

Comparable Midterm Survival After Medial Meniscus Root Repair for High and Low Intraoperative Outerbridge Classification Grades

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Background: While medial meniscus posterior root repairs (MMPRRs) have been shown to reverse harmful biomechanical effects of medial meniscus posterior root tears, it is questionable whether meaningful improvement occurs in patients with advanced chondral loss.

Purpose/Hypothesis: The objectives of this study were to compare midterm survival of MMPRR and to determine patient-reported outcomes (PROs) after MMPRR based on intraoperative Outerbridge grades (0-2 vs 3 and 4). It was hypothesized that patients undergoing MMPRR with Outerbridge grades 3 and 4 would have a decreased rate of MMPRR survival and inferior PROs compared to patients with Outerbridge grades 0 to 2.

Study Design: Cohort study; Level of evidence, 3.

Methods: Consecutive patients who underwent primary isolated MMPRR performed at a single institution between July 2003 and November 2022 with a minimum follow-up of 1 year were included and categorized according to medial compartment Outerbridge grade (0-2 or 3 and 4) based on diagnostic arthroscopy. Failure was defined as reoperation of the index knee. PROs collected included International Knee Documentation Committee (IKDC), visual analog scale (VAS) for pain, and Marx activity scale scores, which were compared to the previously established minimal clinically important difference (MCID) and/or clinically meaningful change. A minimum follow-up of 2 years was used for PRO analyses. Data were collected through electronic medical records and/or prospectively distributed surveys. A post hoc power analysis was performed, yielding a post hoc power of >0.99.

Results: A total of 170 patients were included (74 in the Outerbridge grade 0-2 group and 96 in the Outerbridge grade 3 and 4 group). The mean follow-up time was 5 years. There were no significant descriptive differences between groups. The median survival was 11 years, and there were no significant differences between groups in the survival analysis. There was 80% survival at 8 years overall, with 80% survival at 8 years and 7 years for Outerbridge grades 0 to 2 and grades 3 and 4, respectively. The failure rate was 17.6%, with no significant differences between groups, and the mean time to reoperation was 5.3 years. The mean post-operative IKDC score was 64.1 ± 23.0 . The mean IKDC change was 27.6 ± 29.7 , reaching the MCID of 10.17, with no significant differences between groups. The VAS score decreased from 6.1 ± 2.2 preoperatively to 3.0 ± 3.0 postoperatively, with no significant differences between groups.

Conclusion: Midterm survival and clinical outcomes after MMPRR were comparable between patients with intraoperative Outerbridge grades 0 to 2 and grades 3 and 4, with no significant differences in failure rate or survival. The overall median survival was 11 years, with an 80% survival rate at 8 years. The change in IKDC score exceeded the MCID in both groups. These findings indicate that MMPRR is durable and effective and intraoperative Outerbridge classification grades should not dissuade orthopaedic surgeons from performing MMPRR.

Keywords: meniscus root repair; medial meniscus; survival analysis; midterm outcomes

high as 87% at 5 years, medial meniscus posterior root repair (MMPRR) has been shown to improve this biomechanical effect, as well as clinical outcomes, with survival rates >90% at 7 years.^{12,24} In comparison to meniscectomy, MMPRR has also shown less progression to osteoarthritis (OA) and superior clinical outcomes.¹¹

However, there are patient factors that are known to negatively impact outcomes. These factors, which may be considered relative contraindications to MMPRR, include varus deformity, body mass index (BMI) >35 kg/m², advanced preoperative OA, preoperative Kellgren-Lawrence (KL) grades 2 to 4, and intraoperative Outerbridge classification grades 3 and 4.^{3,5,8,13,15,20,31} While higher Outerbridge classification grades may be considered a relative contraindication for MMPRR, patients with MMPRT have historically been more likely to have a higher Outerbridge classification grade.^{23,30}

The goal of performing MMPRR is to restore the normal meniscal function to preserve articular cartilage. Therefore, in patients with higher intraoperative Outerbridge classification grades, the theoretical disadvantage of MMPRR is the inability to restore joint integrity given the baseline chondral damage. However, there is a paucity in the literature relative to large cohort studies with mid- or long-term follow-up of patients after MMPRR with comparisons according to Outerbridge classification grades.

