No correlation found between palpation and ultrasound for evaluation of effusion in the medial femorotibial and femoropatellar joint compartments of horses

Jennifer H. Ruff, DVM; Sara Tufts, DVM; James Robertson, MS; Caitlyn Horne, DVM, DACVSMR; Lauren V. Schnabel, DVM, PhD, DACVS, DACVSMR; Carrie Jacobs, DVM, DACVS

OBJECTIVE
To compare palpation and ultrasound scores of effusion of the medial femorotibial and femoropatellar joints of horses.

ANIMALS
40 horses (80 stifles) were evaluated over a 12-week period.

METHODS
Horses > 1 year of age without history of stifle disease were enrolled from September to December 2022. Palpation of right and left medial femorotibial and femoropatellar joint compartments was performed. Amount of effusion was scored by a board-certified large animal surgeon, a third-year large animal surgery resident, and an equine sports medicine intern. Effusion of right and left medial femorotibial and femoropatellar joints was quantified with ultrasound by a board-certified equine sports medicine and rehabilitation clinician. Amount of effusion on palpation and ultrasound was graded as none-mild (1), moderate (2), or severe (3). A 2-way intraclass correlation coefficient evaluated interrater reliability of palpation scores. The Spearman rank correlation determined association between palpation and ultrasound scores.

RESULTS
Interrater reliability for palpation of effusion was poor between all observers for all joint compartments. No significant correlation was identified between palpation and ultrasound scores for any joint compartment for any observer.

CLINICAL RELEVANCE
Clinicians often rely on palpation of joint effusion as an indication of stifle pathology. We found interrater reliability to be poor for palpation scores, indicating low agreement for palpation of joint effusion between clinicians within our group. No correlation was found between palpation and ultrasound scores for joint effusion, indicating that clinicians should not rely on palpation alone to quantify joint effusion of the medial femorotibial and femoropatellar joints.

Keywords: ultrasound, palpation, lameness, equine, stifle

Effusion is one of the most common clinical signs identified in horses with joint disease such as osteoarthritis, osteochondrosis dissecans,1 soft tissue injuries,2 and synovial sepsis.3 The use of palpation to detect increased joint effusion is an important component of the orthopedic examination but can be challenging in the more proximal joints of the equine limb.4 In particular, palpation of the joint compartments of the stifle can be affected by horse temperament, limb position, degree of weight-bearing, and quadriceps muscle mass as well as the inability to safely palpate left and right joints simultaneously for comparison.4

Practitioners often rely on stifle palpation to detect effusion as one of the first clinical clues in the diagnosis of stifle disease. Effusion within the femoropatellar joint can be subjectively evaluated on radiographs; however, ultrasound evaluation allows a more sensitive and objective measurement of effusion in the femoropatellar and femorotibial joints.5 The normal ultrasonographic appearance and location of synovial effusion of the stifle joint compartments have been previously described.6–9 Ultrasound evaluation has been shown to be more sensitive compared to palpation for detection of effusion in the distal interphalangeal joint of horses10.
as well as the knee\textsuperscript{11-13} and ankle\textsuperscript{14} of humans. The sensitivity of palpation compared to ultrasound examination for detection of effusion in the equine stifle has yet to be evaluated.

Therefore, the first objective of this study was to compare palpation scores of joint effusion of the medial femorotibial and femoropatellar joints from 3 different observers with varying experience levels. The second objective was to compare palpation scores of naturally occurring joint effusion of the medial femorotibial and femoropatellar joints to ultrasound scores of effusion. We hypothesized that there would be good interrater reliability for palpation scores between observers and that palpation scores of the medial femorotibial and femoropatellar joints would not correlate to ultrasound scores.

**Methods**

Horses > 1 year of age that were presented to the North Carolina State University Veterinary Hospital over a 12-week period from September 19, 2022, to December 14, 2022, for reasons unrelated to pathology of the stifle were enrolled in the study following owner consent. The age, sex, and breed of each horse were recorded as well as the hospital service (internal medicine, soft tissue surgery, orthopedic surgery, and sports medicine) to which they were admitted. The medial femorotibial and femoropatellar joints of all horses were palpated bilaterally by a board-certified large animal surgeon (CJ or LVS), a third-year surgery resident (JR), and a sports medicine intern (ST) with the horse held by an experienced clinical technician. During palpation, the horse was weight-bearing in both limbs with the limb being palpated in a neutral position, as described by Ross.\textsuperscript{4} Femoropatellar effusion was determined by identifying the middle patellar ligament and palpating any effusion between this ligament and the medial and lateral patellar ligaments. Medial femoropatellar effusion was determined by identifying the medial patellar and medial collateral ligaments and palpating effusion between the two, just proximal to the palpable rim of the proximal tibia. Each observer reported effusion for the right and left medial femorotibial and femoropatellar joints to a clinical technician, who recorded the results to blind the observers to the other palpation and ultrasound scores. Effusion was scored for each joint compartment as none-mild, moderate, or severe.

