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Previous cartilage surgery is associated with inferior patient-reported outcomes after knee arthroplasty

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Abstract

Purpose: The hypothesis of the present study assumed that a history of focal cartilage lesions would not affect Knee Injury and Osteoarthritis Outcome scores (KOOSs) following knee arthroplasty compared to a matched national cohort of knee arthroplasty patients.

Methods: Fifty-eight knee arthroplasty patients with previous surgery for focal cartilage lesions (cartilage cohort) were compared to a matched cohort of 116 knee arthroplasty patients from the Norwegian Arthroplasty Register (control group). Age, sex, primary or revision arthroplasty, type of arthroplasty (total, unicondylar or patellofemoral), year of arthroplasty surgery and arthroplasty brand were used as matching criteria. Demographic data and KOOS were obtained through questionnaires. Regression models were employed to adjust for confounding factors.

Results: Mean follow-up post knee arthroplasty surgery was 7.6 years (range 1.2–20.3) in the cartilage cohort and 8.1 (range 1.0–20.9) in the control group. The responding patients were at the time of surgery 54.3 versus 59.0 years in the cartilage and control group, respectively. At follow-up the control group demonstrated higher adjusted Knee Injury and Osteoarthritis Outcome subscores than the previous focal cartilage patients with a mean adjusted difference (95% confidence interval in parentheses): Symptoms 8.4 (0.3, 16.4), Pain 11.8 (2.2, 21.4), Activities of daily living (ADL) 9.3 (−1.2, 18.6), Sport and recreation 8.9 (−1.6, 19.4) and Quality of Life (QoL) 10.6 (0.2, 21.1). The control group also demonstrated higher odds of reaching the patient-acceptable symptom state threshold for the Knee Injury and Osteoarthritis Outcome subscores with odds ratio: Symptoms 2.7 (1.2, 6.4), Pain 3.0 (1.3, 7.0), ADL 2.1 (0.9, 4.6) and QoL 2.4 (1.0, 5.5).

Conclusion: Previous cartilage surgery was associated with inferior patient-reported outcomes after knee arthroplasty. These patients also exhibited

For author affiliations, please refer to page 8.

Abbreviations: ADL, Activities of daily living; FCL, focal cartilage lesion; KOOS, Knee Injury and Osteoarthritis Outcome Score; NAR, Norwegian Arthroplasty Register; PASS, patient-acceptable symptom state; PROM, Patient-Reported Outcome Measure; QoL, Quality of Life; TKA, total knee arthroplasty.

significantly lower odds of reaching the patient-acceptable symptom state threshold for the Knee Injury and Osteoarthritis Outcome subscores.

Level of Evidence: Level III.

KEYWORDS
cartilage, focal cartilage lesions, knee arthroplasty, PASS, PROM

INTRODUCTION

Focal cartilage lesions (FCLs) in the knee exhibit poor natural healing capabilities [1] and may significantly reduce quality of life (QoL) [2, 3]. Even in surgically treated FCLs, normal knee function is often not achieved [4]. The risk of knee arthroplasty in the younger FCL patient is greater, regardless of cartilage treatment strategy [5]. In Norway, more than 95% of knee arthroplasties have been reported to the Norwegian Arthroplasty Register (NAR) since 1994 [6]. Previous knee injury, such as FCL, significantly increases the risk of later osteoarthrosis [7, 8].

While knee arthroplasty generally leads to improvements in function and satisfaction, irrespective of the type of implant used [9], a recent meta-analysis [10] found that previous knee surgery is associated with lower patient satisfaction after knee arthroplasty. None of the patients included in that analysis had been treated for FCL. Only a few studies [11, 12], involving a limited number of patients, have reported patient-reported outcomes after knee arthroplasty in individuals with previous FCL. These studies have several limitations such as only including patients treated with microfracture or the inclusion of patients with concomitant meniscal allografts and thus have limited external validity. Consequently, the patient-reported results of knee arthroplasty in patients with previous FCL remain largely unknown. The aim of the present study was thus to examine the patient-reported results of knee arthroplasty following an FCL and compare these results to a matched national cohort of knee arthroplasty patients. The hypothesis posited that prior FCL did not influence patient-reported outcomes after knee arthroplasty.

