Better Outcomes but No Difference in Joint Space Narrowing at Five Years Among Patients Without Unstable Chondral Lesions Versus Those With Unstable Chondral Lesions (Left In Situ) at the Time of Arthroscopic Partial Meniscectomy

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Purpose: To compare 5-year outcomes among patients with and without unstable chondral lesions undergoing arthroscopic partial meniscectomy (APM). **Methods:** Using data from the Chondral Lesions And Meniscal Procedures (ChAMP) Trial, we compared outcomes for patients with unstable chondral lesions found at the time of APM and left in situ (CL-noDeb, N = 71) versus patients without unstable chondral lesions (NoCL, N = 47) at 5 years after APM. Outcomes included the Western Ontario and McMaster Universities Arthritis Index (WOMAC), Knee Injury and Osteoarthritis Outcome Score (KOOS), visual analog pain scale, Short-form Health Survey (SF-36), physical knee measurements, progressive joint space narrowing on radiographs, and the rate of additional knee surgery. Multivariate linear regression was used to obtain mean differences (MDs) with corresponding 95% confidence intervals (CIs) adjusted for age, body mass index, and preoperative score (for postoperative scores). **Results:** Compared with CL-noDeb, NoCL subjects had significantly greater improvement at 5 years in the KOOS score for function in sport and recreation (MD = 9.9 [95% CI, 0.7-19.1]), SF-36 pain (MD = 13.9 [95% CI, 5.5-22.3]), knee extension (MD = 0.8 [95% CI, 0.1-1.5]), and decreased quadriceps circumference at the mid-portion of the patella (MD = −1.5 [95% CI, −2.7 to −0.3). A greater proportion of patients in the NoCL group achieved the MCID for all outcome scores except for the WOMAC pain score (89% CL-NoDeb vs 87% NoCL) and SF-36 general (29% CL-NoDeb vs 23% NoCL). There were no significant group differences in measures of progressive radiographic joint space narrowing in any compartments of the operative knee and no significant difference in the rate of additional knee surgery within 5 years of the initial APM. **Conclusions:** Patients undergoing APM without unstable chondral lesions had statistically significantly better outcomes than patients with unstable chondral lesions at 5 years after surgery; however, there were no group differences in progressive radiographic joint space narrowing. **Level of Evidence:** Level II, prospective comparative study.

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Arthroscopic partial meniscectomy (APM) for degenerative meniscal tears is commonly performed after failure of nonoperative management, despite evidence that APM is not more effective than sham surgery or exercise therapy for these types of tears.[1-3] There is also increasing evidence that the greater the degree of osteoarthritis at the time of APM, the worse patient reported outcomes may be.[4-6] At the time of APM, about 69% of patients have comorbid chondral lesions that historically have been debrided, although recent evidence from the Chondral Lesions And Meniscus Procedures (ChAMP) Trial suggests that debridement may not be effective for treating unstable chondral lesions.[7-11] Progression of radiographic knee osteoarthritis after APM has been observed in 39.6% of patients.[12]

The ChAMP Trial compared the outcomes of debridement versus observation of unstable chondral lesions encountered during APM.[13] To summarize, subjects were over 30 years of age with symptomatic meniscal tears without radiographic evidence of osteoarthritis in whom at least 3 months of nonoperative management had failed. Subjects with unstable chondral lesions were randomized during surgery to receive debridement (CL-Deb) or observation of unstable chondral lesions (CL-noDeb) encountered during APM; and since unstable chondral lesions could not be confirmed until arthroscopy, subjects with normal chondral surfaces or very minor chondral damage (NoCL) were also enrolled. Comparing this NoCL group to the CL-noDeb group created a unique opportunity to study the effect of unstable chondral lesions on outcomes after APM. At 1 year after APM, the NoCL group had better outcomes than the CL-noDeb group.[14]

For the current study, we performed the same comparisons at 5 years' follow-up. Additionally, we obtained weightbearing knee radiographs to identify differences in joint space narrowing. The primary objective of this study was to compare 5-year outcomes among patients with and without unstable chondral lesions undergoing APM. We hypothesized that patients without unstable chondral lesions would have better clinical outcomes, less joint space narrowing, and lower rates of additional knee surgery than those with unstable chondral lesions at 5 years after APM.

Methods

Study Design

The ChAMP Trial is a parallel (1:1) double-blind randomized controlled trial that investigated the effect of debridement of unstable chondral lesions on pain among patients undergoing APM. The study design and procedures have been published previously in more detail.[13] This study is registered at Clinicaltrials.gov and was approved by our university's institutional review board.

