Original Article

Meniscal Comma Sign Responds to Partial Meniscectomy Despite Increased Levels of Arthritis

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Purpose: To compare the outcomes of patients undergoing partial meniscectomy preoperatively identified with the "meniscal comma sign" with those undergoing meniscectomy with other tear patterns. **Methods:** Patients with meniscal "comma sign," as indicated by a query of magnetic resonance imaging reports, were screened using the search terms "meniscotibial recess," "meniscus perched over the medial tibial margin," or other search terms by radiologists between January 2008 and November 2019. Patients were matched and chart review was done for demographics, revision surgery, and progression to total knee arthroplasty. Radiographs were used for osteoarthritis grading using the Kellgren-Lawrence (KL) scoring system. Preoperative and postoperative International Knee Documentation Committee, Knee Injury and Osteoarthritis Outcome Score, Lysholm, and Short Form 12-item Survey scores were collected. **Results:** A total of 406 patients met inclusion (comma sign = 197; control group = 209). The control group had an increased duration of symptoms at the initial visit ($P = .001$). More patients with the meniscal comma sign received corticosteroid knee injections before surgery ($P = .011$), and they also had greater mean KL scores ($P = .001$) as well as greater KL categorical scores ($P = .002$), indicating more advanced levels or arthritis. There were no differences in those receiving physical therapy (PT) before surgery ($P = .966$) or those receiving injections or PT after surgery ($P = .631$, $P = .37$, respectively). International Knee Documentation Committee, Knee Injury and Osteoarthritis Outcome Score, Lysholm, and Short Form 12-Item Survey Physical scores improved preoperatively to postoperatively in both groups ($P < .05$), and there was no difference between the case and control group ($P > .05$). No significant difference was found in revisions or progression to total knee arthroplasty between cohorts. ($P = .676$ and $P = .424$). **Conclusions:** Patients presenting with preoperative findings of meniscal comma sign fare similarly to those that do not. Patients with this meniscal injury tend to have more advanced grading of osteoarthritic changes in the knee at presentation and seek care earlier than those without. Arthroscopic meniscectomy is a good treatment option for patients with a meniscal fragment in the meniscotibial recess and shows outcomes comparable with those with other tear patterns. **Level of Evidence:** Level III, retrospective cohort.

Meniscal injury is one of the most commonly treated musculoskeletal injuries. Of the approximately 1 million arthroscopic knee surgeries performed each year, approximately one-half are done for meniscal pathology.[1,2] Indications for meniscectomy are not always straightforward, as meniscal tears are commonly encountered in asymptomatic patients and patients with osteoarthritis of the knee.[3] In addition, meniscectomy in an arthritic knee has been shown to do no better than physical therapy (PT) in the long term.[4,5] Consequently, a debate regarding the utility of meniscectomy in the degenerative knee exists, although many surgeons still believe there is a role for partial meniscectomy.[6,7]

Previous investigations have shown that there may be characteristics that portend favorable surgical outcomes, such as having mechanical symptoms or a clear history of trauma. Still, the ability to predict who will benefit from arthroscopic meniscectomy has been called into question.[8-10] Given the controversy, there remains a need for orthopaedic surgeons to be able to identify patients who will benefit from arthroscopic meniscectomy.

Previously described literature defines the "meniscal comma sign," as a descriptive finding on magnetic resonance imaging (MRI) representing an inferiorly displaced flap tear flipped into the meniscotibial recess between the tibial plateau and medial collateral

