ORIGINAL ARTICLE

Clinical and radiological outcomes of a cartilage-preserving pinhole transtibial technique versus standard pull-out repair for traumatic posterior meniscal root tears

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ABSTRACT

BACKGROUND: Traumatic posterior meniscal root tears disrupt normal load transmission, resulting in meniscal extrusion and accelerated osteoarthritis. Although transtibial pull-out repair is widely used, creation of a 4.5-mm tibial tunnel at the joint surface may cause iatrogenic chondral and subchondral bone damage at the root footprint. This study aimed to compare the clinical and radiological outcomes of a modified aperture-preserving pinhole technique, designed to avoid reaming at the tibial joint surface, with those of the standard transtibial pull-out repair.

METHODS: A total of 60 patients with symptomatic posterior meniscal root tears treated between December 2021 and December 2024 were retrospectively analyzed. Patients were divided into two groups according to the surgical technique used. The standard pull-out group (n=30) underwent transtibial repair using a 4.5-mm tibial tunnel created by reaming at the joint surface for suture passage. The modified pinhole group (n=30) was treated with an aperture-preserving technique in which fixation was achieved through a narrow pinhole channel without reaming or drilling at the tibial articular surface, thereby preserving the subchondral bone at the root footprint. In both groups, final fixation was performed using a cortical post-fixation screw. Clinical evaluations were performed preoperatively and at 6 and 12 months postoperatively using the Lysholm Knee Score, International Knee Documentation Committee (IKDC) score, Knee Injury and Osteoarthritis Outcome Score (KOOS), and Visual Analog Scale (VAS) for pain. Radiological assessment was conducted using magnetic resonance imaging to evaluate meniscal extrusion and healing status, classified as complete healing, partial (loose) healing, or failed healing.

RESULTS: Both groups demonstrated significant improvement in all functional outcome scores compared with preoperative values ($p<0.001$). At the 12-month follow-up, the modified pinhole group showed significantly higher Lysholm, IKDC, and KOOS scores than the standard pull-out group, whereas improvements in VAS pain scores were comparable between groups. Meniscal extrusion decreased postoperatively in both groups, with a significantly greater reduction observed in the modified pinhole group. Complete healing was observed in 80% of patients in the modified pinhole group and 60% in the standard pull-out group. No major complications were recorded during the follow-up period.

CONCLUSION: Both surgical techniques resulted in satisfactory clinical and radiological outcomes for posterior meniscal root repair. However, the aperture-preserving modified pinhole technique was associated with superior functional outcomes, reduced progression of meniscal extrusion, and a higher rate of complete healing. Preservation of the subchondral bone and minimization of iatrogenic joint surface damage may positively contribute to meniscal root healing.

Keywords: Arthroscopic repair; meniscal extrusion; meniscal root tear; pinhole technique; transtibial pull-out.

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INTRODUCTION

The menisci play a critical role in load distribution, shock absorption, and joint stability within the knee joint.[1] Traumatic meniscal root tears are defined as disruptions of the meniscus at its tibial footprint attachment and occur most frequently in the posterior horn of the medial meniscus.[2] These injuries compromise the hoop stress mechanism of the meniscus, resulting in meniscal extrusion, increased tibiofemoral contact pressures, and accelerated cartilage degeneration.[3] Increasing biomechanical and clinical evidence indicates that meniscal root tears functionally resemble total meniscectomy rather than partial meniscectomy, because loss of the root attachment abolishes hoop stress transmission and leads to a marked increase in joint contact pressures.[4]

The transtibial pull-out technique, which relies on cortical fixation by passing sutures through a tibial tunnel, is currently the most widely used surgical method for treating meniscal root tears.[5] Alternatively, suture anchor–based techniques have been described and are proposed to provide more anatomical fixation at the joint surface.[6] However, the technical complexity of anchor-based repairs and their proximity to neurovascular structures may increase the risk of iatrogenic complications.[7] Although the transtibial tunnel technique is generally considered technically less demanding, concerns have been raised that creation of a 4-5 mm tunnel at the joint surface may cause iatrogenic cartilage and subchondral bone damage at the meniscal root footprint.[8,9]

In the classic transtibial pull-out technique, a 4.5-mm cannulated reamer is used to create a tibial tunnel over a guide wire. Sutures passed through the meniscal root are subsequently retrieved through this tunnel and secured using a cortical button or a post-fixation screw.[10] However, the relatively large aperture at the joint surface may increase the risk of local cartilage and subchondral bone injury.[11] In the modified technique described in this study, the pinhole opening created by the guide pin at the joint surface was used directly without reaming. Sutures were retrieved through this minimal aperture with the aid of a loop and then fixed with a post-fixation screw at the distal cortex. This approach was designed to preserve the fixation strength of the transtibial technique while minimizing iatrogenic damage to the joint surface and subchondral bone.