Sample Selection and Group Assignment

Patients were screened and enrolled at a single university by 6 sports medicine fellowship–trained orthopaedic surgeons between January 2012 and April 2015. Preoperative inclusion criteria were age $\geq$ 30 years, persistent meniscal tear symptoms for at least 3 months, magnetic resonance imaging–confirmed meniscal tear, and elected to undergo APM. Intraoperative inclusion criteria for randomization to debridement versus observation of unstable chondral lesions were the presence of a tear of 1 or more menisci and at least 1 unstable chondral lesion. Based on consensus methods, the study surgeons defined unstable chondral lesions as those >1 cm^2 with either flaps that could be displaced >5 mm with a probe or containing fibrillated cartilage involving 50% or greater of the depth of the cartilage.[7] Exclusion criteria were osteochondritis dissecans, radiographic evidence of osteophytes or >50% joint space loss, previous knee surgery or trauma, inflammatory joint disease, chondrocalcinosis, gout, significant ligamentous instability, major neurologic deficit, serious medical illness with limited life expectancy or a high intraoperative risk, pregnancy, worker's compensation claim, absence of meniscal tear during arthroscopy, large chondral flaps judged to be impending loose bodies (owing to surgeon concerns that these would break off after surgery and become symptomatic), grade 4 chondral lesions of the patellofemoral compartment >4 cm^2 (based on the difficulty in determining whether the patient's pain generator was the meniscus rather than arthritis), undergoing meniscal repair, microfracture for contained grade 4 chondral lesions, and root avulsion tears of either meniscus.

Patients with unstable chondral lesions identified during arthroscopy were randomly assigned to CL-Deb or CL-noDeb in a 1:1 ratio via a random number generator. A study coordinator with no other involvement in this trial developed the randomization scheme, which was stratified per surgeon in a 1:1 allocation sequence based on random blocks of 2 and 4. A sealed envelope was opened during surgery by the circulating nurse and contained an index card with the treatment allocation written on it. Patients found at surgery to have normal chondral surfaces or with minimal, stable chondral lesions that would not normally be debrided (i.e., grade 1-2 lesions) were included in the NoCL comparison group. Patients and data collectors were blind to treatment assignment and intraoperative findings until 1 year from surgery.

Intervention

APM of the medial, lateral or both menisci was performed on all patients, at which time the articular cartilage was examined. Patients with unstable chondral lesions were randomized to CL-Deb or CL-noDeb. For the CL-Deb group, unstable chondral flaps or fibrillated cartilage was excised with a motorized shaver. No bony debridement or microfracture was performed for any grade 4 lesions. For the CL-noDeb group, chondral lesions were left in situ. No surgical management of chondral lesions was necessary for the NoCL group. Patients received an intra-articular injection of 20 mL of 0.5% bupivacaine at the end of surgery, which is standard procedure for our practice. All patients received a prescription at the time of discharge for Lortab (acetaminophen/hydrocodone, 7.5 mg, or 1 to 2 doses by mouth, twice a day, as needed) and the same order for physical therapy formulated to reduce effusion, regain full range of motion, and progressive strengthening.

Outcome measures

Outcome measures included the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC; pain, stiffness and function scores), Knee Injury and Osteoarthritis Outcome Score (KOOS; pain, symptoms, sports and recreation, and quality-of-life scores), pain visual analog scale (VAS), Short Form Health Survey (SF-36), and physical knee measures (range of motion, quadriceps circumference, and effusion). WOMAC and KOOS scores were both collected to increase applicability. Outcome scores ranged from 0 (extreme problems) to 100 (no problems) for the WOMAC and KOOS, 0 (no knee pain within the past 24 hours) to 10 (worst possible knee pain within the past 24 hours) for the pain VAS, and 0 (lowest level of functioning) to 100 (highest level of functioning) for the SF-36. Range of motion was measured in degrees of extension, degrees short of neutral extension, and degrees of flexion. Knee circumference was measured in centimeters at the midportion of the patella and quadriceps circumference at 10 cm proximal to the superior pole. Knee effusion was also assessed in terms of presence (yes/no) and severity (mild, moderate, severe).

Knee Radiographs and Additional Knee Surgery

Weight-bearing radiographs with bilateral anteroposterior (AP) views, bilateral patellofemoral views, and lateral views were obtained preoperatively and at 5 years after surgery. Two trained sports medicine fellows independently measured the joint space (mm) in all compartments of the knee (medial and lateral tibiofemoral at the center of the respective compartment on the AP weightbearing view and posteroanterior flexed weightbearing view; and medial, central, and lateral patellofemoral in the center of the respective region on the patellofemoral view). Joint-space narrowing in each compartment or patellofemoral region was obtained by subtracting the postoperative from the preoperative value. We also queried patients about whether they had undergone additional surgery on the affected knee, as well as the contralateral one, since completing their 1-year follow-up assessment.

