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The significance of the meniscal flounce sign in canine stifle arthroscopy

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Abstract

Objective: To determine the diagnostic significance of the meniscal flounce sign in association with meniscal tears.

Study design: Prospective cohort study.

Sample population: One hundred and thirty stifles in 120 client-owned dogs that underwent stifle arthroscopy.

Methods: Identification of a positive or negative meniscal flounce sign was recorded with the presence or absence of meniscal pathology. Sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy were calculated.

Results: Eighty-nine stifles (68.5%) were noted to have a positive meniscal flounce sign. Of these stifles, four were noted to have a meniscal tear, and they were all radial tears. A total of 41 stifles (31.5%) had a negative meniscal flounce. Of these stifles, 38 had a meniscal tear. The sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy of the meniscal flounce sign for indicating an intact or torn meniscus were 96.6%, 90.5%, 95.5%, 92.7%, and 94.6%, respectively.

Conclusion: A positive meniscal flounce sign was associated with a normal meniscus and the absence of the flounce sign was associated with a meniscal tear.

Clinical significance: Identification of the meniscal flounce sign during stifle arthroscopy is a strong indicator of a normal medial meniscus. The absence of the sign strongly indicates the presence of meniscal pathology.

1 | INTRODUCTION

Medial meniscal pathology is a common finding in dogs with cranial cruciate ligament disease. The reported incidence of meniscal injuries ranges from 20% to 77% in dogs with concurrent cranial cruciate ligament injuries.[1–6] Postliminary meniscal tears following stifle stabilization have been reported in up to 37% of cases, depending on surgical technique.[7–9] Injuries to the medial meniscus are known to contribute to persistent lameness and affect the long-term outcome and recovery of dogs with cranial cruciate ligament injuries.[7,10] Accurate identification of meniscal pathology is therefore paramount when examining and treating these dogs.

Arthroscopy has become the standard of care for the diagnosis of intra-articular stifle disease in the veterinary

Abbreviations: DA, diagnostic accuracy; FN, false negative; FP, false positive; NPV, negative predictive value; PPV, positive predictive value; Sn, sensitivity; Sp, specificity; TN, true negative; TP, true positive.

field over the past several years and is the gold standard for diagnosing medial meniscal injuries.[4] Arthroscopy is less invasive and allows for improved visualization of all intra-articular structures compared with traditional arthrotomy. Appropriate identification and treatment of meniscal pathology via arthroscopy has been shown to lead to a higher rate of successful long-term outcomes.[11]

In people, visualization of the entire caudal pole of the medial meniscus can be difficult in certain cases. Tight knees, poor portal placement, osteophytosis, or surgeon inexperience can lead to only the free edge of the caudal pole of the meniscus being visualized.[12] The meniscal flounce, a fold in the free, unanchored inner edge of the medial meniscus,[13,14] is a common arthroscopic finding in people and dogs. Its presence is thought to be related to the anatomic configuration of fibers present in the meniscus that allow hoop stress to be exerted during weight bearing.[13] External forces present during arthroscopy can also cause this fold to be present in the free margin of the meniscus.[12] Disruption of the fibers or meniscal attachments in the event of a meniscal tear can produce variation in, or eliminate, the fold/buckling appearance of the free margin.[12,13] In people, the absence of a meniscal flounce is a strong predictor of the presence of a medial meniscal tear.[13]

The meniscal flounce sign has been reported to be a normal finding in dogs,[15,16] but as far as the authors are aware, no studies have reported the significance of its presence. Our purpose was to evaluate the diagnostic utility of the meniscal flounce by measuring the sensitivity, specificity, positive, and negative predictive values. We hypothesized that a positive meniscal flounce sign is an indicator of a normal meniscus and a negative meniscal flounce sign is an indicator of a medial meniscal tear.

