same observer that agreed, quantified as the mean standard deviation of aLDFA measurements for each individual image by modality. Variability was defined as the variation contributed by capturing multiple images and measuring aLDFA multiple times from each image, quantified as the mean standard deviation of measurements made for each bone, averaged by observer and modality. Average aLDFA measurements for each modality were compared to evaluate accuracy. For all analyses, statistical significance was $P < 0.05$.

Results: CT measurement was more precise ($P < 0.001$) and less variable ($P < 0.001$) than radiographic measurement of aLDFA. Neither the CT ($P = 0.123$) nor radiographic ($P = 0.511$) modalities proved systematically different from the photographic modality.

Discussion/Conclusion: CT is the most consistent methodology for measuring femoral varus. CT appears to be a reliable reference standard for future investigations, and when available, could be used preferentially for clinical measurement of aLDFA in dogs.

Acknowledgments: This project was supported by a grant from the Morris Animal Foundation.

2 Correction of developmental canine angular deformity of the humerus: 3 cases

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Introduction: Premature physal closure in the humerus can result not only in angular and torsional deformities but can also retard normal lengthening of the bone resulting in substantial disparity in limb length. Osteotomies are required to correct abnormal limb angulation and torsion. While opening wedges can afford some increased length, severe cases will necessitate distraction osteogenesis. More significant muscle mass in the brachium relative to the antebrachium increases the working length of external fixation constructs, necessitating greater rigidity of the apparatuses.

Materials and Methods: Idiopathic premature closure of the caudal aspect of the proximal humeral physis resulted in severe procurvatum of the proximal humerus in three canine patients. Proximal correction was performed utilizing two

osteotomies. One case was corrected acutely and a bone plate applied. Two cases were managed utilizing distraction osteogenesis: A type 1a external fixation frame, distraction motors and an intramedullary tie in was utilized.

Results: Clinical follow-up saw good to excellent limb function in two of the three cases. One of the cases using external fixation developed septic arthritis of the shoulder and a poor outcome was achieved.

Conclusion: This uncommon developmental angular limb deformity can be managed successfully through use of either acute correction utilizing bone plating or via distraction osteogenesis depending on the severity of the case.

Acknowledgements: There was no proprietary interest of funding provided for this project.

3 Web-based collection of canine hip replacement data from veterinary surgeons and owners: the BVOA hip registry, initial data from 170 cases

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Introduction: Success rates for total hip replacement (THR) have been reported at 95% or greater, with complications reported in 7 – 22% of cases. In human THR, hip registries have been successful in providing an evidence-base in health service provision.

Materials and Methods: The BVOA Canine Hip Registry (CHR) was established in 2008. Records of the CHR database between September 2008 and August 2011 were reviewed. On the census date, all owners were e.mailed a hyperlink to a questionnaire based on the clinical metrology instrument, LOAD [8]. Background and disease variables that influence surgical management and outcome were investigated.

Results: 200 cases were entered on the CHR and 170 were complete enough for further analysis. Mean age was $3.5\text{yrs} \pm 2$ and mean bodyweight was $27.7\text{kg} \pm 10.6$. Indication for surgery was 'hip dysplasia/osteoarthritis' in 150 cases. The surgeon-reported incidence of surgical complication was 9.4%. Following approval, the hyperlink was emailed to 140 owners and an additional 29 questionnaires were mailed (51% response rate). In 82% of responses, owners described their satisfaction with the outcome of THR as "very good" whilst 7% rated their satisfaction as "fair". A 20% complication rate was documented by owners. There was a statistically significant difference in owner-assessed lameness scores before and after THR ($p < 0.0001$).

Discussion/Conclusion: The BVOA Hip Registry represents a novel, ethically-sound framework for multi-center collaboration. The initial results shows promise that this dataset can become a powerful means by which to understand risk factors for complications as well as investigate differences between implant systems.

Acknowledgments: BVOA for funding

4 Efficacy of 30 years of selective breeding to eliminate hip dysplasia in service dogs at the seeing eye, inc: identifying the "target phenotype" to control a complex genetic trait

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Introduction: This study assessed the genetic progress toward improving hips in dog guides at The Seeing Eye. Sires and dams were selected based on estimated breeding values derived from subjective scoring of the hip-extended radiograph (HES). Heritabilities of HES were compared with those derived from hip laxity measured by distraction index (DI).

Materials and Methods: The study population consisted of 12,027 dogs repre-



senting 3 breeds: German Shepherd Dog (GSD), Labrador Retriever (LR) and Golden Retriever (GR). Hips were screened radiographically at 12–18 months of age using HES (since 1979) and by HES and DI (since 1991). Selection decisions were based on HES for the 30-year period. Bayesian statistics incorporating the full pedigree provided heritability estimates.

Results: Eight generations of selection using HES improved hip phenotype until in the final generation, all offspring scored “normal” at 12–18 months of age. However, based on DI, a high percentage (82.9%–96.5%) of the HES normal dogs harbored susceptibility for the OA of CHD. Estimated heritabilities of the HES were 0.39, 0.16, and 0.32 for GSD, LR, and GR, respectively, and for DI, 0.56, 0.57 and 0.60, respectively.

Discussion/Conclusion: DI is the principal predictive factor for hip OA. The higher heritability of DI and the inability to apply further selection pressure using HES justifies incorporating DI into breeding decisions at The Seeing Eye. The high heritability of DI makes it a good candidate phenotype for genomic association studies toward a molecular test for CHD.

Acknowledgments: There was no proprietary interest or funding for this project.

5 Biomechanical testing of a synthetic canine gastrocnemius tendon implant

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Introduction: Current techniques for repair of chronic ruptures of the gastrocnemius tendon rely on suturing the torn tendon and fibrous tissue to the tuber calcaneus. The aim of this study was to test the strength and fixation of a polyethylene terephthalate prosthesis (STIF, Dijon, France) proposed as being suitable for gastrocnemius tendon repair in dogs, using a cadaver model.

Materials and Methods: Eight pelvic limbs were harvested from four recently euthanized adult dogs (weighing 30–45 kg). Proximal and distal fixation was tested separately. Proximally the implant was sutured at the myotendinous junction of the gastrocnemius. Distally, the implant was secured in a 4.5 mm blind ending tunnel in the medullary cavity of the calcaneus using an interference screw (STIF, Dijon, France). Biomechanical testing was performed using an electrodynamic testing machine (E3000, Instron UK).

Results: The mean maximum load at failure (\pm SEM) for the proximal and distal fixations were 269.2 N (\pm 23.4 N) and 620 N (\pm 93.0 N) respectively. There was a significant difference in load to failure between proximal and distal tests ($P=0.016$, paired t-test).

Discussion/Conclusion: The loads to failure in this study far exceed the values reported following experimental repair of chronic gastrocnemius tendon injuries using other methods involving suturing tendon to bone. It is predicted that failure in clinical cases would occur proximally, at the myotendinous junction. Implant pull out could be avoided by patient dependant screw sizing and altered implant positioning. Further evaluation of this implant in clinical cases is warranted.

Acknowledgments: Implants for this study were provided by STIF (Dijon, France)

6 The influence of culture medium conditions on canine adipose derived stem cells

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Introduction: Adipose derived stem cells are a promising therapy for osteoarthritis. Allogeneic stem cells provide many advantages over autologous stem cells but require the selection of a medium that provides consistent, desirable cellular products. We hypothesize that medium type influences the phenotype of cells, allowing selection of a specified cellular product for clinical applications.

Materials and Methods: Fat from six dogs were processed and cultured in these medium conditions: basic growth medium, keratinocyte n-acetylcysteine medi-

um (KNAC), serum free medium, and multipotent adult progenitor cell medium. Cells from each treatment and the initial stem cell product were evaluated for pro-inflammatory and anti-inflammatory gene expression by qRT-PCR. Cell surface marker expression evaluating immunostimulatory, mesenchymal and hematopoietic stem cell markers were evaluated by flow cytometry. Cells from each medium condition were evaluated for multipotential differentiation into bone, fat and cartilage.

Results: The expression of pro-inflammatory and anti-inflammatory cytokines and immunostimulatory markers decreased in all medium conditions, with a greater anti-inflammatory potential in KNAC medium conditions. KNAC treated cells had the greatest expression of mesenchymal cell surface markers and most consistently differentiated into bone, fat and cartilage.