Assessments

Outcomes were originally assessed preoperatively and in the office at 8-12 days, 6 weeks ± 5 days, 3 months ± 2 weeks, 6 months ± 2 weeks, and 1 year ± 1 months after APM (2012-2016). All study patients were invited back into the office for a 5 year ± 1 year assessment between 2017 and 2019 and, when interested, provided their informed consent. Assessors were blind to treatment assignment at all time points up to 5 years; however, patients were unblinded at 1 year when the initial study was complete. For the current study, all outcomes were primarily assessed at 5 years after surgery, and earlier time points were assessed secondarily to examine the overall trend in outcomes.

Statistical Analysis

The *t*-test for continuous data and the χ^2 test (or Fisher's exact test) were used to derive the *P* value for comparisons between the NoCL and CL-noDeb groups. Group comparisons of continuous data were done with unadjusted *t*-tests and multiple linear regression, and group comparisons of categorical data were done with unadjusted and adjusted logistic regression. Linear and logistic regression models were adjusted for age and body mass index (BMI) because there was a statistically significant group difference for these factors. Also, the preoperative outcome measure was adjusted for group comparisons of each corresponding postoperative outcome measure (e.g., preoperative WOMAC pain score was adjusted for in the analysis comparing postoperative WOMAC pain scores). As an exploratory analysis, data from the CL-Deb and CL-noDeb groups were combined and compared to the NoCL group to confirm the consistency of our findings. This was done to determine whether there were any differences that were right around or just under our chosen clinically important difference of 10 points on the outcome scores, as well as to identify any possible radiographic trends that may be a target of future study.

The rate of loss to follow-up was 20% in the CL-noDeb group and 30% in the NoCL group. We initially did a complete case analysis and then repeated the analysis after implementing the multiple imputation technique for missing outcomes data.[15,16] Multiple imputation uses the distribution of the observed data to estimate multiple values that reflect the uncertainty around the true value to fill in the missing outcomes data. The dataset was imputed 5 times, and each of the multiple "imputed" complete datasets was analyzed separately, and the final analysis combined the results from each analyzed dataset. The results of the analysis were not substantially changed after multiple imputation, so adjusted mean differences (MD) and *P* values are presented for the complete case analysis only. The minimum clinically important difference (MCID) was also calculated for outcomes using the distribution-based method (i.e., MCID was equal to half of the standard deviation of the 5-year change score for each outcome), and the proportion of patients meeting the MCID was also calculated.

Radiographic measures of joint space narrowing were obtained from 2 raters and the average of their measurements was obtained. Inter-rater reliability was evaluated with intraclass correlation coefficients. The 5-year difference in radiographic measures was obtained by subtracting the postoperative from the preoperative value. Group comparisons of the 5-year difference in radiographic measures was obtained from 2-sample *t*-tests. The Fisher's exact test was used to compare the rates of additional surgery on the affected and contralateral knees between the CL-noDeb and NoCL groups. A post hoc power analysis revealed that we had 98% power to detect a 10-point difference in the WOMAC (SD = 14). All analyses were done with SAS version 9.4 (SAS Institute, Cary, NC).

Results

Characteristics of the Study Sample

Of the 92 patients who were randomized to CL-noDeb, 2 were deceased and 19 were lost to follow-up at 5 years after surgery, leaving 71 patients for analysis. Of the 68 patients included in the NoCL group, 21 were lost to follow-up at 5 years after surgery leaving 47 patients for analysis (Fig 1). As shown in Table 1, the NoCL group was younger ($P = .01$), weighed less ($P = .02$), had a lower BMI ($P = .006$), was less likely to be obese ($P = .01$), and more likely to have injured their right knee ($P = .04$) than the CL-noDeb group. Characteristics of meniscal tears and chondral lesions can be found in Appendix Tables A1 and A2, respectively.

Outcome Scores at Five-Year Follow-up

There were no group differences in WOMAC pain, stiffness, and physical function scores (Fig 2), as well as no group difference in VAS pain (Table 2). The NoCL group improved more on the KOOS sport and recreation score than the CL-noDeb group (MD = 9.9 [95% CI, 0.7-19.1]), however there were no group differences in the KOOS pain, other symptoms, and quality of life scores (Appendix Figures A1-A4). There was also greater improvement on SF-36 pain for the NoCL versus CL-noDeb groups (MD = 13.9 [95% CI, 5.5-22.3]); however, there were no group differences in SF-36 physical functioning or general health scores (Appendix Table A3). The NoCL group demonstrated greater degrees of knee extension than the CL-noDeb group (MD = 0.8 [95% CI, 0.1-1.5]); however, there were no group differences in degrees short of neutral extension, and degrees of flexion (Appendix Table A4). As shown in Appendix Table A5, quadriceps circumference was decreased at the midportion of the patella for the NoCL versus CL-noDeb groups (MD = −1.5