The purpose of this study was to compare the clinical and radiological outcomes of two transtibial techniques for the surgical treatment of traumatic posterior meniscal root tears: the conventional technique using a 4.5-mm tibial tunnel and a cartilage-preserving modified technique that avoids reaming at the joint surface. We hypothesized that the aperture-preserving technique would provide at least equivalent outcomes in terms of meniscal extrusion and functional recovery at 12-month follow-up compared with the standard transtibial pull-out method.

MATERIALS AND METHODS

This single-center retrospective study was conducted following approval by the Ankara Provincial Health Directorate Non-Interventional Ethics Committee (Date: October 17, 2025; Decision no: 2025-10-1) and in accordance with the principles of the Declaration of Helsinki. A total of 60 patients who underwent arthroscopic repair for traumatic posterior medial meniscal root tears between December 2021 and December 2024 were included.

Patients were divided into two groups according to the transtibial repair technique used. In Group A (n=30), a standard transtibial pull-out technique was performed in which a tibial tunnel was created using a 4.5-mm cannulated reamer over a guide pin. Sutures passed through the meniscal root were retrieved through the tunnel using a shuttle loop and fixed with a post-fixation screw at the distal cortex. In Group B (n=30), an aperture-preserving modified technique was used. After the tibial guide pin exited the joint surface, the pinhole opening was utilized directly without reaming. Sutures were retrieved through this minimal aperture using a loop and similarly fixed with a post-fixation screw at the distal cortex.

Meniscal centralization was not performed in either group, and no additional sutures or anchors were used for meniscal body stabilization. Surgical intervention in all cases was limited strictly to posterior meniscal root repair using the respective techniques.

Inclusion criteria were: age between 18 and 65 years; symptomatic posterior meniscal root tear of traumatic origin; confirmation of the root tear on magnetic resonance imaging (MRI); Kellgren–Lawrence osteoarthritis grade ≤2; and mechanical axis deviation ≤5°.

Exclusion criteria included previous surgery on the same knee; requirement for concomitant high tibial osteotomy or ligament reconstruction; associated ligament injuries; advanced cartilage lesions (Outerbridge grade ≥3); degenerative meniscal root tears; or inability to comply with regular postoperative follow-up.

Traumatic posterior meniscal root tears were defined using a composite diagnostic approach incorporating clinical history, magnetic resonance imaging findings, and intraoperative assessment. Patients were required to have a clearly documented history of acute knee trauma. Preoperative MRI had to demonstrate features suggestive of an acute root injury, including sharp tear margins and/or associated bone marrow edema. In addition, intraoperative arthroscopic examination was required to confirm an acute avulsion-type tear of the posterior meniscal root at its tibial footprint. Only patients fulfilling all three criteria were classified as having traumatic posterior meniscal root tears and included in the traumatic group.

All procedures were performed arthroscopically by a single experienced orthopedic surgeon using standard anteromedial and anterolateral portals. Two high-strength sutures were

passed through the meniscal root using a standardized suture configuration. The tibial tunnel entry point was located anteromedially, just medial to the tibial tuberosity and slightly proximal to the pes anserinus.

In Group A, a 4.5-mm cannulated reamer was advanced over the guide pin to create a tibial tunnel through which the sutures were retrieved externally using a shuttle loop (Fig. 1). In Group B, after the guide pin exited the joint surface, a loop suture was passed through the pinhole opening, allowing retrieval of the sutures without reaming (Fig. 2). In both groups, final fixation was achieved using a post-fixation screw placed at the distal cortex.

Postoperatively, all patients followed the same standardized rehabilitation protocol. During the first 6 weeks, a knee brace limiting flexion to 0-90° was used, and partial weight-bearing was permitted. Full weight-bearing was initiated between weeks 6 and 12. Deep squatting and kneeling were prohibited for 3 months. Strengthening and proprioceptive exercises were initiated after the fourth postoperative month, and return to sports activities was permitted between 6 and 9 months according to individual functional recovery.

Clinical evaluations were performed preoperatively and at 6 and 12 months postoperatively. Functional outcomes were assessed using the Lysholm Knee Score, International Knee Documentation Committee (IKDC) score, and Knee Injury and Osteoarthritis Outcome Score (KOOS). Pain intensity was evaluated using the Visual Analog Scale (VAS).

