A commentary by Marc Tompkins, MD, is linked to the online version of this article at jbjs.org.

Meniscal and Mechanical Symptoms Are Associated with Cartilage Damage, Not Meniscal Pathology

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Background: Traditionally defined "meniscal" and "mechanical" symptoms are thought to arise from meniscal tears. Yet meniscal tears and cartilage damage commonly coexist in symptomatic knees. To better characterize the primary driver of these symptoms, we investigated whether the presence of preoperative patient-reported knee symptoms (PRKS), including knee catching/locking, grinding/clicking/popping, and pain with pivoting, are associated with various intra-articular pathological conditions diagnosed at knee arthroscopy.

Methods: We collected prospective data from 565 consecutive patients who underwent knee arthroscopy from 2012 to 2019 and had PRKS collected via the Knee injury and Osteoarthritis Outcome Score (KOOS) questionnaire. The diagnosis of meniscal pathology and concomitant cartilage damage was confirmed and classified intraoperatively. We used multivariable regression models, adjusting for possible confounders, to examine the association of specific pathological conditions of the knee with the presence of preoperative PRKS.

Results: Tricompartmental cartilage damage was strongly associated with significantly worse PRKS, with an increase of 0.33 point (95% confidence interval [CI] = 0.08 to 0.58; p = 0.01) on a 0 to 4-point scale. We did not observe an association between meniscal pathology and preoperative PRKS.

Conclusions: Contrary to current dogma, this study demonstrates that traditionally defined "meniscal" and "mechanical" knee symptoms are strongly associated with the burden and severity of underlying cartilage damage rather than with specific meniscal pathology.

Level of Evidence: Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

Arthroscopic knee surgery for meniscal pathology is one of the most common procedures in the United States[1]. Clinicians are classically taught that symptomatic meniscal tears often present as intra-articular structural lesions that directly restrict motion or cause pain with impingement. Patients experiencing "mechanical symptoms" (traditionally defined as knee locking or catching) are believed to benefit from arthroscopic reduction, repair, and/or resection of torn meniscal tissue because this injured tissue is presumed to be the primary driver of mechanical phenomena. This tenet has become so widely accepted that additional knee symptoms, including grinding, popping, and clicking as well as pain with knee pivoting/twisting, have also all been attributed to underlying meniscal pathology, giving rise to the broader term of "meniscal symptoms."[2-8] However, the terms "mechanical symptoms" and "meniscal symptoms" are often conflated in current practice and literature, and each carries the onus of a presumptive and isolated diagnosis[2-9].

Surgeons incorporate patient history, physical examination, and magnetic resonance imaging (MRI) of the knee to identify symptomatic meniscal tears. Typically, clinicians regard the presence of "mechanical symptoms" (i.e., knee catching/locking) as an important component of the indications for knee arthroscopy[10]. Mounting evidence from numerous recent studies has begun to challenge this reliance on "mechanical symptoms," suggesting that cartilage damage, anterior cruciate ligament (ACL)

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injury, and synovial inflammatory processes may give rise to mechanical phenomena in the knee[9,11-19]. Others have suggested that the "meniscal symptoms" of grinding/popping/clicking and pain with knee pivoting/twisting—rather than the classic mechanical symptoms of knee catching/locking alone—better represent the array of symptoms most common in patients with a confirmed meniscal tear[4,6-8]. Yet a growing body of evidence challenges the dogma that "mechanical" and "meniscal" symptoms arise primarily from meniscal pathology. Given the high prevalence of concomitant intra-articular pathological conditions observed in symptomatic knees, the primary driver of each of these patient-reported knee symptoms (PRKS) remains largely unknown[6,8,20-25]. Consequently, the indications for knee arthroscopy based on PRKS have also come into question[5,10,12,14,18,19,26].

The aim of the present study was to evaluate the association of various intra-articular pathological conditions, including both cartilage and meniscal damage, with preoperative PRKS previously defined as "mechanical" and/or "meniscal" symptoms. We hypothesized that PRKS are associated with cartilage damage and not with specific meniscal pathology.

