Original Article

Medial Patellofemoral Ligament Reconstruction in Obese Patients Results in Low Complication Rates and Improved Subjective Outcomes

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Purpose: To compare outcomes, activity scores, and complication rates of obese and non-obese patients undergoing medial patellofemoral ligament (MPFL) reconstruction. **Methods:** A retrospective review identified patients undergoing MPFL reconstruction for recurrent patellofemoral instability. Patients were included if they had undergone MPFL reconstruction and had follow-up for a minimum of 6 months. Patients were excluded if they underwent surgery less than 6 months earlier, had no outcome data recorded, or underwent concomitant bony procedures. Patients were divided into 2 groups based on body mass index (BMI): BMI of 30 or greater and BMI less than 30. Presurgical and postsurgical patient-reported outcomes including Knee Injury and Osteoarthritis Outcome Score (KOOS) domains and the Tegner score were collected. Complications requiring reoperation were recorded. $P < .05$ was defined as a statistically significant difference. **Results:** A total of 55 patients (57 knees) were included. There were 26 knees with a BMI of 30 or greater and 31 knees with a BMI less than 30. There were no differences in patient demographic characteristics between the 2 groups. Preoperatively, no significant differences were found in KOOS subscores or Tegner scores ($P = .21$) between groups. At minimum 6-month follow-up (range, 6.1-70.5 months), patients with a BMI of 30 or greater showed statistically significant improvements in the KOOS Pain, Activities of Daily Living, Symptoms, and Sport/Recreation subscores. Patients with a BMI less than 30 showed a statistically significant improvement in the KOOS Quality of Life subscore. The group with a BMI of 30 or greater had significantly lower KOOS Quality of Life (33.34 ± 19.10 vs 54.47 ± 28.00, $P = .03$) and Tegner (2.56 ± 1.59 vs 4.78 ± 2.68, $P = .05$) scores. Complication rates were low, with 2 knees (7.69%) requiring reoperation in the cohort with a BMI of 30 or greater and 4 knees (12.90%) requiring reoperation in the cohort with a BMI less than 30, including 1 reoperation for recurrent patellofemoral instability ($P = .68$). **Conclusions:** In this study, MPFL reconstruction in obese patients was safe and effective, with low complication rates and improvements in most patient-reported outcomes. Compared with patients with a BMI less than 30, obese patients had lower quality-of-life and activity scores at final follow-up. **Level of Evidence:** Level III, retrospective cohort study.

Patellar dislocations constitute 2% to 3% of all knee injuries.[1,2] The yearly risk of a primary patellar dislocation is 5.8 per 100,000.[3] After patellar dislocation, the resultant pathologic laxity of the medial patellofemoral ligament (MPFL) is a frequent contributor to recurrent lateral patellofemoral instability.[4,5] MPFL reconstruction in isolation has shown good clinical outcomes and low recurrence rates.[6,7] Therefore, at present, MPFL reconstruction, with additional realignment procedures as indicated, is the gold

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standard for the surgical management of recurrent patellofemoral instability.[8]

A high body mass index (BMI), defined as a BMI of 30 or greater, has been shown to negatively influence surgical outcomes in patients undergoing total knee arthroplasty (TKA)[9-12] and anterior cruciate ligament reconstruction.[13] However, other studies examining TKA outcomes have shown no differences in scores when comparing patient populations.[14-16] A single study examining meniscectomy outcomes revealed that obese patients had worse preoperative scores but there were no differences postoperatively other than decreased knee flexion.[17] One area that has not been thoroughly studied is the influence of obesity on outcomes, activity rates, and complication rates of surgery for patellofemoral instability. One study examined medial patellotibial ligament reconstruction and reported that obesity was correlated with worse preoperative scores.[18] Still, there are no data regarding the influence of obesity on reconstruction of the MPFL, which is the major static stabilizer of the patella, providing 50% to 60% resistance to lateral displacement in the first 20° to 30° of flexion.[19-22]

The United States is currently experiencing an obesity epidemic, with a recent study reporting an obesity (BMI $\geq$ 30) prevalence of 38.9%.[23] Studies have also shown that the prevalence of obesity in the United States will increase to roughly 48.9% by 2030.[24,25] With a growing population of obese patients, it is imperative to determine the effect of BMI on surgical outcomes. Despite rising numbers of patients with a BMI of 30 or greater requiring MPFL reconstruction, there is a paucity of information to guide surgeons and to counsel patients regarding outcomes and complications of surgical intervention in this cohort.