The primary aim of this study was to compare midterm survival of MMPRR based on intraoperative Outerbridge classification grades (0-2 vs 3 and 4). The secondary aim was to determine patient-reported outcomes (PROs) and functional outcomes of patients after MMPRR based on intraoperative Outerbridge classification grades. It was hypothesized that patients undergoing MMPRR with Outerbridge classification grades 3 and 4 would have significantly decreased survival of MMPRR compared to patients with intraoperative Outerbridge classification grades 0 to 2. It was also hypothesized that patients with Outerbridge classification grades 3 and 4 would have significantly inferior PROs compared to patients with grades 0 to 2.

METHODS

Ethical approval for this study was obtained from the institutional review board (STUDY22100150). A retrospective review of MMPRR performed by 1 of 7 fellowship-trained sports medicine orthopaedic surgeons (J.D.H., D.V., V.M., B.P.L.) at a single academic institution between July

2003 and November 2022 was conducted. Inclusion criteria included skeletally mature patients with an MMPRT identified on magnetic resonance imaging undergoing MMPRR who were at least 14 years of age at the time of surgery and had a minimum follow-up of 1 year. Patients with non-root medial meniscus tears, lateral meniscus tears, prior ipsilateral knee surgery, concomitant partial medial meniscectomy, concomitant ligamentous injury, concomitant associated fracture, and concomitant high tibial osteotomy (HTO) were excluded. Patients whose intraoperative Outerbridge classification grade was unavailable or who had <1 year of follow-up were also excluded. Prospective surveys were distributed via telephone and/or email to all patients with available contact information. The inability to contact a patient was not considered a reason for exclusion.

Patients were categorized as having low-grade or high-grade chondral lesions of the medial compartment defined as Outerbridge classification grades 0 to 2 or grades 3 and 4, respectively, based on diagnostic arthroscopy at the time of MMPRR. Failure was defined as reoperation of the index knee, for example, conversion to unicompartmental knee arthroplasty (UKA) or total knee arthroplasty (TKA), subsequent ipsilateral HTO, or revision MMPRR.

Patient characteristics, imaging, intraoperative findings, postoperative follow-up, retear events, subsequent surgeries, and PROs were retrospectively collected through electronic medical record review. The latest PROs and clinical outcomes were obtained via prospective surveys when available. PROs collected included International Knee Documentation Committee (IKDC), visual analog scale (VAS) for pain, and Marx activity scale scores.^{4,18,29,34} Data regarding PROs were compared to the previously established minimal clinically important difference (MCID) and/or clinically meaningful change. The MCID thresholds were 10.17 for IKDC score, 0.99 for VAS score, and 2.5 for Marx activity scale score.^{2,21,33} Patient Acceptable Symptom State (PASS) thresholds were 67.81, 3.3, and 7.0 for IKDC, VAS, and Marx scores, respectively.^{2,21,33} Patients with a minimum follow-up of 2 years were included in the analysis of PRO data.

All data were managed using REDCap (Vanderbilt University, Nashville, Tennessee) electronic data capture tools hosted at the University of Pittsburgh.

Surgical Technique

All patients underwent arthroscopic primary MMPRR using the transtibial pull-out technique with fixation by

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Ethical approval for this study was obtained from the University of Pittsburgh institutional review board (STUDY22100150).

suspensory cortical button, suture anchor, or cancellous screw and washer, according to surgeon preference. Standard anteromedial and anterolateral portals were utilized for all procedures, with an accessory posteromedial portal implemented, if needed, based on surgeon preference. The meniscus root bed was prepared with a meniscal rasp, and the meniscus root was reduced via 2 cinch sutures through a tibial tunnel. A transtibial guide was placed from the anteromedial aspect of the tibia and positioned toward the insertion point of the medial meniscus root. A Kirschner wire was placed through the guide to create the tunnel and then exchanged for a suture passer to shuttle the sutures passed through the meniscus root. Sutures were secured via suture anchor or tied over the suspensory cortical button or cancellous screw and washer. Chondral damage was addressed with the use of a mechanical shaver or a radiofrequency ablator, if necessary, per surgeon discretion.

Postoperative Protocol

Patients returned for postoperative follow-up at 1 week, 6 weeks, 3 months, 6 months, 9 months, and 1 year after surgery. During phase 1 rehabilitation, patients were kept nonweightbearing for 4 weeks after surgery, using a brace locked in extension for all upright activities. Then, patients advanced to partial weightbearing for 2 weeks and weightbearing as tolerated at 6 weeks. Structured physical therapy was initiated 1 week postoperatively for quadriceps strengthening and range of motion (ROM). Knee flexion was initially limited to 90°. ROM restrictions were progressively lifted 6 weeks postoperatively.

