

# Medial Meniscal Tears Increase Risk of Moderate to Severe Cartilage Damage to the Medial Femoral Condyle

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## Abstract

**Objective** The objective of this study was to evaluate the relationship between displaceable meniscal tears of the medial meniscus, such as bucket handle tears and flap tears, and articular cartilage wear of the medial femoral condyle.

**Methods** Articular cartilage was scored at the time of arthroscopy and tibial plateau leveling osteotomy as normal, mild, moderately, or severely damaged based on the modified Outerbridge classification system. Dogs with complete cranial cruciate ligament rupture were included; there were 245 stifles in total and 116 had a concurrent displaceable meniscal tear consisting of 115 bucket handle tears and 1 flap tear. Stifles were classified as either having no/mild or moderate/severe cartilage wear. The frequency of moderate/severe wear was compared between stifles with normal menisci and stifles with displaceable meniscal tears using a Fisher's exact test.

**Results** Stifles with displaceable meniscal tears had a significantly higher frequency of moderate/severe cartilage wear of the medial femoral condyle in comparison to stifles with normal menisci ( $p = 0.009$ ).

**Clinical Significance** These findings suggest that dogs with cranial cruciate ligament rupture and concurrent bucket handle tears may increase the risk of moderate to severe cartilage injury to the medial femoral condyle.

## Keywords

- cartilage
- canine
- arthroscopy
- cranial cruciate ligament
- meniscus

## Introduction

Medial meniscal damage is most common in dogs with complete cranial cruciate ligament rupture and may affect the likelihood of cartilage damage in the medial femorotibial compartment.<sup>1,2</sup> A recent study in 30 dogs found that stifles with a meniscus tear at the time of arthroscopy had more cartilage damage than dogs without meniscus pathology.<sup>3</sup> However, two larger studies did not find an association between bucket handle tears of the medial meniscus and articular cartilage status.<sup>4,5</sup> Given the discrepant results of these three studies, it remains unclear if medial meniscal damage is associated with a greater risk of cartilage damage identified at the time of primary arthroscopy.

Severe cartilage damage of the medial femoral condyle is sometimes seen in stifles with displaced meniscal tears, such as bucket handle tears, suggesting the displaced meniscal tissue may have abraded the cartilage on the medial femoral condyle (►Fig. 1). Accordingly, we question whether the frequency of cartilage injury on the medial femoral condyle is greater in dogs with displaceable meniscal tears than in dogs with either a normal medial meniscus or medial menisci with non-displaceable lesions, such as partial thickness vertical longitudinal tears. Consequently, the purpose of this study was to evaluate the relationship between displaceable meniscal tears and articular cartilage wear of the medial femoral condyle. We hypothesized that there would be more frequent moderate or severe cartilage wear of the medial

