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ORIGINAL ARTICLE

Clinical and radiographic outcomes of arthroscopic repair versus conservative management for medial meniscus posterior root tears: A comparative cohort study

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ABSTRACT

Objectives: This study aims to compare clinical and radiographic outcomes of arthroscopic repair versus conservative management in patients with medial meniscus posterior root tears (MMPRTs).

Patients and methods: Between January 2019 and December 2021, a total of 41 patients (9 males, 32 females; mean age: 49±12 years; range, 35 to 68 years) who underwent MMPRT repair and 123 patients (11 males, 112 females; mean age: 52±7 years; range, 26 to 74 years) who refused to undergo MMPRT repair and were managed conservatively were included in the study. Surgical candidates had neutral or mild varus alignment (≤5°), preserved joint space, and Kellgren-Lawrence (K-L) Grade 1-2 osteoarthritis. Baseline K-L grades, Lysholm Knee Scores (LKS), and International Knee Documentation Committee (IKDC) scores were recorded.

Results: The mean follow-up was 32±11 (range, 24 to 60) months in the repair group and 28±6 (range, 24 to 48) months in the control group (p=0.025). Baseline LKS scores were similar between the groups (p=0.685), while IKDC scores were lower in the repair group (p=0.001). At final follow-up, the repair group showed higher LKS scores (78±19 *vs*. 65±32; p=0.021) and greater improvements in LKS (+46±25 *vs*. +36±38; p=0.046) and IKDC scores (+38±18 *vs*. +26±27; p=0.002). No repair patients progressed to K-L Grade 4, compared to 11% of controls (p=0.027). No repair patients required further surgery, whereas 20% of conservative patients did, including 7% undergoing arthroplasty.

Conclusion: Arthroscopic MMPRT repair yielded a more favorable functional improvement, no subsequent surgeries, and improved radiographic preservation compared to conservative management, supporting early surgical intervention in selected patients.

Keywords: Conservative, medial meniscus posterior root tear, meniscus, osteoarthritis, repair.

Medial meniscus posterior root tears (MMPRTs) have become a significant concern in orthopedic practice, with their impact on knee joint stability and function gaining increased recognition.[1,2] The medial meniscus is crucial in load distribution, shock absorption, and maintaining joint stability.[3] A compromised meniscus root, whether due to trauma or degenerative changes, disrupts knee biomechanics and imposes increased stress on articular surfaces, accelerating the progression of knee osteoarthritis (OA).[4] Landmark studies by Krych et al.[5] and Bernard et al.[6] have emphasized that untreated MMPRTs accelerate joint degeneration, significantly affecting patient quality of life and increasing the necessity for subsequent surgical interventions such as total knee arthroplasty (TKA).

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Despite growing awareness of the clinical implications of MMPRTs, optimal management strategies still remain controversial. Surgical repair, particularly arthroscopic transtibial pull-out

techniques, has been advocated by numerous studies due to promising results in restoring joint biomechanics, improving clinical outcomes, and potentially slowing OA progression.[7-10] Conversely, systematic reviews and cohort studies have highlighted risks associated with surgical repair, including incomplete meniscal healing, persistent joint degeneration, and subsequent surgeries.[11,12] Furthermore, a subset of literature suggests conservative management can offer adequate symptom relief and knee function outcomes in certain patient populations, thereby avoiding surgical risks altogether.[13-16]