Materials and Methods

Patient Cohort

With institutional review board approval, we prospectively enrolled a consecutive cohort of patients undergoing arthroscopic knee surgery performed by a single surgeon (E.G.M.) at a single academic medical center from August 2012 through December 2019. We entered data into a HIPAA (Health Insurance Portability and Accountability Act)-compliant global registry database (Surgical Outcomes System [SOS]; Arthrex). Knee arthroscopy was considered to be indicated based on a suspicion of a meniscal tear and/or the presence of classically defined "mechanical" and "meniscal" symptoms as demonstrated by the clinical history, physical examination, and/or MRI. Initial exclusion criteria included concomitant ligamentous knee injury, inflammatory arthritis, and a discoid meniscus. Then, from our cohort of 697 patients, we additionally excluded patients because of incomplete data, previous knee surgery, and the performance of both medial and lateral meniscal surgery. All patients completed preoperative Knee injury and Osteoarthritis Outcome Score (KOOS) questionnaires[27]. We followed all patients prospectively for at least 2 years after surgery, with serial KOOS questionnaires collected postoperatively as well.

Patient factors and demographics were collected preoperatively as shown in Table I, whereas the surgical team recorded intraoperative findings, including meniscal tears (location, depth, size, and pattern/orientation), severity of cartilage damage (Outerbridge grade[28]), and burden of cartilage damage (specific locations and number of compartments involved). The meniscal tear pattern/orientation was subcategorized as either "no tear," "stable" (radial, horizontal, complex degenerative, or longitudinal vertical without propagation to include the anterior and posterior horns and without displacement), or "unstable" (oblique/parrot beak, flap with displacement, or bucket-handle/longitudinal vertical with propagation to include the anterior and posterior horns and with displacement).

TABLE I Baseline Patient Characteristics (N = 565)

Mean age ± SD *(yr)*	47.8 ± 11.6
Sex *(no. [%])*	
Female	311 (55.0)
Male	254 (45.0)
Race *(no. [%])*	
Asian	9 (1.6)
Black/African American	29 (5.1)
White	512 (90.6)
Other	9 (1.6)
Unknown	6 (1.1)
Ethnicity *(no. [%])*	
Hispanic/Latino	33 (5.8)
Not Hispanic/Latino	519 (91.9)
Unknown	13 (2.3)
BMI *(no. [%])*	
<25 kg/m^2	116 (20.5)
≥25 kg/m^2	448 (79.3)
Unknown	1 (0.2)
Smoker *(no. [%])*	43 (7.6)
Workers' Compensation *(no. [%])*	23 (4.1)
Diabetic *(no. [%])*	28 (5.0)
Meniscal tear pattern *(no. [%])*	
No tear	121 (21.4)
Stable	374 (66.2)
Unstable	70 (12.4)
Highest articular cartilage/ osteochondral Outerbridge grade *(no. [%])*	
0	150 (26.5)
1	34 (6.0)
2	135 (23.9)
3	121 (21.4)
4	125 (22.1)
Compartment(s) with cartilage damage *(no. [%])*	
None	145 (25.7)
Medial only	26 (4.6)
Lateral only	17 (3.0)
Patellofemoral only	61 (10.8)
Medial + lateral	14 (2.5)
Medial + patellofemoral	180 (31.9)
Lateral + patellofemoral	36 (6.4)
Medial + lateral + patellofemoral	86 (15.2)

Definition of Patient-Reported Knee Symptoms (PRKS)