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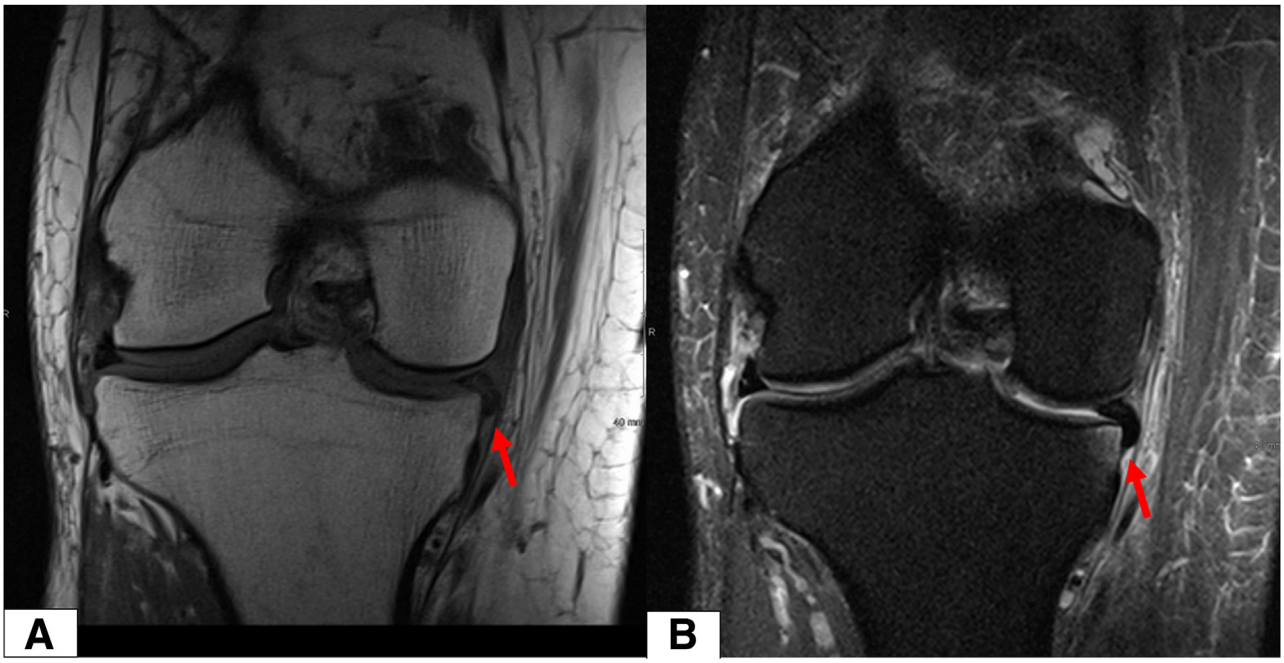

Fig 1. (A) Coronal plane, T1-weighted magnetic resonance image of a right knee. The red arrow is depicting the meniscal comma sign. (B) Coronal plane, T2-weighted magnetic resonance image of a right knee. The red arrow depicts the medial meniscus flap inferiorly displaced into the meniscotibial recess.

ligament (Fig 1).[11,12] Anecdotally, tears with this configuration are painful and reliably respond to arthroscopic surgery (Fig 2). If this is the case, recognition of this pattern preoperatively may result in more favorable surgical outcomes compared with other degenerative-type meniscal tears. The purpose of this study is to compare the outcomes of patients undergoing partial meniscectomy preoperatively identified with the "meniscal comma sign" with those undergoing meniscectomy with other tear patterns. The null hypothesis is that there would be no difference in patient-reported outcomes between patients with a comma sign and those without.

Methods

To identify a cohort of patients with the meniscal "comma sign" (case group), MRI reports from patients who received an MRI at our institution's outpatient imaging system were screened using the search terms "meniscal comma sign," "meniscotibial recess," or "meniscus perched over the medial tibial margin" between January 2008 and November 2019. Patients