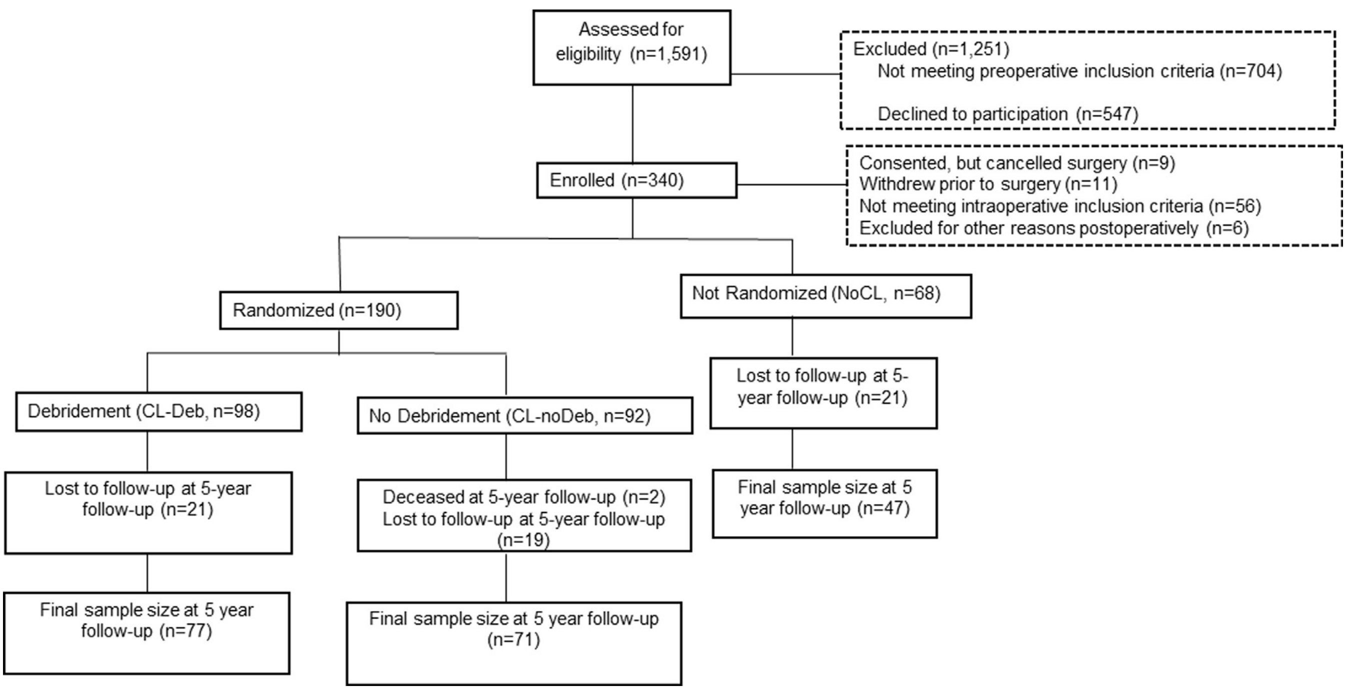

Fig 1. The ChAMP Trial sample flowchart.

Table 1. Demographics of the Patients Who Completed the Chondral Lesions and Meniscal Procedures Trial 5-Year Assessment (n = 118): CL-noDeb Versus NoCL

	CL-noDeb, N = 71)		NoCL, N = 47)		
Demographics and Baseline Measures	N Missing	Statistic	N Missing	Statistic	*P* Value*
Age (y), mean ± SD	0	54.1 ± 7.5	0	50.2 ± 8.6	.01
Sex, no. (%)	0		0		.54
Male		46 (64.8)		33 (70.2)	
Female		25 (35.2)		14 (29.8)	
Weight (lbs), mean ± SD	1	202.8 ± 46.8	0	182.3 ± 38.2	.02†
Body mass index, continuous (kg/m^2), mean ± SD	1	29.8 ± 4.9	0	27.3 ± 4.3	.006
Body mass index, categories, no. (%)	1		0		.01†
Underweight (<18.5 kg/m^2)		1 (1.4)		0 (0.0)	
Normal weight (18.5-24.99 kg/m^2)		9 (12.9)		15 (31.9)	
Overweight (25-29.99 kg/m^2)		25 (35.7)		20 (42.6)	
Obese (≥30 kg/m^2)		35 (50.0)		12 (25.5)	
Injured knee, no. (%)	0		0		.04
Right		33 (46.5)		31 (66.0)	
Left		38 (53.5)		16 (34.0)	

CL-noDeb, No Chondral Debridement; NoCL, No Chondral Lesion.
*For continuous data, *P* values were obtained from *t* tests. For categorical data, *P* values were obtained from χ^2 or Fisher's exact test.
†One outlier for weight (420 lbs) was excluded from group comparisons (calculating *P* value).