The purpose of this study was to compare outcomes, activity scores, and complication rates of obese and non-obese patients undergoing MPFL reconstruction. Our hypothesis was that obese patients would have inferior subjective outcomes, lower activity scores, and an increased complication rate as compared with non-obese patients.

Methods

The study group comprised patients undergoing MPFL reconstruction performed by a single orthopaedic surgeon (S.L.S.) at a Midwest academic orthopaedic practice between 2011 and 2018. Institutional review board approval was received for this study (University of Missouri—Columbia, project No. 2009802). Patients were included if they had undergone MPFL reconstruction and had follow-up for a minimum of 6 months. Patients were excluded if they underwent surgery less than 6 months earlier, had no outcome data recorded, or underwent concomitant bony procedures (e.g., osteotomy or trochleoplasty) or cartilage restoration procedures (e.g., microfracture, autologous chondrocyte implantation, or osteochondral allograft transplantation). Patients who underwent other concomitant soft-tissue procedures, such as lateral retinacular lengthening, were not excluded.

The indications for MPFL reconstruction included a history of patellar dislocation and symptoms of patellofemoral instability with pathologic laxity on physical examination. Underlying risk factors for MPFL failure were assessed on imaging and physical examination, including patellar height, increased lateral quadriceps vector, trochlear dysplasia, and rotational malalignment, and were addressed with additional procedures when indicated. No upper limit was used as a BMI cutoff.

For each patient, the BMI was recorded by a search of the electronic medical record to identify the weight and height on the day of operation. All surgical details including primary and concomitant procedures, as well as complications, were noted by 2 authors (J.M.R. and J.W.W.) and certified by the primary investigator (S.L.S.). Patient-reported outcomes (PROs) were compiled using the PatientIQ software platform (Chicago, IL). Subjective data collection included Knee Injury and Osteoarthritis Outcome Score (KOOS) domains (Pain, Symptoms, Activities of Daily Living [ADL], Sport/Recreation, and Quality of Life [QOL]) and the Tegner activity score. Complications recorded comprised infection and/or wound complication, arthrofibrosis, and recurrent instability that required additional surgery.

Statistical Analysis

For each PRO score and subscore, differences within and between the 2 BMI cohorts ($\geq$30 and $<$30) were analyzed regarding the preoperative score, the postoperative score at 6 months or greater, and the difference between the preoperative and postoperative scores. Average values and standard deviations were generated and the Student *t* test was performed using Microsoft Excel (Redmond, WA) for PRO and patient demographic analyses. Grade 3 or 4 cartilage defects at the time of surgery and complications requiring reoperation were statistically analyzed by the Fisher exact test. A post hoc power analysis was generated in G*Power (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) for the PRO subscores.

Results

Patient Cohort

In total, 57 knees in 55 patients were included in the study. Patient demographic characteristics are presented in Table 1. There were 26 knees with a BMI of 30 or greater and 31 knees with a BMI less than 30. Of the patients included in our sample, 37 (67.2%) were

Table 1. Patient Demographic Characteristics

	BMI ≥ 30	BMI < 30	*P* Value
Total patients (total knees)	25 (26)	30 (31)	—
Female patients, n (%)	16 (64)	21 (70)	.78
Right-sided procedure, n (%)	13 (50)	15 (48)	>.999
Grade 3-4 cartilage defect, n (%)	18 (69)	16 (52)	.28
Mean age, yr	28.3	25.0	.23
Mean BMI	36.1	24.5	<.001