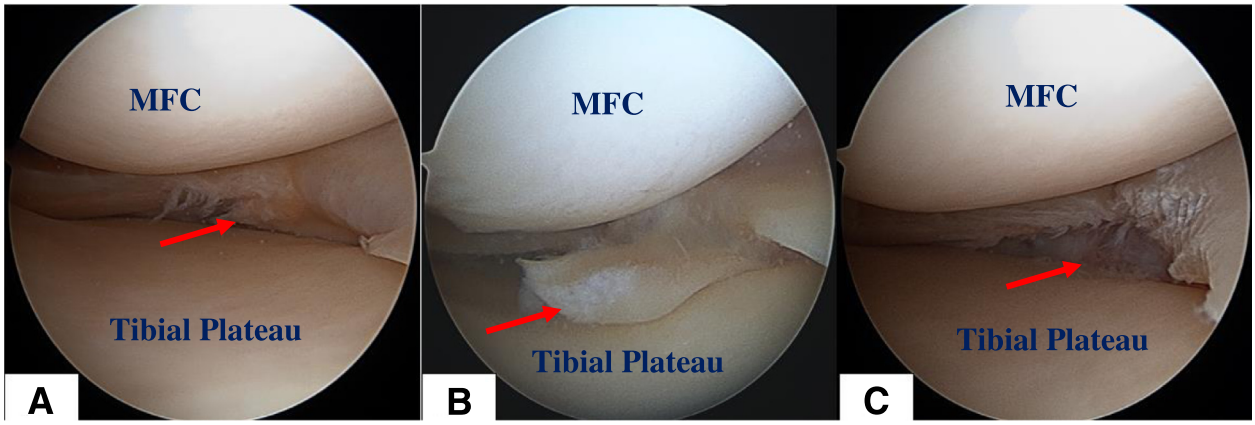

Fig 2. Arthroscopic photos of the right knee with the medial femoral condyle (MFC) superiorly and tibial plateau inferiorly. (A) The red arrow shows the displaced fragment in the meniscotibial recess. (B) The red arrow shows the fragment being brought into the joint in preparation for meniscectomy. (C) The red arrow depicts the site following meniscectomy.

from this preliminary screening were included if they underwent a subsequent meniscectomy at our institution. Patients with concomitant pathology such as a ligament or tendon tear or who underwent a concomitant procedure such as ligament reconstruction, microfracture, high tibial osteotomy, or distal femoral osteotomy in addition to meniscectomy or chondroplasty were excluded.

For the noncomma sign (control group), Current Procedural Terminology codes 29880 and 29881 were used to identify patients. Patients who underwent meniscectomy of the same laterality and on the same date as the "comma sign" patient were included as control patients.

Once cohorts were established, patient records were reviewed to collect data including demographics (age, sex, body mass index), treatment before and after surgery (such as PT or injections), need for revision surgery, and progression to total knee arthroplasty (TKA). Revision surgery was defined by repeat surgery on the same meniscus. Bilateral posteroanterior flexion weight-bearing knee radiographs were used in the assessment of osteoarthritis using the Kellgren-Lawrence scoring system.

Patient-reported outcome measurements were also reviewed. At our institution, preoperative and postoperative International Knee Documentation Committee (IKDC), Knee Injury and Osteoarthritis Outcome Score (KOOS), Lysholm, and Short Form 12-Item Survey (SF-12) scores are routinely collected using the Outcomes Based Electronic Research Database (Universal Research Solution, LLC; Columbia, MO), an electronic system used to collect patient-reported outcome measurements.[13] Included patients were also contacted and invited to complete IKDC, KOOS, Lysholm, SF-12, and visual analog pain scores using the REDCap electronic data capture tool[14,15] and/or Outcomes Based Electronic Research Database. This study was approved by Jefferson institutional review board #20E.393.

Statistical Analysis

Statistical analyses were conducted using R Studio (Version 4.1.2, Vienna, Austria). Demographic information was presented as means with standard deviation or percentages (%) and revision surgery, reasons for revision surgery, eventual TKA, and categorical Kellgren-Lawrence grades were presented as number of patients (N) and percentages. *P* values were calculated using χ^2 analysis. Patient-reported outcome measures were presented as means along with standard deviation or median [first quartile; third quartile] depending on its normality. Continuous Kellgren-Lawrence grades were presented as (N) and percentages. *P* values were calculated using *t*-tests. *P* values less than .05 were deemed significant. Any nonparametric data was reported with median and interquartile ranges for accurate representation.