Ultrasound examinations of both right and left medial femorotibial and femoropatellar joints were performed by a board-certified sports medicine and rehabilitation clinician (CH) who was blinded to the palpation scores. For these examinations, horses were sedated if needed with xylazine (0.3 to 0.6 mg/kg) or detomidine hydrochloride (0.006 to 0.01 mg/kg). If necessary, the hair over the medial femorotibial and femoropatellar joints was clipped. The sites for evaluation were cleaned with 4% chlorhexidine gluconate, and alcohol and ultrasound coupling gel were applied. All ultrasound examinations were performed with the horse weight-bearing in both limbs and with the limb undergoing the examination in a neutral position. Effusion within the medial femorotibial and femoropatellar joints was identified via a 13-MHz linear transducer with the previously described technique.\textsuperscript{6} To determine ultrasonographic effusion of the femoropatellar joint, the femoropatellar articulation was imaged from a cranial approach, moving distally from the distal aspect of the patella to the tibial tuberosity. This was performed with the transducer in both longitudinal and transverse planes both medial and lateral to the middle patellar ligament. The depth (mm) and length (mm) of the lateral and medial aspects of the femoropatellar joint were measured bilaterally in a longitudinal view. To determine ultrasonographic effusion of the medial femorotibial joint, the transducer was placed caudal to the medial patellar ligament in a longitudinal plane, over the palpable joint space. Once the medial meniscus was imaged, effusion within the joint was imaged cranial to this in a longitudinal plane. The depth (mm) and length (mm) of the medial femorotibial joint was measured bilaterally in a longitudinal view in all horses. Additionally, the transverse view was performed in the last 26 horses to determine whether this provided additional helpful information. Based on the measurements of effusion obtained for the femoropatellar and medial femorotibial joints, a scoring guide was made to delineate scoring categories for effusion as none-mild (grade 1), moderate (grade 2), and marked effusion (grade 3; \textit{Supplementary Figures S1-S3}). Ultrasound scores for effusion of the right and left femoropatellar and medial femorotibial joints were determined by a single observer (CH) from saved ultrasound images for each patient.

Statistical analyses were performed via R, version 4.2.2 (R Foundation for Statistical Computing) with a $P$ value of $<.05$ used for significance. Examination of inter-reliability between observers' palpation scores was performed with the intraclass correlation coefficient for agreement by means of a 2-way model. Intraclass coefficient values of $<0.5$ were considered to have poor reliability, values 0.5 to 0.75 were considered to have moderate reliability, values 0.75 to 0.9 were considered to have good reliability, and values $>0.9$ were considered to have excellent reliability.\textsuperscript{15} The Spearman rank correlation was used for examining associations between palpation score of each observer and ultrasound scores. Given that transverse measurement of the medial femorotibial joint was not performed in all horses, it was not included in the statistical analysis. When the value of $P$ was $<.05$ and a correlation was identified, positive $p$ values indicated a positive correlation, whereas negative values indicated a negative correlation. High $p$ values ($>.70$ to $1.0$) were considered to have a high to very high strength of correlation, $p$ values of $.30$ to $.70$ were considered to have a low to moderate strength of correlation, and low $p$ values ($>.00$ to $.30$) were considered to have negligible strength of correlation.\textsuperscript{16}
Results

A total of 40 horses and 80 stifles were enrolled in the study. Breeds included 17 Quarter Horses, 10 Warmbloods, 4 Thoroughbreds, 3 Saddlebreds, 2 Welsh Ponies, 1 Arabian cross, 1 Morgan, 1 Standardbred, and 1 Tennessee Walking Horse. There were 22 geldings, 17 mares, and 1 stallion included. The median age was 13 years (range, 2 to 20 years). The number of femoropatellar and medial femorotibial joints that fit into each scoring category for palpation and ultrasound was summarized (Table 1).

Intraclass coefficient values between the 3 observers for palpation scores of femoropatellar and medial femorotibial joint effusion between observers (Table 2). When comparing palpation scores of the left femoropatellar joint with ultrasound scores for the lateral and medial aspects of the left femoropatellar joint, there was no significant correlation (P value = .244 to .827) between scores for any observer (Table 3). Similarly, no significant correlation (P value = .108 to .870) was identified for any observer when comparing palpation scores of the right femoropatellar joint with ultrasound scores for the lateral or medial aspects of the right femoropatellar joint. When comparing palpation and ultrasound scores of the left medial femorotibial joint, there was no significant correlation (P value = .552 to 1.00) between scores for any observer. Similarly, no significant correlation (P value = .339 to .569) was identified when comparing palpation and ultrasound scores for the right medial femorotibial joint for any observer.

Discussion

Our goal was to compare interrater reliability for palpation scores of effusion within stifle joint compartments between 3 observers and to compare these palpation scores to ultrasound scores of
effusion within stifle joint compartments. Results of this study found poor interrater reliability for palpation of the femoropatellar and medial femorotibial joint compartments and no significant correlations between ultrasound and palpation scores; therefore, we reject our first hypothesis and support our second hypothesis.