We used 3 questions from the KOOS questionnaire to define the presence of each of the preoperative PRKS traditionally defined as "mechanical" or "meniscal" by previous authors[2-9]. The first 2 questions, which follow the prompt "thinking of

your knee symptoms during the last week," were: "Does your knee catch or hang up when moving?" (KOOS question S3) and "Do you feel grinding, hear clicking or any other type of noise when your knee moves?" (KOOS question S2). For these 2 questions, the possible responses were "never" = 0, "rarely" = 1, "sometimes" = 2, "often" = 3, and "always" = 4. Our third question asked: "What amount of knee pain have you experienced in the last week during . . . twisting/pivoting on your knee?" (KOOS question P2), with the possible responses being "none" = 0, "mild" = 1, "moderate" = 2, "severe" = 3, and "extreme" = 4. The minimal clinically important difference (MCID) for the KOOS subscales is estimated to be a change of 8 to 10 points out of 100 points in total[29]. Since each item is scored on a 0 to 4-point scale, the MCID for each item was estimated to be 0.32 point (0.08 × 4).

Statistical Analysis

Summary statistics were displayed as counts, with percentages for categorical variables and means with the standard deviation (SD) for continuous variables. Outcomes included the mean score of the 3 KOOS symptom domains (possible range of 0 to 4, with 4 the most symptomatic) as well as the dichotomized version for each of the 3 domains. The primary analysis dichotomized the individual symptom scores at <2 versus ≥2. We also performed sensitivity analyses dichotomizing individual scores at <3 versus ≥3 to assess the robustness of the results. For patient characteristics and intra-articular pathology variables, as subgrouped in Table II, average scores were compared using analysis of variance (ANOVA) while dichotomized scores were compared using chi-square tests. Linear and logistic regression models were used to examine the independent associations between dependent variables: PRKS and age, sex, body mass index (BMI), smoking status, meniscal tear pattern, and extent of cartilage damage. We considered symptoms as the outcomes and pathological findings as the independent variable, and symptoms as the dependent variable, in the regression models, with the rationale that structural pathology leads to symptoms. In an exploratory analysis, the analyses were repeated stratified by age group. All statistical analyses were performed using SAS version 9.4 (SAS Institute).

Results

The initial cohort included 697 consecutive patients undergoing arthroscopic knee surgery, and 565 subjects were eligible for the final analysis (Fig. 1). Demographics and patient characteristics are outlined in Table I. Patient age ranged from 12 to 81 years with a mean of 47.8 years (SD = 11.6); 55.0% were female, and the majority (90.6%) were White. The duration of symptoms ranged from 0.1 to 48 months with a median of 4 months (interquartile range = 2 to 9 months). Most patients (79.3%) had a BMI of ≥25 kg/m^2, only 4.1% received Workers' Compensation, and 5.0% had diabetes. Most patients (66.2%) had a stable meniscal tear pattern, some (21.4%) had no meniscal tear, and fewer (12.4%) had an unstable meniscal tear pattern. The study population included a broad spectrum of cartilage damage, with a relatively even distribution of severity, locations, and numbers of involved compartments (Table I).

Patient characteristics by symptom scores are shown in Table II. The mean average symptom score was 2.1 (SD = 0.8), with 62.7% of the patients reporting more frequent catching/locking symptoms (i.e., they reported that they had the symptoms "sometimes," "often," or "always"), 74.3% of the patients reporting more frequent grinding/clicking/popping symptoms, and 85.3% reporting worse ("moderate," "severe," or "extreme") pain when pivoting. There was no significant difference between younger patients (≤40 years of age) and older patients (>40 years) with respect to the mean average symptom score or catching/locking or grinding/clicking/popping symptoms, but older patients were more likely to report worse pain when pivoting than younger patients (87.0% versus 79.0%; p = 0.028). Female patients had a higher mean average symptom score compared with male patients (2.2 versus 2.0; p = 0.022) and were more likely to report more frequent grinding/clicking/popping symptoms (78.5% versus 69.3%; p = 0.013). Additional information on patient characteristics according to the presence or absence of symptoms is presented in Appendix Table 1.

Analyzing intra-articular pathology, we did not observe a significant association between the meniscal tear pattern and PRKS scores. The mean average symptom score was 2.1 among those without a meniscal tear, 2.1 among those with a stable meniscal tear pattern, and 2.2 among those with an unstable meniscal tear pattern. Similarly, there was no meaningful difference in grinding/clicking/popping (p = 0.6), pain when pivoting (p = 0.64), or catching/locking (p = 0.1) among those without, with a stable, or with an unstable meniscal tear (Table II).