Given these ongoing controversies, the decision between operative and non-operative management of MMPRTs necessitates careful consideration of clinical and radiographic outcomes. Previous systematic reviews provide conflicting evidence, with some demonstrating clear advantages for arthroscopic repair over conservative treatment in terms of knee function outcomes and OA progression, while others indicate limited or equivocal benefits.[17] Wang et al.,[8] in a comprehensive meta-analysis, reported mean improvements of 41.6 points in Lysholm scores and 29.7 points in International Knee Documentation Committee (IKDC) scores following arthroscopic repair, suggesting substantial functional gains postoperatively. Similarly, Ahn et al.[10] demonstrated significantly superior postoperative Lysholm (77.1 *vs.* 57.6) and IKDC (68.9 *vs.* 53.3) scores in the repair group compared to patients managed conservatively. However, longitudinal studies have reported that, despite anatomically successful repairs, patients may still exhibit persistent meniscal extrusion and progressive medial joint space narrowing on radiographs, raising concerns about the structural and biomechanical integrity of the repaired meniscus over time.[18-22] Additionally, some studies have reported no statistically significant difference in clinical outcomes between arthroscopic repair and conservative treatment, suggesting that non-operative management may be appropriate in selected patients. To illustrate, Ahn et al.[10] reported that, in patients with severe varus alignment (≥5°), pull-out repair of MMRT offered no significant benefit over conservative treatment, making alternative options more appropriate. Lee et al.,[23] in their systematic review, concluded that the superiority of repair was not consistent across all patient populations, particularly in individuals with low functional demands or advanced age. These inconsistencies underscore the ongoing controversy and the necessity for further high-quality comparative studies to clarify the clinical and radiographic benefits of surgical versus conservative treatment approaches. A comprehensive comparative analysis between surgical and conservative management, particularly within larger patient cohorts, remains essential to establish clearer clinical guidelines and optimize patient outcomes.

In the present study, we hypothesized that arthroscopic repair of MMPRTs could lead to superior clinical and radiographic outcomes compared to conservative management. In the present study, we, therefore, aimed to assess clinical and radiographic outcomes in patients diagnosed with MMPRT who underwent either arthroscopic transtibial pull-out repair or conservative management.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at Private Osmangazi Aritmi Hospital, Department of Orthopedics and Traumatology between January 2019 and December 2021. Medical records of patients with a diagnosis of MMPRT were reviewed. Only patients diagnosed with an MMPRT and indicated for arthroscopic repair were included in the study. Radiographic inclusion was based on standardized weight-bearing anteroposterior radiographs of the knee, graded using the Kellgren-Lawrence (K-L) system. Patients were eligible for inclusion only if baseline radiographs demonstrated K-L Grade 1 or 2 OA. All patients also underwent preoperative magnetic resonance imaging (MRI) to evaluate articular cartilage integrity. Individuals with advanced cartilage degeneration (Outerbridge Grade 3 or 4) identified on MRI were excluded from the study, regardless of whether they were considered for surgical repair or conservative management. Thus, no patients with Outerbridge Grade III-IV lesions were enrolled in either the intervention or control groups. Individuals with K-L Grade 3-4 changes were also excluded from enrollment. Among those meeting the radiographic criteria, surgical repair was considered for patients with neutral or mild varus alignment (≤5°), preserved joint space, and no additional knee pathology requiring concurrent surgical treatment. Finally, a total of 41 patients (9 males, 32 females; mean age: 49±12 years; range, 35 to 68 years) who underwent MMPRT repair and 123 patients (11 males, 112 females; mean age: 52±7 years; range, 26 to 74 years) who refused to undergo MMPRT repair were included

