



## Veterinary Orthopedic Society 42<sup>nd</sup> Annual Conference Abstracts

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### Part II

#### PODIUM ABSTRACTS (continued)

#### 41 Assessment of Novel Digital and Smartphone Goniometers for Joint Angle Measurement of the Canine Stifle

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**Introduction:** Goniometry is critical to the rehabilitation and management of orthopaedic patients. Hand-held digital and smartphone-based goniometers offer easy and accessible novel methodologies but have yet to be validated in veterinary medicine. This study's objective was to evaluate three novel goniometers in comparison to the universal goniometer (UG) for goniometry of the canine stifle. We hypothesized that the HALO digital goniometer would be the most accurate.

**Materials and Methods:** Two smartphone applications, iHandy Carpenter (iHandy) and DrGoniometer (DrG), and the digital HALO goniometer (HALO Medical Devices) were compared to the UG and measured against the gold standard of radiographic measurements for reliability (coefficient of variation, CV), and accuracy ( $R^2$ ). Triplicate measurements were performed on eight canine cadaver stifles set in three randomly pre-determined angles each.

**Results:** The UG had a mean CV of 4.88 and  $R^2$  of 0.94. DrG, iHandy, and HALO had a mean CV of 7.37, 7.57, and 12.71 with  $R^2$  of 0.87, 0.81, and 0.61 respectively.

**Discussion/Conclusion:** The UG was the most accurate and reliable device. Subjectively, iHandy was the easiest to learn to use and most efficient. Future studies are needed to determine a valid alternative goniometer.

**Acknowledgements:** Supported by the Young Investigator Grant Program, CSU

#### 42 Evaluation of Gait Patterns in Dogs: The Pace

**Wendland TM; Martin KW; Vitt MA; Duncan CG; Duerr FM**

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**Introduction:** It is unknown whether the pace is indicative of musculoskeletal pathology in dogs. This study investigates whether pacing in dogs is a normal gait pattern or associated with orthopedic disease and to establish the impact speed has on pacing.

**Materials and Methods:** Healthy, medium-large breed dogs were included in the study. Each dog was evaluated for orthopedic abnormalities and lameness by exam and radiography, then separated into non-lame (NL) and mildly lame (ML) groups. Gait was assessed using digital video imaging under 3 conditions: off-leash unrestricted movement (UM); leash-controlled (LEAD), and on a land treadmill (TREAD) after a period of treadmill habituation.

**Results:** Pacing was observed in 17/20 NL and 10/19 ML dogs. Comparison of pacing frequency between groups showed no significant difference under TREAD and UM conditions. NL dogs were significantly more likely to pace than ML dogs under LEAD conditions. All pacing occurred at speeds between walk and trot with speeds ranging from 3.52 km/h-10.24 km/h (2.20-6.36 mph, mean 6.51 km/h [4.04 mph]).

**Discussion/Conclusion:** Pacing was demonstrated in orthopedically normal and abnormal dogs and therefore may be a normal gait observed in canines regardless of musculoskeletal health. Pacing should not be considered a clinical indicator of orthopedic pathology. Relative speed was also determined to be a key factor in pacing.

**Acknowledgements:** Funded in part by the Young Investigator Grant program and by the American Humane Association.

#### 43 Quantitative Comparison of the Walk and Trot of Border Collies and Labrador Retrievers, Breeds with Different Performance Requirements

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**Introduction:** We hypothesized that differences in working function of Border Collies and Labrador Retrievers would be reflected in the temporospatial characteristics of the walk and trot.

**Materials and Methods:** Twenty healthy Border Collies and 20 healthy Labrador Retrievers made three passes across a pressure sensing walkway system that recorded quantitative temporospatial information at a walk and a trot. The following variables were measured for each dog: velocity, total pressure index percentage (TPI%), ratio of weight borne on the thoracic vs. pelvic limbs (T/P TPI%), stance time percentage (ST%), thoracic limb stride length (TSrL), thoracic limb length (TFLL) and thoracic limb angulation ratio (TAR).

**Results:** The mean T/P TPI% for Border Collies at a walk and at a trot were significantly lower than for Labrador Retrievers ( $p = 0.0007$  and  $p = 0.0003$ ). Border Collies had a significantly lower ST% than Labrador Retrievers for the thoracic limbs and pelvic limbs at a walk ( $p = 0.0058$  and  $0.0003$ ) and the trot ( $p = 0.0280$  and  $0.0448$ ). There was no relationship between ST% and TSrL in Border Collies and an inverse correlation between ST% and TSrL in Labrador Retrievers ( $p = 0.0002$ ).

**Discussion/Conclusion:** Key quantitative gait differences were identified and likely provide each breed with a working function advantage.

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

#### 44 Canine Stride Length Assessment Using Inertial Measurement Units during Outdoor and Treadmill Activity

**Martin KW<sup>1</sup>; Wendland TM<sup>1</sup>; Vitt MA<sup>1</sup>; Board WJ<sup>2</sup>; Duncan CG<sup>2</sup>; Duerr FM<sup>1</sup>**

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**Introduction:** Conventional gait analysis systems are limited to the unnatural environment of a gait lab. Inertial measurement units (IMUs) have the potential to address this and other issues. Stride length has been shown to be a reliable indicator of orthopedic pathology in dogs. We assessed stride length using wireless IMUs in normal dogs outdoors and on a treadmill. We hypothesized that there would be no difference between stride outdoors and on a treadmill.

**Materials and Methods:** Data was collected outdoors while dogs were trotted on a lead and on a treadmill at a consistent trotting velocity. The mean stride length for each dog was compared using correlation coefficients and a Paired T-test stratified by thoracic vs. pelvic limbs.

**Results:** The stride length obtained outdoors and on the treadmill was highly correlated for both the thoracic and pelvic limbs, however, it was significantly longer on the treadmill than outdoors.

**Discussion/Conclusion:** IMUs can be used to acquire stride length for dogs in a natural outdoor setting. This may provide a rapid method of objective



outcome measurement that is highly correlated with stride length under controlled velocity. Investigation and validation of IMUs for the acquisition of further kinematic data is currently ongoing.