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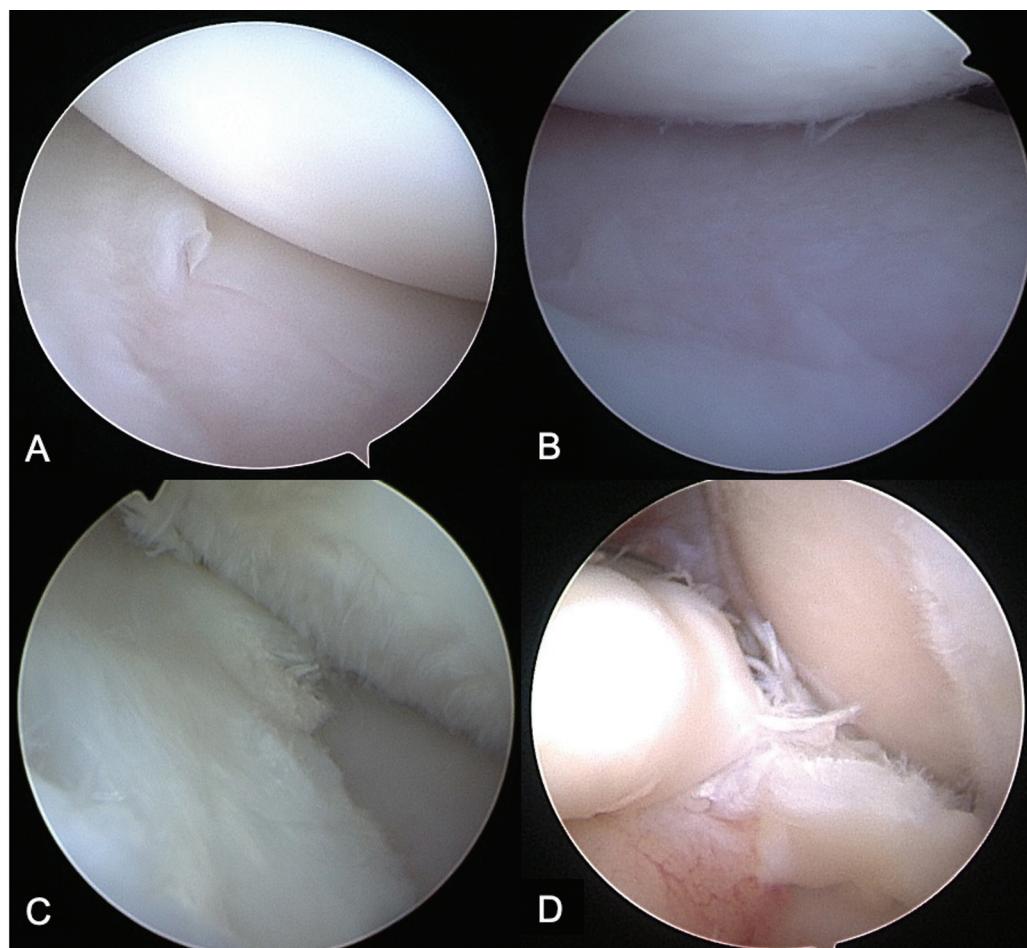
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**Fig. 1** Arthroscopic images showing articular cartilage classification of the medial femoral condyle. (A) Normal corresponds to the modified Outerbridge classification system (MOS) score of 0. (B) Mild corresponds to MOS scores 1 and 2. (C) Moderate corresponds to an MOS score of 3. (D) Severe corresponds to an MOS grade 4, with the appearance that the flap tear of the medial meniscus may have abraded the cartilage on the medial femoral condyle.

femoral condyle in stifles with displaceable meniscal tears in comparison to stifles with normal menisci or non-displaceable meniscal pathology.

## Materials and Methods

The status of the medial meniscus, cranial cruciate ligament, and articular cartilage scores of the medial compartment were prospectively recorded for all dogs undergoing stifle arthroscopy and tibial plateau leveling osteotomy performed by a single surgeon (S.P.F.) from December 2022 through April 2024. These medical records were reviewed and data were transferred into an Excel spreadsheet (Microsoft Excel Version 16.91). Additional information extracted included age, gender, and weight. Each stifle of bilaterally affected dogs was treated as separate records.

During arthroscopy of each stifle, the cranial cruciate ligament was classified as completely or partially torn. The medial meniscus was probed and classified as normal, having a displaceable bucket handle tear, flap tear, non-displaceable vertical longitudinal tear, maceration of the caudal pole, fraying of the axial edge, or hypermobile. The medial meniscus was classified as hypermobile if, with

probing and simultaneous cranial tibial subluxation, the caudomedial meniscotibial ligament palpated lax and there was concern the meniscus might tear in the future. This assessment was used to justify the performance of axial meniscal release. Menisci classified as hypermobile would not displace cranially underneath the medial femoral condyle and no vertical longitudinal tear could be identified.

The articular cartilage of the medial femoral condyle was scored as having no, mild, moderate, or severe cartilage wear. Grading was based upon a modified Outerbridge classification system (MOS).<sup>6</sup> Cartilage wear was classified as none if there was a corresponding MOS of 0, mild if cartilage wear corresponded to an MOS of grade 1 or 2, moderate if cartilage wear corresponded to an MOS of grade 3, and severe if cartilage wear corresponded to MOS grade 4 or 5.

## Statistical Analysis

Only stifles with complete rupture of the cranial cruciate ligament were included in statistical analyses. For the purposes of comparing the frequency of cartilage damage on the medial femoral condyle as it relates to meniscal status, all stifles were classified as having either no/mild (MOS grade

**Table 1** Frequency of cartilage wear as a function of meniscal status

Meniscal morphology	MOS 0	MOS 1	MOS 2	MOS 3	MOS 4	MOS 5	Total
Normal	33	22	5	2	1	0	63
Bucket handle tear	42	48	6	10	9	0	115
Flap tear	0	0	0	0	1	0	1
Non-displaceable vertical longitudinal tear	6	2	0	0	0	0	8
Maceration of caudal pole	0	0	1	1	0	0	2
Frayed axial edge	1	4	0	0	0	0	5
Hypermobile	30	13	5	2	1	0	51
Total	112	89	17	15	12	0	245

Abbreviation: MOS, modified Outerbridge classification system.