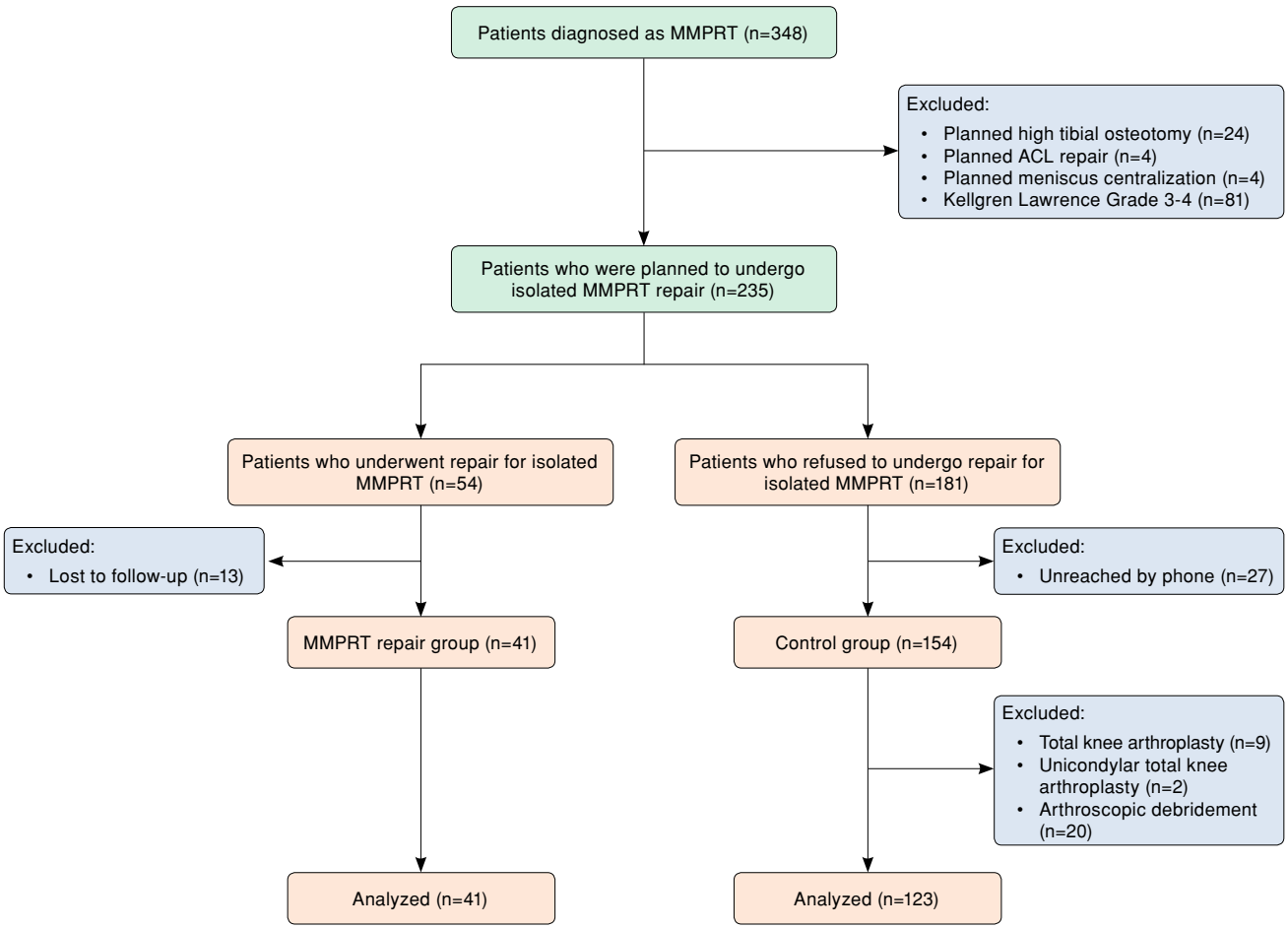


FIGURE 1. Study flowchart.
MMPRT: Medial meniscus posterior root tear; ACL: Anterior cruciate ligament.

in the study. The study flowchart is shown in Figure 1. Written informed consent was obtained from each patient. The study protocol was approved by the İstinye University Human Research Ethics Committee (Date: 19.01.2024, No: 23-295). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Conservative management was defined as non-operative treatment including activity modification, non-steroidal anti-inflammatory drugs (NSAIDs), physical therapy, and intra-articular injections, based on individual patient needs and physician discretion. All patients underwent preoperative evaluation with 1.5 Tesla MRI to assess the integrity of the medial compartment cartilage. Despite K-L Grade 1-2 findings on radiographs, patients exhibiting more advanced cartilage lesions on MRI (potential Outerbridge Grade 3 and 4 cartilage lesion) were considered unsuitable for repair. The patients were divided into two groups. The repair group comprised patients who underwent arthroscopic transtibial pull-out MMPRT repair which was secured with either a cortical button or screw fixation (Figure 2). The control group included patients who chose not to undergo surgical intervention and received conservative treatment.

Surgical technique

All arthroscopic MMPRT repairs were performed under spinal or general anesthesia with the patient in the supine position and a tourniquet applied to the proximal thigh. Standard anterolateral and anteromedial portals were established for diagnostic arthroscopy. After arthroscopic identification of the MMPRT, the tear site was debrided to remove frayed tissue, and the bony root attachment site was prepared with a curette and shaver to promote healing. Suture