In contrast, the mean average symptom score increased with the severity of cartilage damage as defined by the Outerbridge grade. The mean average symptom score was 2.0 among those with an Outerbridge grade of <3 compared with 2.3 among those with a grade of ≥3 (p < 0.001). However, the relationship between the Outerbridge grade and the symptom scores was mostly driven by catching/locking and grinding/clicking/popping symptoms (p < 0.001 and p = 0.011, respectively). The mean average symptom score also increased with the burden of cartilage damage as defined by the number of compartments involved, from 1.9 for those with no compartment involvement to 2.4 for those with tricompartmental damage (p < 0.001). The relationship between the burden of cartilage damage and the individual symptom scores was again most apparent for catching/locking symptoms (49.0% of those with no compartments involved reported that they sometimes, often, or always had such symptoms compared with 77.9% of those with tricompartmental involvement).

Multivariable linear regression models examining the independent effect of each factor on the mean average symptom score showed the following to be significant predictors of a higher mean average symptom score: female sex (an increase of 0.17 point, 95% confidence interval [CI] = 0.05 to 0.30; p = 0.007), BMI of ≥25 kg/m^2 (an increase of 0.23 point, 95% CI =

TABLE II KOOS Patient-Reported Knee Symptoms (PRKS) by Patient Characteristics

		Average Symptom Score*			Catching/Locking†			Grinding/Clicking/ Popping‡			Pivot Pain§		
	No.	Mean	SD	P Value	No.	%	P Value	No.	%	P Value	No.	%	P Value
All	565	2.1	0.8		354	62.7		420	74.3		482	85.3	
Age at treatment				0.29			0.59			0.9			0.028
≤40 yr	119	2.1	0.7		72	60.5		89	74.8		94	79.0	
>40 yr	446	2.1	0.8		282	63.2		331	74.2		388	87.0	
Sex				0.022			0.15			0.013			0.26
Female	311	2.2	0.8		203	65.3		244	78.5		270	86.8	
Male	254	2.0	0.8		151	59.4		176	69.3		212	83.5	
BMI				0.001			0.064			0.42			0.004
<25 kg/m^2	116	1.9	0.8		64	55.2		83	71.6		89	76.7	
≥25 kg/m^2	448	2.2	0.8		289	64.5		337	75.2		392	87.5	
Smoker				0.013			0.18			0.46			0.053
No	522	2.1	0.8		323	61.9		386	73.9		441	84.5	
Yes	43	2.4	0.8		31	72.1		34	79.1		41	95.3	
Meniscal tear pattern				0.64			0.1			0.6			0.64
No tear	121	2.1	0.8		67	55.4		87	71.9	6	100	82.6	
Stable	374	2.1	0.8		238	63.6		283	75.7		322	86.1	
Unstable	70	2.2	0.7		49	70.0		50	71.4		60	85.7	
Highest articular cartilage/osteochondral Outerbridge grade				0.0002			0.001			0.081			0.92
0	150	2.0	0.7		76	50.7		106	70.7		126	84.0	
1	34	2.0	0.8		19	55.9		23	67.6		29	85.3	
2	135	2.1	0.8		84	62.2		95	70.4		116	85.9	
3	121	2.1	0.7		83	68.6		92	76.0		106	87.6	
4	125	2.4	0.7		92	73.6		104	83.2		105	84.0	
Compartment(s) with cartilage damage				0.0004			0.0003			0.68			0.38
None	145	1.9	0.7		71	49.0		101	69.7		122	84.1	
Medial only	26	2.2	0.8		18	69.2		21	80.8		19	73.1	
Lateral only	17	2.4	0.7		14	82.4		13	76.5		12	70.6	
Patellofemoral only	61	2.0	0.8		34	55.7		44	72.1		54	88.5	
Medial + lateral	14	2.0	0.9		7	50.0		11	78.6		12	85.7	
Medial + patellofemoral	180	2.1	0.8		121	67.2		133	73.9		157	87.2	
Lateral + patellofemoral	36	2.1	0.8		22	61.1		27	75.0		31	86.1	
Medial + lateral + patellofemoral	86	2.4	0.8		67	77.9		70	81.4		75	87.2	