Results

A total of 406 patients were enrolled in this study between the meniscal comma sign group (n = 197) and a non-meniscal comma sign control group (n = 209). Characteristics of the groups are presented in Table 1.

Baseline demographics showed no differences in age, body mass index, laterality, or sex at time of surgery. The control group had a significantly increased duration of symptoms at initial visit compared with the meniscal comma group (13.9 vs 9.90 weeks, $P = .001$) (Table 1).

Table 1. Patient Demographics

	Control	Meniscal Comma Sign	
	N = 209	N = 197	*P* Value
Age at surgery, yr	54.6 (11.3)	54.8 (11.9)	.808
Sex			.147
Female	70 (33.5%)	52 (26.4%)	
Male	139 (66.5%)	145 (73.6%)	
BMI	30.0 (5.55)	29.7 (4.93)	.901
Duration of symptoms at initial visit, wk	13.9 (26.0)	9.90 (17.0)	**.001**
Affected side			.3046
Left	103 (49.3%)	87 (44.2%)	
Right	104 (49.8%)	110 (55.8%)	
Injection before surgery	61 (29.2 %)	91 (46.2 %)	**.011**
PT before surgery	30 (14.4%)	27 (13.7%)	.966
Injection after surgery	52 (25.1%)	53 (27.7%)	.631
PT after surgery	109 (52.7%)	92 (47.7%)	.370
Injury mechanism			.338
Sport	24 (25.5%)	19 (18.8%)	
Other	70 (74.5%)	82 (81.2%)	

NOTE. *P*-values in bold are statistically significant.
BMI, body mass index; PT, physical therapy.

Table 2. Patient-Reported Outcomes

Total	Control N = 209	*P* Value Pre- vs Postoperative	Meniscal Comma Sign N = 197	*P* Value Pre- vs Postoperative	*P* Value Control vs Comma Sign
IKDC		**<.001**		**<.001**	
Preoperative	41.0 (13.6)		40.9 (14.0)		.988
Postoperative	69.1 [51.7;85.1]		73.6 [55.2;90.8]		.395
KOOS		**<.001**		**<.001**	
Preoperative	53.6 [46.2;61.6]		54.8 [44.9;59.4]		.882
Postoperative	72.6 [54.8;84.6]		71.8 [52.5;92.3]		.909
Lysholm		**<.001**		**.002**	
Preoperative	37.6 (27.2)		44.9 (26.1)		.386
Postoperative	73.1 (15.1)		75.5 (19.8)		.728
SF-12 Mental		.474		.082	
Preoperative	57.6 [50.1;61.3]		57.8 [50.7;62.2]		.525
Postoperative	55.9 [47.7;59.9]		57.4 [52.0;60.3]		.634
SF-12 Physical		**<.001**		**<.001**	
Preoperative	37.6 (8.15)		36.2 (9.09)		.354
Postoperative	44.5 [36.2;53.1]		42.0 [33.3;53.5]		.369
Postperative VAS	10.0 [2.50;33.0]		10.0 [1.50;31.2]		.768
Follow-up, mo	28.9 (22.9) [1-93]		31.3 (20.8) [2-84]		.480

NOTE. *P*-values in bold are statistically significant. Values are presented as mean (standard deviation) or mean [first quartile; third quartile].
IKDC, International Knee Documentation Committee; KOOS, Knee Injury and Osteoarthritis Outcome Score Lysholm; SF-12, Short Form 12-item Survey; VAS, visual analog scale.

A significantly greater proportion of case patients received corticosteroid knee injections before surgery (46.2% vs 29.2%, $P = .011$); however, there was no difference in those who received PT (14.4% vs 13.7% $P = .966$).

After surgery, there was no difference in those who received PT (52.7% vs 47.7%, $P = .370$) or received intra-articular injections (25.1% vs 27.7%, $P = .631$, respectively). It is also noted that the majority of patients in both groups did not sustain a traumatic injury, with sports injuries making up only 25.5% of the control and 18.8% in the meniscus comma sign group ($P = .338$).