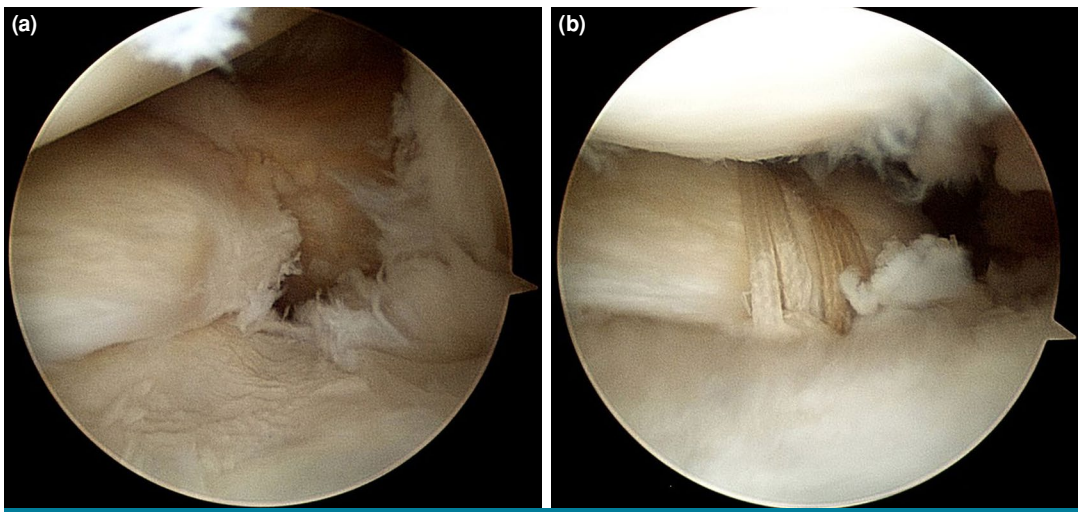


FIGURE 2. Arthroscopic images of the medial meniscus posterior root. **(a)** Complete radial tear at the root attachment site consistent with a medial meniscus posterior root tear. **(b)** Postoperative appearance following arthroscopic transtibial pull-out repair showing stable fixation of the repaired root.

passage was performed using a self-retrieving suture passer (First-Pass Mini®; Smith & Nephew Inc., Memphis, TN, USA) to place two simple cinch-loop sutures (No. 2 high-strength non-absorbable sutures) through the meniscal root. The transtibial tunnel was created using a tibial aiming guide set at 55°, exiting at the prepared root footprint. The tunnel was drilled with a 4.5-mm cannulated drill. Sutures were retrieved through the tibial tunnel and secured using either a cortical button fixation device (EndoButton®; Smith & Nephew Inc., Memphis, TN, USA) or a 4.5-mm titanium cortical screw based on surgeon preference. Meniscal centralization was not performed in this study cohort. The knee was immobilized in full extension postoperatively, and patients followed a standardized rehabilitation protocol: non-weight-bearing with crutches for six weeks, passive range of motion limited to 0-90° for the first four weeks, gradual progression to full range of motion thereafter, and initiation of partial weight-bearing at six weeks. Jogging was permitted at four to six months and return to sports activities was allowed at nine to 12 months depending on clinical recovery. All procedures were performed by orthopedic surgeons specializing in sports medicine and arthroscopic knee surgery, each with more than 10 years of independent surgical experience.

As with all surgical procedures, detailed preoperative discussions were conducted with all patients to aid in decision-making. These discussions included an explanation of the potential benefits of surgical repair, such as improved knee function outcomes, reduced pain, and slowed progression of OA. Patients were also informed about the risks of conservative management, including the higher likelihood of requiring subsequent interventions such as total knee replacement or arthroscopic debridement. Additionally, the risks associated with surgery, expected recovery timelines, the importance of adherence to postoperative rehabilitation, and alternative treatment options were clearly outlined. This process ensured patients had a thorough understanding of their treatment options and could make an informed decision regarding their care. Patients in the control group who eventually underwent surgery during follow-up were excluded from the analysis of clinical and radiographic outcomes to evaluate the natural history of conservative management. This approach was chosen to preserve the integrity of the comparison but may introduce attrition bias, as these surgical crossovers likely represent failures of conservative treatment.

Data collection

Patients' age, sex, and body mass index (BMI) were recorded from the medical records. Each patient in the control group, comprising individuals who chose not to undergo arthroscopic MMPRT repair, was contacted for a follow-up visit. A detailed review of their orthopedic history was conducted, including assessments of prior orthopedic examinations, drug prescriptions,

intra-articular injections, physical therapy, and surgeries.