**Acknowledgements:** This project was funded in part by Morris Animal Foundation and CSU's College Research Council.

#### 45 Changes in Hoof Kinetics and Kinematics in Response to Regular Hoof Trimming

**Faramarzi B**

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**Introduction:** Proper hoof preparation and preserving hoof balance are integral to horses' soundness and performance. Thus far, hoof balance is mainly assessed by visual examination which is not flawless. Modern Pressure plates (PP) can provide an objective evaluation of hoof biomechanics. The objective of this study was to assess the effect of hoof trimming on hoof biomechanics using a pressure plate.

**Materials and Methods:** Nine clinically sound Arabian horses were used in this study. Each horse was led across the PP by an experienced horse handler. A digital camera was positioned alongside the PP and foot strike and gait was recorded. For both hooves mid-stance, vertical force (N), contact pressure (Kpa), contact area (cm<sup>2</sup>), stance phase duration (s), swing phase duration (s), gait cycle duration (s), duty factor and swing phase were calculated. Kinetic and kinematic data were analyzed using appropriate statistical tests and P-value of  $\leq 0.05$  was considered significant.

**Results:** Among kinetic parameters vertical force increased from 1291 to 1508 N and contact pressure increased 115 to 134 kPa after trimming. Left and right hooves were not statistically different except for contact pressure. Among kinematics variables stance phase duration, swing phase duration and gait cycle duration decreased significantly.

**Discussion/Conclusion:** The observed changes in kinetic and kinematic parameters are related to hoof trimming. A better understanding of changes in post trim loading patterns requires further research.

**Acknowledgements:** This study was partially supported by the Arabian Horse Foundation.

#### 46 Densitometric Comparison of Autogenous Cancellous Bone Graft and Extracorporeal Shock Wave Therapy for Osteotomy Healing after Tibial Tuberosity Advancement

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**Introduction:** Extracorporeal Shock Wave Therapy (ESWT) and Autogenous Cancellous Bone Grafting (ACBG) are 2 modalities used to enhance bone healing. Our objective was to determine which treatment would result in greater osteotomy healing after Tibial Tuberosity Advancement (TTA) in dogs.

**Materials and Methods:** This was a prospective randomized clinical trial using dogs presenting for cranial cruciate ligament rupture. Treatment groups included: TTA with ACBG (TTAg), TTA with ACBG and ESWT (TTAgS), TTA with ESWT (TTAS), and TTA without additional therapy (TTAo). Osteotomy healing was assessed via densitometry (conversion of optical density to millimeters of aluminum equivalent) 4 and 8 weeks after surgery. A mixed model analysis of variance was used for comparisons between groups.

**Results:** Four weeks after surgery, osteotomy gap density was significantly greater for TTAgS compared to both TTAs and TTAo. No other significant differences were noted.

**Discussion/Conclusion:** No significant differences in osteotomy gap density were noted 8 weeks after surgery regardless of treatment group. The combi-

nation of ACBG and ESWT led to increased density of the osteotomy gap 4 weeks post-operatively. There were no significant differences in osteotomy gap density between dogs treated with ESWT alone compared to the control group at any time point during this study.

**Acknowledgements:** Intramural funding was obtained for this project.

#### 47 Comparison of Pet-Owner Satisfaction with Stifle Orthoses or Tibial Plateau Leveling Osteotomy for the Treatment of Cranial Cruciate Ligament Disease in Dogs

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**Introduction:** There is a lack of information describing stifle orthoses outcome for treatment of canine cranial cruciate ligament disease (CCLD). The study purpose was to compare pet-owner satisfaction following surgical/non-surgical treatment of CCLD.

**Materials and Methods:** Online survey to pet-owners: either a stifle orthosis (ORTHOSIS) or tibial plateau leveling osteotomy (TPLO) for CCLD.

**Results:** The ORTHOSIS group response rate was 25% and 40% for the TPLO group. Greater than 85% of owners in both groups would repeat the chosen treatment again (P=0.32). A greater number of TPLO dogs showed no/mild lameness following intervention (98%,P=0.04) compared to the ORTHOSIS group (88%). A larger number of TPLO owners rated the treatment as excellent (TPLO:68%;ORTHOSIS:41%,P=0.003). Forty-four percent of ORTHOSIS owners reported skin issues. Thirteen percent of ORTHOSIS dogs subsequently underwent a surgical procedure on the treated leg and eight percent of owners reported their dog never adjusted to the orthosis.

**Discussion/Conclusion:** A high percentage in both groups reported positive satisfaction. Owners selecting stifle orthoses should be advised of the potential for complications including persistent lameness, skin issues, orthosis non-acceptance, and subsequent surgery.

**Acknowledgements:** Dr. Mich (OrthoPets co-owner); Dr. Duerr is a paid consultant for OrthoPets.

#### 48 Stifle Pain As a Cause of Poor Performance in Sport Horses: 13 Cases

**Read RM**

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**Introduction:** This case series highlights the stifle as potentially underestimated cause of poor performance. This has not been previously described.

**Materials and Methods:** Retrospective review was performed on all horses that presented with poor performance and were diagnosed with primary stifle pain by diagnostic analgesia. All cases received full orthopedic work up including diagnostic imaging.

**Results:** Thirteen horses met the inclusion criteria. All were middle-aged sport horses with mild hind limb lameness (1/10-3/10); 3/13 unilateral, and 10/13 bilateral. 9/13 of horses had previous treatment at other sites. All but one showed improvement upon diagnostic analgesia of the stifle; the other had significant imaging abnormalities. 6/13 were evaluated under saddle, and all showed improvement post stifle analgesia. 4/13 had pain isolated to the stifle alone, and 9/13 also had pathology in other regions: 6/9 SIJs; 7/9 HLPD; 2/9 back pain; and 1/9 forelimb DIP joint pain. There were radiographic changes in 4/13, and 7/13 had mild ultrasonographic changes. 9/13 horses underwent gamma scintigraphy, none of which showed significant stifle uptake. Nine horses underwent stifle arthroscopy, and all had significant pathology.