Beginning at 6 weeks postoperatively, patients advanced to strength, balance, stretching, and proprioceptive exercises to achieve functional movements. At 3 months postoperatively, patients began focusing on work and sport-specific physical demands. Patients were cleared to fully return to work or sporting activities when dynamic muscular control was achieved without pain or swelling, which occurred approximately 6 months after surgery and was based on individual patient progress.

Statistical Analysis

Categorical variables are presented as frequencies and percentages and were compared between groups using chi-square tests. Continuous variables are summarized as means and standard deviations and were analyzed using *t* tests and rank-sum tests. Kaplan-Meier estimates were used to assess survival using the log-rank test. A Spearman rank correlation was performed between preoperative KL grades and intraoperative Outerbridge classification grades. Differences in distribution of preoperative KL grades between groups were evaluated using the Fisher exact test. Overall progression of the study population from preoperative to final follow-up KL grades was analyzed using the Wilcoxon signed-rank test. Differences in the radiographic progression of KL grades between groups were evaluated using the Mann-Whitney *U* test.

Additionally, an ordered logistic regression was used to determine if intraoperative Outerbridge classification grade was an independent predictor of KL grade at the final follow-up, adjusting for preoperative KL grade and the duration of radiographic follow-up available. Finally, to determine if preoperative KL grade influenced the prognostic value of intraoperative Outerbridge classification grades, a multivariable Cox proportional hazards regression model was used to evaluate the effect of Outerbridge classification grade on MMPRR survival while adjusting for preoperative KL grade. The model's proportional hazards assumption was verified for all covariates using Schoenfeld residuals (global test $P = .61$). For continuous PROs, multivariable linear regression models were used to adjust for preoperative KL grade. Statistical significance was set at $p < .05$. All statistical analysis was performed in Stata (StataNow/SE 18.5; StataCorp).

A post hoc power analysis was performed using G*Power 3.1 (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). Because no prior survivorship effect sizes between Outerbridge classification grades were available, the effect sizes were estimated from IKDC differences between Outerbridge classification grade groups reported by Chung et al.⁹ Using a 2-sample *t* test with an α value .05, effect size *d* of 1.20, and this study's final sample sizes (74 for Outerbridge classification grades 0-2 and 96 for Outerbridge classification grades 3 and 4), the analysis resulted in a noncentrality parameter δ value of 7.77 and a critical *t* value of 1.65 ($df = 168$), corresponding to a post hoc power of >0.99 .

RESULTS

A total of 364 patients were initially identified, and after exclusions, 170 patients were included in the study (Figure 1). The final cohort consisted of 74 patients with Outerbridge classification grades 0 to 2 and 96 patients with Outerbridge classification grades 3 and 4. The overall mean follow-up time from surgery was 5 ± 3 years (range, 1-16 years), and the mean age was 53 ± 11 years (range, 17-72 years). There were no significant differences between the groups in terms of age, sex, BMI, or setting of injury (Table 1).

Survival Analysis

The overall median survival was 11 years (Figure 2), and there were no statistically significant differences in survival between the 2 groups ($P = .15$) (Figure 3). The overall population had 80% survival at 8 years, and there was an 80% survival at 8 years and 7 years for the Outerbridge classification grades 0 to 2 and 3 and 4, respectively.

Failure Rate

The overall failure rate was 18%, with a mean time to reoperation of 5 ± 4 years (range, <1 to 14 years). No differences in failure rates were observed between groups ($P = .40$).

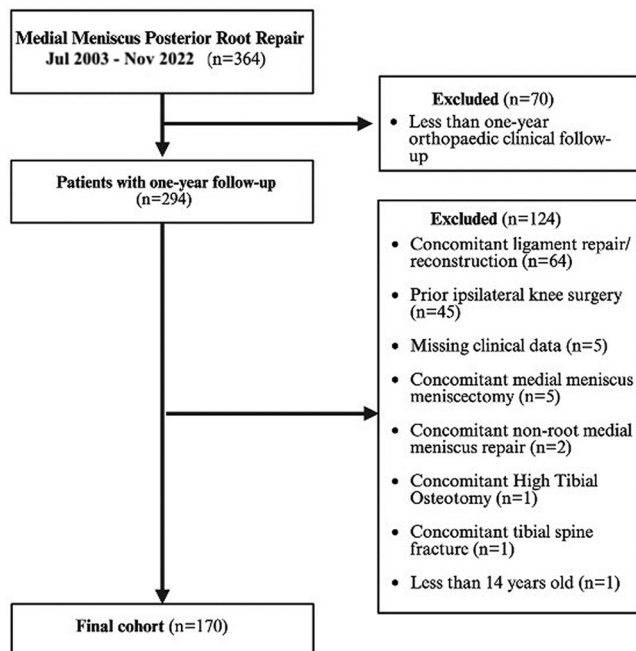


Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart of study inclusion and exclusion criteria.