Radiological evaluation was conducted using MRI in the coronal, sagittal, and axial planes. Meniscal extrusion was measured in millimeters on coronal images as the distance between the outer edge of the tibial plateau and the peripheral margin of the meniscus. The difference between preoperative and 12-month postoperative extrusion values was analyzed, and extrusion ≥3 mm was considered pathological.

MRI assessments were performed independently by two observers blinded to both the surgical technique and clinical outcomes. Interobserver reliability was evaluated using the intraclass correlation coefficient (ICC).

Meniscal root healing was assessed on postoperative MRI and classified into three categories according to predefined radiological criteria.

Complete healing was defined as anatomical continuity of the repaired meniscal root with its native tibial attachment, restoration of normal meniscal morphology, and absence of displacement or a gap at the footprint. Partial (loose) healing was defined as continuity between the meniscal root and tibial attachment with incomplete integration, mild displacement, or persistent increased signal intensity at the repair site, indicating incomplete biological healing. Failed healing was defined as persistent discontinuity, redisplacement, re-avulsion of the root, or absence of structural continuity on MRI. All MRI evaluations were performed using standardized protocols.

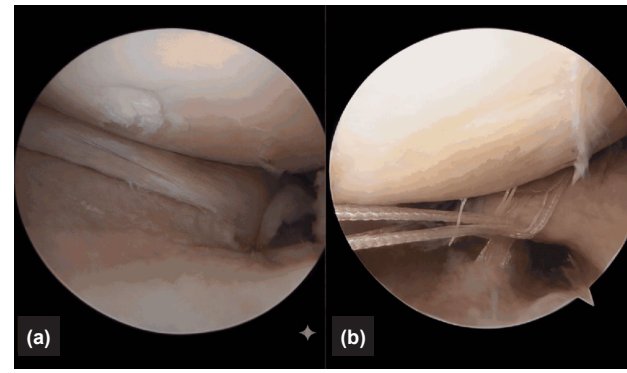

Figure 1. Arthroscopic images demonstrating a posterior meniscal root tear **(a)** and creation of a 4.5-mm tibial tunnel for standard pull-out repair **(b)**.

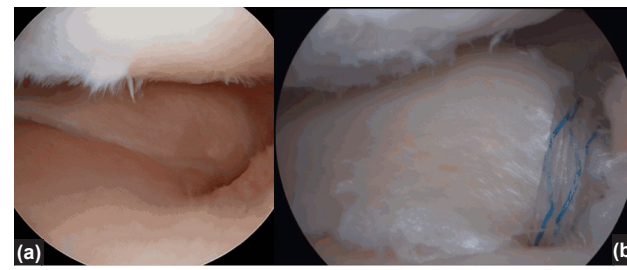

Figure 2. Arthroscopic images demonstrating a posterior meniscal root tear **(a)** and the aperture-preserving pinhole transtibial repair technique performed using only the guide pin without additional reaming **(b)**.

Patient allocation to each surgical technique was not randomized. The choice of technique was based on the surgeon's clinical preference and intraoperative assessment rather than chronological order. All procedures were performed by a single surgeon experienced in both techniques before the study period; therefore, the potential influence of a learning curve was considered minimal.

Representative MRI images demonstrating complete, partial (loose), and failed healing were prepared and provided as supplementary material to improve the reproducibility and clarity of radiological assessment (Fig. 3).

Statistical Analysis

All statistical analyses were performed using SPSS software (IBM Corp., version 11.5, Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were presented as frequencies and percentages. Normality of data distribution was assessed using the Kolmogorov–Smirnov test.

For intergroup comparisons, Student's t-test was used for continuous variables with normal distribution, whereas the Mann–Whitney U test was applied for variables that did not meet normality assumptions. Categorical variables were analyzed using the chi-square test or Fisher's exact test, as appropriate.

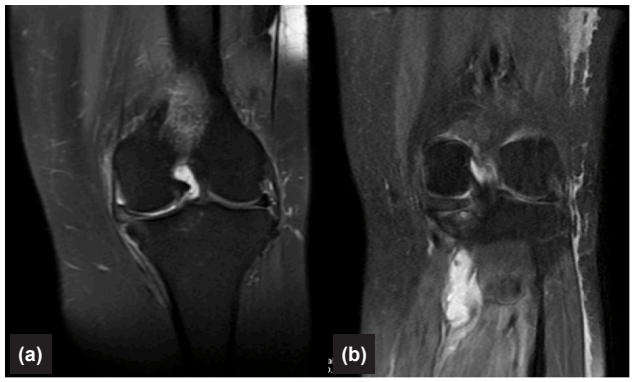

Figure 3. Coronal magnetic resonance imaging demonstrating posterior medial meniscal root pathology and postoperative appearance. **(a)** Preoperative image showing meniscal extrusion associated with a posterior medial meniscal root tear. **(b)** Postoperative image obtained after arthroscopic repair, demonstrating reduction of meniscal extrusion and restoration of meniscal position at the tibial plateau.