Identification of effusion and palpation of the stifle joint compartments can be difficult and variable between clinicians for a variety of reasons. The proximal location and increased soft tissue coverage compared to joints within the distal limb make palpation limited to the cranial, lateral, and mediaspals of the stifle and can make effusion less obvious both visually and on palpation.14 Muscling around the stifle can vary by breed, size, age, and body condition score. Similar to our hospital population, our study included horses of various breeds, ages, and size, which may have contributed to the variability in palpation scores. Temperament of the horse and limb position can also affect the ability to palpate and identify joint effusion within the stifle. Ideally, the stifle should be palpated with the limb in a neutral position and weight-bearing with the foot flat on the ground; however, this may not be possible if the horse has severe pain preventing weight-bearing and can thus affect accurate palpation of effusion.1

Other reasons for increased variability between observers would include the varying experience level of the observers and the use of horses with no known stifle pathology. In this study, a board-certified large animal surgeon, a large animal surgery resident, and a sports medicine intern, all with varying experience levels, palpated and scored stifle effusion. This study included horses presenting to the hospital for reasons unrelated to pathology of the stifle; however, throughout the study some horses were identified to have marked effusion and stifle disease. While this population incidentally included horses with and without stifle pathology, a consistent population of horses with stifle disease and increased effusion may have been easier for inexperienced observers to identify effusion on palpation and may have yielded more reliable palpation scores.

Previous studies have found ultrasound to be more sensitive than palpation for detection of effusion in the distal interphalangeal joint of horses10 as well as the knee11-13 and ankle14 of humans. Ultrasound examination allows for identification and quantification of effusion within joints, therefore providing a more objective method when compared to palpation. Currently, however, there is no published grading scale for stifle joint effusion, and in this study grades were subjectively determined by a single board-certified sports medicine and rehabilitation clinician with substantial experience in stifle ultrasound. While this is not a validated grading scale for stifle joint effusion, the scoring guide was created for this study to ensure consistency between ultrasonographic measurements of effusion. This scoring guide could also be used for future studies regarding stifle effusion grading.

Transverse measurements of the medial femorotibial joint were performed in the majority of horses in this study. The medial femorotibial joint is traditionally viewed in the longitudinal view; however, after multiple horses were evaluated, it was elected to begin also documenting the transverse view to determine whether this would provide further relevant information. It was elected to not include the transverse measurements in the scoring guide or final data analysis due to the lack of data for all horses and unknown significance of measurements in the transverse view. Evaluating the medial femorotibial joint in both views may give us more information about the amount of effusion present, and further studies should be performed to investigate the importance of evaluating the medial femorotibial joint in both longitudinal and transverse planes.

In this study, ultrasound was considered the more objective measurement of effusion, and when ultrasound scores were compared to palpation scores, no correlation was identified. There is some degree of normal fluid volume within the medial femorotibial and femoropatellar joints. Therefore, other benefits of ultrasound over palpation alone include ability to assess other characteristics of the fluid and the joint, such as the character of the synovium and synovial fluid, and also assessment of soft tissue structures, such as the menisci and collateral ligaments. Downsides to using ultrasound for identification of joint effusion include the added expense and time required, potentially a lack of expertise with stifle ultrasound, and/or a lack of availability in the field.

Limitations of this study included the use of horses with varying amounts of effusion, having clinicians of varying experience levels performing palpation, and the lack of an established grading scale for effusion. While we did not include horses presenting for stifle pathology, some horses included in the study were identified to have stifle disease and marked effusion during ultrasound and clinical examination. This was helpful, as it allowed us to include horses with increased effusion in addition to those with minimal effusion. Future studies could include comparing palpation to ultrasound scores in horses with known stifle disease to determine whether clinician variability and correlation with ultrasound changes improve when consistent effusion is present. Comparing reliability of palpation scores between clinicians of similar experience level would also be interesting in cases with and without stifle pathology. Finally, establishing an ultrasonographic grading scale of stifle joint compartment effusion by experimentally distending joint compartments with varying amounts of fluid followed by ultrasound could be performed.

In conclusion, we found poor interrater reliability between clinicians of varying experience level for scores of effusion of the femoropatellar and medial femorotibial joints. We also found no correlation between palpation and ultrasound scores of effusion of the femoropatellar and medial femorotibial joints. Clinicians should be aware of these findings, when performing orthopedic and lameness examinations in horses where stifle pathology is suspected, and should consider using ultrasound to detect the presence of joint effusion.
Acknowledgments
The authors would like to thank Mrs. Chelsea Pineda for her technical assistance and data entry support as well as Mr. Adam Gamble for his technical assistance.

Disclosures
The authors have nothing to disclose. No AI-assisted technologies were used in the generation of this manuscript.

Funding
Dr. Schnabel was supported by the Fund for Orthopedic Research in Honor of Gus and Equine Athletes (FORGE), and Dr. Jacobs was supported by the NC State Equine Orthopedic Practice Plan.

References

Supplementary Materials
Supplementary materials are posted online at the journal website: avmajournals.avma.org