**Discussion/Conclusion:** This case series demonstrates that stifle pain can be the primary cause of poor performance in non-racing sport horses.



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

#### 49 Fatal Musculoskeletal Injuries of the Fetlock Joints in California Racehorses

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**Introduction:** Fetlock injuries comprise over half of fatal musculoskeletal injuries among racehorses. Horses with nonspecific physical examination fetlock abnormalities are at increased risk for severe fetlock injury. Specific lesions may predispose to injury. Our objective was to characterize fatal fetlock injuries and associated pre-existing lesions in racehorses.

**Materials and Methods:** Postmortem records were retrospectively reviewed for 358 California racehorses that incurred a fatal fetlock injury during a 2-year period. Findings were categorized by primary injury site, fracture configuration, and evidence of associated pre-existing lesions.

**Results:** Fetlock injuries occurred in 52% of musculoskeletal fatalities. Proximal sesamoid bone (PSB) fracture was most common. Most (88%) fetlock injuries had evidence of pre-existing pathology. A discrete pre-existing lesion was observed in 65% of horses with primary PSB fracture(s), most commonly focal subchondral discoloration, porosity, and adjacent sclerosis at the abaxial aspect of the medial PSB. Visible lesions were observed in 95% of horses with PSB fracture(s) and 98% of fractured metacarpi/tarsi but few proximal phalangeal bones. Evidence of pre-existing pathology was observed in 47% of horses with a primary soft tissue injury.

**Discussion/Conclusion:** Specific lesions predispose to fetlock injuries. Awareness should enhance early lesion detection and catastrophic injury prevention.

**Acknowledgements:** California Horse Racing Board's Racing Safety Program and American Quarter Horse Foundation.

#### 50 Feeding Enrichment Increases Daily Activity Level

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**Introduction:** The idea of this study was to use food as an exercise self-motivator by having dogs work for their daily ration. Our hypothesis was that dogs feeding from an enrichment device have a higher daily activity level, measured in minutes, than dogs feeding from a plain metal bowl.

**Materials and Methods:** Forty-four days of feeding were block-randomly assigned to a Kong Wobbler or bowl. That way, the difference between group means can be statistically tested with modified t-test. A single-case design evaluated the effect of feeding with the Kong on the activity level of a sedentary, 12-year-old Chihuahua with Grade 2, bilateral luxating patellas and a BCS of 6. The second subject was an active, healthy, 2-year-old female German shorthaired pointer with a BCS of 4.5.

**Results:** Using the Kong, the Chihuahua's activity level increased by 37.4 minutes over bowl feeding ( $p < 0.001$ ), and the GSP's activity level increased by 31 minutes ( $P < 0.001$ ).

**Discussion/Conclusion:** Feeding from the Kong, both dogs increased daily activity beyond that expected by chance, suggesting that feeding enrichment is a way to increase activity level in dogs without time-consuming leash walking. While activity level is important, a larger study of sedentary dogs feeding from enrichment devices is needed using weight loss and change in BCS as outcomes. This study serves as first step in the research process, and introduces surgeons to a simple but powerful study design that can be used to test hypotheses in individual subjects.

**Acknowledgements:** None.

#### 51 A Biomechanical Evaluation of the Use of Supplemental Drop-Wire & Half-Pin Fixation Elements in Single-Ring Circular Fixator Constructs.

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**Introduction:** We evaluated the biomechanical effects of placing a supplemental fixation wire or one to three half-pins on single-ring circular fixator constructs.

**Materials and Methods:** Constructs (base single-ring construct, constructs with a supplemental drop-wire or one to three supplemental half-pins) assembled using 66 mm rings, 1.6 mm olive wires & 3.2 mm pins securing a Delrin rod were loaded in axial compression, caudocranial & mediolateral bending, & torsion. Stiffness & microstrain assessed.

**Results:** Compression & torsion: significant stiffness differences were noted between the three pin & two pin constructs, but not others. Caudocranial bending: significant differences in stiffness were noted between all constructs. Mediolateral bending & torsion: the two & three pin constructs were significantly stiffer than the drop-wire & one pin constructs which were significantly stiffer than the base single-ring construct. In the drop-wire construct, strain was reduced in both wires attached to the ring. In the one pin construct, strain in the distal wire was greater than in the drop-wire construct & strain was significantly greater in the half-pin than the drop-wire. Strain in all of the fixation elements was reduced by placing additional pins.

**Discussion/Conclusion:** While a single supplemental half-pin afforded a similar increase in stiffness to a supplemental drop-wire, the single pin induced cantilever bending & high fixation element strain. Strain was reduced & displacement was linear with placement of additional pins.

**Acknowledgements:** Funding provided by IMEX Veterinary, Inc.

#### POSTER ABSTRACTS

#### 52 Outcome and Major Complications Following Surgical Correction of Grade IV Medial Patellar Luxation in Dogs: 29 Stifles

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**Introduction:** The purpose of this study was to report the short and long-term outcomes and complications of dogs with grade IV medial patellar luxation (MPL) treated surgically.

**Materials and Methods:** Medical records for 24 dogs (29 stifles) with surgical correction of grade IV MPL between March 2008 to April 2014 were reviewed retrospectively. Long-term follow-up was obtained via orthopedic examination, radiographs, and client questionnaires.

**Results:** There was a 24% major complication rate associated with surgical repair of grade IV MPL, and an overall revision rate of 21%. Femoral corrective osteotomy was performed in 86% of dogs. Grade II-IV recurrent luxation occurred in 21%. At long-term follow-up, all owners reported return to function as "full" or "acceptable." All dogs scored  $\leq 2$  out of 5 (0=normal) for both pain and lameness when evaluated by a surgeon. Surgical repair of grade IV MPL had an overall success rate of 93%.

**Discussion/Conclusion:** Surgical repair of grade IV MPL had a favorable overall success rate, with improved limb function and a high degree of owner satisfaction.