Discussion/Conclusion: Our results indicate culture of stem cells provides more predictable, consistent products compared to autologous preparations and allows specific selection of cell phenotype for cell therapy.

Acknowledgments: Supported in part by the National Institute of Health Musculoskeletal Training Grant and the Tata Foundation Endowment.

7 The variability of individual aspirates of equine bone marrow-derived mesenchymal stem cells

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Introduction: Previous work in our laboratory has shown large variation chondrogenesis of equine bone marrow aspirates. This study was performed to determine to test the null hypothesis that multiple bone marrow aspirates taken from the same horse would show no difference in MSC chondrogenesis.

Materials and Methods: Two to three separate bone marrow aspirates were collected from the tuber coxae of 11 healthy horses. All aspirates were expanded in control or FGF-2 supplemented media. After expansion, monolayers were trypsinized and resuspended into three dimensional pellets supplemented with media to promote chondrogenesis. Pellets were harvested after two weeks and analyzed for total pellet DNA, GAG, and collagen type II content. A one-way analysis of variance was performed with a p value <0.05 .

Results: There were significant differences in total pellet DNA and DMMB content between aspirates from the same horse in the control pellet cultures. Similarly, pellets treated with 100 ng/mL of FGF-2 had significant differences in total pellet DNA, DMMB, and collagen type II content between aspirates from the same horse. Treatment with 100 ng/mL of FGF-2 significantly increased the total pellet DNA, DMMB, and collagen type II content. However, treatment with FGF-2 did not alter these vast differences between aspirates from the same horse.

Discussion/Conclusion: There is marked variation in the chondrogenic capacity of bone marrow aspirates from the same horse. The use of bone marrow MSCs for tissue engineering should include evaluation of multiple aspirates.

Acknowledgments: There was no external funding for this study.

8 Chondrogenic capacities of equine mesenchymal stem cells isolated from synovium, bone marrow and fat

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Introduction: Stem cell therapies provide considerable promise for repair of articular cartilage, given that these cells are capable of chondrogenesis. However, MSCs exhibit source-dependent differences in phenotypic and biosynthetic activities. This study compared the chondrogenic capacities and phenotype of MSCs from equine synovium (SYN), bone marrow (BM) and adipose tissue (FAT).

Materials and Methods: Bone marrow, synovium and fat were collected from the six clinically normal adult horses. Primary cells were expanded through two monolayer passages. The cells were then transferred to chondrogenic pellet cultures for up to 20 days. Chondrogenesis was assessed by Q-PCR analyses of aggrecan, collagen types II and X mRNAs. Matrix synthesis was assessed by



measuring collagen type II protein secretion, sulfated glycosaminoglycan (sGAG) secretion and alkaline phosphatase (ALP) activity.

Results: BM and SYN cells significantly up-regulated chondrocytic genes, at levels matching or exceeding those of primary chondrocyte cultures. BM cells, but not SYN cells, also significantly increased Coll X mRNA expression. In contrast, FAT cells were minimally chondrogenic. BM and SYN cells secreted significantly more Coll II and sGAG than the FAT cells. BM cell pellets also increased ALP activity.

Discussion/Conclusion: Equine MSCs isolated from bone marrow and synovium readily underwent chondrogenesis, while adipose-derived MSCs were minimally chondrogenic. Of note, BM- MSCs also up-regulated collagen type X and increased ALP activity, consistent with the endochondral chondrogenic lineage. Phenotypically, SYN cells are a more appropriate cell source for articular cartilage repair than other MSCs.

Acknowledgments: Funded by USDA's Animal Health and Diseases Fund.

9 Synthetic potential of canine synoviocytes versus meniscofibrochondrocytes for meniscal tissue engineering

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Introduction: Current clinical treatments for axial meniscal injuries in dogs are limited; our study evaluates the synthetic potential of meniscal and synovial cells from surgical debris for production of an autologous fibrocartilage bioscaffold to address meniscal insufficiency.

Materials and Methods: Synoviocytes and meniscal fibrochondrocytes (MFCs) were obtained arthroscopically from 5 dogs with naturally occurring meniscal injury and MFCs were obtained from 4 normal dogs. Cells were cultured in monolayer sheets or as tensioned synoviocyte or meniscal fibrochondrocyte bioscaffolds (TSB or TMB) and analyzed for fibrochondrogenic gene expression and extracellular matrix, and cell viability.

Results: TSB had higher relative collagen expression than TMB. Percentage GAG content and % collagen per dry weight were higher for TMB and TSB vs. monolayer sheets. TMB and TSB had uniform Type 1 Collagen immunoreactivity and regional GAG deposition/ moderate Type 2 Collagen immunoreactivity. Cell viability for TSB and TMB was 60–70% and 30–40%.

Discussion/Conclusion: Bioscaffolds contained meniscal-fibrocartilage (ECM) components; tensile stimuli likely accounted for higher bioscaffold collagen content versus monolayer. The biological and biomechanical environment in this study was more favorable to synoviocytes versus MFC; the initial tension applied likely exceeded the 2% strain experienced by adult MFCs. The MFC in this study originated from tears in the axial, avascular region of the meniscus, which have been documented to have decreased synthetic/ reparative potential. TMB and TSB produced meniscal like ECM, however TMB cell viability was lower versus TSB. Autologous, diseased MFCs and synoviocytes may provide a cell source for future meniscal tissue engineering.

Acknowledgments: There was no proprietary interest for this project; this project was funded internally and by the Morris Animal Foundation.

10 Progression toward biological femoral head resurfacing in dogs

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Introduction: Given limitations of current THR procedures, our current research objective is to develop implants and surgical techniques for biological replacement of the canine femoral head.

Materials and Methods: Sixteen pairs of femurs from adult dogs were harvested. Orthogonal photographs of the femoral head and neck were acquired and the femoral head-neck offset was quantified. A porous patient-specific femoral prosthesis was manufactured with poly-ε-caprolactone (PCL) using fused

deposition modeling, implanted in one femur from a cadaver, and loaded to failure. The contralateral femur was tested as a control. Porous PCL cylinders were sterilized by UV light exposure, isopropyl alcohol submersion, or Sterrad® sterilization and subsequently cultured with canine chondrocytes. Cellular metabolism was quantitatively assessed using a resazurin assay.

Results: Dogs have substantial cranial and ventral offset of the femoral head from the femoral neck. The stiffness of the femoral head construct was 966.4 N/mm and the load to failure exceeded 700 N and was greater than the contralateral native femur. PCL constructs that were Sterrad® sterilized had significantly lower ($p < 0.001$) chondrocyte viability than all other treatment groups.

Discussion/Conclusion: These data suggest that 1) femoral head replacement/ resurfacing prostheses that use an articular surface mounted symmetrically upon a femoral stem will fail to reproduce normal canine hip kinematics 2) patient-specific PCL scaffolds can be engineered to be sufficiently robust to withstand physiologic levels of loading, and 3) sterilization protocols can have profound effects on cellular viability associated with the PCL implants.

Acknowledgments: There are no disclosures to be made.

11 The effect of a polycaprolactone hydrogel containing lysophosphatidic acid on bone healing in dogs

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Introduction: The purpose of this study was to determine the efficacy of a polycaprolactone (PCL) hydrogel as a carrier for lysophosphatidic acid (LPA) and to determine the ideal dose of LPA to maximally stimulate bone healing. Our hypotheses were that a PCL hydrogel would be a suitable biomaterial for delivery of LPA and that defects containing PCL hydrogel with LPA would have greater bone healing compared to defects containing PCL hydrogel alone.

Materials and Methods: Bilateral ulnar osteotomies were performed on 6 purpose bred dogs split into two groups. Control defects were filled with only PCL hydrogel. Contralateral defects were filled with PCL hydrogel with either a 1mM or 5mM LPA solution. Dual-energy X-ray absorptiometry (DXA) was performed before surgery and biweekly for 12 weeks after surgery. Total bone area, mineral density (BMD) and mineral content (BMC) were determined at each time point. Data was analyzed using repeated measures Fisher's Least Significant Difference test to determine relationships between the effect of treatment over time on total bone area, BMC and BMD.