[95% CI, −2.7 to −0.3]). There were no group differences in the presence or severity of knee effusion (Appendix Tables A6, A7).

MCID for Outcomes

The MCID values for the CL-noDeb and NoCL groups are presented in Appendix Table A8. The proportion of patients that achieved the MCID for WOMAC pain score was slightly higher for the CL-noDeb (89%) versus NoCL (87%) groups. A greater proportion of patients in the NoCL group achieved the MCID for all other outcome scores compared to the CL-noDeb group, except for SF-36 general.

Knee Radiographs

Inter-rater reliability was found to be moderate to excellent for most radiographic measures of joint space narrowing (Appendix Table A9). We compared the mean 5-year difference in joint space narrowing for all compartments of the operative and nonoperative knees (medial and lateral tibiofemoral; medial, central, and lateral patellofemoral) between the NoCL and CL-noDeb groups (Appendix Table A10). For the medial tibiofemoral AP view on the nonoperative side, the mean 5-year difference in joint space narrowing was lower for the NoCL versus CL-noDeb groups (*P* = .01). There were no other statistically significant group differences; however, there was a trend toward the CL-noDeb group having increased joint space narrowing.

Additional Knee Surgery

As shown in Fig 3, there was no difference in the overall rate of additional surgery on the affected (*P* = .05) and contralateral (*P* = .14) knee for the NoCL group versus the CL-noDeb group at 5 years' follow-up. Eleven percent of the CL-noDeb group had undergone total or unicompartmental knee arthroplasty by 5 years' follow-up versus none in the NoCL group.

Exploratory Analysis

The results remained the same after combining the CL-noDeb and CL-Deb groups (data not shown), although a few additional findings are noted here. Compared to the CL-noDeb+CL-Deb groups, the NoCL group improved more on the KOOS pain score (MD = 5.6 [95% CI, 0.2-10.9]), KOOS function in sport and recreation (MD = 10.5 [95%, 2.3-18.8]), KOOS quality of life score (MD = 8.1 [95% CI, 0.3-15.9]), SF-36 pain score (MD = 12.3 [95% CI, 5.1-19.5]), and degrees of extension (MD = 0.8 [95% CI, 0.2-1.4]). Quadriceps circumference was decreased at the mid-portion of the patella for the NoCL versus CL-noDeb+CL-Deb groups (MD = −1.4 [95% CI, −2.5 to −0.3). The NoCL group was more likely to achieve the MCID for WOMAC pain and for most other outcome measures compared to the CL-noDeb+CL-Deb groups. Based on the patellofemoral central radiographs on the operative side, the mean 5-year difference in joint space narrowing was less for the NoCL group versus the CL-noDeb+CL-Deb groups (*P* = .04). Based on both the medial tibiofemoral AP radiographs on the operative and nonoperative side, the mean 5-year difference in joint space narrowing was less for the NoCL group versus the CL-noDeb+CL-Deb groups ($P_{operative}$ = .04, $P_{nonoperative}$ = .01). There was no difference in the rate of additional knee surgery on the affected (0% vs 9% arthroplasty, *P* = .09) and contralateral (0% vs 7% arthroplasty, *P* = .29) knee for the NoCL group versus the CL-noDeb+CL-Deb groups.