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





### 53 Evaluation of a Novel Transarticular Implant for the Treatment of Canine Stifle Instability

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**Introduction:** A surgical technique utilizing a novel extracapsular articulated stifle stabilizing implant has been evaluated in 25 patients. The hypothesis was that the implant would provide continuous stifle stabilization to the cranial cruciate ligament (CrCL) deficient stifle facilitating early mobilization of the affected limb and post-operative improvement in stifle range of motion, thigh circumference and lameness score.

**Materials and Methods:** Twenty-five cases of naturally occurring canine CrCL deficiency were treated with a novel transarticular implant. All patients had physical and radiographic evidence of CrCL deficiency. Patients were assessed prior to surgery and postoperatively between 4 and 9.5 months (mean 6.0 months) for cranial tibial translation, thigh circumference, stifle range of motion and lameness score.

**Results:** Implants were well tolerated by all patients. Lameness scores and range of motion were significantly improved post-operatively. Thigh circumference initially decreased and then returned to or increased over preoperative measurements in the majority of patients. Abnormal cranial tibial translation was eliminated in all patients.

**Discussion/Conclusion:** Twenty four of 25 patients were weight bearing within 24 hours of surgery and patients showed significant improvement in stifle function on postoperative evaluations. This implant is a promising alternative for the treatment of the CrCL deficient canine stifle. Investigations are ongoing to further assess the long term clinical efficacy of this implant.

**Acknowledgements:** The authors hold the patent to this implant.

### 54 Juxta-Articular Cranial Closing Wedge Osteotomy for Treatment of Cranial Cruciate Ligament Insufficiency in Dogs with Excessive Tibial Plateau Angles: Technique and Complications in 17 Cases

**Cross AR; Frederick SW**

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**Introduction:** Surgical treatment of dogs with eTPA (TPA > 34 degrees) remains challenging. Most reported osteotomy procedures are physically limited in the amount of angular alteration possible. The objective of this study was to report the incidence of short-term complications following a juxta-articular CCWO.

**Materials and Methods:** Medical records were reviewed for dogs with CCL insufficiency receiving a juxta-articular CCWO due to eTPA. Relevant clinical and surgical data was recorded. A cranial tibial wedge equal to the TPA was excised immediately distal to the patellar ligament insertion. The osteotomy was stabilized with a TPLO plate and pin and tension-band wire apparatus.

**Results:** Sixteen dogs (17 knees) met all inclusion criteria. Median follow-up time was 48 days. Median pre-operative TPA was 48 degrees. Median and mean post-operative TPA was 10 degrees and mean change in TPA during the follow-up period was 0 degrees with 5 knees having a TPA increase greater than 1 degree. No fixation complications occurred. Two patients developed implant-associated infections that required implant removal to resolve. All patients were recovering well clinically at their last follow-up examination.

**Discussion/Conclusion:** Juxta-articular CCWO is an effective TPA leveling procedure for eTPA, allowing a mean change in TPA of 40 degrees in these cases. Although direct comparisons among retrospective studies are difficult, our results appear to compare favorably, with no implant complications and a second surgical procedure frequency of 11.7%.

**Acknowledgements:** None

### 55 Thermographic Assessment of the Normal Canine Stifle and Comparative Thermography Study of TTA and TPLO

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**Introduction:** Thermography has been used for evaluation of arthritis and inflammatory diseases, obtaining fast and objective measurements of skin temperature. The aim of this study was to compare dogs with unilateral cranial cruciate ligament disease (CCLD) operated using TTA or TPLO by thermographic evaluation.

**Materials & Methods:** Thirty dogs weighing over 20kg were evaluated. Dogs were allocated into three groups. Group one comprised ten healthy dogs submitted to thermographic assessment of both stifles for determination of normal baseline temperature values. Groups two and three comprised ten dogs each diagnosed with unilateral stifle instability and submitted to joint stabilization using TTA and TPLO respectively. Dogs treated with TTA or TPLO were submitted to thermographic assessment prior to surgery and at postoperative days 30, 60 and 90. All dogs were clipped and four views were taken before and after five minutes of exercise in a treadmill. We used a Thermacam T400 and FLIR Quick Report for all thermographic evaluations.

**Results:** The control group showed no differences between stifles in the same dog. Significant (Student test:  $P < 0.05$ ) differences were documented within TPLO and TTA treatment groups at postoperative day 30 (normal stifle warmer than operated for both groups). At postoperative days 60 and 90, operated and contralateral limbs did not differ significantly (Student test:  $P < 0.05$ ) within TTA and TPLO treatment groups.

**Discussion/Conclusion:** These results may indicate that both techniques (TTA and TPLO) are able to restore to normal thermographic parameters based on evaluation (comparison) of the normal canine stifle thermography (without CCLD).

**Acknowledgements:** CAPES and FAPESP

### 56 The Effects of Cranial Cruciate Ligament Insufficiency on Patellofemoral Kinematics in Dogs: An in-Vivo Study

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**Introduction:** Cranial cruciate ligament rupture is among the most frequently presenting orthopaedic issues in dogs. The relative motion between the femur and patella subsequent to cranial cruciate ligament rupture is not well described in-vivo. The goal of this study is to characterize movement of the patella relative to the femur in cranial cruciate ligament-deficient dogs and compare these kinematic measurements to contralateral, healthy stifle joints.

**Materials and Methods:** Ten dogs with complete, unilateral cranial cruciate ligament rupture underwent computed tomography scans of their hind limbs to create 3D models of the patellofemoral joint. Stifle motion was captured via fluoroscopy while the dogs walked on a treadmill. The 3D models of the patella and femur were digitally superimposed over the fluoroscopic images with shape-matching software, allowing for calculation of the precise movement of the patella relative to the femur.

**Results:** Cranial cruciate ligament deficiency caused significant increases in patellar flexion angle and cranial displacement ( $P < 0.05$ ) when compared to the healthy, contralateral stifle. Proximal-distal translation was not significantly affected by cranial cruciate ligament deficiency.