*The mean score of the KOOS S3, S2, and P2 items (range, 0 to 4; 4 = worst). †Patients reported "sometimes," "often," or "always" to KOOS Item S3 ("Does your knee catch or hang up when moving?"). ‡Patients reported "sometimes," "often," or "always" to KOOS Item S2 ("Do you feel grinding, hear clicking or any other type of noise when your knee moves?"). §Patients reported "moderate," "severe," or "extreme" to KOOS Item P2 ("What amount of knee pain have you experienced the last week during . . . twisting/pivoting on your knee?").

0.07 to 0.40; p = 0.006), smoking (an increase of 0.25 point, 95% CI = 0.02 to 0.48; p = 0.037), and tricompartmental cartilage damage (an increase of 0.33 point, 95% CI = 0.08 to 0.58; p = 0.01). We did not observe significant differences in symptom scores among the various meniscal tear patterns. The Outerbridge grade was no longer a significant predictor after controlling for the burden of cartilage damage as defined by the number of compartments involved. In the multivariable models for individual dichotomized symptoms, significant associations were noted between tricompartmental involvement and a higher frequency of catching/locking symptoms (adjusted odds ratio [aOR] = 2.77, 95% CI = 1.32 to 5.84; p = 0.007), female sex and a

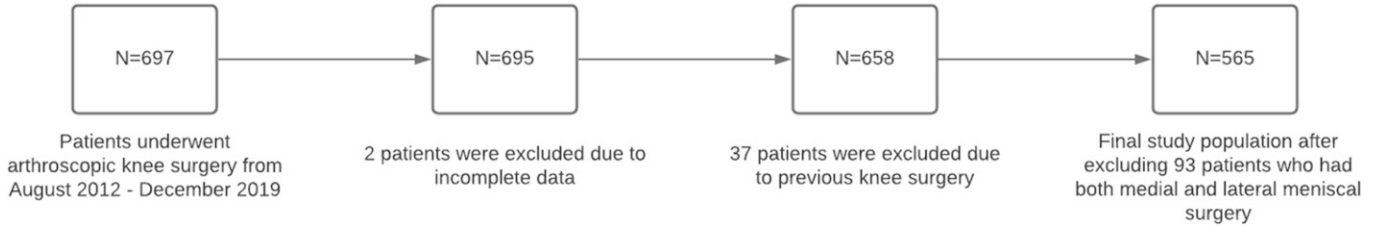

Fig. 1
Enrollment of patients.

higher frequency of grinding/clicking/popping symptoms (aOR = 1.66, 95% CI = 1.11 to 2.46; p = 0.013), and a BMI of ≥25 kg/m^2 and worse pain when pivoting (aOR = 2.14, 95% CI = 1.20 to 3.81; p = 0.01) (Table III).

The results of a sensitivity analysis dichotomizing individual symptom scores at <3 versus ≥3 were largely similar (Table IV). In an exploratory analysis stratified by age, female sex, a BMI of ≥25 kg/m^2, and a positive smoking status, each remained a significant predictor of a higher mean average symptom score among those with an age of >40 years, while the burden of underlying cartilage damage was the only significant predictor of a higher mean average symptom score among those with an age of ≤40 years. For individual dichotomized symptoms, there was a significant interaction between BMI and age group for those with catching/locking symptoms (p = 0.003): those with a BMI of ≥25 kg/m^2 were less likely to report such symptoms in the younger group (aOR = 0.36, 95% CI = 0.14 to 0.93; p = 0.035) while those with a BMI of ≥25 kg/m^2 were more likely to report such symptoms in the older group (adjusted OR = 2.36, 95% CI = 1.34 to 4.14; p = 0.003) (see Appendix Table 2).