Initial full-length standing anteroposterior and lateral radiographs of the knee, as well as knee MRI scans, were obtained for each patient. At the final follow-up, standing anteroposterior and lateral radiographs were repeated. Radiographic progression was assessed using the K-L grading system based on standardized standing anteroposterior and lateral knee radiographs obtained at baseline and at the final follow-up. No serial MRI-based assessment was performed for radiographic progression in this study. The radiographs of the patients were evaluated and classified according to the K-L classification system by the authors of the study. Both observers performed K-L grading twice, with a minimum interval of four weeks between the first and second assessments to reduce recall bias. The Lysholm Knee Score (LKS), which evaluates symptoms such as pain, instability, and swelling, and the IKDC subjective form, a widely used measure of knee function and activity level, were used to assess clinical outcomes. The LKS and IKDC scores were collected as patient-reported outcome measures during outpatient visits. Pre-treatment scores were available for all patients in both the repair and control groups. Due to the retrospective nature of the study, outcome assessors were not blinded to treatment allocation. All complications were documented.

Statistical analysis

While a priori power analysis was not feasible due to the retrospective nature of the study, a post-hoc power analysis was conducted using the G*Power version 3.1.9.7 software (Heinrich Heine University Düsseldorf, Düsseldorf, Germany), targeting comparisons of mean differences in LKS and IKDC scores as well as rates of KL grade progression. Based on the observed effect sizes, the post-hoc statistical power was 84% for the change in IKDC score (p=0.002), 79% for postoperative LKS scores, and 47% for LKS score improvement. Although the study demonstrated lower power for some secondary endpoints, the statistical power for the primary outcome (LKS score) was adequate to detect clinically meaningful differences.

Statistical analysis was performed using the IBM SPSS version 26.0 software (IBM Corp., Armonk, NY, USA). Continuous variables were presented in mean and standard deviation (SD) or median (min-max), while categorical variables were presented in number and frequency. Mean comparisons were conducted using either the t-test or Mann-Whitney U test, depending on the results of the Kolmogorov-Smirnov normality test. Comparisons of categorical variables were carried out using the chi-square test. For K-L grading, inter- and intra-observer reliability were evaluated using intraclass correlation coefficients (ICCs) with a two-way random-effects model for absolute agreement. The ICC values were interpreted according to commonly accepted thresholds: poor (<0.50), moderate (0.50-0.75), good (0.75-0.90), and excellent (>0.90) agreement. In our study, inter-observer reliability for K-L grading was 0.86 (95% CI: 0.82-0.89), indicating good agreement, and intra-observer reliability was 0.91 (95% CI: 0.88-0.94), indicating excellent

TABLE I
Demographics and clinical characteristics of the study groups

	Repair group (n=41)					Control group (n=123)					
Variables	n	%	Mean±SD	Median	Range	n	%	Mean±SD	Median	Range	*p*
Age (year)			49±12					52±7			0.102*
Sex											0.027**
Female	32					112					
Male	9					11					
BMI (kg/m^2)			30±6					32±5			0.179*
K-L Grade 1 (preoperative)	5	12				15	12				0.621**
K-L Grade 2 (preoperative)	36	88				108	88				
Lysholm score (preoperative)			31±20					30±20			0.685*
IKDC score (preoperative)			24±9					32±21			0.001*
Follow-up duration (month)			32±11	30	24-60			28±6	27	24-48	0.025*

SD: Standard deviation; BMI: Body mass index; IKDC: International Knee Documentation Committee; * p value according to the Student's t test; ** p value according to the Chi-square test.

TABLE II
Interventions that have been made for the control group during follow-up (n=123)

Intervention	n	%
Readmission - Yes	77	63
Readmission - No	46	37
Analgesic use - Yes	26	21
Analgesic use - No	97	79
Physical therapy - Yes	11	9
Physical therapy - No	112	91
Intra-articular injection - Yes	46	37
Intra-articular injection - No	78	63

agreement. A *p* value of <0.05 was considered statistically significant.

RESULTS

All numerical outcomes for functional scores and radiographic classifications, including means and standard deviations, are detailed in Tables I-IV. The proportion of males was significantly higher in the repair group compared to the control group (p=0.027). There was no significant difference between the groups in terms of mean age (49±12 *vs.* 52±7 years, p=0.102), BMI (30±6 *vs.* 32±5 kg/m², p=0.179), K-L Grade 1-2 distribution (p=0.621), or preoperative LKS scores (31±20 *vs.* 30±20, p=0.685). However, the mean preoperative IKDC score was significantly lower in the repair group (24±9 *vs.* 32±21, p=0.001) (Table I).