Changes in clinical and radiological parameters over time were evaluated using repeated-measures analysis of variance (ANOVA). When statistically significant differences were detected, Bonferroni-adjusted post hoc tests were performed for pairwise comparisons. Interobserver reliability for radiological measurements was assessed using the intraclass correlation coefficient. A p value <0.05 was considered statistically significant for all analyses.

RESULTS

A total of 60 patients were included in the study, with 30 patients in Group A (transtibial pull-out technique) and 30 patients in Group B (pinhole technique). No statistically significant differences were observed between the groups regarding age, sex distribution, body mass index, affected side, or follow-up duration (p>0.05) (Table 1). The mean follow-up period was 26.4±3.1 months in Group A and 25.9±2.8 months in Group B.

Table 1. Demographic characteristics of the patients

Characteristic	Group A (n=30)	Group B (n=30)	p
Age (years, mean±SD)	56.8±6.2	55.9±6.5	0.62
Gender (female/male)	14/16	13/17	0.79
BMI (kg/m², mean±SD)	27.6±2.9	27.3±3.1	0.74
Affected side (right/left)	17/13	18/12	0.80
Follow-up duration (months)	26.4±3.1	25.9±2.8	0.58

BMI: Body mass index.

Table 2. Comparison of clinical outcome scores between groups at preoperative and postoperative follow-up

Score	Group	Preoperative (mean±SD)	6 months (mean±SD)	12 months (mean±SD)	p (within-group)	p (between groups at 12 months)
Lysholm score	A	52.1±7.8	78.4±6.5	83.9±6.1	0.001	
	B	51.6±8.2	82.6±6.3	88.7±5.7	0.001	0.021
IKDC score						
	A	47.8±8.0	72.9±7.1	78.6±6.4	0.001	
	B	48.4±7.6	77.2±6.8	83.4±6.0	0.001	0.018
KOOS						
	A	46.2±8.7	71.8±7.4	76.9±6.9	0.001	
	B	47.1±8.3	75.9±7.2	81.8±6.7	0.001	0.026
VAS score (0–10)	A	6.8±1.0	2.7±0.9	2.1±0.8	0.001	
	B	6.7±0.9	2.4±0.8	1.8±0.7	0.001	0.19

IKDC: International Knee Documentation Committee; KOOS: Knee Injury and Osteoarthritis Outcome Score; VAS: Visual Analog Scale.

No significant differences were observed between the groups in preoperative Lysholm, International Knee Documentation Committee, Knee Injury and Osteoarthritis Outcome Score, or Visual Analog Scale scores (p>0.05). Both groups demonstrated significant improvement in all clinical outcome scores at postoperative follow-up compared with preoperative values (p<0.001). Improvements observed at the 6-month follow-up were comparable between groups. However, at the 12-month evaluation, Lysholm (88.7±5.7 vs. 83.9±6.1; p=0.021), IKDC (83.4±6.0 vs. 78.6±6.4; p=0.018), and KOOS (81.8±6.7 vs. 76.9±6.9; p=0.026) scores were significantly higher in Group B than in Group A. VAS scores decreased significantly in both groups compared with preoperative values (p<0.001), with no statistically significant difference between the groups at final follow-up (p=0.19) (Table 2).

Effect size analysis demonstrated a large effect for Lysholm scores (Cohen's d=0.81), a moderate-to-large effect for IKDC scores (d=0.77), a moderate effect for KOOS scores (d=0.72), and a small effect for VAS scores (d=0.40), all favoring Group B (Table 3). Although the absolute differences in mean functional scores did not exceed the reported minimal clinically important difference thresholds, a consistent trend toward higher functional outcome scores was observed in the pinhole technique group.