Discussion

This study evaluating the preoperative patient-reported knee symptoms (PRKS) traditionally defined as "mechanical symptoms" (i.e., knee catching/locking) or "meniscal symptoms" (i.e., knee grinding/clicking/popping or pain with pivoting) and their associations with various intra-articular pathological conditions diagnosed at knee arthroscopy demonstrates that preoperative PRKS are strongly associated with the burden of underlying cartilage damage, and not with specific meniscal pathology. Given that meniscal tears commonly coexist with cartilage damage in symptomatic knees[20-24], our findings suggest that the primary driver of PRKS in persons with concomitant pathology is in fact structural cartilage damage. Our data align with the observation that cartilage damage and

TABLE III Multivariable Regression Models of KOOS Patient-Reported Knee Symptoms (PRKS)*

	Average Symptom Score†			Catching/Locking‡			Grinding/Clicking/Popping§			Pivot Pain#		
	Effect Estimate	95% CI	P Value	aOR	95% CI	P Value	aOR	95% CI	P Value	aOR	95% CI	P Value
Age ≤40 yr	0.05	−0.11-0.22	0.52	1.23	0.77-1.96	0.38	1.30	0.78-2.17	0.32	0.61	0.34-1.09	0.096
Female	0.17	0.05-0.30	0.007	1.33	0.92-1.90	0.13	1.66	1.11-2.46	0.013	1.48	0.91-2.42	0.12
BMI ≥25 kg/m^2	0.23	0.07-0.40	0.006	1.36	0.86-2.16	0.19	1.28	0.77-2.12	0.34	2.14	1.20-3.81	0.01
Smoker	0.25	0.02-0.48	0.037	1.46	0.72-2.96	0.29	1.26	0.58-2.73	0.56	3.43	0.80-14.60	0.096
Meniscal tear pattern												
Stable vs. no tear	−0.02	−0.19-0.14	0.79	1.12	0.70-1.77	0.64	1.13	0.68-1.88	0.64	1.36	0.74-2.49	0.32
Unstable vs. no tear	0.08	−0.15-0.31	0.48	1.68	0.86-3.25	0.13	0.91	0.46-1.83	0.80	1.53	0.64-3.67	0.34
Highest articular cartilage/osteochondral Outerbridge grade 3 or 4	0.13	−0.03-0.29	0.12	1.35	0.86-2.13	0.19	1.64	1.00-2.69	0.051	0.78	0.42-1.47	0.45
No. of compartments with cartilage damage												
1 vs. 0	0.17	−0.03-0.37	0.100	1.65	0.94-2.87	0.079	1.18	0.64-2.18	0.59	0.70	0.34-1.47	0.35
2 vs. 0	0.10	−0.11-0.30	0.35	1.54	0.88-2.70	0.13	0.95	0.52-1.74	0.87	0.87	0.39-1.94	0.73
3 vs. 0	0.33	0.08-0.58	0.010	2.77	1.32-5.84	0.007	1.19	0.53-2.65	0.97	0.97	0.36-2.63	0.95

*aOR = adjusted odds ratio. †Linear regression model for the mean score of the KOOS S3, S2, and P2 items (range, 0 to 4; 4 = worst). ‡Logistic regression model for reporting "sometimes," "often," or "always" to KOOS Item S3 ("Does your knee catch or hang up when moving?"). §Logistic regression model for reporting "sometimes," "often," or "always" to KOOS Item S2 ("Do you feel grinding, hear clicking or any other type of noise when your knee moves?"). #Logistic regression model for reporting "moderate," "severe," or "extreme" to KOOS Item P2 ("What amount of knee pain have you experienced the last week during . . . twisting/pivoting on your knee?").