The mean follow-up duration was significantly longer in the repair group than in the control group. The mean follow-up was 32±11 (range, 24 to 60) months in the repair group and 28±6 (range, 24 to 48) months in the control group (p=0.025). Interventions performed for the control group during follow-up are presented in Table II. In total, 31 control patients (20%) underwent surgery: 11 patients (7%) received knee arthroplasty (9 total and 2 unicondylar), and 20 patients (13%) underwent arthroscopic debridement. These patients were excluded from the assessment of clinical and radiographic outcomes to evaluate the natural history of conservative management. No postoperative complications or secondary surgeries were encountered in the repair group during a mean follow-up period of 32±11 months. At the final follow-up, the repair group had significantly higher LKS scores compared to the control group (78±19 *vs.* 65±32, p=0.021). While final IKDC scores were not significantly different (61±17 *vs.* 57±30, p=0.403), the changes from baseline were significantly greater in the repair group for both LKS (+46±25 *vs.* +36±38, p=0.046) and IKDC scores (+38±18 *vs.* +26±27, p=0.002).

Radiographically, preoperative K-L grades were similar between groups. However, at final

TABLE III
Clinical outcome scores of the treatment groups

	Repair group (n=41)	Control group (n=123)	
Outcome	Mean±SD	Mean±SD	*p*
Final Lysholm score	78±19	65±32	0.021
Final IKDC score	61±17	57±30	0.403
Change in Lysholm score	46±25	36±38	0.046
Change in IKDC score	38±18	26±27	0.002

SD: Standard deviation; IKDC: International Knee Documentation Committee.

TABLE IV
The radiographic classifications and clinical scores of the study groups at the latest follow-up

	Preoperative repair group		Preoperative control group		Final repair group		Final control group	
KL grade	n	%	n	%	n	%	n	%
Grade 1	5	5	15	12	4	10	13	11
Grade 2	36	88	108	88	32	78	92	75
Grade 3	-	-	-	-	5	12	4	3
Grade 4	-	-	-	-	0	0	14	11