METHODS

Cartilage cohort

In a previously published long-term follow-up of 322 patients operated between 1999 and 2012 in six Norwegian hospitals with an arthroscopically verified FCL in the knee, 59 patients with subsequent knee arthroplasty were identified [5]. FCL surgeries were performed by experienced cartilage surgeons. The mean duration from FCL surgery to knee arthroplasty was 12.7 years. In one of the patients, insufficient details on the arthroplasty procedure were available, and the patient was excluded from the present study. Consequently, 58 patients with knee arthroplasty following previous FCLs were included.

Control cohort

A matched control group (1:3) from the NAR operated between 1994 and 2020, was recruited, with 174 eligible participants identified. Patients in the NAR registered as deceased, having rheumatoid arthritis, having had a previous FCL or any type of cartilage surgery, or a previous multi-ligamentous injury were excluded prior to matching. The FCL group and the control group were then matched on the following variables: Year of birth (+/−10 years), sex, primary or revision arthroplasty (and cause of revision), type of arthroplasty (total, unicondylar or patellofemoral), year of arthroplasty surgery and brand of the arthroplasty. The inclusion procedure is illustrated in Figure 1. Of the 174 patients found eligible for the control group, 116 (66.7%) consented to participate in the present study. The characteristics of the exposure groups are summarized in Table 1.

Data collection

Each patient in the control group received a questionnaire by post, along with the Knee Injury and Osteoarthritis Outcome Score (KOOS) [13], as this has been validated for both knee arthroplasty and FCL patients [14–16]. The cartilage cohort had previously completed the same questionnaire regarding body height, weight, level of education, knee function, level of activity and any previous knee surgery. The knee arthroplasty patients of both groups had completed their KOOS scores at minimum 1-year postsurgery. The NAR does not contain information on the treating surgeon.

Statistics

Demographic differences between the previous cartilage patients and the control group were assessed using the Student T test and the χ^2 test.

