Introduction – Animal models have been utilized extensively for meniscal disease research. The anterior cruciate ligament transection (ACLt) model is a commonly used canine model of osteoarthritis and the resultant knee instability often leads to naturally occurring medial meniscal injury. However, the ability to monitor the development and progression of meniscal injury can be as challenging in the ACLt model as it is in the clinical patient. The optimal diagnostic method should be minimally invasive, cost effective, efficient, accurate, and clinically relevant. Advanced imaging techniques such as magnetic resonance imaging (MRI) and ultrasonography are promising minimally invasive techniques to evaluate the development and progression of meniscal injury in the animal model. MRI is a sensitive diagnostic tool, but is costly and may not be available for use in animal model studies. Ultrasonography is more cost effective and widely available compared to MRI; however, the reported accuracy for meniscal ultrasonography varies widely. Most studies evaluating the effectiveness of MRI and ultrasonography as diagnostic modalities and gross and histologic evaluations; darker blue indicates a strong correlation while lighter blue indicates a moderately strong correlation.

Materials and Methods – All procedures were in accordance with the University Animal Care and Use Committee. Twenty-one transport dogs were used for a blinded prospective parent study evaluating a proprietary compound for treatment of osteoarthritis. All dogs underwent right knee MRI, arthroscopic exploration and ACL transection, leaving the left limb as the unoperated control. The dogs were leash-walked ten minutes per day for eight weeks, during which time they received either the experimental compound or placebo daily per os. Eight weeks post-operatively, MRI and second-look arthroscopy were performed on the operated knee, and ultrasonographic examinations were performed on both knees. For all points, knee MR images were acquired with a 1.5T magnet and sequences included: 3D spoiled gradient with fat suppression, T2W 3D gradient recalled echo, and Fast Fat Suppressed Dual Echo Spin Echo. Ultrasonographic examination was performed using a 12-14 MHz high-resolution probe. Sonographic inspection of the menisci included evaluation for joint effusion, synovial thickening, and osteophytosis. Arthroscopy was performed with a 2.7mm 30° foreoblique arthroscope with digital image capture using both anteromedial and anterolateral portals to examine all major intra-articular structures in all joint compartments. Eight weeks after ACL transection, dogs were humanely euthanatized. Both hind limbs were disarticulated at the knee joint and the menisci were carefully removed for gross inspection and further processing. Gross and arthroscopic meniscal inspection and scoring were performed by one surgeon (JLC) and sonographic and MRI examination and scoring were performed by one radiologist (CRC), both of whom were blinded to dog number and treatment group. For all outcome measures, menisci were subjectively scored for presence and severity of pathology in the anterior horn, body, and posterior horn using a 4-point scale: 0-normal, 1-minimal tearing or fraying, 2-mild tearing or fraying, 3-moderate tearing or fraying, 4-severe tearing or fraying. Statistical analyses for significant differences (p<0.05) between groups and strength of correlations among outcome measures were performed.

Results – By both gross and arthroscopic scoring, medial menisci had significantly more frequent and severe damage than lateral menisci (p<0.001). A predominance of medial meniscal pathology was limited to the posterior horn; therefore, statistical analyses were performed only for the posterior medial meniscus. There were strong and significant positive correlations between gross, histopathologic, arthroscopic, MRI and sonographic imaging of the posterior medial meniscus (Table 1).

Using gross examination as the gold standard, arthroscopy was more sensitive than ultrasonography and had higher specificity and positive and negative predictive values than both MRI and ultrasonography. MRI was highly sensitive, but not specific, for detection of posterior medial meniscal pathology in this study (Table 2). Ultrasonography more consistently correctly diagnosed the presence of posterior medial meniscal pathology than MRI. Arthroscopy was 3.3 times more likely than ultrasound and 4.7 times more likely than MRI to correctly diagnose the presence or absence of gross pathology of the medial meniscus of dogs eight weeks post ACLt; however, these differences were not statistically significant using the Chi-square test (p=0.34). There were no significant differences with respect to presence or severity of meniscal pathology between treatment (experimental compound) and control (placebo) groups for any outcome measure (p>0.37).

Conclusion – Significantly greater pathology in the medial meniscus compared to the lateral meniscus in the ACLt canine model is consistent with previously reported data, supporting the model and outcome measures used in this study. Arthroscopic examination of the meniscus correlates extremely well with gross examination for presence and severity of pathology. All individual diagnostic modalities had positive and relatively strong correlations with all other outcome measures. Ultrasonographic evaluation of meniscal pathology is advantageous over MRI in this ACLt canine model based on consistency of diagnosis of meniscal tears occurring most commonly in the posterior portion of the medial meniscus. The lack of specificity of MRI as well as the strength of correlation between MRI and histopathologic data may indicate the capability of MRI to pick up subtle, early meniscal architectural changes; however, the clinical relevance of these changes is as yet unknown. Technical expertise is necessary for performance and interpretation of both ultrasound and MRI; however, availability, noninvasiveness, and cost are notable advantages of ultrasound for aid in diagnosis of meniscal tears in dogs. These advantages may exist not only for the animal model of meniscal disease but also for the clinical patient.

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