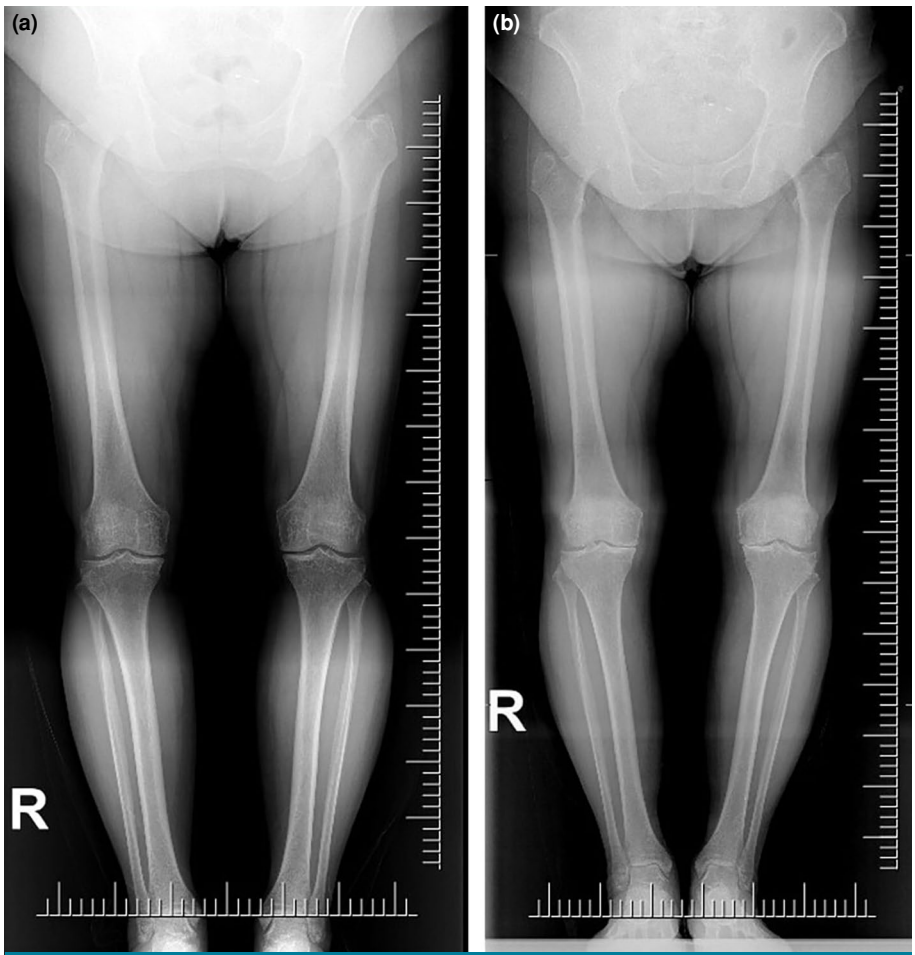


FIGURE 3. Standing anteroposterior radiographs of both knees in a patient diagnosed with bilateral MMPRTs. Arthroscopic repair was recommended for both knees; however, the patient declined surgical intervention and was managed conservatively. **(a)** Baseline radiograph demonstrating Kellgren-Lawrence Grade 2 osteoarthritis in the medial compartments bilaterally. **(b)** One-year follow-up radiograph showing progression of Kellgren-Lawrence Grade from 2 to 3 in both knees.
MMPRTs: Medial meniscus posterior root tears.

follow-up, the control group had a significantly higher proportion of Grade 4 OA (11%) compared to none in the repair group (p=0.027) (Figure 3). Table III presents the radiographic classifications (K-L grades) of the study groups at the latest follow-up, while Table IV summarizes the final LKS and IKDC scores and changes from baseline.

DISCUSSION

In the present study, we assessed clinical and radiographic outcomes in patients diagnosed with MMPRT who underwent either arthroscopic transtibial pull-out repair or conservative management. The main finding of this study was that patients who underwent arthroscopic transtibial pull-out repair for MMPRT achieved significantly greater improvements in LKS and IKDC scores, along with improved radiographic preservation, compared to those managed conservatively, in line with our initial hypothesis. Notably, the repair group began with lower baseline IKDC scores yet demonstrated greater overall improvement, suggesting a potentially larger treatment effect despite worse initial functional status. In addition, 20% of the patients managed non-operatively required subsequent surgery, and 7% underwent TKA during the follow-up period, highlighting the potential for disease progression in the absence of surgical intervention.

These findings are also consistent with previous studies reporting functional and structural benefits of repair over conservative management. Wang et al.[8] reported mean postoperative improvements of 41.6 points in LKS scores and 29.7 points in IKDC scores following arthroscopic repair, while Ahn et al.[10] observed significantly higher postoperative LKS (77.1 *vs.* 57.6) and IKDC (68.9 *vs.* 53.3) scores in surgically treated patients compared to those treated conservatively. Similarly, systematic reviews and meta-analyses by Perry et al.,[17] Krivicich et al.,[24] and Elnewishy et al.[25] showed that repair was associated with improved patient-reported outcomes, reduced rates of OA progression, and a lower incidence of conversion to arthroplasty. However, the literature also indicates that successful anatomical repair does not always translate into complete biomechanical restoration. Several longitudinal imaging studies have demonstrated persistent or progressive medial meniscal extrusion and joint space narrowing after repair, despite symptomatic improvement.[11,19,26-28] Given these observations, adjunct meniscal centralization has been advocated to address persistent or progressive extrusion by tethering the meniscotibial-meniscocapsular complex to the tibial plateau and recentering the mid-body of the meniscus. Biomechanical work demonstrates that centralization restores near-native forces on a posterior medial meniscus root repair and mitigates varus-related load increases, supporting its use, when peripheral attachments are lax or disrupted.[29] Early clinical data, including a comparative series, suggest that adding centralization to root repair yields greater reductions in medial meniscal extrusion and improved patient-reported outcomes versus isolated repair at two years.[30] Nevertheless, techniques (transtibial sutures *vs.* anchor-based) and indications remain heterogeneous, and high-quality prospective trials are still needed.[31,32] Since centralization was not performed in our cohort, its potential effect on radiographic progression remains uncertain; future studies should investigate this aspect, and clinicians should consider the technique while managing patients with >3 mm extrusion and correctable alignment.[33,34]