2 | MATERIALS AND METHODS

All dogs that presented between February 2018 and November 2020 and that underwent exploratory stifle arthroscopy were enrolled in the study with their owners' consent. All of the dogs that were included were undergoing a first-look arthroscopic examination for suspected cranial cruciate ligament injury, or a second-look examination for suspected subsequent meniscal injury. They were eligible for inclusion if they underwent a successful exploratory arthroscopy with observation and probing of the caudal pole of the medial meniscus. Dogs undergoing a second-look exploratory arthroscopy were included if no previous meniscal release or partial meniscectomy was performed. Dogs were excluded from the study if probing of the caudal pole of the medial meniscus was unable to be performed arthroscopically, or if a conversion to open arthrotomy was performed.

All arthroscopic procedures were performed by two board–certified surgeons (MR, DH). Stifle joint arthroscopy was performed with a 1.9, 2.4, 2.7, or 4.0 mm 30° fore oblique arthroscope with a video capture system (Synergy, Arthrex Vet Systems, Naples, Florida). Arthroscopy was performed with a standard craniolateral camera portal and craniomedial instrument portal as previously described.[17] Fat-pad debridement was performed as needed to improve visibility. The medial and lateral menisci were observed and probed with a small meniscal probe (VET Probe, Arthrex Vet Systems). An assistant placed the stifle starting with ~30° of stifle flexion. Cranial thrust maneuver, with varus or valgus stress and rotation stress, was performed as needed, to observe and probe the menisci. Alternatively, in a small number of cases, further subluxation or distraction of the stifle was maintained by use of a stifle distractor (Ventura Stifle Thrust Lever, IMEX, Longview, Texas) or small Hohmann retractor positioned on the caudal aspect of the tibia through a separate craniolateral instrument port. This maneuver was performed to assist with probing and treatment following assessment of the free edge of the caudal pole of the medial meniscus and identification of the status of the meniscal flounce.

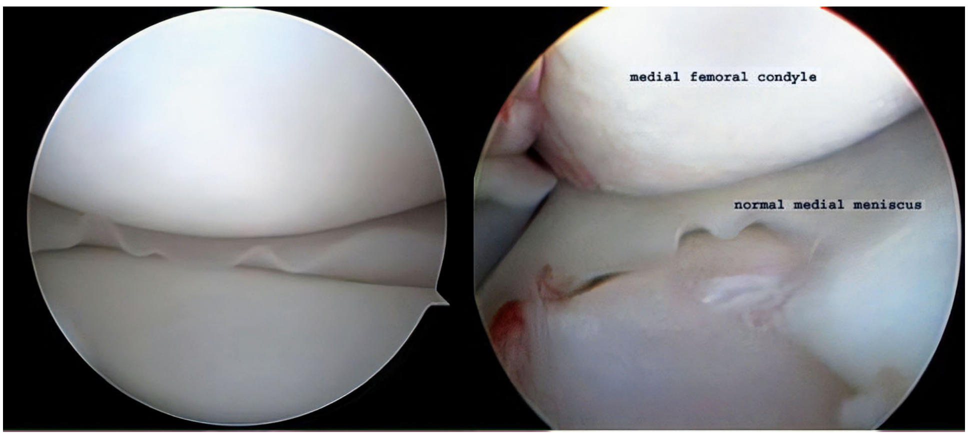

FIGURE 1 Arthroscopic view of the caudal pole of the medial meniscus in two dogs. Note the normal appearance of the flounce sign along the free inner edge of the meniscus

Signalment, bodyweight, laterality of the operated limb, type of cranial cruciate ligament injury, presence or absence of the meniscal flounce sign (Figures 1 and 2), description of any meniscal pathology, and concurrent joint pathology were recorded. Cranial cruciate ligament status was classified as complete or with partial tears. Meniscal tears were classified as previously described.[18] All data were maintained in standard spreadsheet format (Excel version 14.7.7, Microsoft, Redmond, Washington). Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were calculated (Python 3.8, Python Software Foundation, Beaverton, Oregon). True positives were defined as stifles with a positive meniscal flounce sign and absent meniscal pathology. False positives were defined as stifles with a positive meniscal flounce sign and meniscal pathology. True negatives were defined as stifles with a negative meniscal flounce sign and meniscal pathology. False negatives were defined as stifles with a negative meniscal flounce sign and absent meniscal pathology. The results were further tested with a χ^2 test.