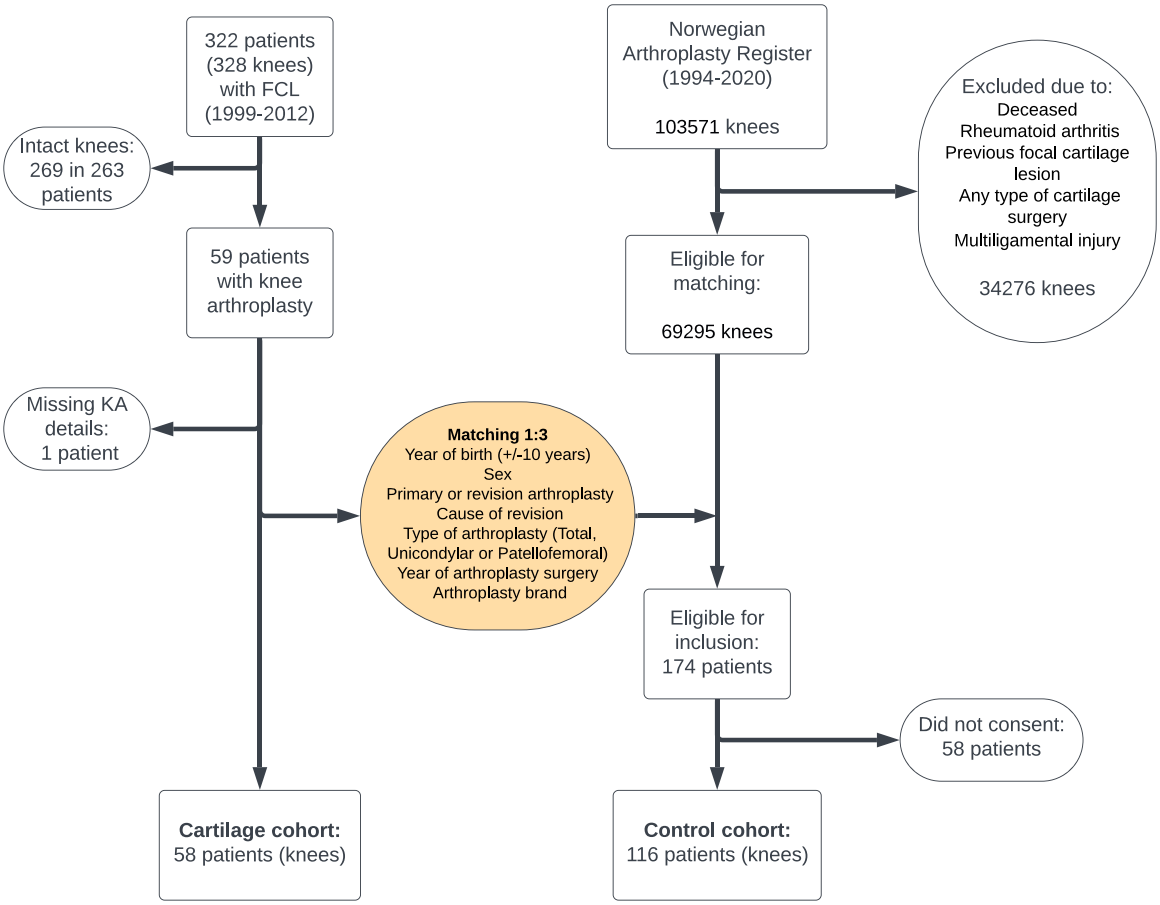

FIGURE 1 Flowchart illustrating the inclusion of participants. FCL, focal cartilage lesion; KA, knee arthroplasty.

Multiple linear regression models were employed to analyse the differences in KOOS subscores between the previous cartilage patients and the patients from the control group. The models were adjusted for the following variables: sex, age at the time of arthroplasty surgery, level of education, primary or revision arthroplasty, type of arthroplasty, body mass index (BMI) group and any additional knee surgery before arthroplasty surgery, except cartilage surgery or purely diagnostic arthroscopy. The continuous variables in the model were evaluated and linear correlations were found.

Logistic regression models were utilized to estimate the odds of not reaching the patient acceptable symptom state (PASS) for each KOOS subscore. These models were adjusted with the same variables as the multiple regression models. The PASS score for KOOS subscores at 3 years follow-up after knee arthroplasty reported by Connelly et al. [17], with a threshold of a KOOS Symptoms score of 84.0, KOOS Pain 87.5, KOOS activities of daily living (ADL) 87.5, and KOOS QoL 66.0 was used. A $p < 0.05$ was regarded as statistically significant. The data were analysed using STATA 17 (StataCorp).

Power analysis

Prior to enrolment, a power analysis was performed. To achieve an 80% chance of detecting a significant difference of 10 points in KOOS subscales between the exposure groups with an assumed standard deviation of 20, 64 patients in each group were required. A 10-point difference was selected as the minimal clinically important difference, as suggested by the developers of the KOOS score [13].

RESULTS

The mean follow-up from the knee arthroplasty to the reporting of KOOS scores by the participants was 7.6 years (range 1.2–20.3) in the cartilage cohort and 8.1 (range 1.0–20.9) in the control group. Osteoarthritis was reported as the indication for the knee arthroplasty surgeries in all participants in the study population. All 11 patients (knees) with patellofemoral or unicompartmental knee arthroplasty had received knee arthroplasty in the same compartment where the previous FCL were located. None of the patients had

TABLE 1 Demographics and descriptive statistics.

	Frequency or mean[a]		
	KA after focal cartilage lesion	Control group	*p*
Knees	58	116	
Male/female	29 (50.0%)/29 (50.0%)	62 (53.5%)/54 (46.6%)	0.7
Right/left knee	32 (55.2%)/26 (44.8%)	110 (94.8%)/6 (5.2%)	<0.001
Age at the time of KA surgery	54.3 (51.6–57.0)	59.0 (57.3–60.7)	0.003
Age at follow-up	61.9 (59.2–64.5)	67.1 (65.4–68.8)	<0.001
Years from arthroplasty surgery to end of study	7.6 (6.1–9.1)	8.1 (7.1–9.0)	0.6
Level of education			
High school	32 (59.3%)	87 (75.7%)	0.03
Bachelor's/Master's degree	22 (40.7%)	28 (24.3%)	0.5
Body mass index (BMI) at follow-up	29.5 (28.3–30.7)	30.0 (29.1–30.9)	
<25	7 (13.4%)	12 (11.0%)	
25–29	26 (50.0%)	55 (50.5%)	0.9
≥30	19 (36.5%)	42 (38.5%)	
Previous ACL reconstruction in ipsilateral knee			
Yes	8 (13.8%)	1 (0.9%)	
No	50 (86.2%)	115 (99.1%)	<0.001
Previous meniscal resection in ipsilateral knee			
Yes	17 (29.3%)	20 (17.2%)	
No	41 (70.7%)	96 (82.8%)	0.04
Previous ipsilateral osteotomy	1 (1.7%)	1 (0.9%)	0.6
Any previous knee surgery except cartilage surgery			
Yes	33 (56.9%)	29 (25.0%)	<0.001
No	25 (43.1%)	87 (75.0%)	
Type of knee arthroplasty			
Unicompartmental	8 (13.8%)	22 (19.1%)	
Patellofemoral	3 (5.2%)	4 (3.5%)	
Total KA	42 (72.4%)	76 (66.1%)	0.7
Total KA with patella	5 (8.6%)	13 (11.3%)	
Primary knee arthroplasty	45 (77.6%)	109 (94%)	0.001
Revision knee arthroplasty	13 (22.4%)	7 (6%)	