Radiological evaluation revealed no significant difference in preoperative meniscal extrusion between Group A (4.0±0.9 mm) and Group B (4.6±1.0 mm; p=0.68). At the 12-month follow-up, meniscal extrusion decreased significantly in both groups compared with preoperative values. The magnitude of extrusion reduction was significantly greater in Group B than in Group A (Δ extrusion: 1.4±0.6 mm vs. 0.9±0.5 mm; p=0.008). In addition, mean meniscal extrusion at 12 months was lower in Group B than in Group A (3.1±1.0 mm vs. 3.2±0.9 mm; p=0.031) (Table 4).

Regarding meniscal root healing status, complete healing was observed in 18 patients (60%) in Group A, partial (loose) healing in eight patients (26.7%), and failed healing in four

Table 3. Effect size analysis (Cohen's d) and minimal important difference (MID) thresholds for functional outcome scores

Score	Group A (mean±SD)	Group B (mean±SD)	Mean difference	Pooled SD	Cohen's d	Effect magnitude	Reported MID	Clinical interpretation
Lysholm score	83.9±6.1	88.7±5.7	4.8	5.9	0.81	Large	8–10 points	Borderline clinical relevance
IKDC score	78.6±6.4	83.4±6.0	4.8	6.2	0.77	Moderate-to-large	9–11 points	Borderline clinical relevance
KOOS	76.9±6.9	81.8±6.7	4.9	6.8	0.72	Moderate	8–10 points	Borderline clinical relevance
VAS score	2.1±0.8	1.8±0.7	0.3	0.75	0.40	Small	1.0–1.5 cm	Clinically minor difference

IKDC: International Knee Documentation Committee; KOOS: Knee injury and Osteoarthritis Outcome Score; VAS: Visual Analog Scale; MID: Minimal important difference; SD: Standard deviation.

Table 4. Radiological findings and meniscal healing status at 12-month follow-up

Characteristic	Group A (n=30)	Group B (n=30)	p
Preoperative extrusion (mm)	4.0±0.9	4.6±1.0	0.68
Extrusion at 12 months (mm)	3.2±0.9	3.1±1.0	0.031
Δ Extrusion (mm)	0.9±0.5	1.4±0.6	0.008
Complete healing, n (%)	18 (60.0%)	24 (80.0%)	0.047
Partial (loose) healing, n (%)	8 (26.7%)	5 (16.7%)	
Failed healing, n (%)	4 (13.3%)	1 (3.3%)	

BMI: Body mass index.

Table 5. Postoperative complications observed in both groups

Characteristic	Group A (n=30)	Group B (n=30)
Cartilage degeneration around the tunnel	2	0
Suture failure	1	0
Suture abrasion	0	1
Revision surgery required	1	1
Major complication (infection, neurovascular injury, thromboembol-ic events)	0	0

patients (13.3%). In Group B, complete healing was observed in 24 patients (80%), partial healing in five patients (16.7%), and failed healing in one patient (3.3%). The difference in complete healing rates between the groups was statistically significant (p=0.047) (Table 4).

With respect to complications, cartilage degeneration around the tibial tunnel was observed in two patients and suture failure in one patient in Group A. In Group B, one patient required revision surgery because of suture abrasion. No major complications, including infection, thromboembolic events, or neurovascular injury, were observed in either group (Table 5).

DISCUSSION

The present study compared the clinical and radiological outcomes of two transtibial techniques used for repair of traumatic posterior meniscal root tears. The principal finding was that, although both techniques resulted in significant postoperative improvement in functional outcomes, the aperture-preserving pinhole technique demonstrated superior Lysholm, IKDC, and KOOS scores at 12-month follow-up. In addition, this technique was associated with a greater reduction in meniscal extrusion and a higher rate of complete meniscal root healing on magnetic resonance imaging. These findings suggest that avoiding reaming at the tibial joint surface may provide advantages in both functional recovery and meniscal healing.

Despite the statistically significant differences observed between the groups, it is important to acknowledge that the absolute improvements in Lysholm and IKDC scores did not exceed established minimal clinically important difference thresholds. Nevertheless, the consistent trend toward higher patient-reported outcome scores and the moderate-to-large effect sizes observed in the pinhole group suggest a meaningful functional advantage at the group level. These findings highlight the importance of interpreting statistical significance in conjunction with effect size and overall functional patterns rather than relying solely on absolute score differences.

Untreated meniscal root tears are known to disrupt knee biomechanics, leading to loss of hoop stress transmission, increased contact pressures, and accelerated osteoarthritic degeneration.[12] Consequently, contemporary treatment strategies emphasize anatomic restoration of the meniscal root attachment to the tibial footprint.[13] Previous studies have demonstrated that meniscal root repair yields superior functional outcomes and lower rates of progression to total knee arthroplasty compared with partial meniscectomy.[14,15] Consistent with this literature, both repair techniques in the present study resulted in significant functional improvement. However, patients treated with the pinhole technique demonstrated higher functional scores and a greater proportion of complete healing at final follow-up, suggesting that preservation of the native root footprint may enhance biological and biomechanical restoration.