Results: There was no significant difference in DXA-based total bone area ($p = 0.96$), BMC ($p = 0.99$) or BMD ($p = 0.56$) over time between treatments.

Discussion/Conclusion: Bone inhibitory effects of the PCL hydrogel were evident in this study. This finding may have clinical applications for delaying or preventing bone formation for procedures such as juvenile angular limb corrections. Future research into the utility of LPA based osteogenesis is on-going to combine the molecule with a non-inhibitory transport medium.

Acknowledgments: We wish to thank the Comparative Orthopedic Research Laboratory staff for their valuable assistance in conducting this project. This study was funded by the Washington State Life Sciences Discovery Fund.

12 Augmentation of radius and ulna diaphyseal fracture repair in toy breed dogs using a free autogenous omental graft

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Introduction: Radius/ulna fracture complications following bone plate repair occur in up to 54% of dogs <6kg body weight. We hypothesized free omental



autograft (OM) would increase the rate of bone healing and reduce complications following bone plate fixation in dogs weighing <6kgs.

Materials and Methods: Twenty-one dogs (body weight ≤6kg) with 23 diaphyseal radius/ulna fractures treated with open reduction and bone plate fixation were evaluated. Eight dogs with 9 fractures received an OM in addition to bone plating by placing a 2 to 3 cm²-sized portion of omentum over the bone plate and around the radius and ulna on the surface of the bones medially and laterally. Radiographs were obtained every 2 weeks until radiographic bone healing.

Results: Median time to complete radiographic healing in OM dogs was 70 (range 28–98) days and no major complications occurred. Owners reported OM dogs fully active without lameness 2–12 months after healing. Six control dogs were lost to follow-up; median time to healing for the rest was 91 (56–144) days. Six controls developed osteopenia necessitating plate removal, 4 of which refractured 1 to 5 months later. Three refractures healed after replating; one was amputated. Owners reported no lameness 6–48 months after healing in controls.

Discussion/Conclusion: Omentum-induced angiogenesis and fracture healing occurs through vascular endothelial growth factor-mediated neovascularization, callus formation, and mineralization. OM used in bone plated radius/ulna fractures in dogs <6 kg improved bone healing, decreased osteopenia and reduced plate removal and refracture in the short-term.

Acknowledgments: There was no financial support/proprietary interest.

13 Multi-center, controlled, randomized, single-blind clinical trial of diaphyseal fracture repair in dogs using recombinant human bone morphogenetic protein-2 delivered on an absorbable collagen sponge (rhBMP-2/ACS; TruScient™)

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Introduction: Recombinant human bone morphogenetic protein-2 (rhBMP-2) has previously been shown to augment bone healing in multiple canine experimental in vivo studies. The purpose of this study was to evaluate the efficacy and safety of rhBMP-2 (0.2 mg/ml) delivered on an absorbable collagen sponge (rhBMP-2/ACS; TruScient™) when added to standard of care (SOC) surgical management (treatment group) versus SOC alone (control group) for repair of naturally occurring diaphyseal fractures. The hypothesis of this study was that TruScient + SOC reduces the time to radiographic fracture union in dogs with diaphyseal fractures and has an acceptable safety profile.

Materials and Methods: Dogs with diaphyseal fractures repaired using SOC techniques (without bone graft) were randomized to treatment and control groups. Group effects on radiographic fracture healing time, clinical evaluation and adverse events were compared using a generalized linear mixed model, repeated measures ANOVA or Fisher's exact test.

Results: There was a statistically significant reduction in time to radiographic fracture union for the treatment compared to the control group (P=0.0001). Radiographic fracture union was achieved by week 6 in 83.3 % of treated compared to 50.0% of control dogs. There was a significantly greater frequency of moderate (week 3) and mild (weeks 9 and 12) swelling in the treatment compared to control group (P<0.05).

Discussion/Conclusion: TruScient + SOC was effective in reducing time to radiographic fracture union and has an acceptable safety profile. These results demonstrate that TruScient + SOC fracture management in dogs can accelerate bone healing in naturally occurring diaphyseal fractures.

Acknowledgments: This study was sponsored by Pfizer, Inc; New York, NY.

14 Multibody modeling of the canine cranial cruciate ligament deficient stifle joint

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Introduction: The objectives of this study were to develop a multibody model of the canine hind limb with an anatomically correct stifle, validate the model against experimental data, and use the model to study effects of CCL deficiency and TPLO surgery on stifle joint kinetics and kinematics.

Materials and Methods: Purpose-bred dogs and cadaveric hindlimbs were used with IACUC approval. Dogs were assessed via electromyography, force-plate kinetics, and optical tracking kinematics. MRI of the cadaveric hindlimbs was performed and each limb attached to a mechanical testing system. Load cells were used to measure quadriceps and Achilles tendon forces, and vertical and cranial-caudal forces on the paw during motion. MRI was converted into 3D geometries and ligament insertion/origin points aligned in and modeled. The medial and lateral articular and meniscal cartilages were segmented. The contacts between each of these segments were modeled using a contact function. The model of the canine hind limb was validated using experimental measurements. Models of the CCL insufficient stifle and of the same stifle after computational TPLO surgeries underwent the same motion profile and pressure distribution assessments.

Results: Pressure distributions and magnitudes in the lateral and medial compartments as well as ligament forces were all significantly different among intact, CCL deficient, and TPLO-treated limbs, with the most severe changes in association with TPLO.

Discussion/Conclusion: This validated computational model can efficiently provide critical data with respect to surgical manipulations of the canine hindlimb for treatment of CCL disease.

Acknowledgments: Funded by NIH-NIAMS & Missouri Life Sciences Research Board (09–1078)

15 Effect of systemically injected bone marrow derived stem cells on structural bone allograft osteointegration

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Introduction: Structural allografts are used to reconstruct segmental long bone defects. However, poor graft integration has resulted in failure rates approaching 60%. The purpose of this study was to investigate the homing potential of systemically introduced rhBMP2-overexpressing bone marrow derived stem cells to the site of allograft transplant in a murine model and quantify improvements in graft healing.

Materials and Methods: N=104 C3H mice were divided into four groups after undergoing a diaphyseal C57BL/6 cortical allograft transplant. Twenty received a tail vein injection of 1x10⁶ C3H-derived rhBMP2/β-gal expressing cells (C9) and were sacrificed over 14 days for β-gal staining. Eighty-four mice were divided into three groups. Twenty-eight mice received no BMSCs. Twenty-eight mice received a single injection of C3H-derived BMSCs and an equal number received a single injection of 1x10⁶ C9 cells at the time of transplant. At five and nine weeks, biomechanical testing, micro-computed tomography, and histologic analyses were performed to quantify healing.



Results: Histochemical staining confirmed C9 cell presence in the callus through 14 days. No significant differences in biomechanical parameters were identified between the experimental groups at either timepoint ($p > 0.243$), nor was there a significant difference between new bone callus formation ($p > 0.668$). There were no grossly identifiable differences in histomorphometric parameters between groups at either timepoint.

Discussion/Conclusion: Despite C9 cell presence in the callus through two weeks, no improvement in functional outcome resulted from delivery of the rhBMP2-overexpressing cells to the site of allograft transplant. Our data indicate that a single systemic injection of the C9 cell line is not efficacious in this model.

Acknowledgments: This work was funded by a competitive grant from the Musculoskeletal Transplant Foundation

16 Clinical implementation of a novel osteotomy of the radius to correct biapical canine angular limb deformities

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Angular deformities of the canine antebrachium are not uncommon. Radii of affected animals can demonstrate a biapical deformity: A varus deformity of the proximal radius accompanied by a compensatory distal valgus. These two centers of rotation of angulation (CORA) typically necessitate two corrective osteotomies. The proximal CORA is typically adjacent to the elbow joint and correction at this level represents a considerable challenge. If the osteotomy is made distal to this proximal CORA, medial translation will occur. Compensation for this translation is often limited by bone contact. Four cases of profound biapical antebrachial limb deformity have been managed by the author utilizing a single oblique osteotomy made in the distal third of the radius. The length of the cut is twice the diameter of the radius and angled proximo-caudal to cranio-distal. An ulna osteotomy is preformed and the distal section of the radius is translated, angulated and de-rotated to re-align the elbow and carpal joints, without necessitating individual correction of the CORAs. The obliquity and direction of the cut allows improved bone contact when managing expected translation while still allowing for full correction. Ilizarov ring hybrid fixation, or multi-planar external fixation was utilized. All cases resulted in desired limb alignment and bone healing. Delayed union in the second case, necessitated replacement of the external fixation with a bone plate: Minor modifications to the technique in the third and fourth case resulted in uncomplicated bone healing.