Abbreviations: ACL, anterior cruciate ligament; KA, knee arthroplasty.
[a]Percentage or 95% confidence interval in parenthesis.

received focal inlay implants. Patients in the FCL group were significantly younger at the questionnaire follow-up and at the time of knee arthroplasty (Table 1). The FCL cohort had significantly more knees with revision arthroplasties ($p = 0.001$), more previous knee surgeries in addition to the previous cartilage surgery ($p < 0.001$) and a higher level of education ($p = 0.03$). No significant differences between the groups in the distribution of sex, BMI, follow-up time, or type of arthroplasty were observed.

The KOOS subscores for the arthroplasty patients from the cartilage cohort and the control group are presented in

Figure 2. The adjusted results, as presented in Table 2, demonstrated significantly lower scores for KOOS Symptoms (8.4 points, $p = 0.042$), Pain (11.8 points, $p = 0.016$) and QoL (10.4 points, $p = 0.045$) subscores in the cartilage cohort. A sensitivity analysis was performed without adjusting for previous additional surgeries, but otherwise using the same regression models (Supporting Information S1: Table 1). KOOS Symptoms and Pain subscore for the cartilage cohort remained significantly inferior to those of the control group, but QoL was not significantly lower. Given the high number of revision arthroplasties in the cartilage cohort, a sensitivity analysis using the same regression models was performed, but only including the primary knee arthroplasty (Supporting Information S1: Table 2). In addition, a sensitivity analysis only including total knee arthroplasty (TKA) was performed. The results were consistent with the original analysis.

Approximately 65% of the arthroplasty patients with previous FCL failed to reach the PASS thresholds for the KOOS subscores versus 46% in the control group (Table 3). There were significantly higher odds of reaching the PASS threshold in the subscores for KOOS Symptoms Pain and QoL in the control group (Table 3).

DISCUSSION

The principal findings of the present study were that at an average of 8 years following knee arthroplasty, patients with a history of previous cartilage surgery demonstrated significantly lower scores for KOOS Symptoms, Pain and QoL compared to a matched cohort from the NAR. Additionally, there were significantly lower odds of reaching the PASS threshold for the same KOOS subscores in the previous cartilage patients.

Failed FCL surgery with residual symptoms remains a clinical challenge [18]. In the absence of osteoarthritis, resurfacing with mini-implants has gained popularity and is advocated in a recent consensus paper [18]. In the present study, all previous FCL patients were reported to have osteoarthritis by the treating surgeon at the time of knee arthroplasty. Preoperative X-rays were not available to the research group, but the surgeon probably no longer considered the condition to be an FCL, but rather osteoarthritis in one or more compartments of the knee.

In a study of 972 patients from the NAR Lygre et al. [19] reported similar or slightly better KOOS subscores than in the control group in the present study. The tendency towards better KOOS score in their study might be explained by an older patient population (76 years vs. 67 years in the control group in the present study) as younger age has been shown to predict poorer Patient Reported Outcome Measures (PROMs) in knee arthroplasty patients [20]. Furthermore, Lygre et al. only included primary TKAs. Nevertheless, this might suggest that the KOOS subscores in the control group were representative of the average knee arthroplasty patient in Norway.