There were 11 reoperations (15%) in the Outerbridge classification grade 0 to 2 group at a mean of 4 ± 4 years (range, <1 to 11 years). The 11 reoperations were 2 TKAs, 2 UKAs, 2 revision MMPRRs, 1 medial meniscus repair, 1 cartilage repair procedure, 1 chondroplasty, 1 partial meniscectomy, and 1 removal of symptomatic hardware. There were 19 reoperations (20%) in the Outerbridge classification grade 3 and 4 group at a mean of 6 ± 5 years (range, <1 to 14 years). The 19 reoperations were 12 TKAs, 4 UKAs, 1 revision MMPRR, 1 partial meniscectomy, and 1 meniscectomy. After adjusting for preoperative KL grade, intraoperative Outerbridge classification grades 3 and 4 were not a significant predictor of failure (HR, 1.04 [95% CI, 0.49-2.24]; $P = .91$). There were no postoperative infections.

Follow-up Time

The overall mean follow-up time from surgery was 5 ± 3 years (range 1-16 years), and no difference in follow-up times between groups was observed ($P = .20$). The Outerbridge classification grade 0 to 2 group had a mean follow-up of 5 ± 3 years (range, 1-15 years), while the Outerbridge classification grade 3 and 4 group had a mean follow-up of 5 ± 4 years (range, 1-16 years).

Patient-Reported Outcomes

Preoperative, postoperative, and change in IKDC, VAS, and Marx scores are presented in Table 2. For patients

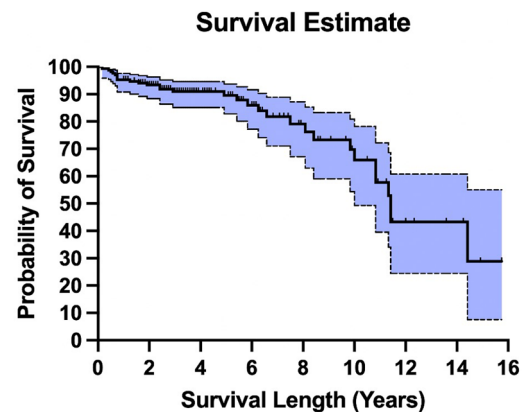


Figure 2. Survival analysis of medial meniscus posterior root repairs.

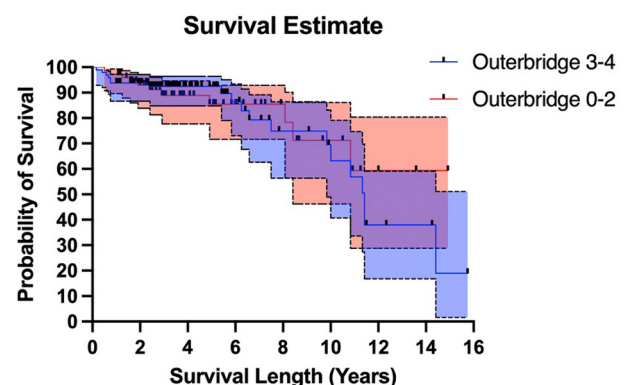


Figure 3. Survival analysis of medial meniscus posterior root repairs comparing the Outerbridge classification grade 0 to 2 group to the Outerbridge classification grade 3 and 4 group.

with a minimum of 2 years of follow-up, MMPRR resulted in significant improvements in IKDC scores (33.3 ± 16.2 to 60.8 ± 24.0 ; $P < .001$) and VAS pain scores (5.9 ± 2.2 to 3.0 ± 2.9 ; $P < .001$), while no significant change in Marx activity levels from baseline to final follow-up was detected (5.0 ± 5.5 to 4.4 ± 5.7 ; $P = .557$). There were no significant differences in preoperative scores, final follow-up scores, or the magnitude of raw improvement for IKDC, VAS, or Marx activity scale scores between low-grade and high-grade Outerbridge cohorts (Table 2). Additionally, there were no significant differences in the rates of achieving the MCID or PASS between the Outerbridge classification grade 0 to 2 and grade 3 and 4 groups across IKDC, VAS, or Marx activity scale scores (Table 3).