NOTE. Significance was determined using the Fisher exact test or Student *t* test as appropriate, with $P < .05$ defined as significant.
BMI, body mass index.

female patients. The mean BMI in the obese cohort was 36.1 ± 6.0, and the mean BMI in the non-obese cohort was 24.5 ± 3.2 ($P < .001$). The mean age of the sample was 28.3 ± 10.9 years in the cohort with a BMI of 30 or greater and 25.0 ± 9.7 years in the cohort with a BMI less than 30 ($P = .23$) (range, 13.06-50.79 years). At the time of surgery, 18 knees (69.23%) in the obese cohort and 16 knees (51.61%) in the non-obese cohort were found to have grade 3 or 4 cartilage defects ($P = .28$). Adjunct advanced cartilage restoration treatment of these grade 3 or 4 lesions was administered in 8 of 18 knees (44.44%) in the cohort with a BMI of 30 or greater and 6 of 16 knees (37.50%) in the cohort with a BMI less than 30 ($P = .74$). The mean follow-up period was 16.7 ± 17.0 months (range, 6.1-70.5 months) in the obese cohort and 12.63 ± 8.6 months (range, 6.1-37.9 months) in the non-obese cohort ($P = .27$). The obese group included 14 knees that underwent last follow-up at 6 months to 1 year; 7 knees, at 1 to 2 years; and 5 knees, at greater than 2 years. The non-obese group included 17 knees that underwent last follow-up at 6 months to 1 year; 11 knees, at 1 to 2 years; and 3 knees, at greater than 2 years.

PRO Data

The cohort with a BMI of 30 or greater showed statistically significant improvements in the KOOS Pain ($P = .02$), Symptoms ($P = .002$), ADL ($P = .004$), and Sport/Recreation ($P = .01$) subscores. This group also showed statistically insignificant improvements in KOOS QOL ($P = .12$) and Tegner ($P = .20$) scores (Table 2). In the cohort with a BMI of 30 or greater, the complication rate was 7.69%, with 1 knee requiring additional surgery for an infection and/or wound complication and 1 knee requiring additional surgery for arthrofibrosis (Table 3).

The cohort with a BMI less than 30 showed a statistically significant improvement in the KOOS QOL subscore ($P = .05$). This group also showed statistically insignificant improvements in the KOOS Pain ($P = .33$), Symptoms ($P = .52$), ADL ($P = .26$), and Sport/Recreation ($P = .29$) subscores, as well as the Tegner score

Table 2. PROs of Patients With BMI Greater Than 30 Versus BMI Less Than 30

	BMI ≥ 30	BMI < 30	*P* Value for BMI ≥ 30 vs BMI < 30
KOOS			
Pain subscore			
Preoperative	49.43 ± 22.03	53.72 ± 20.59	.58
Postoperative	63.66 ± 23.31	70.05 ± 28.95	.54
P value for preoperative vs postoperative	.02	.33	
Symptoms subscore			
Preoperative	46.69 ± 15.75	55.85 ± 18.38	.15
Postoperative	60.64 ± 18.79	65.94 ± 16.91	.46
P value for preoperative vs postoperative	.002	.52	
Activities of Daily Living subscore			
Preoperative	49.91 ± 21.52	60.91 ± 19.87	.15
Postoperative	68.63 ± 29.74	77.32 ± 29.21	.46
P value for preoperative vs postoperative	.004	.26	
Sport/Recreation subscore			
Preoperative	16.56 ±22.41	25.33 ± 23.18	.29
Postoperative	39.58 ± 31.22	54.64 ± 36.50	.27
P value for preoperative vs postoperative	.01	.29	
Quality of Life subscore			
Preoperative	22.28 ± 27.10	20.03 ± 20.21	.79
Postoperative	33.34 ± 19.10	54.47 ± 28.00	.03
P value for preoperative vs postoperative	.12	.05	
Tegner score			
Preoperative	1.81 ± 1.22	2.47 ± 1.60	.21
Postoperative	2.56 ± 1.59	4.78 ± 2.68	.05
P value for preoperative vs postoperative	.20	.25	

NOTE. Data are presented as mean ± standard deviation. Significance was determined using the Student *t* test, with $P < .05$ defined as significant.
BMI, body mass index; KOOS, Knee Injury and Osteoarthritis Outcome Score; PRO, patient-reported outcome.