0–2) or moderate/severe (MOS grade 3–5) cartilage wear on the medial femoral condyle.

Two comparisons were made to determine whether the presence of displaceable meniscal tears, specifically bucket handle and flap tears, increased the frequency of moderate/severe cartilage wear on the medial femoral condyle. In the first comparison, the frequency of moderate/severe cartilage wear was compared between displaceable meniscal tears versus normal menisci. In the second comparison, the frequency of moderate/severe cartilage wear was compared between displaceable meniscal tears and all other menisci (normal and abnormal but without displaceable meniscal tissue). A Fisher's exact test was used to determine whether frequencies of moderate/severe cartilage wear differed between meniscal groups. A student's *t*-test was performed on normally distributed data to determine if age or body weight differed between the groups. Statistical analyses were performed using Graphpad Prism Software (version 10.0.0 for Windows, Boston, MA).

## Results

A complete rupture of the cranial cruciate ligament was identified in 245 stifles, which were included for further analyses. Of the cases with complete cranial cruciate ligament rupture, there were 121 neutered females, 7 intact females, 111 neutered males, and 6 intact males.

### Medial Meniscus

The medial meniscus was normal in 25.7% (63/245) of stifles. A displaceable, bucket handle tear of the medial meniscus was diagnosed in 115 of the 245 (46.9%) stifles and a displaceable flap tear was identified in one additional stifle (0.4%, 1/245). The frequency of medial meniscus pathologies is shown in **Table 1**.

### Articular Cartilage Scores

Sixty of 63 stifles (95.2%) with normal menisci had normal/mild articular cartilage wear on the medial femoral condyle and only 3 of 63 (4.8%) had moderate/severe cartilage wear on the medial femoral condyle. Conversely, 82.7% (96/116) of stifles with displaceable meniscal tears had

normal/mild cartilage wear on the medial femoral condyle and 17.2% (20/116) had moderate/severe cartilage injury. This difference was significant ( $p=0.019$ ). When comparing the age and weight of dogs in these two groups, the mean body weight of dogs with a normal medial meniscus was 32.5 ( $\pm 12.1$ ) kg and the mean body weight of dogs with displaceable meniscus tears was 31.1 ( $\pm 11.2$ ) kg; this difference was not significant ( $p=0.42$ ). Dogs with normal menisci had a mean age of 5.5 ( $\pm 2.5$ ) years and dogs with displaceable meniscal tears had a mean age of 6.8 ( $\pm 2.9$ ) years. This difference was significant ( $p=0.002$ ). The distribution of all articular cartilage scores is shown in **Table 1**.

For the second comparison, normal/mild cartilage wear was identified in 94.6% (122/129) of stifles that had normal menisci and non-displaceable meniscus pathology. Moderate to severe cartilage wear was identified in 5.4% (7/129) of stifles in this group. The frequency of moderate/severe cartilage wear in stifles with displaceable meniscal tears was significantly greater when compared with the group including normal and abnormal, but non-displaceable, menisci ( $p=0.004$ ). When comparing the weight of dogs with a displaceable meniscal tear (31.1 [ $\pm 11.2$ ] kg) to the weight of dogs with a normal meniscus and non-displaceable meniscal tear (29.1 [ $\pm 14.5$ ] kg) the difference was not significant ( $p=0.23$ ). The age of dogs with displaceable meniscal tears was not significant ( $p=0.2$ ) from dogs with either normal or non-displaceable meniscal tears (6.3 [ $\pm 2.8$ ] years).

## Discussion

The data suggest that displaceable meniscal tears are associated with a greater risk of having moderate to severe cartilage damage of the medial femoral condyle. Since there was only one stifle with a flap tear, the comparisons performed were primarily of stifles with bucket handle tears of the medial meniscus to either normal menisci or normal menisci and menisci with non-displaceable pathology. We speculate that the increased frequency of moderate/severe cartilage wear observed on the medial femoral condyle in stifles with displaceable meniscal tears is due to the potential for abrasion of the cartilage by the bucket handle tissue that can move into an ectopic location. However, these data are

insufficient to demonstrate causation and other explanatory variables could be considered.