After controlling for preoperative KL grade, a multivariable linear regression analysis found that Outerbridge classification grades 3 and 4 did not significantly influence final IKDC ($P = .49$), VAS ($P = .69$), or Marx activity scale ($P = .48$) scores. Furthermore, adjusting for preoperative baseline scores, intraoperative Outerbridge classification grades 3 and 4 were not significant predictors of final IKDC ($P = .822$), VAS ($P = .781$), or Marx activity scale ($P = .874$) scores.

TABLE 1
Patient Characteristics^a

	Total (n = 170)	Outerbridge Classification Grades 0-2 (n = 74)	Outerbridge Classification Grades 3 and 4 (n = 96)	P Value
Age, y	52.8 ± 10.6	50.9 ± 12.8	54.2 ± 8.2	.20
Sex				.45
Male	50 (29)	24 (32)	26 (27)	
Female	120 (71)	50 (68)	70 (73)	
BMI, kg/m ²	32.1 ± 6.3	31.1 ± 6.6	32.8 ± 6.0	.08
Injury setting				.07
Nontraumatic	41 (24)	14 (19)	27 (28)	
Acute ADL	98 (58)	41 (55)	57 (59)	
Acute sports	24 (14)	16 (22)	8 (8)	
Acute trauma	4 (2)	2 (3)	2 (2)	
No injury setting information	3 (2)	1 (1)	2 (2)	
Follow-up time, y	5 (1-16)	5 (1-15)	5 (1-16)	.20

^aData are presented as n (%), n (mean ± SD), or mean (range). ADL, activities of daily living; BMI, body mass index.

TABLE 2
Patient Outcomes^a

	Total (n = 170)	Outerbridge Classification Grades 0-2 (n = 74)	Outerbridge Classification Grades 3 and 4 (n = 96)	P Value
IKDC score				
Preoperative	27 (30.8 ± 17.1)	31 (34.3 ± 14.8)	58 (32.7 ± 15.9)	.40
Final follow-up	61 (64.7 ± 22.5)	62 (63.5 ± 23.7)	123 (64.1 ± 23.0)	.76
Change	25 (32.4 ± 26.9)	24 (22.5 ± 32.2)	49 (27.6 ± 29.7)	.25
Marx score				
Preoperative	27 (5.3 ± 5.6)	31 (4.7 ± 5.4)	58 (5.0 ± 5.4)	.67
Final follow-up	61 (5.0 ± 5.8)	61 (4.2 ± 5.2)	122 (4.6 ± 5.5)	.46
Change	25 (−0.5 ± 7.4)	23 (−0.8 ± 7.4)	48 (−0.6 ± 7.3)	.89
VAS score				
Preoperative	30 (6.2 ± 2.3)	37 (6.0 ± 2.2)	67 (6.1 ± 2.2)	.71
Final follow-up	48 (2.5 ± 3.0)	52 (3.4 ± 2.9)	100 (3.0 ± 3.0)	.15
Change	23 (−3.2 ± 3.7)	23 (−2.5 ± 4.1)	46 (−2.8 ± 3.9)	.57
Reoperation	30 (17.6)	11 (14.9)	19 (19.8)	.40
Time to reoperation, y	5.3 (0.2 to 14.4)	4.0 (0.5 to 10.8)	6.2 (0.2 to 14.4)	.40

^aData are presented as n (%), n (mean ± SD), or mean (range). Change refers to change between preoperative and postoperative values. IKDC, International Knee Documentation Committee; VAS, visual analog scale.

Analysis of KL and Outerbridge Classification Grades

There were no significant differences in preoperative distribution of KL grades between Outerbridge classification grades 0 to 2 and grades 3 and 4 ($P = .16$). Additionally, a Spearman rank correlation identified a weak, nonsignificant correlation between preoperative KL grade and intraoperative Outerbridge classification grade ($\rho = 0.13$; $P = .09$).