Table 3. Complications Requiring Reoperation in Patients With BMI Greater Than 30 Versus BMI Less Than 30

Complication	BMI ≥ 30	BMI < 30	*P* Value
Wound healing or infection, n	1	1	
Stiffness, n	1	2	
Recurrent patellofemoral instability, n	0	1	
Total, n (%)	2 (7.69)	4 (12.90)	.68

NOTE. Significance was determined using the Fisher exact test, with $P < .05$ defined as significant.
BMI, body mass index.

($P = .25$) (Table 2). In the cohort with a BMI less than 30, the complication rate was 12.90%, with 1 knee requiring additional surgery for an infection and/or wound complication, 2 knees requiring additional surgery for stiffness, and 1 knee requiring additional surgery for recurrent patellofemoral instability with subsequent MPFL reconstruction (Table 3).

There were no significant differences in preoperative scores between the obese and non-obese cohorts for any of the PROs measured. On comparison of the obese and non-obese cohorts at most recent follow-up, the non-obese patients showed statistically significantly superior outcomes in terms of the KOOS QOL subscore (54.47 ± 28.00 vs 33.34 ± 19.10, $P = .03$) and Tegner score (4.78 ± 2.68 vs 2.56 ± 1.59, $P = .05$) (Table 2). The post hoc power analysis generated in G*Power for the KOOS subscores revealed a power of 0.484. An a priori test did not precede the start of this study owing to all consecutive patients being enrolled. At the conclusion of the study, an a priori power analysis for the KOOS subscores was conducted and showed that 164 patients were needed to achieve a power of 80%. Complication rates were low, with 2 knees (7.69%) requiring reoperation in the cohort with a BMI of 30 or greater and 4 knees (12.90%) requiring reoperation in the cohort with a BMI less than 30 ($P = .68$) (Table 3).

Discussion

Our most important finding was that the obese cohort showed statistically significant within-group improvements in the KOOS Pain, ADL, Symptoms, and Sport/Recreation subscores. The non-obese cohort showed improvements in all of these areas, but they were not statistically significant; however, a statistically significant improvement was seen in the KOOS QOL subscore. In addition, the only difference in preoperative or postoperative PROs between the obese and non-obese cohorts was that non-obese patients had higher postoperative KOOS QOL and Tegner scores.

The consequences of increased BMI on cartilage are well understood. Previous literature has reported that a high BMI is correlated with increased strain on the articular cartilage of the medial and lateral compartments.[26] An increased BMI has also been associated with an increased prevalence of patellar cartilage defects. Gunardi et al.[27] reported a reduction in patellar cartilage volume of 13 mL for every 1-unit increase in the current BMI, with a reduction of 27 mL per BMI unit increase over a period of 10 years. McAlindon et al.[28] found obesity to be an important risk factor for patellofemoral, tibiofemoral, and combined patterns of osteoarthritic changes in the knee. However, in our study, we found a statistically insignificant increased prevalence of grade 3 or 4 cartilage abnormalities in the obese cohort.