Although this study specifically focused on traumatic posterior meniscal root tears, degenerative root tears are more frequently encountered in older patient populations. Degenerative tears often develop in the absence of a distinct traumatic event and are commonly associated with compromised tissue quality, cartilage degeneration, and early osteoarthritis. These biological differences may influence healing capacity and clinical outcomes. Therefore, the results of the present study should be interpreted primarily in the context of traumatic meniscal root injuries, and caution is warranted when extrapolating these findings to degenerative root tears. Further studies specifically addressing degenerative etiologies are needed to improve generalizability.

From a safety perspective, the absence of major complications in the pinhole group suggests that this technique represents a reliable surgical option. Preservation of the joint surface may be particularly advantageous in younger and physically active patients, for whom long-term joint preservation is a key consideration. Nevertheless, both techniques demonstrated acceptable safety profiles and appear to be dependable when performed appropriately.

Previous reports have indicated that large-diameter tibial tunnels created during standard transtibial pull-out repair may contribute to iatrogenic cartilage and subchondral bone damage, potentially promoting postoperative meniscal extru-

sion.[15] Although suture anchor–based techniques have been proposed to preserve the joint surface and limit extrusion, their technical complexity and associated risks may restrict widespread adoption.[14,16] The pinhole technique evaluated in the present study avoids additional reaming at the joint surface while maintaining the fixation principles of transtibial repair. This modification may combine the joint surface–preserving advantages of anchor-based techniques with the technical simplicity and strong fixation associated with transtibial methods.[17]

Biomechanical studies have further supported the rationale for minimizing tibial tunnel diameter. Cinque et al.[18] demonstrated that larger bony defects at the tibial footprint can lead to micromotion at the fixation site, described as the "bungee" and "windshield-wiper" effects, which may promote progressive meniscal extrusion. Similarly, Kim et al.[9] reported that modified techniques using smaller tunnels resulted in reduced extrusion and improved biomechanical stability. The greater reduction in meniscal extrusion observed in the pinhole group in the present study is consistent with these biomechanical findings and supports the concept that aperture preservation contributes to a more stable repair construct.

Meniscal extrusion is widely regarded as a surrogate marker of meniscal dysfunction and altered load transmission. In the present study, postoperative extrusion decreased in both groups, with a more pronounced reduction observed in the pinhole technique group. This finding suggests that preservation of tibial bone stock and minimization of iatrogenic joint surface damage may facilitate improved meniscal positioning and functional restoration.

Several limitations of this study should be acknowledged. First, its retrospective, single-center design introduces an inherent risk of selection bias, and patient allocation to surgical technique was not randomized. Second, although the mean follow-up duration exceeded 24 months, the primary outcome analyses focused on 12-month data. Consequently, the study was not designed to evaluate long-term cartilage preservation, osteoarthritis progression, or conversion to total knee arthroplasty. In addition, biomechanical testing and second-look arthroscopy were not performed to directly confirm mechanical stability or biological healing. Nevertheless, the use of standardized surgical techniques performed by a single experienced surgeon, a homogeneous patient cohort, and blinded assessment of both clinical and radiological outcomes represent important strengths of the study.

CONCLUSION

Both the standard transtibial tunnel technique and the aperture-preserving modified pinhole technique yielded satisfactory clinical and radiological outcomes in the arthroscopic treatment of traumatic posterior medial meniscal root tears. The modified pinhole technique, performed without reaming at the tibial joint surface, was associated with lower postoperative meniscal extrusion, a higher rate of complete healing, and superior functional scores at 12-month follow-up.

Although statistically significant differences were observed between the techniques, these findings should be interpreted in the context of their absolute magnitude and clinical relevance. The observed advantages of the pinhole technique may not translate into clinically meaningful benefits for every patient, and treatment decisions should take into account individual patient characteristics, functional demands, and surgeon experience. Nevertheless, joint surface–preserving modifications of transtibial meniscal root repair may represent a valuable and safe alternative to conventional techniques in appropriately selected patients.

Ethics Committee Approval: This study was approved by the Ankara Provincial Health Directorate Non-Interventional Ethics Committee (Date: 17.10.2025, Decision No: 2025-10-1).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: M.C.G.; Design: M.C.G.; Data collection and/or processing: M.C.G.; Analysis and/or interpretation: M.D.; Literature review: M.D.; Writing: M.C.G.; Critical review: M.D.