Several studies have reported no correlation between previous knee surgery and PROM scores in knee

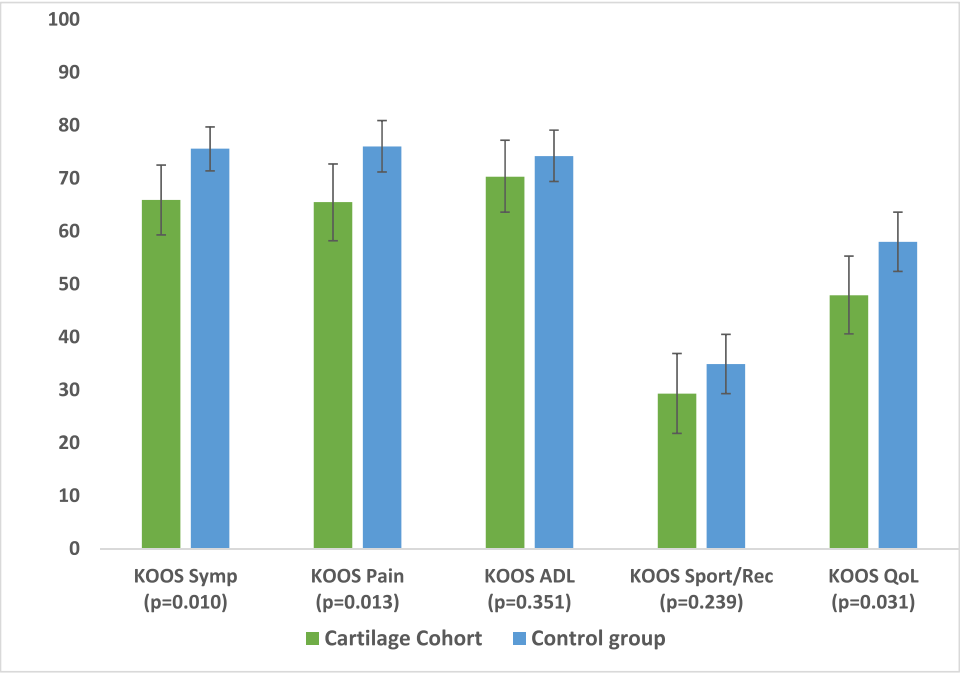

FIGURE 2 KOOS score at final follow-up for the arthroplasty patients from the cartilage cohort and the control group. Mean score with 95% confidence intervals. ADL, activities of daily living; KOOS, Knee Injury and Osteoarthritis Outcome Score; QoL, Quality of Life.

TABLE 2 Difference in KOOS score between the knee arthroplasty patients with previous focal cartilage lesion and the knee arthroplasty patients in the control group.

	Crude		Adjusted[a]	
	Mean difference[b]	*p*	Mean difference[b]	*p*
KOOS Symptoms				
Cartilage cohort	Ref		Ref	
Control group	9.6 (2.3, 16.9)	0.01	8.4 (0.3, 16.4)	0.04
KOOS Pain				
Cartilage cohort	Ref		Ref	
Control group	10.9 (2.5, 19.4)	0.01	11.8 (2.2, 21.4)	0.02
KOOS ADL				
Cartilage cohort	Ref		Ref	
Control group	4.3 (−3.9, 12.6)	0.3	9.3 (−1.2, 18.6)	0.053
KOOS Sport/rec				
Cartilage cohort	Ref		Ref	
Control group	5.5 (−3.7, 14.8)	0.2	8.9 (−1.6, 19.4)	0.1
KOOS QoL				
Cartilage cohort	Ref		Ref	
Control group	10.4 (1.2, 19.6)	0.03	10.6 (0.2, 21.1)	0.045

Abbreviations: ADL, activities of daily living; KOOS, Knee Injury and Osteoarthritis Outcome Score; QoL, Quality of Life.

[a]Adjusted for age at arthroplasty surgery, level of education, primary or revision arthroplasty, sex, type of arthroplasty and previous ipsilateral knee surgery in addition to cartilage surgery.

[b]Mean difference in KOOS score from reference with 95% confidence intervals in parentheses. Negative numbers imply lower mean score than reference.

TABLE 3 The odds of failing to achieve the patient-acceptable symptom state for the KOOS subscores.