Acknowledgement: There was no proprietary interest or funding provided for this project

17 Arthroscopic biceps ulnar release procedure (BURP): assessment of regional damage and completeness of release

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Introduction: Our purpose was to assess the influence of arthroscopist experience on BURP completeness and regional damage.

Materials and Methods: Twenty elbows from 10 cadavers were assigned to experienced- or inexperienced-arthroscopist groups. Using conventional portals, surgeons sought to identify the medial collateral ligament (MCL) and biceps tendon (BT) before attempting a complete release under arthroscopic visualization. Surgeons estimated % BT release, predicted MCL and median nerve damage, and assigned a standardized 1–5 “visual control score” (VCS) that described the degree of BT and MCL visualization during the procedure. Following the BURP, elbow dissection determined % tenotomy completion and MCL / median nerve damage. Statistical analyses assessed for differences in VCS, rate of complete release, and presence of regional damage between experienced- and inexperienced-arthroscopist groups.

Results: A complete BURP was performed in 85% of elbows. There was an association between procedural VCS and tenotomy completeness ($p < 0.01$),

though there was none between visualization of complete release and tenotomy completeness ($p = 0.47$). Incomplete MCL damage was noted in 9.5% of elbows. There was no association between VCS and the presence of regional damage ($p = 0.24$), but surgeon perception of MCL damage was predictive of it ($p < 0.01$). Surgeon experience did not influence VCS, regional damage, or BURP completeness.

Discussion/Conclusion: In canine cadavers, arthroscopic BURP can be performed safely and consistently using conventional arthroscopy instruments and portals by experienced and inexperienced arthroscopists.

Acknowledgments: There was no proprietary interest for this project.

18 Prospective clinical trial of canine unicompartamental elbow (CUE) arthroplasty

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Introduction: The objective of this study was to determine mid-term levels of function and complications of the Canine Unicompartamental Elbow (CUE) arthroplasty system for surgical treatment of Medial Compartment Disease (MCD) in dogs in a prospective multicenter clinical trial.

Materials and Methods: With ACUC approval and informed client consent, dogs (weighing between 20 and 40 kg) with MCD of one or both elbows were enrolled. Examination included assessment of lameness (Grade 0–4), pain, range of motion, and radiographic appearance of the elbows. Force-plate or pressure mat assessments were performed in a subset of patients. CUEs were placed via medial approach to the elbow. Recheck examinations were performed on each dog 6–10 weeks and ~6 months after surgery. Data were analyzed for statistically significant ($p < 0.05$) differences.

Results: Full function was achieved in 52%, acceptable in 28%, and unacceptable in 20%. A catastrophic complication occurred in one dog (4%), major complications occurred in 20%, minor in 28%, and none in 48%. Degree of lameness was significantly less 6 months after CUE (Preop = 2.7 mean; 6mo Postop = 0.3 mean). Force-plate and pressure mat analyses ($n=9$) have shown improvements in the range of 8–27% for measured variables in CUE limbs at 6 months compared to preop. Radiographs revealed no evidence of implant displacement, subsidence, or loosening except in one dog which had ulnar implant loosening.

Discussion/Conclusion: The Arthrex CUE system is associated with an 80% success rate and 24% major/catastrophic complication rate in the first 25 dogs treated for MCD.

Acknowledgments: JLC and KS are patent-holders for the Arthrex CUE and will receive royalties. JK is an Arthrex employee.

19 Effect of screw insertional torque on mechanical properties of 5 different angular stable systems

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Introduction: The purpose of this study was to compare the screw push out strength and resistance to cantilever bending of five different angular stable systems. Our first hypothesis was that there is a significant difference between the systems regarding push out strength and cantilever bending. Furthermore, our second hypothesis was that screws insertion torque has an influence on push out strength and cantilever bending properties of the locking mechanism.



Materials and Methods: Five different implant systems were evaluated. The 3.5 mm Synthes LCP, the 3.5 mm Traumavet Fixin, the 3.5 mm Securos PAX, the 3.5 mm Orthomed SOP, and the 3.5 mm Veterinary Instrumentation locking system. Screws were then inserted using a variable torque limiting device which was set to 0.8, 1.5, 2.5, and 3.5 Nm. To evaluate the push out strength, the constructs were mounted in a custom made device. A force was applied at the level of the screw tip acting along the long axis of the screw at a constant displacement rate of 1 mm/min. For cantilever bending a load was applied perpendicular to the long axis of the screw at a constant displacement rate of 1 mm/min. Statistical analysis of the push out strength and cantilever bending stiffness were performed using analysis of variance ANOVA (p -value 0,001).

Results: A statistically significant influence of the insertional torque on push out strength was seen in the Securos ($p = 0.00001$) and the Traumavet ($p = 0.00001$) system. A statistically significant influence of the insertional torque on bending stiffness was only seen in the Securos system ($p = 0.00098$).

Discussion/Conclusion: For the Orthomed, Synthes and Veterinary Instrumentation systems insertional torque did not influence push out strength nor cantilever bending stiffness. When using the Traumavet and Securos angular stable systems, the minimum acceptable insertion torque should be 2,5 Nm, in order to obtain correct screw-plate coupling. In the Securos system insertional torque positively influence the push out strength and cantilever bending stiffness values.

Acknowledgments: N/A

20 Sacroiliac luxation in the dog; a comparative study of screw position and loosening with dorsolateral vs. ventrolateral approach

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Introduction: A dorsolateral or ventrolateral approach is described for repairing sacroiliac (SI) luxations. This retrospective study compared both techniques for accuracy of screw purchase, placement and loosening; our null hypothesis was no significant difference between both approaches.

Materials and Methods: Radiographs of surgically treated SI luxations were reviewed from January 2000–June 2011. Only cases with immediate and ≥ 4 wk postoperative radiographs were included. Screw location and purchase into the sacral body, percent reduction, and subsequent screw loosening were assessed. Wilcoxon Matched Pairs Signed Rank Test (WMPSRT) and Mann-Whitney tests (W) were performed on screw purchase/loosening and sacroiliac reduction data; Chi-square (χ^2) analysis was performed on categorical data of screw loosening ($p < 0.05$).

Results: Proper screw placement was attained in 97% (66/68), with no difference between approaches ($\chi^2 = 1.832$, $p = 0.1759$). Placement accuracy, dorsal vs. ventral approach, was 100% (32/32) and 94% (34/36), respectively. No significant implant loosening was observed between serial radiographs (WMPSRT=135, $p = 0.6823$). Individual screw loosening was different between approach, with less loosening via ventrolateral approach ($W = 382$, $p = 0.0174$), but combined screw purchase was not different (WMPSRT=112, $p = 0.3422$; $W = 101$, $p = 0.1425$). Accuracy of dorsal vs. ventral approach, =80% reduction, was 92% (12/13) and 83% (15/18), respectively. Reduction was different between serial radiographs (WMPSRT=496, $p < 0.0001$), but not between approaches ($W = 83$, $p = 0.1799$).

Discussion/Conclusion: Our null hypothesis was rejected when screw loosening was considered individually. Normally, > 1 screw is placed. Combined screw loosening was not different; therefore, there may be no clinical difference between approaches.

Acknowledgments: No proprietary interest or funding.

21 Contact mechanics of the osteochondral autograft transfer system with and without meniscectomy for treatment of simulated lateral femoral condylar articular cartilage defects in dogs

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Introduction: The purpose of this study was to determine the effect of the Osteochondral Autograft Transfer System (OATS) on the contact mechanics of stifles with a simulated lateral femoral condylar cartilage defect, and to evaluate the contribution of the meniscus to the contact mechanics of the stifle before and after treatment of the simulated defect.