Informed Consent: Retrospective study.

Conflict of Interest: None declared.

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REFERENCES

1. Dzidzishvili L, López-Torres II, Arguello JM, Sáez D, Calvo E. Prognostic factors and midterm clinical outcome of transtibial pullout and partial meniscectomy for medial meniscus posterior root tears in middle-aged patients. Indian J Orthop 2022;56:1457–63. [CrossRef]
2. Hantouly AT, Aminake G, Khan AS, Ayyan M, Olory B, Zikria B, et al. Meniscus root tears: state of the art. Int Orthop 2024;48:955–64. [CrossRef]
3. Eseonu KC, Neale J, Lyons A, Kluzek S. Are outcomes of acute meniscus root tear repair better than debridement or nonoperative management? A systematic review. Am J Sports Med 2022;50:3130–9. [CrossRef]
4. Chung KS, Ha JK, Ra HJ, Kim JG. Prognostic factors in the midterm results of pullout fixation for posterior root tears of the medial meniscus. Arthroscopy 2016;32:1319–27. [CrossRef]
5. Briese T, Kieninger A, Peez C, Deichsel A, Herbst E, Balke M, et al. A novel meniscal root refixation pull-in technique with an all-suture anchor shows biomechanical properties comparable to standard suture anchor and transtibial pull-out techniques. Journal of Experimental Orthopaedics 2025;12:e70310. [CrossRef]
6. Bhatia S, Laprade CM, Ellman MB, Laprade RF. Meniscal root tears: Significance, diagnosis, and treatment. Am J Sports Med 2014;42:3016–30. [CrossRef]
7. Balke M, Akoto R, Offerhaus C, Hoeher J. Suture anchor refixation of meniscal root tears without an additional portal. Arthrosc Tech 2018;7:e511–e15. [CrossRef]
8. Feucht MJ, Kühle J, Bode G, Mehl J, Schmal H, Südkamp NP, et al. Arthroscopic Transtibial pullout repair for posterior medial meniscus root tears: a systematic review of clinical, radiographic, and second-look arthroscopic results. Arthroscopy 2015;31:1808–16. [CrossRef]

9. Kim SB, Ha JK, Lee SW, Kim DW, Shim JC, Kim JG, et al. Medial meniscus root tear refixation: comparison of clinical, radiologic, and arthroscopic findings with medial meniscectomy. Arthroscopy 2011;27:346–54. [CrossRef]
10. Lee DW, Ha JK, Kim JG. Medial meniscus posterior root tear: a comprehensive review. Knee Surg Relat Res 2014;26:125–34. [CrossRef]
11. Ulku TK, Kaya A, Kocaoglu B. Suture configuration techniques have no effect on mid-term clinical outcomes of arthroscopic meniscus root repairs. Knee 2020;27:676–82. [CrossRef]
12. LaPrade CM, James EW, Cram TR, Feagin JA, Engebretsen L, LaPrade RF. Meniscal root tears: a classification system based on tear morphology. Am J Sports Med 2015;43:363–9. [CrossRef]
13. Takase R, Ohsawa T, Hashimoto S, Kurihara S, Yanagisawa S, Hagiwara K, et al. Insufficient restoration of meniscal extrusion by transtibial pullout repair for medial meniscus posterior root tears. Knee Surg Sports Traumatol Arthrosc 2023;31:4895–902. [CrossRef]
14. Seo HS, Lee SC, Jung KA. Second-look arthroscopic findings after repairs of posterior root tears of the medial meniscus. Am J Sports Med 2011;39:99–107. [CrossRef]
15. Moon HS, Choi CH, Jung M, Lee DY, Hong SP, Kim SH. Early surgical repair of medial meniscus posterior root tear minimizes the progression of meniscal extrusion: 2-year follow-up of clinical and radiographic parameters after arthroscopic transtibial pull-out repair. Am J Sports Med 2020;48:2692–702. [CrossRef]
16. Arora M, Jani C, Shukla T. Intra-tunnel knotless anchor fixation for lateral meniscus posterior root tears: a novel technique. Indian J Orthop 2024;58:1657–61. [CrossRef]
17. Xue H, Furumatsu T, Okazaki Y, Hiranaka T, Kintaka K, Zhang X, et al. Histological analysis of repaired tissue after pullout repair of a medial meniscus posterior root tear. Acta Medica Okayama. Okayama University Medical School 2021;75:225–30.
18. Cinque ME, Hinz M, Sidrak J, Hollenbeck JFM, Buchalter WH, Kanakamedala A, et al. Biomechanical comparison of transtibial pull-out fixation versus suture anchor fixation for repair of medial meniscus posterior root tears. Am J Sports Med 2025;53:2128–35. [CrossRef]