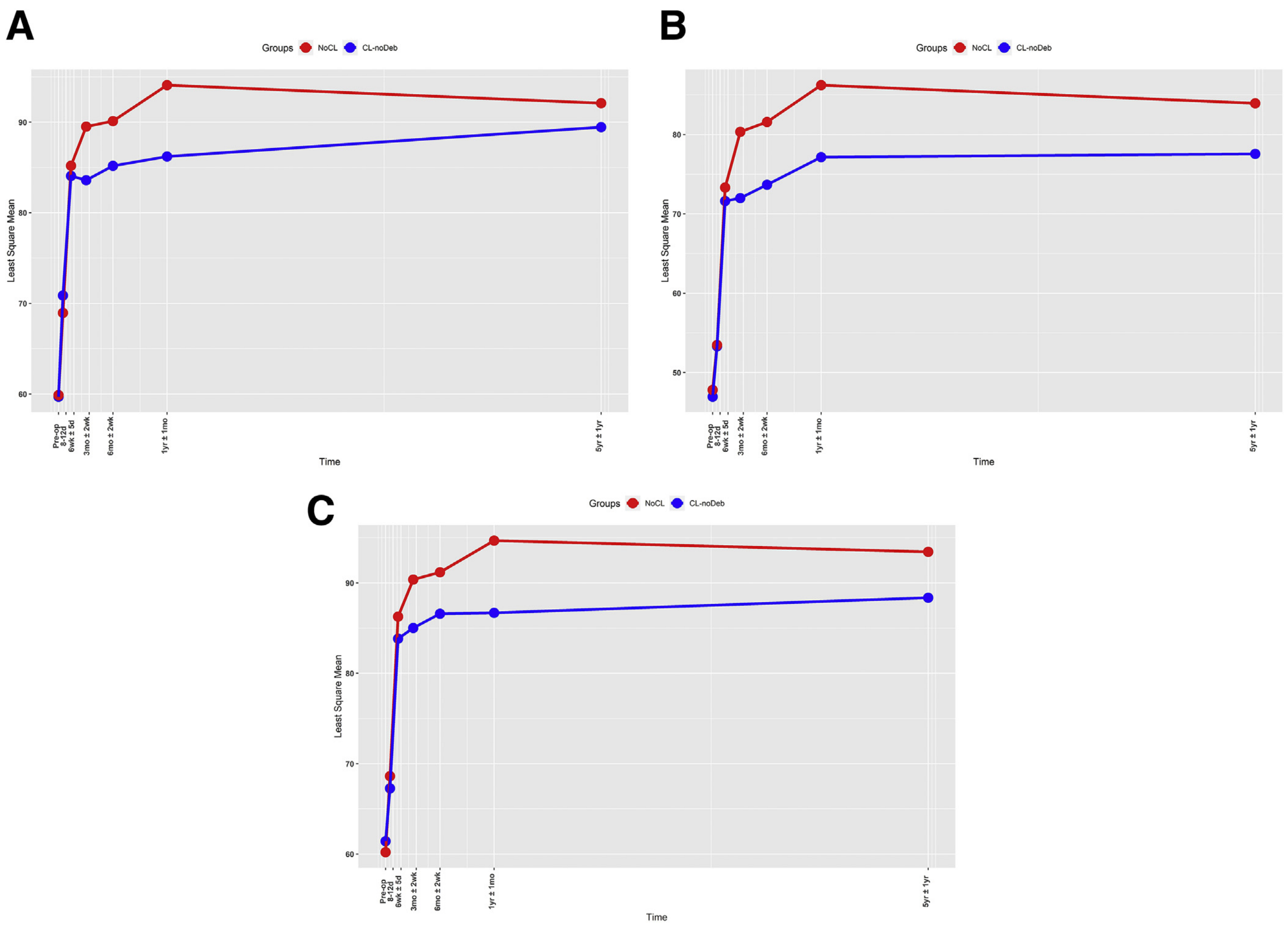

Fig 2. (A) The mean difference between the no unstable chondral lesions (NoCL) and chondral lesions with no debridement (CL-noDeb) groups in Western Ontario and McMaster Universities Arthritis Index (WOMAC) pain scores (with imputation for missing data and adjusted for age, body mass index, and the preoperative measurement). There was a significant difference at 3 months ($P = .01$) and 1 year ($P = .003$). (B) The mean difference between the NoCL and CL-noDeb groups in WOMAC stiffness scores (with imputation for missing data and adjusted for age, body mass index, and the preoperative measurement). There was a significant difference at 3 months ($P = .02$), 6 months ($P = 0.04$), and 1 year ($P = .01$). (C) The mean difference between the NoCL and CL-noDeb groups in WOMAC function scores (with imputation for missing data and adjusted for age, body mass index, and the preoperative measurement). There was a significant difference at 3 months ($P = .02$), 6 months ($P = .04$), and 1 year ($P = .002$).

Discussion

We found that patients with normal chondral surfaces demonstrated greater improvement in function, pain and range of motion than those with unstable chondral lesions. However, there was no 5-year group differences in radiographic tibiofemoral joint space narrowing and the overall rate of additional knee surgery, although more arthroplasties were performed in the CL-noDeb group.