Materials and Methods: Eight unpaired cadaveric stifles were axially loaded using an MTS with the stifle intact, after creation of an 8 mm lateral femoral condylar defect, after OATS treatment, and after a lateral meniscectomy with the OATS graft in place and removed. Lateral compartment femorotibial contact area (CA) and peak contact pressure (PCP) were measured.

Results: With the lateral meniscus intact, there was a significant decrease in CA and PCP in the defect group compared to the control, while the OATS treatment group was not significantly different than the control. Lateral meniscectomy significantly decreased CA and increased PCP in the defect model and the OATS treated condition.

Discussion/Conclusion: OATS treatment was successful at restoring normal femorotibial contact mechanics with the lateral meniscus intact. The lateral meniscus distributes loads throughout the lateral compartment, and appeared to have a protective effect on the articular surfaces of the lateral compartment of the stifle when a defect is present. Removal of the lateral meniscus should be avoided if possible to help maintain femorotibial contact mechanics.

Acknowledgments: OATS instrumentation used in this study was provided free of charge by Arthrex Vet Systems. One of the co-authors is a paid consultant for Arthrex Vet Systems.

22 In vitro biomechanical evaluation of a locking compression plate and a novel monocortical locking plate system in an equine fracture model

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Introduction: Management of equine long bone fractures is dependent on anatomic reconstruction and maintenance of fracture stability by internal fixation with sharing of weight bearing forces on the healing bone and implants. The objective of this study was to biomechanically evaluate and compare the 8 hole locking compression plate (LCP) and a novel monocortical 8 hole Advanced Locking Plate System (ALPS) using a composite equine defect fracture model.

Materials and Methods: Two different constructs were tested: 1) 4.5 mm Broad LCP (Synthes) with 5.0 mm bicortical locking screws, and 2) 20 mm ALPS secured with 4.5 mm monocortical locking screws (KYON) secured to the surface composite bones following the creation of a 3 mm gap. Constructs were evaluated by 4-point bending single cycle to failure ($n = 8$) and single cycle torsional testing to failure ($n = 8$).

Results: The ALPS construct had significantly greater failure load (N), displacement at failure (mm) and bending moment (Nm) as compared to the LCP construct with four-point bending ($P < 0.0001$). Torsional testing to failure revealed that the LCP construct was significantly more stable with a greater yield torque (Nm) as compared to the ALPS20 construct ($P < 0.0001$).

Discussion/Conclusion: The results of this study demonstrate that despite the greater failure load of the ALPS20 construct with four-point bending single cycle



to failure, the LCP is still the more ideal system for fracture repair with the significantly greater yield torque.

Acknowledgments: Supplies were provided by Synthes and Kyon.

23 Biomechanical comparison of contoured 3.5mm broad limited contact dynamic compression plates (LC-DCP) and semi-contoured 3.5mm broad locking compression plates (LCP) in a canine radial interfragmentary gap model

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Introduction: The objective of this study was to compare the biomechanical properties of the anatomically-contoured 3.5mm broad limited contact dynamic compression plate (LC-DCP) to the semi-contoured 3.5mm broad locking compression plate (LCP) when applied in buttress fashion across an interfragmentary gap in canine radii.

Materials and Methods: Twenty-two paired canine radii were obtained from eleven large breed dogs. Each radius was randomly assigned to the 3.5mm broad LC-DCP group or the 3.5mm LCP group. A 30mm mid-diaphyseal osteotomy was performed at the same plate location in each specimen. Data collected during non-destructive testing were used to calculate global construct stiffness and gap stiffness, while data collected during destructive testing were used to determine maximum load, displacement at max load, and gap subsidence at maximum load. Mode of failure was recorded for each specimen.

Results: The 3.5mm broad LCP demonstrated greater gap stiffness ($p=0.02$), greater maximum load ($p=0.001$), and less gap subsidence at maximum load ($p<0.001$) compared to the 3.5mm broad LC-DCP. Global construct stiffness did not differ between groups ($p=0.78$). An increased number of specimens failed via screw pullout in the LC-DCP group ($p=0.01$), while more LCP constructs failed via bone fracture ($p=0.002$).

Discussion/Conclusion: The results suggest that the 3.5mm broad LCP may be a more suitable option for bridge plating when the clinical scenario demands rigid fixation across an interfragmentary gap.

Acknowledgments: We graciously acknowledge Synthes Veterinary, Inc. for providing the implants used in this study.

24 Synovial fluid bupivacaine concentrations following single intra-articular injection into normal and osteoarthritic canine stifles

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Introduction: Intra-articular bupivacaine injection is commonly performed during stifle surgery. Recent *ex vivo* studies suggest that bupivacaine may be cytotoxic to articular chondrocytes. A recent study used explanted chondrocytes incubated in 0.5% bupivacaine solution. The actual synovial fluid bupivacaine concentration after intra-articular injection is unknown. Our purpose was to determine synovial fluid bupivacaine concentrations after single intra-articular injection, and to investigate the relationship between bupivacaine clearance and inflammation.

Materials and Methods: Twenty two client-owned dogs undergoing stifle surgery for cranial cruciate ligament disease were recruited (osteoarthritic stifles). Eight purpose-bred beagles also participated (normal stifles). Under general anesthesia or sedation, 0.2ml/kg of 0.5% bupivacaine (1mg/kg) were injected into the stifle joint. Joint fluid samples were taken immediately after and

30 minutes after injection, and analyzed for bupivacaine and PGE₂ concentrations.

Results: Immediately after injection the median (IQR) bupivacaine concentrations in osteoarthritic and normal stifles were 2.5mg/ml (2.1 – 2.9 mg/ml) and 3.5mg/ml (3.3 – 3.8 mg/ml), respectively. Thirty minutes after injection bupivacaine concentrations in osteoarthritic and normal stifles were 0.6mg/ml (0.4 – 0.7 ml/ml) and 0.3mg/ml (0.3 – 0.5 mg/ml), respectively. There was no significant difference in bupivacaine clearance (ml/hr/kg) between osteoarthritic and normal stifles. There was no correlation between bupivacaine clearance and PGE₂ concentration ($r=0.14$; $p=0.47$).

Discussion/Conclusion: Bupivacaine concentration decreases quickly after single intra-articular injection, and its clearance does not correlate with degree of inflammation. Investigations are warranted to examine whether the bupivacaine levels reported in this study are chondrotoxic.

Acknowledgments: Funding provided for this study by the WSU Comparative Orthopedic Research Laboratory.

25 3-dimensional kinematics of the normal canine elbow at the walk and at the trot

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Introduction: While hip and stifle kinematics have been extensively described, a comprehensive 3-D kinematic evaluation of the canine elbow has yet to be performed. Our purpose was to investigate normal elbow kinematics using dynamic radiostereometric analysis (RSA). We hypothesized that flexion/extension would occur concurrently with measurable degrees of varus/valgus, internal/external rotation, and radioulnar motion.

Materials and Methods: After implantation of bone markers in the right humerus, radius and ulna of 6 large-breed dogs, dynamic RSA was performed. Flexion/extension, varus/valgus and internal/external rotation were expressed in a humer-antebrachial joint coordinate system (JCS) while pro-/supination and proximodistal translation were expressed in a radioulnar JCS. Kinematic data were compared using 2-factor repeated measure ANOVA ($p<0.05$).

Results: During gait, varus/valgus (mean amplitude \pm SD, $16.6\pm 3.4^\circ$ [walk] and $19.6\pm 3.4^\circ$ [trot], $p=0.07$), internal/external rotation ($14.0\pm 1.3^\circ$ and $17.5\pm 4.8^\circ$, $p=0.11$) and pronation/supination ($15.2\pm 4.1^\circ$ and $17.4\pm 4.4^\circ$, $p=0.03$) all occurred concurrently to flexion/extension ($70.7\pm 7.1^\circ$ and $71.2\pm 8.1^\circ$, $p=0.45$). Minimal radioulnar translation (0.93 ± 0.16 mm and 0.90 ± 0.16 mm, $p=0.23$) occurred with no differences between gaits.