TABLE IV Sensitivity Analysis of Individual Symptom Score Threshold*

	Catching/Locking†			Grinding/Clicking/Popping‡			Pivot Pain§		
	aOR	95% CI	P Value	aOR	95% CI	P Value	aOR	95% CI	P Value
Age ≤40 yr	1.31	0.78-2.20	0.31	1.01	0.64-1.59	0.96	0.73	0.47-1.15	0.17
Female	1.56	1.04-2.34	0.031	1.39	0.98-1.97	0.068	1.14	0.80-1.61	0.47
BMI ≥25 kg/m²	1.03	0.61-1.73	0.92	1.41	0.89-2.24	0.14	1.34	0.86-2.11	0.2
Smoker	1.43	0.72-2.84	0.31	1.84	0.96-3.50	0.065	1.70	0.89-3.27	0.11
Meniscal tear pattern									
Stable vs. no tear	0.76	0.45-1.27	0.29	0.81	0.52-1.27	0.36	1.12	0.72-1.75	0.62
Unstable vs. no tear	0.81	0.40-1.66	0.56	0.65	0.34-1.22	0.18	2.11	1.12-3.98	0.021
Highest articular cartilage/osteochondral Outerbridge grade 3 or 4	1.09	0.67-1.77	0.73	1.40	0.90-2.18	0.13	0.78	0.51-1.20	0.26
No. of compartments with cartilage damage									
1 vs. 0	2.55	1.32-4.91	0.005	1.11	0.64-1.94	0.70	1.36	0.79-2.35	0.27
2 vs. 0	2.07	1.06-4.05	0.034	0.84	0.48-1.47	0.54	1.37	0.79-2.37	0.26
3 vs. 0	3.12	1.42-6.88	0.005	1.35	0.68-2.71	0.39	1.49	0.75-2.95	0.25

*aOR = adjusted odds ratio. †Logistic regression model for reporting "often" or "always" to KOOS Item S3 ("Does your knee catch or hang up when moving?"). ‡Logistic regression model for reporting "often" or "always" to KOOS Item S2 ("Do you feel grinding, hear clicking or any other type of noise when your knee moves?"). §Logistic regression model for reporting "severe" or "extreme" to KOOS Item P2 ("What amount of knee pain have you experienced the last week during . . . twisting/pivoting on your knee?").

meniscal tears are both manifestations of overall degenerative knee disease[20,23,30-32].

The rates of PRKS as well as the frequency of the various intra-articular pathological conditions observed in this study are in accordance with those of previous investigations (Table II)[2,3,9,10,12-14,18,19]. A number of recent publications have challenged the tenet that "mechanical symptoms" are primarily generated by meniscal pathology[5,10,14,19]. Pihl et al. found no strong associations between specific meniscal pathology and the presence of self-reported catching/locking[10]. They noted weak associations between catching/locking and only a few rare structural pathological conditions, including ACL tears, large anterior-to-posterior-horn (meniscal) tears, and simultaneous tears of both the medial and the lateral meniscus. In another cross-sectional analysis, Thorlund et al. found that catching/locking symptoms were equally prevalent in patients with and without a meniscal tear (adjusted prevalence ratio = 0.89, 95% CI = 0.77 to 1.03, for catching/locking and 1.02, 95% CI = 0.84 to 1.23, for the inability to straighten the knee fully)[19]. Additionally, they observed that knees with a meniscal tear had a greater frequency of coexisting cartilage defects, ACL injuries, and synovitis. These concomitant pathological conditions were also more severe when present alongside meniscal tears[19]. Our data concur with these studies demonstrating no significant association between the meniscal tear pattern and preoperative catching/locking symptoms. A few groups have compared cohorts of younger and older patients, believing that age and baseline degenerative disease burden may explain differing rates of PRKS[10,12,14,18,33]. Subgroup analyses in our study population comparing younger patients (≤40 years of age) and older patients (>40 years of age) did show some statistically significant differences in PRKS scores; however, none were clinically meaningful. Furthermore, we did not find clinically meaningful differences in PRKS according to BMI or smoking status.