In the present study, the between-group difference in LKS scores at final follow-up (13 points) exceeded the minimal clinically important difference (MCID) of approximately 10 points reported for various knee pathologies, including meniscal injuries.[35] This suggests a clinically meaningful benefit for patients undergoing repair. Although the difference in IKDC change from baseline was statistically significant, the absolute between-group difference at final follow-up did not exceed the commonly reported MCID threshold of 11.5 points, indicating a more modest functional advantage by this measure.[36,37] These observations suggest that while repair reliably improves symptoms and function, the magnitude of benefit may vary depending on the assessment tool.

Radiographic evaluation using K-L grading demonstrated a significant difference in OA progression between groups. None of the repair patients progressed to K-L Grade 4, whereas 11% of the conservative group did. This finding aligns with Bernard et al.,[6] who reported less radiographic progression after repair compared to non-operative management or meniscectomy. Lee et al.[38] conducted a systematic review of 56 studies involving 3,191 patients and found that meniscus root repair provides improved radiological preservation, lower progression to TKA, and greater functional improvement compared to partial meniscectomy or non-operative management. These findings suggest that repair may slow degenerative changes by restoring more normal load distribution within the knee, thereby mitigating cartilage wear. However, it should be noted that we did not assess meniscal extrusion, an increasingly recognized radiographic marker of meniscal function and a predictor of OA progression.[20]

A key strength of this study is the relatively large number of patients as a single-center comparative cohort. The 3:1 ratio between the conservative and surgical groups reflects real-world patterns at our institution, where many patients meeting surgical indications opt for non-operative care. Including all eligible controls increased statistical power for detecting differences in outcomes.

Nonetheless, several limitations must be acknowledged. The retrospective design inherently carries risks of bias and confounding. Treatment allocation was based on patient preference rather than randomization, introducing selection bias. Patients who declined surgery may differ systematically in motivation, activity level, baseline symptoms, or comorbidities from those who elected to undergo repair. While baseline characteristics were compared and found to be broadly similar in

terms of age, BMI, OA severity, and preoperative LKS scores, unmeasured confounding cannot be excluded. We did not perform multivariate adjustment or propensity score matching, which would have strengthened the internal validity of our comparisons.

Furthermore, 31 patients from the conservative group who subsequently underwent surgical intervention were excluded from outcome analysis to focus on the natural history of untreated MMPRT. While this preserved the intention of the study, it may underestimate the true clinical burden of conservative management, as these "crossover" patients likely represent treatment failures. Our reliance on K-L grading as the sole radiographic measure limits the granularity of structural assessment. As noted, meniscal extrusion and cartilage thickness were not evaluated. The MRI follow-up would have provided more detailed insights into joint preservation and meniscal healing. Additionally, the follow-up duration (mean ~30 months) is relatively short compared to some long-term series, and it is possible that differences in structural outcomes may evolve over a longer period. The imbalance in group sizes, while reflective of real-world practice, may have influenced statistical comparisons. The larger control group could increase precision in estimating non-operative outcomes, but may also limit direct comparability.

In conclusion, our study showed that arthroscopic transtibial pull-out repair for MMPRTs provided a more favorable clinical improvement and radiographic preservation compared to conservative management over a minimum two-year follow-up. Patients who underwent repair achieved significantly greater gains in LKS and IKDC scores, despite having worse baseline function, and none required subsequent surgery or progressed to K-L Grade 4 OA. These findings align with prior literature supporting repair as the preferred option for appropriately selected patients, particularly those with early-stage OA, neutral or mild varus alignment, and preserved joint space. While non-operative management may be suitable for certain low-demand or comorbid patients, it carries higher risks of deterioration and surgical conversion. Future multi-center, large-scale, prospective, randomized-controlled studies with longer follow-up and advanced imaging techniques are necessary to confirm these benefits and further clarify the role of adjunct techniques, such as meniscal centralization, in optimizing long-term outcomes.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea/concept, design, analysis and/or Interpretation; Y.O.K., İ.Y.Ç.; Control/supervision, critical review; İ.Y.Ç.; Data collection and/or processing, literature review, writing the article, references and fundings, materials; Y.O.K.

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