Discussion/Conclusion: Our results demonstrate that the elbow joint does not behave as simple hinge joint and that radioulnar motion is an important aspect of normal elbow kinematics. These findings may eventually guide prosthetic design refinement to improve prosthetic joint kinematics and decrease the risk of excessive interfacial stresses. In addition, this study is a first step towards further applied science research and clinical applications such as evaluation of joint contact pattern/pressure in normal dogs, dysplastic dogs, and after surgical procedures such as sliding humeral osteotomy and proximal radial/ulnar osteotomies.

Acknowledgments: MSU CAF Endowed Research Fund, ACVS Surgeon-in-Training Research Grant, and VOS Hohn Johnson Research Award.



26 Investigation of incidence and risk factors for surgical glove perforation in small animal veterinary surgery

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Introduction: To identify incidence and risk factors for surgical glove perforation in small animal surgery.

Materials and Methods: Observational cohort study conducted at a veterinary teaching hospital. 2132 surgical gloves worn over 363 surgical procedures. All gloves worn by operative team members were assessed for perforation at end-procedure using the water leak test. Information was recorded on putative risk factors by a surgical team member. Associations between risk factors and perforation were assessed using multivariable multi-level random-effects logistic regression models to control for hierarchical data structure.

Results: At least one glove perforation occurred in 26.2% of surgical procedures. Identified risk factors for glove perforation included increased surgical duration (surgery > 1 hour OR=1.79, 95%CI= 1.12–2.86), performing orthopedic procedures (OR=1.88; 95% CI=1.23–2.88), any procedure using powered instruments (OR=1.93; 95%CI=1.21–3.09) or surgical wire (OR=3.02; 95%CI=1.50–6.05), use of polyisoprene as a glove material (OR=1.59, 95%CI=1.05–2.39), and operative role as primary surgeon (OR=2.01; 95%CI=1.35–2.98). The ability of the wearer to detect perforations intra-operatively was poor, with a sensitivity of 30.8%.

Discussion/Conclusion: There is a high incidence of unrecognized glove perforations in small animal surgery. Double gloving should be considered when performing invasive procedures on small animals. Double gloving may be indicated for all procedures, particularly when surgical duration is over one hour in length, when orthopedic procedures are performed, or when powered instruments or surgical wire are used.

Acknowledgments: Pet Trust Fund, Ontario Veterinary College, University of Guelph

27 A prospective, randomized clinical trial evaluating the effect of proximal ulnar osteotomy for the treatment of a fragmented medial coronoid process in the dog

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Introduction: Fragmented medial coronoid process in the canine elbow carries a guarded long term prognosis, with most dogs progressing to debilitation osteoarthritis and lameness regardless of medical or surgical intervention. Proximal ulnar osteotomy (PUO) is thought to be a potential surgical option to improve long term success. The goal of this study was to determine if dogs that have a PUO at the time of their arthroscopic removal would be more likely to have a successful outcome than dogs without.

Materials and Methods: Twenty dogs were randomly assigned to one of the two treatment groups. A successful outcome was defined as one in which there was an improvement in the overall Canine Brief Pain Inventory score, an increase in net ground reaction forces by 5% for the affect limb and a static or improved dGEM-RIC score (to evaluate cartilage health by measuring GAG content) at the 6 month time point.

Results: A successful outcome was seen in 3/16 dogs (18.8%) of dogs overall, with two of those dogs in the arthroscopy only group and one of those dogs in the arthroscopy plus PUO group.

Discussion/Conclusion: Although owners overall were very happy with the outcome and cartilage health actually improved in over half of the cases, limb function did not improve in most of these cases, with the majority of the unsuccessful cases being the arthroscopy plus PUO group.

Acknowledgments: Funding was provided by the ACVS Minimally Invasive Grant, University of Minnesota College of Veterinary Medicine Companion

Animal Grant and Fitzpatrick Referrals paid for all MRI scans for FR patients, and scans were performed with full owner volitional consent

28 Treatment of equine distal interphalangeal cartilage and collateral ligament injuries with autologous conditioned serum: 37 cases

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Introduction: this case series compares the efficacy of autologous conditioned serum (ACS) for treatment of distal interphalangeal (DIP) joint cartilage and collateral ligament injuries diagnosed on MRI.

Materials and Methods: 37 clinical cases treated by the author were reviewed. All cases underwent a conventional orthopaedic evaluation and a standing MRI examination of the feet using a 0.27Tesla magnet. 2 ml aliquots of ACS were then injected into the affected DIP joint(s) 5–6 times at weekly intervals. Collateral ligament cases also received a course of extracorporeal shockwave therapy using a Swiss Dolorclast machine to the affected ligament from an approach proximal to the coronary band. An initial injection of ACS was also performed into cases with more severely affected collateral ligaments, using ultrasound assistance. All cases were correctively shod and underwent a controlled exercise regime.

Results: 19 cases of collateral desmopathy were treated. The average duration of lameness prior to presentation was 2 months. The mean lameness grade was 2.9/10, and the median age 8 years. Of cases with long term follow up, 8 out of 13 (62%) were back in full work at one year. 18 cases of DIP cartilage pathology were identified. The average duration of lameness prior to presentation was 3 months. The mean lameness grade was 2.4/10, and the median age 10 years. Of cases with long term follow up, 8 out of 10 (80%) were back in full work at one year. A Fishers exact test showed no significant difference in outcome between the two groups.

Conclusions: The outcome for collateral desmopathy cases is better than conservative management, and comparable with the other case series with more interventional treatment. There is a trend for the prognosis to be better in cases with only cartilage pathology identified.

Acknowledgments: Sarah Powell MRCVS for MRI interpretation

29 Clinical outcome using canine platelet enhancement therapy (C-PET)

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Introduction: Platelet-derived growth factors can affect regenerative processes in joints that may be of value in treating osteoarthritis (OA). We tested the null hypothesis that no significant differences in clinical outcome parameters using subjective and objective measures of lameness and/or pain would result from a single intra-articular autologous platelet injection compared to saline injected controls when followed over 12 weeks.

Materials and Methods: Client-owned dogs with OA of the elbow (n=5), stifle (13), tarsus (1) or shoulder (1), after meeting radiographic and clinical-based inclusion criteria for OA, were enrolled with informed consent and randomized to platelet treatment, or saline with an option to cross-over to platelet therapy at 12 weeks. A novel, minimally-invasive, point-of-use, filter-based technique was used for concentrating platelets (C-PET, Canine-Platelet Enhancement Therapy; Pall Corp., Port Washington, NY). Pain and/or lameness was determined using the Hudson Visual Analog Scale (HVAS) and Canine Brief Pain Inventory (CBPI) at two sites, and force plate-derived peak vertical force (PVF) and vertical impulse (VI) were performed at one (n=10). Both parametric (paired t-test; PVF, VI) and non-parametric (Wilcoxon matched-pairs; HVAS, CBPI) methods of data analysis were employed using Prism ver 5 (GraphPad Inc., San Diego, CA).



Results: Combined C-PET treatment data (C-PET plus n=2 cross-over animals) showed a statistically significant improvement in week 12 treatment scores compared to week 0 (HVAS p=0.0005, CBPI p=0.0020, PVF p=0.0307), but not in saline controls. VI remained unaffected.

Discussion/Conclusion: C-PET provided a measurable reduction in lameness associated with OA in this cohort of dogs at 12 weeks.

Acknowledgments: Special thanks to Dr. Akikazu Ishihara and Nicole Stingle at OSU for data compilation and study coordination, respectively and Dr. Marc Togneri, Dr. David Clark, and Kimberly Holt at Western University for study participation. GAO, VG and JAS are employees of Pall Corporation who provided funding for, and whose product was used in, this study.

30 Prospective clinical trial of autogenous conditioned plasma versus hyaluronan plus steroid for treatment of chronic elbow osteoarthritis in dogs

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Introduction: Hyaluronan (HA) and platelet-rich plasma products, including Autogenous Conditioned Plasma (ACP; Arthrex), are two products used for intra-articular treatment of OA. The objective of the present study was to compare mid-term clinical outcomes in dogs with chronic bilateral elbow OA treated with either HA plus steroid (HA+S) or ACP.