Radiographic Follow-up

Radiographs were available for 109 patients (42 patients in the Outerbridge classification grade 0-2 group and 67 patients in the Outerbridge classification grade 3 and 4 group). Overall, the study population demonstrated a significant radiographic progression of OA (ie, KL grades)

from the preoperative baseline to the final follow-up ($P < .001$). When comparing Outerbridge classification grade groups in terms of KL grades, patients with Outerbridge classification grades 3 and 4 demonstrated significantly higher radiographic progression of OA than patients with Outerbridge classification grades 0 to 2 ($P = .01$). Additionally, ordered logistic regression demonstrated that Outerbridge classification grades 3 and 4 were significant independent predictors of worse final KL grade, when adjusting for preoperative KL grade and follow-up length ($P = .01$).

DISCUSSION

The primary finding of this study was that patients with intraoperative Outerbridge classification grades 0 to 2

TABLE 3
MCID and PASS Achievement^a

	Outerbridge Classification Grades 0-2	Outerbridge Classification Grades 3 and 4	Total	P Value
IKDC score				
Achieved MCID	20/25 (80.0)	13/24 (54.2)	33/49 (67.3)	.07
Achieved PASS	32/61 (52.5)	32/62 (51.6)	64/123 (52.0)	>.99
VAS score				
Achieved MCID	18/23 (78.3)	14/23 (60.9)	32/46 (69.6)	.34
Achieved PASS	33/48 (68.8)	28/52 (53.8)	61/100 (61.0)	.15
Marx score				
Achieved MCID	7/25 (28.0)	6/23 (26.1)	13/48 (27.1)	>.99
Achieved PASS	22/61 (36.1)	19/61 (31.1)	41/122 (33.6)	.70

^aData are presented as n (%). The values for MCID and PASS were considered as follows: IKDC score (MCID ≥ 10.17 ; PASS ≥ 67.81), VAS score (MCID ≤ -0.99 ; PASS ≤ 3.3), and Marx score (MCID ≥ 2.5 ; PASS ≥ 7.0). IKDC, International Knee Documentation Committee; MCID, minimal clinically important difference; PASS, Patient Acceptable Symptom State; VAS, visual analog scale.

versus 3 and 4 had comparable midterm survival rates of MMPRR, with 80% survival at 8 years and 7 years for Outerbridge classification grades 0 to 2 and 3 and 4, respectively. These findings support the midterm benefit of MMPRR and suggest that Outerbridge classification grades 3 and 4 may not be a contraindication for MMPRR. Although previous studies have identified Outerbridge classification grades 3 and 4 as risk factors for poorer outcomes after MMPRR, there is a gap in the literature in terms of mid- and long-term survival rates between Outerbridge classification grades, preventing a direct comparison.^{1,20,31}

The overall study population had an 80% survivor rate at 8 years and median survival of 11 years. Previous MMPRR analyses report comparable outcomes, with survival rates ranging from 99% at 5 years to 78% at 10 years, and significantly better survivorship than partial meniscectomy at all time points.^{10,12,22,26}

Additionally, this study found an overall failure rate of 17.6% with a mean time to reoperation of 5.3 years, and no differences in failure rates and time to reoperation between groups. Previously published failure rates for MMPRR range from approximately 3% to 23% at different follow-up periods up to 10 years, and thus encompass the failure rate identified in the present study.^{10,16,19,32} Importantly, previous literature has reported long-term failure to be independently associated with Outerbridge classification grades 3 and 4, a relationship that was not observed in the current study.^{9,20,31}

Interestingly, although there were no significant differences in time to reoperation between groups, the Outerbridge classification grade 3 and 4 group demonstrated a longer mean time to reoperation of 6.2 years compared with the 4.0 years in the Outerbridge classification grade 0 to 2 group. This difference may be due to the nature of the subsequent procedures. While the reoperations in the Outerbridge classification grade 3 and 4 group were more frequently conversions to UKAs or TKAs, the Outerbridge classification grade 0 to 2 group more commonly underwent additional meniscal or chondral procedures. Because arthroplasties represent a more definitive intervention, typically pursued after the failure of nonoperative and joint-preserving options, patients may delay arthroplasties

longer than less invasive and less definitive arthroscopic interventions, which could account for the observed difference in time to reoperation.