**Discussion/Conclusion:** In-vivo patellofemoral kinematics in cranial cruciate ligament-deficient stifles differ significantly from stifles with an intact cranial cruciate ligament. Knowledge of the patellofemoral kinematics in



cranial cruciate ligament-deficient stifles provides a foundation to examine existing methods surgical repair.

**Acknowledgements:** Department of Clinical Sciences, University of Florida

### 57 CASE REPORT: Treatment of Patellar Ligament Laceration with the Mini-TightRope System to Augment Primary Repair

**Robb AC; PineI CB**

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**Introduction:** This report describes a novel technique for repair of patellar ligament (PL) laceration. PL injuries are traditionally treated by primary repair augmented with internal and/or external coaptation. In this case, the Mini-TightRope system was successfully used as an internal splint to support primary repair after failure of the more traditional nylon leader technique.

**Materials and Methods:** A 2 year-old, 41.5kg, spayed female Great Pyrenees Mix was treated for a complete laceration of the left PL. The diagnosis was confirmed with radiographs demonstrating patella alta (L:P ratio of 2.7). Surgical repair was performed using primary repair of the tendon with #2 FiberWire and a patellobtibial suture using 80# nylon leader. The patient was also placed in a Spica splint postoperatively. 14 days after the repair, radiographs revealed recurrent patella alta (L:P ratio of 2.5). A second surgical repair was performed, this time employing a Mini-TightRope system to augment primary repair with #2 FiberWire. A Spica splint was again placed post-operatively.

**Results:** External coaptation was employed in the recovery period using a custom orthotic and, primarily, Spica splint. Serial ultrasound examination revealed progressive healing of the PL over 17 weeks. By 25 weeks, the patient showed only mild lameness and had normal clinical function, with no discomfort associated with palpation of the PL or associated structures, and an L:P ratio of 1.8.

**Discussion:** The Mini-TightRope is a viable alternative for internal coaptation to support primary repair of PL lacerations.

**Acknowledgements:** There was no proprietary interest or funding provided for this report.

### 58 Characterization of Canine Plasma Using Commercially Available 'Platelet Rich Plasma' Concentrating Systems

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**Introduction:** Human PRPs made using different commercially available devices have very different cellular characteristics. No published study has compared canine PRPs made using several commercially available systems.

**Materials and Methods:** Fifteen dogs 18 months to 9 years and 17 to 45 kilograms with no concurrent disease except for osteoarthritis were used in this cross-over study. PRP was made using blood from each of the 15 dogs with each of 5 different PRP systems. Complete blood counts were performed on whole blood samples and the plasma products. The degree of platelet, leukocyte, and erythrocyte concentration or reduction were quantified.

**Results:** The different systems varied in the volume of blood processed, the method of PRP preparation, and the volume of PRP produced. Mean PRP concentration ranged from 5X above whole blood with one system to a system that decreased platelet concentration. Similarly, leukocyte concentrations varied from being negligible in some PRPs up to a 3.3X increase above baseline with another system. Likewise, hematocrit ranged from 0 to 22 depending upon the system used.

**Discussion/Conclusion:** Canine PRPs produced using different systems can vary dramatically in cellular characteristics. Research studies should provide detailed information on the PRP investigated. Clinicians should be aware of

the data (or its absence) supporting use of a specific PRP for a specific medical condition.

**Acknowledgements:** This study was supported by equipment donations from all companies and also financial support from Arthrex. Drs. Franklin and Cook are consultants for Arthrex.

### 59 Comparison of PRP and Stromal Vascular Fraction Supplemented with a Novel Nanofiber Polymer for the Treatment of Cartilage Pathology in Dogs

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**Introduction:** A novel treatment combining stromal vascular fraction and a biodegradable nanofiber polymer (SVFN) has been developed with the goal of increasing intra-articular residence time of SVF stromal cells. The ultimate objectives are to improve tissue regeneration and lameness in dogs with cartilage defects. The purposes of this project were to compare SVFN to platelet rich plasma (PRP) in regards to safety of intra-articular administration, cartilage regenerative benefits, and efficacy in improving lameness.

**Materials and Methods:** An osteochondral defect (8mm x 5mm deep) was created in the medial femoral condyle of both stifles in eight beagles that were to be euthanized for reasons unrelated to this study. Two weeks later dogs were randomly allocated to receive either SVFN or PRP in one stifle and saline injection in the contralateral stifle. Subjective lameness scores were assigned for both pelvic limbs by a blinded observer immediately prior to and 7 and 28 days post treatment. Changes in lameness from baseline were assessed using a repeated measures analysis.

**Results:** No side effects were appreciated with intra-articular injection of SVFN. No statistically significant improvements in lameness scores were identified in comparison to saline for either PRP or SVFN.

**Discussion/Conclusion:** From a clinical perspective the use of the novel SVFN treatment did not have any deleterious consequences. However, neither PRP nor SVFN significantly improved lameness scores in comparison to saline within the study period.

**Acknowledgements:** Study funded by MediVet America.

### 60 Abstract withdrawn.

### 61 Comprehensive Protein Profiling of Synovial Fluid in Osteoarthritis

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**Introduction:** The aim of the study was to characterise the protein complement of synovial fluid from horses (SF) in health and osteoarthritis (OA) using liquid chromatography mass spectrometry (LC-MS/MS) following peptide-based depletion of high abundance proteins.

**Materials and Methods:** SF was used from nine normal and nine OA Thoroughbred horses. Samples were analysed with LC-MS/MS using a NanoAcquity LC coupled to a LTQ Orbitrap Velos. In order to enrich the lower-abundance protein fractions protein equalisation was first undertaken using ProteoMiner™. Progenesis™ LC-MS software was used for label-free quantification. In addition immunohistochemistry, western blotting and mRNA expression analysis was undertaken on selected joint tissues.

**Results:** The number of protein identifications was increased by 33% in the ProteoMiner™ treated SF compared to undepleted SF. A total of 754 proteins were identified in SF. A subset of 10 proteins were identified which were differentially expressed in OA SF. S100-A10, a calcium binding protein was up-regulated in OA and validated with western blotting and immunohistochem-



istry. Several new OA specific peptide fragments (neopeptides) were identified.