Materials and Methods: Dogs greater than 1 year with radiographic evidence of bilateral elbow OA were enrolled in a prospective, randomized, double-blinded clinical trial. Each dog underwent initial assessment of lameness (Grade 0–4) by author 1 and client assessment of function using a validated survey (Hudson, et al). Each dog subsequently received either ACP (2.5 mls per joint) or HA+S (2 mls Hylartin-V + 20 mg Depomedrol) given by author 2 based on coin flip. Lameness grading was repeated (Au1) at 6 months post-injection and client assessment repeated at weeks 1, 6, 12 and at 6 months post-injection.

Results: Ten dogs (5 in each group) completed all portions of the study. Pre-treatment lameness grades were 1.2+0.97 for HA+S and 1.8+1.1 for ACP and were not different between groups. Post-treatment lameness grades were 0.4+0.55 for HA+S and 0.8+0.64 for ACP with each being significantly (p<0.045) less lame than pre-treatment, but not different between groups. Based upon client-based assessments, improvements in scores for activity, lameness, pain, and overall categories were noted for both groups.

Discussion/Conclusion: These data suggest that ACP and HA+steroid have beneficial effects for dogs with chronic bilateral elbow OA.

Acknowledgments: Study funded by Arthrex. Au2 consults for Arthrex.

31 Establishing guidelines for radial and cubital torsion angles in normal dogs via computed tomography and multi planar reconstruction

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Introduction: This study aims to create repeatable guidelines for measuring radial torsion and radial head position relative to the distal humerus in a normal population of dogs.

Materials and Methods: 22 one-year-old large breed dogs (labradors and golden retrievers) free from musculoskeletal disease were evaluated. CT scans were performed with the patient's elbows in full extension and the distal limb pronated. The images were evaluated with multi planar reconstruction. Established landmarks were used to identify torsion of the distal radius relative to the proximal radius. The attachment points of the collateral ligaments on the distal humerus were identified: These landmarks were utilized to quantify rotational position of the radius relative to the humerus.

Results: The mean angle of radial torsion was 3.30 degrees (95 CI 1.695–4.897). The position of the radial head in relation to the humerus varied between –7.38 and 8.35 degrees with a mean of –2.10. The intraclass correlation

coefficient for three observers was 0.9886. Very high reliability of the repeat measurements of the individual readers was seen with intraclass correlation coefficients from 0.9838 to 0.9922.

Discussion/Conclusion: When these radiographic landmarks are used, normal large breed labradors or golden retrievers demonstrate mild external rotation of the radius along the length of the bone. The radial head demonstrates mild internal rotation relative to the humeral condyles. The landmarks utilized appear reliable; this information can assist surgeons in the correction of pathological radial torsion and radial head subluxation.

Acknowledgments: There was no proprietary interest or funding provided for this project.

32 Effect of various barriers on skin surface temperature during icing

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Introduction: Local hypothermia is widely used in veterinary medicine in the treatment of soft tissue and orthopaedic injuries but there are no reports in the veterinary literature investigating the effects bandages have on the effectiveness of cold therapy. The purpose of this study was to investigate the differences in skin temperature during cold therapy applied through a dry towel, a wet towel, a modified Robert Jones bandage (MRJ), and ice applied directly to the skin (control).

Materials and Methods: Five dogs completed 30 minute treatment sessions consisting of ice applied to the proximal tibia in each of the following conditions: ice pack applied over a dry towel, wet towel, modified Robert Jones bandage, and control.

Results: Mean skin temperature during the 30 minute treatment session for the control group was 16.11 °C, for the wet towel 14.45°, for the dry towel 20.66°, and for MRJ 32.61°. Mean skin temperature in the control group and the wet towel group was significantly lower than in the dry towel or MRJ group. There was no difference (P > 0.05) between mean skin temperature at any time point between the control and wet towel groups.

Discussion/Conclusion: Application of ice packs either directly to the skin or through a wet towel barrier results in reduction of skin surface temperatures to levels that are considered therapeutic within a practical time frame for use in veterinary patients.

Acknowledgments: None

33 Effects of Hylartin-V® in combination with triamcinolone acetate on interleukin-1 induced inflammatory mediator production

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Introduction: Previously published studies have demonstrated that interleukin-1 (IL-1) induces proteoglycan and collagen type II catabolism, often through the action of matrix metalloproteinases (MMPs). Corticosteroids and hyaluronic acid are commonly used intra-articular medications for the treatment of osteoarthritis. Our hypothesis was administration of an intermediate acting corticosteroid (triamcinolone acetate) alone or in combination with a high molecular weight hyaluronic acid (Hylartin-V®) can mitigate the effects of IL-1 administration on the production of inflammatory mediators from equine chondrocytes.

Materials and Methods: Normal chondrocyte pellets were isolated from 7 horses. Chondrocyte pellet cultures from each horse were treated with fresh control media, IL-1 media, or IL-1 media containing triamcinolone acetate (TA), Hylartin-V (HA) or TA with HA. Production and release of MMP-1, MMP-3 and MMP-13 into the media was determined via quantitative ELISA.

Results: IL-1 administration caused a significant increase in the concentration of MMP-1, MMP-3 and MMP-13 present in the media. 2.0 mg/ml of HA caused a



significant decrease in the concentration of MMP-1 and MMP-3 present in the media. Both 0.06 mg/ml and 0.6 mg/ml of TA caused a significant decrease in the concentration of MMP-13 present in the media.

Discussion/Conclusion: Based on the results of this study, high molecular weight HA down regulated the production of MMP-1 and MMP-3, indicating that treatment with HA may be protective for collagen type II and proteoglycan. Conversely, TA down regulated the production of MMP-13, indicating that treatment with TA may be protective of collagen type II.

Acknowledgments: Funding provided by USDA-Hatch.

34 Scintigraphic in-vivo tracking of mesenchymal stem cells in an equine model of tendinopathy

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Introduction: Better knowledge of the distribution and persistence of mesenchymal stem cells (MSCs) after administration would help understanding healing process and optimizing routes of administration. The objective of our study was to compare the distribution and the persistence of MSCs after intra-arterial (IA) and intra-venous (IV) regional limb perfusions (RLP) and intra-lesional (IL) injections using scintigraphic in-vivo tracking on a model of superficial digital flexor tendinopathy in the horse.

Materials and Methods: Lesions were induced mechanically in the superficial digital flexor tendon of both front limbs of 8 horses. Technetium-labeled MSCs were injected 3 days after surgery in 6 horses using IA and IV RLP and IL injections, and 10 days after lesion induction in 2 horses using IA and IV RLP. Scintigraphic images were obtained at multiple time points up to 24 hours post-injection. Lesion uptake and radioactivity persistence in the lesion and the overall limb were evaluated.

Results: Lesion uptake was higher with IL injection than with the RLP techniques. Radioactivity persistence decreased over time and was similar with all 3 techniques. In the limbs injected 10 days after surgery, the lesion uptake with IA RLP was higher than in the 3 day-old lesions at the initial time points.

Discussion/Conclusion: The higher lesion uptake observed with the IA RLP at the initial time points, in the horses with 10-day old lesions, suggests the existence of a time-dependent homing phenomenon.

Acknowledgments: This study was funded by the Center for Equine Health, UC Davis.

35 Surgeon's use of adipose stem cell therapy

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Introduction: This abstract describes the clinical outcome and retreatment history in a set of dogs treated at a surgical practice that received adipose stem cells primarily in elbows (76%) and hips (14%) to improve their quality of life.

Materials and Methods: Forty-nine dogs with documented arthritis or OCD were chosen from a larger group of dogs treated with adipose stem cells. All dogs underwent lameness exams to document the source of their pain. They had veterinary and owner evaluation prior to treatment and at 30, 60 and/or 90 days post treatment. Treatment consisted of intravenous and intra-articular adipose stem cells.

Results: Clinical outcomes showed 78.1% (n=32; p=0.0015) of cases were improved at 30 days post treatment, 84.0% (n=25; p<0.0001) at 60 days and 70.0% (n=20; p=0.0013) at 90 days. Any p value less than 0.016667 was significant. The average length of time to retreatment was 11 months in the 22/49 (45%) animals that were retreated. The initial yield of cells allowed an average of 7 cryopreserved doses so retreatment did not require an additional collection or cell culturing.

Discussion/Conclusion: Stem cell therapy provided a statistically significant improvement in the quality of life in more than 70% of cases. The mechanism for

the improvement in daily function may relate to cell production of lubricin or anti-inflammatory cytokines within the joint.