On the other hand, the effect of obesity in the patellofemoral instability setting is overall a poorly studied subject. There have been a small number of studies to date that have addressed outcomes related to BMI in patellofemoral instability. In a pediatric and adolescent cohort, increased BMI was not found to be associated with the risk of recurrent instability after nonoperative treatment of acute first-time patellar dislocation.[29] BMI has been shown to correlate with worse symptoms at the preoperative status in a study related to medial patellotibial ligament reconstruction. In the same study, Zaffagnini et al.[18] showed that postoperative BMI was positively correlated with the tilt angle and negatively correlated with the sulcus angle. These findings indicated an association between higher BMI and radiographic evidence of patellofemoral dysplasia.[18] A BMI greater than 30 has also been associated with a significantly lower Kujala score compared with a BMI less than 30 in a cohort of patients after MPFL reconstruction.[30] The study's purpose was not to specifically evaluate the influence of BMI on MPFL reconstruction, as in our study; therefore, evaluation and consideration of demographic variables that can act as confounding factors were not performed. Although the literature on non-obese patients supports our finding of a statistically significant improvement in the KOOS QOL score,[31-33] there are no other studies specifically looking at how the outcomes of obese patients compare with the outcomes of non-obese patients after MPFL reconstruction.

Our results suggest that both obese and non-obese patients can show significant improvements in many aspects, with obese patients showing improvements in the KOOS Pain, ADL, Symptoms, and Sport/Recreation subscores and non-obese patients showing an improvement in the KOOS QOL subscore even as early as 6 months postoperatively. Such improvements can also be found in many other studies within the literature.[31-33] Thus, we believe our hypothesis was proved wrong because obese patients overall reported similar outcomes to non-obese patients. However, some differences can be pointed out: Comparing the obese group with the non-obese group, we recognize that obese patients perceive improvements in the categories related to symptoms and daily activities (KOOS Pain,

ADL, Symptoms, and Sport/Recreation subscores) whereas non-obese patients perceive a more global improvement in their quality of life (KOOS QOL subscore). The only difference in preoperative or postoperative PROs between the obese and non-obese cohorts was that non-obese patients had higher postoperative KOOS QOL and Tegner scores. These findings suggest that even though many scores were similar between obese and non-obese patients, overall non-obese patients have a better quality of life and higher level of sports activities. In addition, it is important to consider that the PROs used in this study are not specific to patellofemoral instability yet provide information about the perceived symptoms and functional status of the patient. Another important consideration is that given an extended follow-up period and a larger sample size with higher power, more of our findings could potentially, otherwise, be significant. It is also interesting to note that complication rates were very low and were similar between the 2 groups. This finding is in contrast to the results of several other studies concerning knee surgery complication rates that found obesity to be significantly associated with higher complication rates.[34,35] This may be because we had a smaller sample size, we did not observe patients long enough, or possibly, MPFL reconstruction carries a much different risk profile than TKA. In addition, obese patients who undergo MPFL reconstruction are young, with a mean age of 25.0 ± 9.7 years in our cohort, and likely do not present with as many comorbidities that can increase complication rates as older obese patients undergoing TKA. Therefore, we believe our results suggest that MPFL reconstructions should be used as indicated in all patients with recurrent patellofemoral instability, regardless of BMI. Good outcomes with low complication rates are to be expected.

Limitations

There are limitations associated with this study. The power of the study is an important consideration. Although the usefulness of post hoc power calculations is disputed, our study—by calculation—was underpowered. The lack of power within the context of negative results makes it difficult to determine the utility of our study. Because of our small sample size, we were unable to select discrete times in the follow-up period (6 months, 1 year, and so on) at which to compare all patients; doing so would leave a sample size too small to show significance. Our study also had a lack of long-term follow-up through PROs, which resulted in a minimum of 6 months being used. A 2-year period would have been more suitable for establishing long-term significance because during the first 2 years, (1) failures increase (most failures occur in the first 2 years) and (2) PROs in the survival cohort (non-failures) tend to continue to improve.[36-38]

Conclusions

In this study, MPFL reconstruction in obese patients was safe and effective, with low complication rates and improvements in most PROs. Compared with patients with a BMI less than 30, obese patients had lower quality-of-life and activity scores at final follow-up.

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