		Crude		Adjusted[a]	
	Failures,*n* (%)	OR[b]	*p*	OR[b]	*p*
KOOS Symptoms					
Control group	52 (44.8%)	1		1	
Cartilage cohort	40 (69.0%)	2.7 (1.4, 5.3)	0.003	2.7 (1.2, 6.4)	0.020
KOOS Pain					
Control group	51 (44.0%	1		1	
Cartilage cohort	39 (67.2%)	2.6 (1.4, 5.1)	0.004	3.0 (1.3, 7.0)	0.010
KOOS activities of daily living					
Control group	57 (49.1%)	1		1	
Cartilage cohort	34 (58.6%)	1.5 (0.8, 2.8)	0.239	2.1 (0.9, 4.6)	0.076
KOOS Quality of Life					
Control group	53 (45.7%)	1		1	
Cartilage cohort	38 (65.5%)	2.3 (1.2, 4.3)	0.014	2.4 (1.0, 5.5)	0.041

Abbreviation: KOOS, Knee Injury and Osteoarthritis Outcome Score.

[a]Adjusted for age at arthroplasty surgery, level of education, primary or revision arthroplasty, sex, type of arthroplasty and previous ipsilateral knee surgery in addition to cartilage surgery.

[b]Odds ratio from the regression model with 95% confidence intervals in parentheses.

arthroplasty patients [21–23]. However, a recent meta-analysis by Zhang et al. [24] found that previous knee surgery had a negative effect on postoperative PROMs in knee arthroplasty patients. In the present study, the patients in the cartilage cohort had significantly more surgical procedures in addition to their cartilage surgery than those in the control group. To reduce the risk of these additional procedures confounding the analysis of the KOOS score, the regression models were adjusted for any additional surgical procedures apart from cartilage surgery and purely diagnostic arthroscopy. The sensitivity analysis (Supporting Information S1: Table 1) without this adjustment, also demonstrated inferior results in the cartilage cohort for KOOS Symptoms and Pain, but not for QoL. This supports the findings of Zhang et al. [24].

There were also significantly more revision arthroplasties in the cartilage cohort. Although this variable was part of the matching procedure, a complete match was not achieved due to variations in response rates. The regression models were thus adjusted for primary versus revision arthroplasty. The sensitivity analysis including only primary knee arthroplasty (Supporting Information S1: Table 2) showed equivalent results to the original analysis, indicating that the models adequately adjusted for revision knee arthroplasty.

Significantly lower KOOS Symptoms, Pain, and QoL subscores after knee arthroplasty were demonstrated in the previous cartilage cohort. This concurs with the findings of Ansari et al. [11] in a cohort of 21 previous microfracture patients with a mean 7.8 points lower improvement in the Knee Society Score (KSS) in the cartilage cohort than in a matched group of knee arthroplasty patients. The difference in KSS is, however, below the clinically important difference demonstrated by Lizaur-Utrilla et al. [25]. Ansari et al. [11] did not report any power analysis prior to analysing the KSS results and the power analysis of the present study suggests that the Ansari study was underpowered.

Frank et al. [12] presented 13 knee arthroplasty patients with previous chondral auto/allograft matched 1:1 to a cohort of knee arthroplasty patients with osteoarthritis, finding a mean KSS improvement of 16 points lower in the cartilage cohort. However, they included patients with concomitant meniscal allograft in the cartilage cohort, which could have substantially confounded their results.

This represents the first study of patient-reported results in knee arthroplasty patients with previous cartilage lesions where PASS is reported. Reporting the percentage of patients having reached the PASS threshold offers several advantages, as outlined in a recent review by Mabrouk et al. [26]. It ensures that identified differences are not only statistically significant but also clinically relevant. Significantly better odds of reaching PASS threshold in the control group than in the cartilage cohort for the KOOS Symptoms, Pain and QoL subscores were found, and PASS was not reached by two-thirds of the cartilage cohort. This supports the findings of lower KOOS subscores in the cartilage cohort.