**Discussion/Conclusion:** The protein equalisation method compressed the dynamic range of the synovial proteins identifying the most comprehensive SF proteome to date. A number of proteins were identified for the first time in SF which may be involved in the pathogenesis of OA. We identified a distinct set of proteins and neopeptides that may act as potential biomarkers to distinguish between normal and OA joints.

**Acknowledgements:** Dr Ben McDermott for technical assistance

## 62 Evaluation of a Novel Arthrocentesis Teaching Model in Canine Cadavers

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**Introduction:** This article reports the design of a novel model for teaching arthrocentesis. In the clinical setting, animal safety is of the utmost importance and practice is thus limited.

**Materials and Methods:** The elbow, stifle and carpus on eight thawed medium dog cadavers were analyzed. Objectives were: to develop a model with higher yield compared with an unmodified cadaver, to determine if aspiration immediately after (T1) or three hours after (T2) injection affected diagnostic yield and lastly, to determine whether choice of injection fluid, mineral oil (MO) or hypertonic saline (HS), affected yield. Arthrocentesis was performed prior to injection and yield measured (control). Test joints were injected with MO or HS and yield measured after range of motion (T1). T2 yield was measured to simulate lab preparation.

**Results:** Both models had statistically significant higher yields compared with the unmodified cadaver at T1 and T2 ( $p < 0.05$ ), with the exception of HST2 carpus. T2 had a statistically significant lower yield when compared to T1 in HS carpus, HS elbow and MO carpus. Overall, irrespective of fluid volume or type, percent yield was lower in T2 compared to T1. The diagnostic yield was not significantly different between HS and MO in most joints.

**Discussion/Conclusion:** Within the time frame assessed both models were acceptable. HS arthrocentesis models, however, proved appropriate for student trial due to impracticality with MO.

**Acknowledgements:** None.

## 63 Vertical Force Gait Analysis in Dogs with Computed Tomography Assessment of Elbow and Radio-Ulnar Incongruity Evaluation

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**Introduction:** Elbow incongruity is defined as a malalignment of joint surfaces. A mismatch between the radial and ulna surfaces could lead to limb lameness and degenerative joint disease (DJD). Our objectives were to compare the vertical forces in dogs with and without clinical signs of elbow disease and evaluate if incongruity of less than 1 mm is linked to kinetic changes.

**Materials and Methods:** Twenty dogs (40 elbows) were evaluated with a pressure walkway at 1.2 m/s. Peak vertical force and vertical impulse were measured and reported as % of body weight (%BW). Computed tomography (CT) assessment was used to detect degenerative changes and incongruity. The criteria of groups were: elbows with (n=8) or without (n=32) clinical signs for the first comparison and elbows with  $\geq 1$ mm (n=7) or  $< 1$ mm of radio-ulnar incongruity (n=33) for the second comparison. ANOVA with Tukey's test were used ( $p < 0.05$ ).

**Results:** No significant difference was detected in vertical force analysis between groups (PVF and VI). The general means  $\pm$  standard deviation for PVF and VI were  $51.8 \pm 6.2$  %BW and  $22.6 \pm 4.0$  %BW\*s respectively. Only

two elbows with clinical signs had lower vertical force values. Twenty eight elbows with incongruity lower than 1mm showed signs of DJD on clinical and CT evaluation.

**Discussion/Conclusion:** No significant kinetic differences were identified between the sound and lame groups, or between the congruent group and incongruent group with DJD.

**Acknowledgements:** Funding from FAPESP- n°2013/21406-5.

## 64 Kinetic Gait Analysis of British Bulldogs

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**Introduction:** Orthopedic diseases affect ground reaction forces. Breed conformation may interfere with locomotion and predispose to orthopedic disease. The aim of this study was to describe the vertical forces of bulldogs, whilst walking on a pressure walkway.

**Materials and Methods:** Thirteen Bulldogs selected from a random sample, were evaluated on a pressure sensitive walkway. Peak vertical force (PVF), vertical impulse (VI), symmetry index (SI), rate of loading, stance phase duration (SP), radiography, clinical findings and incidence of orthopedic diseases were recorded. Paired T-test was used to compare data. Results: means of PVF  $23.4 \pm 7.4$ %BW, VI  $4.6 \pm 1.2$ %BW\*sec and SP  $0.35 \pm 0.1$ sec had no statistical difference ( $P > 0.05$ ) on comparing right and left hind limbs. SI for hind limb was  $16.0 \pm 13.5$ . All 13 dogs had radiographic evidence of hip dysplasia without signs of pain or discomfort on physical examination. 69% of the dogs had concurrent orthopedic disease.

**Discussion/Conclusion:** The values of PVF, VI and SP are similar to other reported breeds but mean symmetry index for hind limbs in our sample was higher than the reported mean in healthy dogs (0.3 to 9.6%), although no indication of pain was found. This asymmetry could be a result of lameness not evident during the clinical exam. We found a high incidence of orthopedic diseases based on this data and healthy Bulldogs are needed to compare these values.

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## 65 Minimally Invasive Osteosynthesis with Locked Plates in Tibial Fractures in Dogs

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**Introduction:** Late advances in bone biology have led to a better understanding of bone remodeling with consequent adjustments to classic internal fixation protocols. Minimally invasive plate osteosynthesis (MIPO) is one of the latest developments for the biological management of fractures. The aim of this study was to evaluate the use of locked plates applied minimally invasively in tibial fractures in dogs.

**Materials and Methods:** Ten dogs with tibial fractures were used. Ambulation, edema intensity, radiographic images and bone densitometry were assessed on days 0, 15, 30, 60, 90 and 120 postoperatively.

**Results:** At 30 days postoperatively all dogs were weight bearing when walking with no signs of edema on the affected limb. Clinical fracture union was observed in two dogs at day 15, in six patients at day 60 and in eight dogs at day 90. Optical densitometry confirmed the consolidation periods and the evidence of bone remodeling.