Beyond survival, functional improvement was displayed across both groups, as evidenced by an improvement in IKDC score. The mean change in IKDC score in the overall study population was 27.6, with no differences in change in IKDC score between Outerbridge classification grade groups. Patients in both groups exceeded the previously established MCID of 10.17, indicating that clinically meaningful patient-perceived improvement was achieved regardless of intraoperative Outerbridge classification grades.²⁷ Additionally, the present study did not find any significant differences in postoperative IKDC score between groups, with an overall mean postoperative IKDC score of 64.1. This contrasts with previous literature that reported a significantly smaller IKDC score for patients with Outerbridge classification grades 3 and 4 when compared to grades 0 to 2 at midterm follow-up after MMPRR.^{9,20}

In addition to functional improvement, the patients in the present study demonstrated a clinically meaningful reduction in pain after MMPRR, with a mean decrease in VAS score of 2.8 from pre- to postoperatively, and no significant differences between groups. This 2.8-point decrease in VAS score exceeds the MCID of a 0.99-point decrease while also comparing favorably to prior MMPRR studies, which have reported a decrease in VAS score from pre- to postoperatively of 2.1 to 2.7.^{14,25,28,37} Additionally, the current study found a mean postoperative VAS score of 3.0, with no significant differences between groups. Mid- and long-term follow-up studies reported comparably sustained pain relief after MMPRR, with final VAS values between 1 and 3, and no differences in pain outcomes between Outerbridge classification grades 1 to 2 and grades 3 and 4.^{10,26,31,32,36}

Activity levels as measured by the Marx activity scale did not significantly change postoperatively in the present study for the overall population nor in each group, maintaining the mean value of 4.6 for the overall population, 5.0 for the Outerbridge classification grade 0 to 2 group, and 4.2 for the Outerbridge classification grade 3 and 4 group. Prior MMPRR studies, although reporting activity outcomes with the Tegner activity scale rather than the Marx activity

scale, have demonstrated similarly stable or slightly increased activity levels at short- to midterm follow-up.^{6,7,25,35,36} There appears to be a gap in the previous literature specifically in terms of comparing MMPRR activity outcomes across Outerbridge classification grades, preventing direct comparisons with prior literature. The observed maintained Marx activity scores throughout this study's population highlight the relative advantage of MMPRR in generally maintaining activity levels, even in the setting of preoperative Outerbridge classification grades 3 and 4.

The lack of differences in IKDC, VAS, and Marx activity scale outcomes between intraoperative Outerbridge classification grades 0 to 2 and 3 and 4 suggests that the status of chondral damage at the time of surgery may not be as dominant of a determinant of mid- to long-term clinical outcomes after isolated MMPRR as previously thought. One possible explanation is that with the MMPRR restoration of meniscal biomechanical function and reduction of compartmental contact pressures, the negative mechanical effects of preexisting chondral damage may be diminished.^{17,36} In this context, the knee may be biomechanically more influenced by limb alignment and general OA status than by localized compartment chondral damage.^{8,31} Notably, preoperative KL grade was not independently associated with inferior outcomes in multivariable analysis, suggesting that radiographic OA severity by itself may not prevent clinically meaningful outcome improvement after MMPRR. Therefore, although not included in this study, it is plausible that limb alignment, that is, coronal plane load distribution, has a more substantial influence on MMPRR failure and PROs.^{8,20,31} Altogether, these findings possibly indicate that intraoperative Outerbridge classification grades in isolation may be less of a prognostic determinant than previously considered.^{20,31}

There are limitations to this study. First, the retrospective design introduces the risk of selection and reporting bias, despite the inclusion of prospectively collected questionnaires. Additionally, surveys were administered years after the index procedure, which may contribute to recall bias. Also, unmeasured confounding factors such as minor variability of surgical technique among the 7 included surgeons or patient postoperative compliance may have influenced outcomes. Finally, while preoperative KL grade was included in the analyses, the lack of mechanical alignment data in the present study limits the ability to fully account for biomechanical load distribution and the potential influence of malalignment on MMPRR survivorship and OA progression. These factors should be considered when interpreting the results, and future prospective studies with standardized protocols, higher follow-up rates, and long-term clinical and radiographic assessment are needed in order to better generalize the results of the present study.

CONCLUSION

Midterm survival and clinical outcomes after MMPRR were comparable between patients with intraoperative Outerbridge classification grades 0 to 2 versus 3 and 4.

No significant differences were observed between groups in failure rate or survivorship, with an overall median survival of 11 years and 80% survival rate at 8 years. Similarly, change in IKDC score exceeded the MCID in both groups. The findings of this study support MMPRR as a durable and effective procedure, indicating that intraoperative Outerbridge classification grades should not dissuade orthopaedic surgeons from performing MMPRR.

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