The data indicated that dogs with displaceable meniscal tears were older than dogs with normal menisci. Accordingly, it is possible that age might explain the difference in frequency of moderate/severe cartilage wear on the medial femoral condyle. However, we would argue against the observed difference in age being the true explanation for the difference in cartilage wear. The difference in mean age, 1.3 years, is relatively small and likely clinically insignificant. Additionally, there was no difference in age when comparing dogs with displaceable meniscal tears to dogs with either normal menisci or menisci with non-displaceable meniscal tears. Conversely, the findings of increased risk of moderate/severe cartilage damage on the medial femoral condyle remained regardless of whether the comparison was solely between displaceable meniscal tears and normal menisci, or between displaceable meniscal tears and both normal menisci and menisci with non-displaceable lesions. Consequently, we conclude that displaceable meniscal tear status is more likely than age to explain the differences seen in cartilage damage on the medial femoral condyle.

These data and conclusions, although consistent with one previous study, are in contrast to two prior studies.<sup>4,5</sup> Importantly, there were differences in study methodologies. One study assessed the MOS in 10 different locations in the stifle joint and did not find an association between meniscal status and the MOS score of the joint.<sup>4</sup> However, because the study evaluated many locations throughout the joint, and had relatively few stifles with meniscal tears, this might have affected the ability to identify an association between meniscal status and cartilage wear on the medial femoral condyle specifically. In another study, the methodology and case numbers were very similar to our study. However, the study compared the distribution of cartilage scores using a Wilcoxon rank-sum test while we evaluated cartilage as a binary variable, either none/mild or moderate/severe, and this may have affected the ability to detect a significant difference. The aforementioned study identified a trend, but not significance, toward meniscal damage increasing the risk of cartilage wear on the medial femoral condyle with a *p*-value of 0.065.<sup>5</sup> It is worth noting that in all the aforementioned studies, including this one, a majority of the dogs had normal cartilage or only mild articular cartilage wear.

Limitations of this study include the evaluation of both the meniscus and cartilage contemporaneously by a single surgeon, which could have led to bias. Additionally, as the data were collected over the span of a year, there could have been unintentional drift in the scoring of the menisci and cartilage over time. These limitations could be overcome in future

studies with video recordings of the arthroscopy to be reviewed by blinded independent observers.

In conclusion, displaced meniscal tears result in a significant likelihood of moderate to severe cartilage damage on the medial femoral condyle compared with intact or non-displaced meniscal injuries. These data are clinically relevant because they suggest that delaying treatment for dogs with cranial cruciate ligament rupture may increase the risk of moderate to severe cartilage injury to the medial femoral condyle. Previous studies have demonstrated that a longer duration between the onset of clinical signs of lameness increases the risk of having a meniscal tear.<sup>1-3,7</sup> Consequently, it would be evidence-based to conclude that delaying treatment could increase the risk of sustaining a bucket handle tear, and in turn, could increase the risk of moderate to severe cartilage injury on the medial femoral condyle based on these data.

#### Authors' Contribution

S.P.F. contributed to the conception of the study, data acquisition, and data interpretation. S.L.C. contributed to data analysis and interpretation. Both authors drafted, revised, and approved the manuscript.

#### Conflict of Interest

None declared.

#### References

- 1 Hayes GM, Langley-Hobbs SJ, Jeffery ND. Risk factors for medial meniscal injury in association with cranial cruciate ligament rupture. *J Small Anim Pract* 2010;51(12):630-634
- 2 Colthurst SMM, Simcock JO, Cashmore RG. Comparison of incidence of medial meniscal injury in small dogs (<15 kg) and medium-to-large dogs (>15 kg) with naturally occurring cranial cruciate ligament disease undergoing tibial plateau levelling osteotomy: 580 stifles (2015 - 2019). *J Small Anim Pract* 2022; 63(09):686-691
- 3 Saban C, Hebrard I, Roels J, Harel M, Livet V, Cachon T. Concurrent bucket handle meniscal tear treated with arthroscopic partial meniscectomy does not influence midterm outcomes after tibial plateau leveling osteotomy. *Am J Vet Res* 2023;84(10):1-8
- 4 Agnello KA, Hayashi K, Brown DC. Arthroscopic Articular Cartilage Scores of the Canine Stifle Joint with Naturally Occurring Cranial Cruciate Ligament Disease. *Vet Comp Orthop Traumatol* 2021;34 (03):153-160
- 5 Kaufman K, Beale BS, Thames HD, Saunders WB. Articular cartilage scores in cranial cruciate ligament-deficient dogs with or without bucket handle tears of the medial meniscus. *Vet Surg* 2017;46(01):120-129
- 6 Franklin SP, Burke EE, Holmes SP. Utility of MRI for characterizing articular cartilage pathology in dogs with medial coronoid process disease. *Front Vet Sci* 2017;4:25
- 7 Flo GL. Meniscal Injuries. In: *Veterinary Clinics of North America: Small Animal Practice*; 1993:831-843