**Discussion/Conclusion:** The treatment of tibial fractures by MIPO is an effective alternative to open reduction internal fixation, results in early use of the limb and effective clinical union, and can be performed without the use of image intensifiers and in different types of fractures.

**Acknowledgements:** There was no funding provided for this project.





## 66 Narrow Field of View 3T MRI Identifies Articular Cartilage Lesions in Canine Cadaveric Stifles

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**Introduction:** The objective of this study was to determine if narrow field of view 3T MRI was capable of identifying experimentally induced cartilage lesions in canine stifles.

**Materials and Methods:** 42 canine cadaveric stifles (n=6/group) were treated with sham control, 0.5, 1.0, or 3.0 mm deep lesions in the medial or lateral femoral condyle. PD- and T1-weighted, FLASH, and T2 maps were generated in dorsal and sagittal planes. Lesion location and size were determined by blinded observers using MRI and compared to histologic measurements. Accuracy of MRI was determined using concordance correlation coefficients.

**Results:** Lesions were identified correctly in 98.8% (observer 1) and 98.2% (observer 2) of joints. Correlation between MRI and histopathology was better for lesion depth (observer 1: 0.683–0.8355; observer 2: 0.7595–0.8324) versus diameter (observer 1: 0.2991–0.5395; observer 2: 0.4818–0.6837). However, MRI overestimated lesion depth (histopathology: 1.65 mm; observer 1: 2.07–2.38 mm; observer 2: 2–2.2 mm) and diameter (histopathology: 6.98 mm; observer 1: 8.33–8.8 mm; observer 2: 6.64–7.16 mm).

**Discussion/Conclusion:** 3T MRI accurately identified canine articular cartilage lesions. There was superior correlation of MRI to histopathologic measurements for lesion depth, although MRI overestimated both depth and diameter. Additional studies are necessary to evaluate the ability of MRI to accurately identify canine articular cartilage lesions in vivo.

**Acknowledgements:** ACVR CT/MRI Society resident grant.

## 67 Platelet-Derived Growth Factor-BB (PDGF-BB) Stimulates MG-63 Osteosarcoma Cell Invasion of Three-Dimensional Collagen Matrices in a Membrane-Type MMP Dependent Manner.

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**Introduction:** Cellular invasion of the extracellular matrix is essential for many physiological and pathological processes. Invasion of 3D matrices requires an invasion stimulus, integrins, proteinases such as matrix metalloproteinases (MMPs), and cytoskeletal rearrangement. Previous work has linked soluble MMPs to tumor invasion and metastasis. Recent studies suggest that membrane-type MMPs (MT-MMPs) are required for focused pericellular proteolysis that occurs during tumor invasion. We hypothesized that PDGF-BB would induce invasion of 3D collagen matrices by MG-63 osteosarcoma cells in an MT-MMP dependent manner.

**Materials and Methods:** MG-63 cells were seeded on 3.75 mg/ml Collagen I gels in a serum-free environment and allowed to invade for 24–72 hours. Cell invasion was determined as well as analysis of conditioned media and cell lysates via Western blot and gelatin zymography.

**Results:** PDGF-BB induced a dose- and time-dependent invasion of MG-63 cells into 3D collagen matrices. PDGF-BB resulted in increased expression of MT1-MMP, MMP-1, and MMP-2. The MMP inhibitors GM6001, TAPI-O, and TIMP-3, which broadly inhibit both soluble and membrane-type MMPs, significantly inhibited MG-63 invasion. Addition of TIMP-1, which inhibits soluble MMPs, or the serine proteinase inhibitor aprotinin, had a markedly reduced effect. Lastly, the addition of the PDGF receptor tyrosine kinase inhibitor AG1296 resulted in a significant reduction in MG63 invasion.

**Discussion/Conclusion:** This work suggests that PDGF-BB is an important growth factor in osteosarcoma cell invasion and metastasis, and that MT-MMPs are required for this process.

**Acknowledgements:** None.

## 68 Influence of Mesenchymal Stromal Cells on Pulmonary Metastases and Local Recurrence Following Primary Tumor Removal in a Murine Osteosarcoma Model

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**Introduction:** Mesenchymal stromal cells (MSCs) improve bone healing; however, MSCs also promote primary and metastatic tumor growth in the presence of gross tumor. Previously, we reported on pilot data regarding the safety of MSC usage in a model of OSA. In this follow-on project, we hypothesized that MSCs would have no influence on pulmonary metastases or local disease recurrence in a minimal disease setting.

**Materials and Methods:** Primary tumor was established in mice and confirmed using bioluminescence imaging (BLI). At ten days, either a coxofemoral amputation or a femorotibial amputation was performed. Mice were randomized to receive no MSCs, 5x10<sup>5</sup> MSCs locally into the surgical site, or 5x10<sup>5</sup> MSCs intravenously. Development of pulmonary metastases or local recurrence was monitored by BLI and caliper measurements at the amputation site. Mice were sacrificed at 21 days (metastasis study) or 41 days (local recurrence study). Lungs and amputation sites were examined histologically. Significance was set at p < 0.05.

**Results:** Mice receiving IV MSCs had faster BLI expression of pulmonary disease and higher median number of metastatic nodules. Despite an observable treatment effect, statistical significance was not met. MSCs administered locally had no influence on either pulmonary metastatic burden or local recurrence.

**Discussion/Conclusion:** Local MSC administration appears to be safe; however, further study is warranted to evaluate the safety and influence of IV MSCs on minimal residual pulmonary metastatic disease.

**Acknowledgements:** Funding provided by the Laboratory of Comparative Musculoskeletal Oncology and Traumatology.

## 69 Efficacy of Canine Adipose-Derived Mesenchymal Stem Cell Therapy in an Immune-Deficient Murine Model of Implant-Associated Osteomyelitis

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**Introduction:** In previous work performed in our laboratory, a single treatment with human amnion-derived MSCs was shown to transiently diminish the severity of luciferase expressing *S. aureus* osteomyelitis (OM) in an immune-deficient murine model of implant-associated OM. The objective of this study was to evaluate the efficacy of repeat delivery of canine adipose-derived MSCs (cAdMSCs) in an immune-deficient murine model of implant-associated OM.