Acknowledgement: There was no proprietary interest or funding provided for this project.

36 Adipose-derived adult stem cells as trophic mediators of tissue repair

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Introduction: Adult stem cells may promote tissue regeneration via cell differentiation or the production of bioactive proteins. Adipose tissue is a readily available source of adult stem cells (ASC) for musculoskeletal applications; however, their growth factor expression profile in the horse is not known. The purpose of this study was to evaluate the expression of selected growth factors involved in tendon healing. We hypothesized that growth factor expression would be higher in ASC compared to tendon fibroblasts (TF) from the same horse.

Materials and Methods: Passaged and cryopreserved TF and ASC from superficial digital flexor tendons and adipose tissue of 8 horses were grown in monolayer culture for 24 hours and harvested for gene expression via real time fluorescent PCR using the ddCT method and GAPDH as the housekeeping gene. Genes of interest included IGF-I, TGF- β 1, TGF- β 3, PDGF-BB, FGF-2, and SDF-1. Data were compared using paired t-tests with significance set at P<0.05.

Results: ASC produced significantly more RNA than TF. There were no significant differences in gene expression for IGF-I, FGF-2, or SDF-1. Gene expression for TGF- β 1 and - β 3 was significantly higher in TF than ASC.

Discussion/Conclusion: The results of this study failed to support our hypothesis and suggest that passaged ASC do not accurately represent freshly isolated cells or that culture in supplemented medium may down regulate growth factor expression. Further studies are required to compare the expression profile of fresh and passaged cells.

Acknowledgments: Funding for this study was provided by the VOS and the USEF.

37 Calculation of magnetic resonance T1 values in normal and abnormal equine tendons

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Introduction: Increased T1 values have been reported in human patients with chronic Achilles tendinopathy. The objectives of our study were to determine the range of normal T1 values of the equine superficial flexor tendon (SDFT), deep digital flexor tendon (DDFT) and suspensory ligament (SL), and to calculate the T1 values of abnormal equine SDFT and DDFT.

Materials and Methods: Six equine front limbs from 6 horses with no history of tendon injuries and both front limbs from 3 horses with known SDFT and/or DDFT lesions were used. The T1 values of the SDFT, DDFT and SL were calculated using ratios of image intensities obtained from an inversion recovery spin echo pulse sequence, and a spin echo proton density pulse sequence. Limbs were imaged with a 1.5T MR scanner, using the magic angle orientation to retain signal from the tendons and ligaments.

Results: A significant difference was observed between the T1 values of normal SDFT, DDFT and SL. The T1 values for normal SDFT, DDFT and SL were respectively 288 (\pm 17) msec, 244 (\pm 14) msec and 349 (\pm 16) msec. Increased T1 values were observed in all tendons considered abnormal on ultrasound examination.

Discussion/Conclusion: The differences in T1 values between normal SDFT, DDFT and SL most likely relate to differences in the composition of the extracel-



lular matrix. The increased T1 values observed in horses with tendinopathy might reflect changes in the biochemical composition of the tendons.

Acknowledgments: This study was funded by the Center for Equine Health, UC Davis.

38 In-vivo femorotibial alignment during conscious weight-bearing after tibial tuberosity advancement

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Introduction: No in-vivo studies have investigated if a patellar tendon angle, measured using the common tangent method (PTA_{CT}), of 90° consistently neutralizes tibial subluxation. The aim of this retrospective study was to determine the effects of tibial tuberosity advancement (TTA) on femorotibial joint alignment under static weight-bearing conditions in dogs treated for CrCL insufficiency.

Materials and Methods: The distance from the origin to insertion of the CrCL (CrCL_d) was measured on non-weight-bearing immediate post-operative and weight-bearing follow-up radiographs. CrCL_d was compared with a paired t-test. The relationship between change in CrCL_d (? CrCL_d) and post-operative PTA_{CT} was assessed using Pearson's correlation. Outcome was assessed with an owner questionnaire, and peak vertical force (PVF) and vertical impulse (VI) as percentages of body weight.

Results: Following TTA, 21 of 30 stifles were persistently subluxated at a mean \pm SD follow-up of 18 ± 14 months. Follow-up weight-bearing CrCL_d increased compared to post-operative non-weight-bearing CrCL_d ($P < 0.001$), with a mean CrCL_d increase on weight-bearing radiographs of $15.8 \pm 9.6\%$ (5.8 ± 3.4 mm). Post-operative PTA_{CT} was $89 \pm 3^\circ$ and did not correlate with ? CrCL_d ($r = 0.002$, $P = 0.994$). Mean PVF and VI were $64 \pm 14\%$ BW and $9 \pm 2\%$ BW, respectively. Owners felt TTA provided a substantial improvement in lameness.

Discussion/Conclusion: TTA does not restore complete femorotibial stability during stance at a PTA_{CT} of 90°, but the effects of this finding with respect to limb function are unclear.

Acknowledgments: Financial support for follow-up standing radiographs was obtained from funding provided by Kyon, Zurich, Switzerland.

39 Custom built uniplanar constrained total knee replacement in the canine and feline: clinical applications, design principles, surgical technique and clinical outcome

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Introduction: This series reports the use of a custom made uniplanar constrained total knee replacement (UCTKR) in the canine and feline. The surgical technique and clinical outcomes are reported in this study.

Materials and Methods: The implants used for all cases were custom made based upon computed tomographic measurements. The femoral and tibial com-

ponents are constructed from a cobalt chromium alloy interacting with the femur and tibia via a tapering beveled intramedullary stem which is fixed in the appropriate orientation using PMMA cement. The components are constrained using a bushing and axel pin.

Results: UCTKR was performed unilaterally in 3 canines, staged bilaterally in 1 canine and unilaterally in 2 felines. Indications for use were failed non-constrained total knee replacement (TKR,) multi-ligamentous disruption of the stifle joint and patient size/species which precluded the use of commercial TKR systems. Short term functional outcome was excellent (5) and good (1). Both felines returned to 'normal' outdoor life. Mean radiographic follow up was 15 (range 6–24 months); no implant complications were established in that time frame.

Discussion/Conclusion: In the canine the UCTKR is a valid treatment method in cases of profound stifle instability and in the revision of failed commercial non-constrained TKR. The UCTKR remains the only available option for TKR in the feline patient and is indicated for use in debilitating degenerative joint disease and multi-ligamentous disruption of the stifle joint.

Acknowledgments: All implants were designed and manufactured by OrthoFitz, UK, of which the author is a director.

40 Incidence of cranial cruciate ligament rupture in dogs ovariohysterectomized at less than six-months of age

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Introduction: The majority (53–65%) of dogs >15kg body weight with cranial cruciate ligament rupture (CCLD) are gonadectomized females. The purpose of this report was to determine the effect of age at the time of ovariohysterectomy (OVH) on development of CCLD.

Materials and Methods: Medical records were examined to identify 130 female spayed Labrador retrievers, Golden Retrievers, German shepherds, Rottweilers, and mixed breed dogs with positive stifle cranial drawer test and 68 breed-matched dogs greater than 7-years of age with no evidence of CCLD following examination by a veterinarian. The age at OVH was obtained from medical records or owner contact. The two-sided chi squared test for linear trend was used to determine the relative risk of CCLD in dogs spayed at ≤ 6 months, between 6–12 months, and >12 months of age with significance at $P \leq 0.05$.

Results: Dogs were ≥ 18 -kg body weight and the average age was 7.84 ± 3.09 years (CCLD, mean \pm standard deviation) and 10.70 ± 2.23 (control). The relative risk of CCLD was 1.6x for dogs spayed ≤ 6 months (95% [CI] = 1.28–1.99), and there was a significant inverse linear trend toward decreased incidence of CCLD with increasing age, $P < 0.0001$. The odds ratio for receiving OVH at ≤ 6 months of age was 4.1 (95% [CI] = 2.15–7.71).

Discussion/Conclusion: OVH =6 months of age significantly increases the risk of CCLD and owners may be counseled on the increased risk in dogs >18 kg body weight.

Acknowledgments: There was no financial support or proprietary interest.

Part II to follow in issue 4/2012.