We found that patients in the NoCL group had greater improvement in knee function, pain, degrees of extension, and decreased quadriceps circumference at 5 years after APM compared to patients in the CL-noDeb group. These findings provide support for our hypothesis, and we suspect that decreased quadriceps circumference was likely due to decreased BMI in the NoCL group. A previous study of the ChAMP trial found that patients without unstable chondral lesions had more improvement in knee symptoms, function, quality of life, increased flexion, and decreased quadriceps circumference at 1 year after APM compared to patients with unstable chondral lesions.[14] Furthermore, patients tend to have good outcomes at least 5 years after APM; however, Matsusue et al.[17] found that patients with grades III or IV chondral damage tended to do worse than patients with grade I or II chondral damage.[18] Two studies have found that female patients, as well as patients with radiographic knee osteoarthritis (OA) tend to have worse symptoms and function at 4 to 10 years after APM.[19,20]

Table 2. Comparison of Pain Visual Analogue Scale Scores Between the CL-noDeb and NoCL Groups by Study Visit

	No. with Data	Unadjusted Mean Group Difference (95% Confidence Interval)*,†	*P* Value	Adjusted Mean Group Difference (95% Confidence Interval)†,‡	*P* Value
Preoperative Measurement	157	−0.3 (−0.9, 0.4)	.45	0.1 (−0.6, 0.8)	.72
Postoperative Measurements					
8-12 days	151	−0.3 (−0.9, 0.4)	.42	−0.2 (−0.8, 0.4)	.55
6 weeks ± 5 days	144	−0.1 (−0.7, 0.5)	.79	−0.03 (−0.6, 0.5)	.91
3 months ± 2 weeks	138	−0.6 (−1.1, −0.04)	.04	−0.5 (−1.1, 0.05)	.07
6 months ± 2 weeks	135	−0.7 (−1.4, 0.03)	.06	−0.7 (−1.4, −0.04)	.04
1 year ± 1 month	126	−0.5 (−1.1, 0.9)	.10	−0.6 (−1.2, 0.04)	.07
5 year ± 1 year	114	−0.3 (−0.8, 0.2)	.27	−0.4 (−0.9, 0.1)	.16

CL-noDeb, No Chondral Debridement; NoCL, No Chondral Lesion.
*The *t*-tests were used for unadjusted analyses.
†The mean difference is equal to the mean outcome score in the NoCL group minus the mean outcome score in the CL-noDeb group.
‡Multivariate linear regression was used with adjustment for age and body mass index at all study visits. For comparisons of the postoperative measurements, the regression model was also adjusted for the preoperative measurement.

Knee OA has been found to progress over time after APM,[21] and although we found no differences in joint space narrowing, in any compartment of the knee, between patients without unstable chondral lesions versus those with chondral lesions, we did not have a sufficient sample size to examine this association stratified by location of chondral lesion or meniscal tear. Several previous studies have examined knee OA after APM, but the definition and measurement of knee OA has varied among studies.[18,22-24] One study found that preexisting chondromalacia was more often associated with knee OA at 5 years after APM.[22] Covall et al.[18] found that 39% of patients had no progression of radiographic knee OA based on the Fairbanks criteria, while 46% had a 1-grade change and 15% had a 2- or more grade change. Based on a study by Kruger-Franke et al.,[23] 33% of 100 patients had progression of knee OA at least 7 years after APM in patients with no intra-articular lesions at the time of surgery aside from minimal chondral damage (Outerbridge grade 2). Allen et al.[24] studied 217 patients at an average of 17 years after APM and found that 18% had radiographic joint degeneration and 7% had signs and symptoms of knee OA.[6,25]

We report the rate of unicompartmental and total knee arthroplasty for patients without unstable chondral lesions (0%) versus those with chondral lesions (11.3%) but could not formally compare the 2 groups because the NoCL group had 0 arthroplasty events. The CL-noDeb group may have been more likely to convert to TKA because this group was older and had higher weight and BMI compared to the NoCL group, as age and increased BMI have been found to be risk factors for osteoarthritis after APM.[4] Because of this, we adjusted our analysis for age and BMI to control for the possible confounding effects of these variables. Other