**Materials and Methods:** Luciferase-expressing *S. aureus* implant-associated OM was induced in the left distal femur of 23 athymic mice. Fifteen days following infection, 13 mice received 500,000 cAdMSCs into the soft tissues of the left distal femur and 10 received the carrier alone. Respective treatments were repeated 14 and 28 days later. Weekly radiographs of the left femur and images of luciferase expression were obtained and analyzed by an observer blinded to treatment group. The mean luciferase expression, mean percent



change luciferase expression, and mean radiographic score of OM over time was calculated and compared.

**Results:** Mice treated with cAdMSCs had significantly less luciferase expression by day 20 than the control group ( $p < 0.05$ ). There was no statistical difference in radiographic score of OM between groups at any time point.

**Discussion/Conclusion:** cAdMSCs appeared to suppress worsening of infection, however, repeat dosing of cAdMSCs did not prolong this effect. Follow-on studies will include how local delivery of cAdMSCs in conjunction with antibiotic therapy compares to antibiotic therapy alone in this immune-deficient murine model of osteomyelitis.

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## 70 Abstract withdrawn.

## 71 Sequencing and Characterization of Equine Aggrecan-Size Does Matter

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**Introduction:** Aggrecan is the major non-collagenous protein in cartilage. Aggrecan is highly substituted with sulfated glycosaminoglycans (sGAG) that bind water and provide resistance to compression. Aggrecan cleavage is critical in osteoarthritis, a disease that affects many performance horses. We have fully sequenced equine aggrecan to confirm the conservation of major enzymatic cleavage sites within the protein.

**Materials and Methods:** Equine aggrecan was sequenced using RT-PCR and rapid amplification of cDNA ends. Enzymatic cleavage sites were mapped according to information from other species. Chondrocyte culture and synovial fluids were analyzed by Western blotting to identify major amino aggrecan fragments.

**Results:** The 61KB equine aggrecan gene is on chromosome 1, contains 17 exons and codes for 2728 amino acids. The CS1 sequence is 800 base pairs longer than documented in the equine genome database. Polymorphism in CS1 is due to variable numbers of the 21-amino acid core VNTR sequence in this domain. Western blotting showed complex post-secretion processing of aggrecan. The NITEGE fragment, generated by ADAMTS cleavage, was the dominant amino fragment in joint fluid.

**Discussion/Conclusion:** Equine aggrecan contains an expanded CS1 domain that substantially increases water-binding potential. All major enzymatic cleavage sites were identified. Western blots indicate that ADAMTS cleavage in the interglobular domain, which releases all sGAG side-chains from the bound core protein, is a major activity in equine cartilage. CS1 polymorphisms might be associated with genetic predisposition to osteoarthritis, as has been suggested in people.

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

## 72 Impact of FGF-2 on Equine Synovial Fluid Chondro-Progenitor Proliferation and Differentiation.

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**Introduction:** Mesenchymal progenitor cells (MPCs) show promise for cell-based articular cartilage repair. Progenitor cells in equine synovial fluid (SF) can be expanded and induced to undergo chondrogenic differentiation with

phenotypic characteristics of articular, as opposed to endochondral, chondrocytes. Monolayer expansion of these cells requires several weeks, however. This study was conducted to determine the effect of fibroblast growth factor-2 (FGF-2) on equine synovial fluid MPC monolayer proliferation and subsequent chondrogenesis.

**Materials and Methods:** Synovial fluid was obtained from equine joints and diluted 1:10 in culture medium for primary culture. Colony-forming assays were performed during primary cultures. At first passage, SF cells were seeded at 5,000 cells/cm<sup>2</sup> with or without FGF-2. Expansion was continued for two passages, then cells were transferred to chondrogenic pellet cultures. Pellets were analyzed at 10 and 20 days for chondrogenic mRNA expression, collagen type II and sulfated glycosaminoglycan content.

**Results:** There was a mean of 59.2 cfu (range 25.2–178.7) per ml of synovial fluid in primary cultures. During passage, FGF-2 reduced 'days to confluence' by 50% and increased cell density at confluence two-fold; a net four-fold increase in proliferation. FGF-2 increased expression of collagen type II mRNA at 20 days and prevented development of a peripheral 'monolayer' on the pellet surfaces.

**Discussion/Conclusion:** FGF-2 was a potent SF-MPC mitogen and also improved cytomorphology. FGF-2 supplementation improves the clinical utility of these cells for cartilage repair applications.

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

## 73 Validation of a Technique for Radiographic Quantitative Assessment of Cranial Tibial Subluxation at Varying Degrees of Stifle Flexion with or without Intact Cruciate Ligament

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**Introduction:** This study was designed to validate a technique to assess tibial subluxation relative to the femoral condyles on stifle radiographs at 90°, 110°, and 135° of stifle flexion in CrCL intact, partially, and completely transected conditions. We hypothesized our technique would allow accurate quantification of tibial translation relative to the femur at all measured stifle flexion angles and CrCL conditions.

**Materials and Methods:** Radiopaque markers were placed at the CrCL attachments in eight cadaveric pelvic limbs. Mediolateral stifle radiographs were obtained at all flexion angles and CrCL conditions. Radiographic measurements included: CrCL length, and intercondylar distance (ICD) defined as distance between tibial mechanical axis (TMA) and femoral condylar axis (FCA).

**Results:** Complete CrCL transection caused significant cranial tibial translation. Stifle flexion angle affected ICD, but not CrCL. Normalized measured CrCL length and ICD were significantly different. The change in distance detected by CrCL measurement and ICD as CrCL transection status changed wasn't different. A significant positive correlation existed between measured CrCL and ICD.

**Discussion/Conclusion:** Stifle flexion angle affected measured ICD more than the CrCL length, probably due to a non-isometric femoral location. In conclusion, we accept our hypothesis as the ICD measurement technique was able to quantify tibial translation at various stifle flexion angles.

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