The reason for inferior results in the cartilage cohort remains elusive. However, several explanations for why previous FCLs still seem to result in inferior patient satisfaction after knee arthroplasty surgery could be considered. There is likely to be substantial selection bias in which cartilage patients need a knee arthroplasty. Psychological factors have been shown to influence PROMs [27] and knee arthroplasty patients with failed cartilage surgery might have more psychological issues than the average knee arthroplasty patients. In a recent review by Olsen et al. [28], preoperative pain catastrophizing was associated with worse pain in knee arthroplasty patients. Furthermore, Sellevold et al. [29] found preoperative duration of pain and psychological stress to be associated with less improvement after knee arthroplasty surgery. The cartilage cohort might have experienced a longer duration of knee pain prior to the knee arthroplasty than the control group. One or more FCLs have been shown to alter the knee homeostasis [30], potentially reducing knee function even after a knee arthroplasty.

The main strength of the present study was the high number of included patients with knee arthroplasty after a previous arthroscopically verified and symptomatic FCL in the ipsilateral knee. The follow-up period after knee arthroplasty was mid- to long-term, and several studies have shown stable PROMs from 1 year postoperative in knee arthroplasty patients [31–33]. The previous FCL patients with patellofemoral or unicompartmental knee arthroplasty had received knee arthroplasty in the compartment where the previous FCL was located, suggesting a correlation between the FCL and the subsequent knee arthroplasty. Any additional ipsilateral knee surgery was reported by the participants in the questionnaire, reducing the risk of overlooking any surgery performed at another hospital.

There were several limitations to this study. The necessary number of FCL knees required by the preinclusion power analysis was not met, with a shortfall of six knees. To reduce the risk of an underpowered analysis, an analysis of whether patients' self-reported KOOS subscores were above the PASS threshold was performed.

Only 67% of eligible patients agreed to participate in the present study, potentially introducing bias to the results. Furthermore, radiographs before the knee arthroplasty were not available and there could have been a discrepancy in the degree of osteoarthritis in the FCL group and the control group. However, Dowsey et al. [34] found no association between Kellgren–Lawrence scores and preoperative PROMs in knee arthroplasty patients. Preoperative PROMs were not available, and these are known to be a key factor in determining the postoperative PROM scores [10, 35, 36]. There could have been a discrepancy in the preoperative KOOS scores between the groups. However, several studies have demonstrated

that cartilage patients have similar KOOS QoL subscores to patients awaiting knee arthroplasty [2, 3], indicating that the preoperative PROM in the cartilage cohort might be comparable to those in the control group.

Although the control group was matched, differences in the distribution of age, education level and revision TKA due to uneven response rates were observed. This resulted in unbalanced groups, necessitating adjustment with regression models.

Improvement in function and satisfaction is provided by knee arthroplasty regardless of the type of implant in patients with osteoarthrosis [9]. This seems to be true also in the context of a previous FCL [12]. However, the present study suggests that both surgeons and patients should be aware of lower improvement in PROMs after knee arthroplasty in cases with a history of previous FCL as part of the shared decision making.

CONCLUSION

Previous cartilage surgery was associated with inferior patient-reported outcome after knee arthroplasty at mean 8 years following knee arthroplasty. Patients with previous focal cartilage lesions demonstrated significantly lower KOOS Symptoms, Pain and QoL subscores compared to a matched cohort. The cartilage cohort also had significantly lower odds of reaching the PASS threshold for the same KOOS subscores.

AUTHOR CONTRIBUTIONS

Thomas Birkenes: Conceptualization; methodology; formal analysis; writing—original draft. **Håvard Visnes:** Conceptualization; writing—editing; supervision. **Ove Furnes:** Conceptualization; methodology; writing—editing. **Asbjørn Årøen:** Conceptualization; resources; writing—editing; funding acquisition. **Stein Håkon Låstad Lygre:** Methodology; formal analysis; writing—editing. **Eirik Solheim:** Resources; writing—editing. **Gunnar Knutsen:** Resources; writing—editing. **Jon Olav Drogset:** Resources; writing—editing. **Stig Heir:** Resources; writing—editing. **Lars Engebretsen:** Resources; writing—editing. **Sverre Løken:** Resources; writing—editing. All authors have read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

Gunnar Knutsen, Lars Engebretsen and Jon Olav Drogset are editorial board members of KSSTA. The remaining authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy and ethical restrictions. Any request would, however, need to be approved by the Data Protection officer at Haukeland University Hospital.

ETHICS STATEMENT

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Regional Ethics Committee (2017/1387). All participants have provided informed consent prior to inclusion.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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