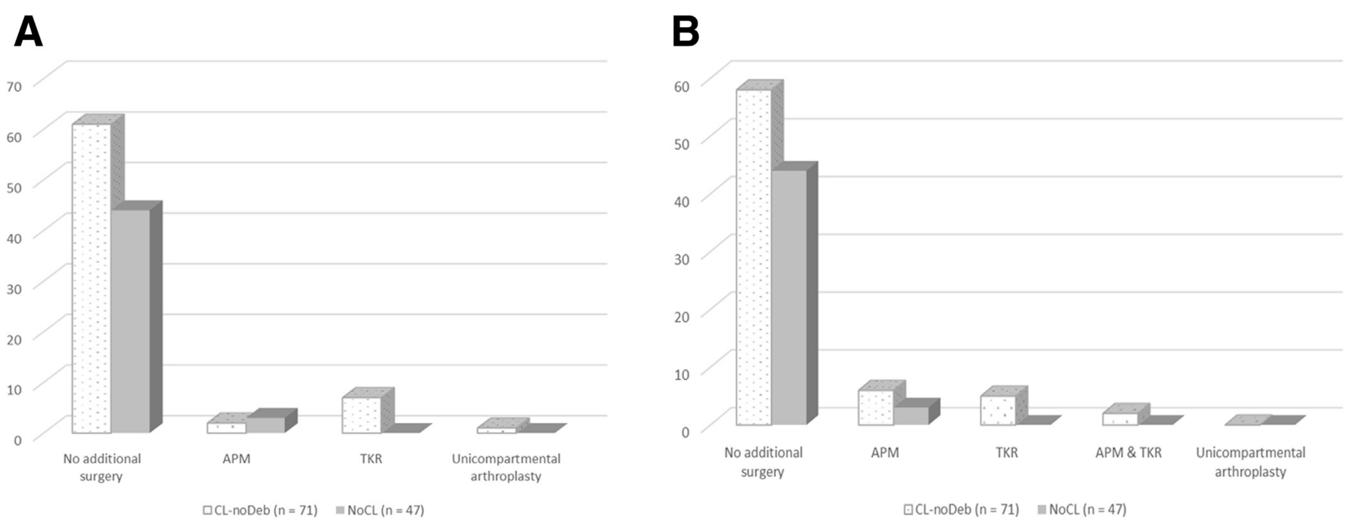

Fig 3. (A) Additional surgery on the affected knee by study group. There was no significant difference in the frequency of additional surgery between the groups at 5 years ($P = .05$). (B) Additional surgery on the contralateral knee by study group. There was no significant difference in the frequency of additional surgery between the groups at 5 years ($P = .14$).

studies have reported higher rates of conversion to total knee arthroplasty between 1 to 9 years after APM ranging from 14% to 19%; however, these studies included more patients (>300).[26,27] Previous research has shown that the likelihood of having a total knee arthroplasty is 5 to 15 times greater for patients who previously underwent APM compared with those who did not, although these studies did not examine the effect of unstable chondral lesions at the time of APM.[28-31] Interestingly, our study found that no patients without unstable chondral lesions underwent total knee arthroplasty within 5 years of APM, which may simply be due to their degenerative joint disease being less advanced. Longer-term outcomes are needed to further elucidate this finding. We also found similar rates of arthroplasty in the operative and nonoperative knees when the CL-NoDeb and CL-Deb groups were pooled, with 9% of knees undergoing arthroplasty on the APM side versus 7% on the nonoperative side. Rodriguez-Merchan et al.[26] found that the greatest predictor of conversion to total knee arthroplasty after APM was higher Kellgren-Lawrence grade for knee OA.

The strengths of this study include random treatment assignment, the use of valid and reliable outcome measures, and clinical and radiographic evaluation at 5 years. We had a high response rate of 74% at 5 years after APM. Furthermore, we verified the results of this study by comparing the pooled outcomes of the CL-noDeb+CL-Deb groups with those of the NoCL group and found no substantial differences in the results.

Limitations

There are several limitations of this study. Patients were unblinded to treatment allocation at 1 year after surgery; however, they were not reminded of their treatment allocation at 5-year follow-up in an effort to minimize subject recall bias. Postoperative knee radiographs were obtained in standard fashion at our facility; however, preoperative imaging was performed at various facilities. Therefore random measurement error may have occurred as a result of variations in equipment and the skill level of the radiology technicians. Although inter-rater reliability of the radiographic measures was moderate to excellent, we did not assess intrarater reliability. Additionally, some measures of joint-space narrowing (particularly the patellofemoral joint) were negative to a small degree, which was likely due to variation in the technique used to obtain the radiographs. Selection bias may have occurred because patients with normal chondral surfaces were younger and weighed less than those with unstable chondral lesions; however, our analyses were adjusted to control for confounding effects of these variables. The findings of this study may not be generalizable to worker's compensation cases and patients with radiographic evidence of degenerative joint disease, because these were exclusion criteria. We observed 20% to 30% loss to follow-up in each group at 5 years; however, this is comparable to the rate of loss to follow-up (24%) a recent 5-year follow-up study for a randomized controlled trial that compared operative and nonoperative treatment for degenerative meniscus tear.[30] Last, this was a secondary analysis and not designed to evaluate the associations examined in the current study. However, a power analysis using the actual data from our study showed 98% power to detect a 10-point difference in the WOMAC.

Conclusions

In conclusion, patients undergoing APM without unstable chondral lesions had statistically significantly better outcomes than patients with unstable chondral lesions at 5 years after surgery; however, there were no group differences in progressive radiographic joint space narrowing.

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