ORİJİNAL ÇALIŞMA - *ÖZ*

Travmatik posterior menisküs kök yırtıklarında artriküler yüzeyi koruyan pinhole transtibial teknik ile standart pull-out onarımın klinik ve radyolojik karşılaştırması

AMAÇ: Travmatik Posterior menisküs kök yırtıkları menisküsün stres mekanizmasını bozarak menisküsün ekstrüzyonuna ve erken dönemde osteoartrit gelişimine yol açmaktadır. Transtibial pull-out onarımı menisküs kök tamiri için yaygın olarak kullanılan bir yöntemdir; ancak 4,5 mm çapında tibial tünel açılması kök ayak izi bölgesinde iyatrojenik kıkırdak ve kemik defektlerine neden olabilmektedir. Bu çalışmanın amacı eklem yüzeyinde frezleme gerektirmeyen, açıklığı koruyan modifiye tekniğin standart pull-out yöntemi ile karşılaştırılarak klinik ve radyolojik sonuçlarının değerlendirilmesidir.

GEREÇ VE YÖNTEM: Aralık 2021 ile Aralık 2024 tarihleri arasında travmatik posterior menisküs kök yırtığı bulunan 60 hasta retrospektif olarak çalışmaya dahil edilmiştir. Hastalar iki gruba ayrılmıştır. Birinci gruba 4.5 mm çapında tibial tünel açılarak standart pull-out onarımı yapılan 30 hasta dahil edildi. İkinci gruba eklem yüzeyinde frezleme yapılmadan modifiye pinhole tekniği uygulanan 30 hasta dahil edildi. Her iki grupta da fiksasyon kortikal postfiksasyon vidası ile yapıldı. Hastaların klinik değerlendirmeleri ameliyat öncesinde, ameliyat sonrası altıncı ve on ikinci aylarda yapılmıştır. Fonksiyonel değerlendirmede Lysholm diz skoru (Lysholm), Uluslararası Diz Dokümantasyon Komitesi skoru (International Knee Documentation Committee), Diz Yaralanması ve Osteoartrit Sonuç Skoru (Knee Injury and Osteoarthritis Outcome Score) ve görsel analog ağrı skoru (Visual Analogue Scale) kullanılmıştır. Radyolojik değerlendirme manyetik rezonans görüntüleme ile yapılmış ve menisküs ekstrüzyonu ile iyileşme durumu (tam, kısmi, başarısız) incelenmiştir.

BULGULAR: Her iki grupta da fonksiyonel skorlar ameliyat öncesine göre anlamlı düzeyde artış göstermiştir ($p<0.001$). On ikinci ay değerlendirmesinde modifiye pinhole tekniği uygulanan grupta Lysholm diz skoru, Uluslararası Diz Dokümantasyon Komitesi skoru ve Diz Yaralanması ve Osteoartrit Sonuç Skoru standart pull-out grubuna göre anlamlı olarak daha yüksek bulunmuştur. Görsel analog ağrı skorundaki iyileşme ise iki grup arasında benzer bulunmuştur. Menisküs ekstrüzyonu her iki grupta da artmış olmakla birlikte, artış miktarı modifiye pinhole grubunda daha düşük saptanmıştır. Tam iyileşme oranı modifiye pinhole grubunda %80, standart pull-out grubunda ise %60 bulunmuştur. Çalışma süresince majör komplikasyon izlenmemiştir.

SONUÇ: Posterior menisküs kök yırtıklarının onarımında her iki teknik de tatmin edici sonuçlar sağlamaktadır. Bununla birlikte eklem yüzeyinde açıklığı koruyan ve frezleme gerektirmeyen modifiye pinhole tekniği daha iyi fonksiyonel iyileşme, daha düşük menisküs ekstrüzyon progresyonu ve daha yüksek tam iyileşme oranı ile üstünlük göstermektedir. Eklem yüzeyinde iyatrojenik hasarın en aza indirilmesi menisküs kök onarımının başarısını artırabilir.

Anahtar sözcükler: Artroskopik onarım; menisküs ekstrüzyonu; menisküs kök yırtığı; pinhole tekniği; transtibial pull-out.

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