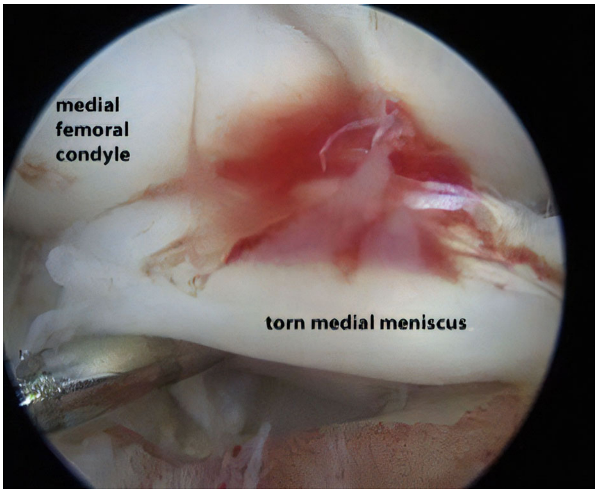

FIGURE 2 Arthroscopic view of a probed bucket handle tear of the caudal pole of the medial meniscus in a dog. Note the absence of the flounce sign

3 | RESULTS

A total of 130 stifles in 120 dogs fulfilled the inclusion criteria and were included in the study. One hundred and twenty-eight stifles underwent first-look arthroscopy for suspected cranial cruciate ligament injury. An additional two stifles were included for second-look arthroscopic examinations for suspect subsequent meniscal tears following previous stifle stabilization. Among the total stifles, 61 were male (57 castrated, 4 intact), and 69 were female (67 spayed, 2 intact). Seventy-four left stifles and 56 right stifles were evaluated. The most common breeds represented were pit bull mixed breed dogs (n = 45). Among pure bred animals, the most common breeds included Labrador retrievers (n = 18) and German shepherds (n = 7). The bodyweight ranged from 6.7 to 55.4 kg (31.0 ± 10.2), and age ranged from 1 to 14 years (6.7 ± 3.1).

The meniscal flounce sign was positive in 89 stifles (68.5%). Normal menisci were noted in 85 of those 89 stifles. The meniscal flounce sign was negative in 41 stifles. Meniscal tears were noted in 38 of those 41 stifles. A total of 42 stifles (32.3%) had meniscal tears. Bucket- handle tears were most common (n = 31, 73.8%). The remaining meniscal tears were vertical longitudinal (n = 2), radial (n = 4), and complex/degenerative (n = 5). Of stifles with meniscal tears, all but one had complete rupture of the cranial cruciate ligament. The one stifle with an incompetent partial cranial cruciate ligament tear had a bucket handle meniscal tear and a grade 5 cartilage lesion on the lateral femoral condyle. Among the 88 stifles with normal menisci, 21 (23.9%) had partial tears of the cranial cruciate ligament. One lateral meniscal tear was noted in the entire population. A total of nine stifles had mild fraying of the caudal cruciate ligament. Of these nine stifles, five were noted to have meniscal pathology. No other significant joint pathology was identified. Of the two stifles that underwent a second look arthroscopy, one was found to have a bucket-handle tear of the meniscus. No meniscal pathology was identified in the second stifle.

TABLE 1 Meniscal flounce status and meniscal probing status via arthroscopy for 130 canine stifles

Medial meniscal flounce sign	Probed meniscus, normal	Probed meniscus, torn	Total	
Positive	85 (TP)	4 (FP)	89	0.955 (PPV)
Negative	3 (FN)	38 (TN)	41	0.927 (NPV)
Total	88	42	130	
	0.966 (Sn)	0.905 (Sp)		0.946 (DA)

Abbreviations: DA, diagnostic accuracy; FN, false negative; FP, false positive; NPV, negative predictive value; PPV, positive predictive value; Sn, sensitivity; Sp, specificity; TP, true positive; TN, true negative.