With mounting evidence to refute the association between "mechanical symptoms" and meniscal pathology, a number of groups have speculated whether catching/locking symptoms are a manifestation of other intra-articular factors including osteoarthritis, loose bodies, focal chondral lesions/chondral flap tears, and synovial inflammatory processes[9,11-17,19]. Two previous studies have shown a trend toward an association between the presence of cartilage damage and the presence of degenerative meniscal tears[18,19], and one also noted a trend toward an association between catching/locking symptoms and a higher prevalence of radiographic evidence of osteoarthritis and cartilage damage at arthroscopy[14]. However, none of these previous investigations quantified a direct association between cartilage damage and preoperative PRKS. To our knowledge, the current study is the first to quantify a predominant and strong association between preoperative PRKS and the burden of cartilage damage when evaluated alongside coexisting intra-articular pathological conditions verified by arthroscopy. Our data show that the burden of cartilage damage, as defined by the number of compartments involved, demonstrates the strongest association with preoperative PRKS.

It is prudent to note that our patient population demonstrated a trend toward degenerative pathology. Also, the average patient BMI was 27.9 kg/m², with 79.3% of the patients

having a BMI of ≥25 kg/m^2. Few patients (12.4%) had an unstable meniscal tear pattern, some (21.4%) had no meniscal tear, and many (43.5%) had cartilage damage of the highest Outerbridge grades (3 or 4). Yet these findings regarding overweight BMI category[5-7,10-14,18,25], absent meniscal pathology[25], and more severe or frequent concomitant cartilage damage[2,3,5,6,9,10,12-14,18,19,25] in patients with PRKS are consistent with those of similar studies. We caution that our patient population, much like those in prior studies, demonstrated how nonspecific these classically defined "mechanical" and "meniscal" symptoms are for meniscal pathology. Our findings further question the diagnostic utility of these symptoms, and the use of these symptoms as the indications for knee arthroscopy.

This study has limitations. First, the MCID for each KOOS single line item is not known. The MCID for the KOOS symptom subscales is estimated to be a change of 8 to 10 points out of the 100-point total[29], which equates to a ≥0.32-point difference for each single line item. It is possible that this conversion does not accurately reflect the MCID for each single line item independently or for the MCID of these symptoms in aggregate; however, this value is consistent with estimates provided by recent studies analyzing the MCID of the KOOS questionnaire[34-36]. We acknowledge that arthroscopic surgery has proven clinical success for symptoms associated with isolated meniscal tears—particularly distinct acute/traumatic meniscal tears, such as specific athletic injuries, and large, highly unstable patterns (e.g., bucket-handle tears)—especially in young patients.

All diagnoses were confirmed via direct visualization and probing at the time of arthroscopy by a single surgeon, therefore minimizing the effects of interobserver variation or misclassification of intra-articular pathology. The study population also captures a broad range of severity and variety of knee pathology, including more advanced stages of osteoarthritis as well as acute/traumatic meniscal tears (2 populations principally excluded from previous studies)[5,6,9,12,14], enhancing the generalizability and external validity of our findings.

In conclusion, our study adds strong evidence to refute the current dogma that meniscal pathology is the primary driver of traditionally defined "meniscal" and "mechanical" knee symptoms. Our findings challenge the clinical importance of PRKS in the specific diagnosis of meniscal tears. To our knowledge, the current study is the first to quantify a predominant and strong association between preoperative PRKS and cartilage damage, rather than meniscal pathology, with all diagnoses verified by arthroscopy. Furthermore, we discourage the use of the misleading terms "meniscal symptoms" and "mechanical symptoms" in practice and in research reports and instead favor the specific descriptors for knee symptoms (e.g., "catching/locking" and "grinding/clicking/popping"). In the next phase of this study, we seek to evaluate outcomes of arthroscopic surgery in patients with and without specific PRKS.

Appendix

eA Supporting material provided by the authors is posted with the online version of this article as a data supplement at jbjs.org (http://links.lww.com/JBJS/G274). ■

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