Clinical Outcomes

A total of 367 of 406 (90.4%) patients had postoperative patient-reported outcome measures recorded. Mean follow-up was 28.9 ± 22.9 months in the control group and 31.3 ± 20.8 months in the case group (Table 2). International Knee Documentation Committee (IKDC), Knee Injury and Osteoarthritis Outcome Score (KOOS), Lysholm, and SF-12 Physical scores improved significantly from preoperative levels to postoperative levels in the control group. Similarly, case patients experienced significant increases from preoperative IKDC, KOOS, Lysholm, and SF-12 Physical scores. IKDC, KOOS, Lysholm, and SF-12 Physical scores surpassed MCID values previously established in the literature for meniscal procedures.[16-18] When comparing the control group to the case group, we found no significant differences between preoperative or postoperative reported outcome scores. There was also no significant difference when comparing visual analog scale scores between both groups ($P = .768$).

Table 3. Complications and Revisions

	Control N = 209	Meniscal Comma Sign N = 197	*P* Value
Revision surgery			.676
No	205 (99.0%)	190 (98.4%)	
Yes	2 (0.97%)	3 (1.55%)	
Reason for revision			.2615
Infection at portal site	0 (0.00%)	1 (0.51%)	
Medial meniscus retear	1 (0.48%)	0 (0.00%)	
Repeat injury	1 (0.48%)	1 (0.51%)	
Eventual TKA			.424
No	195 (94.7%)	182 (96.8%)	
Yes	11 (5.34%)	6 (3.19%)	
Time to TKA, mo	23.8 (15.2)	22.5 (15.6)	.436

TKE, total knee arthroscopy.

Table 4. Preoperative Evaluation Using Kellgren-Lawrence Score

	Control	Meniscal Comma Sign	
	N = 166	N = 174	*P* Value
Kellgren-Lawrence (continuous)	1.31 (0.61)	1.55 (0.75)	**.001**
Kellgren-Lawrence (categorical)			**.002**
0	3 (1.81%)	5 (2.87%)	
1	119 (71.7%)	89 (51.1%)	
2	34 (20.5%)	62 (35.6%)	
3	10 (6.02%)	16 (9.20%)	
4	0 (0.00%)	2 (1.15%)	

NOTE. N = Available data sample size; continuous data are presented as mean (standard deviation). *P*-values in bold are statistically significant.

There was no significant difference in revision rates between cohorts ($P = .676$). There were a total of 5 revisions with 4 available reports (Table 3). There were 2 in the control group and 3 in the case group. Indication for revision included a retear of the meniscus for 2 patients in the control group, whereas the case group included infection at the portal site and repeat injury. Eventual TKA was not significantly different between cohorts and was seen in a total of 17 patients with 11 (5.3%) in the control group and 6 (3.2%) in the case group. Time to TKA from meniscectomy was not significant between groups ($P = .436$) where control patients who had an eventual TKA did so at an average of 23.8 months and the case group had surgery at 22.5 months.

Radiographic Evaluation

Preoperative knee radiographs were evaluated for both cohorts and a Kellgren-Lawrence score was evaluated. Of the 340 available radiographs that were evaluated, the case group had a greater mean Kellgren-Lawrence score (1.55 vs 1.31, $P = .001$) and overall had a larger volume of patient's labeled as Kellgren-Lawrence 2-4 (45.95% vs 26.52%, $P = .002$) (Table 4).

Discussion

Patients with the "comma sign" had decreased duration of symptoms at presentation and greater levels of arthritis as measured by Kellgren-Lawrence score. Despite these differences IKDC, KOOS, Lysholm, and SF-12 Physical scores improved in both groups after partial meniscectomy by the same amount, with no differences in the need for revision surgery.