Note: Sensitivity = TP/(TP + FN), Specificity = TN/(TN + FP), Positive predictive value = TP/(TP + FP), Negative predictive value = TN/(TN + FN), Diagnostic Accuracy = (TP + TN)/total.

Sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy of the meniscal flounce sign to indicate an intact or torn meniscus were 96.6%, 90.5%, 95.5%, 92.7%, and 94.6% respectively ($P < .001$) (Table 1).

4 | DISCUSSION

The results demonstrate an association between a positive meniscal flounce sign and a normal meniscus and between a negative meniscal flounce sign and meniscal pathology. When the meniscal flounce sign was noted, the meniscus was normal in 95.5% of cases. This indicated a low chance of finding a meniscal tear when the flounce sign is present. When the meniscal flounce sign was absent, a meniscal tear was found in 92.7% of cases. The overall accuracy of the meniscal flounce as a sign that could be used to identify the meniscal tear status was 94.6%, which is similar to the findings in human knee arthroscopy.[12–14]

The absence of the meniscal flounce sign was noted in menisci with all tear types except for radial tears. These results indicate that the loss of the meniscal flounce sign is most consistent with a longitudinal, bucket handle, or complex/degenerative tear of the medial meniscus. Visualization of the meniscal flounce sign should not replace careful probing of the meniscus, but can be used in conjunction with it to obtain the most accurate diagnosis.

Small radial tears of the caudal pole of the medial meniscus were noted in four stifles in this study. All four of these stifles also had a positive meniscal flounce sign. This may be because small peripheral radial tears do not cause enough disruption in the meniscal fibers to eliminate the flounce sign. In people, the flounce can be present in several different regions of the meniscus, depending on the individual.[12] The four cases in our study had small radial tears in different regions from where the meniscal flounce sign was noted. A further study with a larger sample size could be performed to determine if the absence of the flounce sign is specific to non-radial meniscal tears.

Williams et al. found that medial collateral ligament laxity can alter joint mechanics and the appearance of the meniscal flounce sign.[12] Medial collateral ligament injuries were not noted in any stifles in this study. There were very low numbers of stifles with other intra-articular pathology, such as cartilage defects, caudal cruciate ligament tears, and lateral meniscal tears. Due to the limited amount of concurrent joint pathology, no association between these findings and the meniscal flounce sign could be determined.

Our study had a few limitations. Our sample size was large enough to obtain significant data regarding the meniscal flounce sign but the total number of stifles with meniscal tears was small. This could have resulted in the lower specificity in our study compared with human surgical studies.[13,14] A larger sample size could alter the statistical power of this study. Additional true negatives would increase the specificity whereas increased false positives would decrease the specificity and overall power of the study.

An additional potential limitation of our study is the technique used for limb positioning. Our study had two surgeons and manual assistants to position the limbs during the arthroscopic procedure. It is possible that the manual positioning led to variability in the visibility of the meniscus and in the stress placed on the meniscus. This may explain the three normal menisci with a negative meniscal flounce sign. Despite this finding, our results correlate closely with a human study in which a leg holder was used for consistent positioning throughout the procedure.[13] To determine the importance of this finding, a positioning device could be used to limit variation in the stress on the medial meniscus and standardize the field of view.

Stifle retractor devices are regularly used in stifle arthroscopy. In this study, such a device was used in cases with tight joints where there was difficulty probing the meniscus. All stifles in this study had the meniscal flounce status noted prior to placement of the retractor. Our study did not evaluate whether the placement of the retractor and further stifle distraction altered the appearance of the flounce. Depending on surgical technique, it is important to note the meniscal flounce status prior to placement of a retractor. A future study could be performed to determine if further distraction of the stifle with use of a retractor alters the joint mechanics enough to change the appearance of the meniscal flounce sign.

We found the meniscal flounce sign to be of diagnostic value in the arthroscopic diagnosis of meniscal pathology in dogs. The high sensitivity, specificity, positive predictive value, and negative predictive value indicate that the presence of the meniscal flounce sign is typically indicative of a normal meniscus, whereas the absence of the sign is suggestive of a meniscal tear.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this report.

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