One intriguing finding is that both the "comma sign" and control groups experienced similar improvements in scores after surgery. Not only were these improvements statistically significant for IKDC, KOOS, Lysholm, and SF-12 Physical scores, but also they all surpassed minimal clinically important difference.[16-18] Partial meniscectomy has been shown to reliably improve patient-reported outcomes in patients with meniscus tears, though its utility over structured physical therapy has been called into question.[19] Several studies, including randomized controlled trials, have shown no difference in outcomes between meniscectomy and physical therapy for degenerative meniscal tears.[20-23] Therefore, it is important to identify patients with meniscal tears who will benefit from a partial meniscectomy, as the one-size-fits-all approach of operating on meniscus tears is clearly not appropriate.

"Comma sign" patients may be one group that responds well to surgery. Improvements in scores were the same between the comma and control groups despite the comma group having greater arthritis on the Kellgren-Lawrence scale. This is contrary to previous studies, which have demonstrated increasing levels of arthritis to be a negative predictor of a good clinical result after arthroscopy. Hong et al.[24] concluded that Kellgren-Lawrence score > 2 and age > 50 years were prognostic for clinical failure in a group of 160 patients undergoing arthroscopic partial meniscectomy. Eijgenraam et al.[25] performed a systematic review of 32 studies looking at predictors of clinical outcomes after partial meniscectomy. They found baseline knee osteoarthritis to be a moderate predictor of worse clinical outcomes. Our results suggest that patients with a "comma sign" respond well to surgery despite higher grades of arthritis.

However, it needs to be acknowledged that patients with and without the comma sign responded similarly to surgery. Although a comma sign has previously been postulated to be an indication for partial meniscectomy, it is possible these patients respond to both conservative and operative care in the same way. The groups may not behave differently as previously thought.

Finally, patients with the "comma sign" presented approximately 1 month earlier than control patients despite having increased levels of arthritis. The underlying cause for this is not elucidated in our study, but anecdotally the increased pressure on the subchondral bone that occurs when a piece of meniscus flips into the meniscotibial recess often leads to subchondral bone edema which is very painful.[26] This may cause patients to seek care earlier. Similarly, patients with the "comma sign" had more frequent preoperative corticosteroid

knee injections.[11] This could be attributed to initial nonoperative treatment for the substantial pain that a "comma sign is known to have. Furthermore, the case group had significantly greater Kellgren-Lawrence grades for osteoarthritis, where corticosteroids are frequently used to mitigate the symptoms and provide short-term pain relief.[27]

This paper has several strengths. Foremost, it provides valuable information about how patients with a "comma sign" compare to other patients who require meniscectomy in terms of both patient characteristics and treatment response. Further research is needed to better understand the significance of the comma sign and other MRI findings in predicting surgical outcomes, and to identify factors that may be strongly associated with both positive and negative outcomes for patients.

Limitations

Like all studies, this work should be viewed within the context of its limitations. As a result of the retrospective study design, we are limited to the data available within the electronic medical record of each patient. Second, patients did not always complete all patient-reported outcome tests. This led to variable follow-up rates between different scores, which may produce a selective nonresponse bias. Lastly, we did not include preoperative MRI data within our demographic of control versus case patients. Although we did include Kellgren-Lawrence grading through the use of AP radiographs, further information could have been extracted through MRI.

Conclusions

Patients presenting with preoperative findings of meniscal comma sign favor similarly to those that do not. Patients with this meniscal injury tend to have more advanced grading of osteoarthritic changes in the knee upon presentation and seek care earlier than those without. Arthroscopic meniscectomy is a good treatment option for patients with a meniscal fragment in the meniscotibial recess and shows outcomes comparable with those with other tear patterns.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: F.P.T. reports board membership, American Academy of Orthopaedic Surgeons, American Orthopaedic Society for Sports Medicine, and the American Board of Orthopaedic Surgery; equity or stocks from Trice Medical that includes, and a patent with royalties paid to Tigon Medical. K.B.F. reports board membership, American Orthopaedic Society for Sports Medicine; travel reimbursement from Liberty Surgical; and consultant or advisor for DePuy Synthes, Vericel Corporation, and Medical Device Business Services. All other authors (A.R.P., R.T.K., C.C., J.H.S.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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