RESEARCH ARTICLE

Evaluating the Outcome of Meniscus Root Repair Surgery in Patients with Degenerative Meniscus Posterior Root Tears

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Received: 6 January 2024 *Accepted: 22 January 2025*

Abstract

Objectives: Transtibial pullout repair provides significant clinical improvement in individuals with meniscal root tears; however, there is no consensus on radiological outcomes. In this research, meniscal extrusion and clinical status were evaluated in a homogeneous series of subjects with degenerative medial meniscus posterior root tears (MMPRT).

Methods: This retrospective-prospective study was conducted on 16 subjects with degenerative posterior root tears of the medial meniscus who underwent transtibial pullout repair at Shafa Yahyaian Hospital from March 2017 to February 2021. The study population included two males and 14 females. The average age of the study participants was 50.9 ± 11 years. The patients were followed up for an average of 19.7±14.8 months. The Lysholm knee scoring scale was used for clinical evaluation of the knee. MRI (magnetic resonance imaging) was used both before and after surgery to assess the improvement in meniscal extrusion.

Results: The average total Lysholm knee score increased from 49.6±10.5 to 79.1±11.1 (P<0.001). The knee status was poor in one subject, fair in ten subjects, good in two subjects, and excellent in three subjects. In the last follow-up session, all subscales of the Lysholm Knee Scoring Scale showed improvement. The mean meniscal extrusion was 5.7±1.8 mm before surgery and 3.4±2.5 mm after surgery based on MRI results (P=0.008). Improvement in Lysholm score was not correlated with improvement in meniscal extrusion.

Conclusion: Transtibial pullout repair provides significant clinical improvement in degenerative meniscal root tears, even in individuals in whom the meniscal extrusion is not reversed.

Level of evidence: IV

Keywords: Degenerative meniscal root tear, Meniscal extrusion, Transtibial pullout technique

Introduction

The knee meniscus is a viscoelastic structure located between the tibia and femur that distributes axial loads and absorbs unexpected shocks by increasing the tibiofemoral load-bearing contact area and reducing contact pressure.[1,2] A meniscal root tear occurs when the root attachment is avulsed or destabilized from its insertion, which may involve either the anterior or posterior roots of the medial or lateral meniscus.[3,4] These tears can result from trauma, but are more commonly degenerative. Degenerative meniscal root tears most frequently affect the posterior root of the medial meniscus in middle-aged women.[4-7]

Biomechanical disruptions caused by meniscal root tears increase tibiofemoral contact pressure, thereby predisposing patients to early-onset degenerative osteoarthritis.[8] While non-surgical treatments may provide short-term symptomatic relief and functional improvement, they do not halt the progression of knee joint

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THE ONLINE VERSION OF THIS ARTICLE ABJS.MUMS.AC.IR

Arch Bone Jt Surg. 2025; 13(10):656-662 Doi: 10.22038/ABJS.2025.76992.3556 http://abjs.mums.ac.ir

degeneration.[9,10] Consequently, surgical intervention is typically recommended to delay degenerative changes and enhance both function and symptoms.[11-13] Among surgical options, transtibial pullout repair is widely regarded as an effective technique for managing meniscal root tears.[11,14,15]

This study aimed to evaluate the clinical outcomes of a homogeneous cohort of patients with degenerative posterior root tears of the medial meniscus (MMPRT) who underwent arthroscopic transtibial pullout repair, and to examine the correlation between clinical results and MRI findings.

Materials and Methods

Patients & Methods

The Institutional Review Board of Shafa Yahyaian Hospital, Tehran, Iran, approved this retrospective cohort study. Medical records of patients with meniscal root tears who underwent surgical treatment at the same hospital between March 2017 and February 2021 were reviewed. The inclusion criteria were patients aged 25 years or older with degenerative posterior root tears of the medial meniscus (MMPRT) who underwent arthroscopic transtibial pullout repair and had a minimum follow-up period of one year. Exclusion criteria were: presence of cruciate ligament rupture, osteoarthritis of grade higher than II based on the Kellgren-Lawrence classification,[16] intraoperative Outerbridge chondromalacia grade greater than 3, malalignment greater than 5º, preoperative MRI evidence of subchondral collapse, and poor-quality intraoperative meniscal tissue.[17] Patients who were lost to follow-up were also excluded. Ultimately, 16 eligible patients were included in the study.

Surgery and postoperative protocol

Two orthopedic surgeons performed meniscal root repair surgeries at a single institution. All patients underwent a standardized arthroscopic transtibial pullout technique. Briefly, with the patient in the supine position on a standard operating table, a tourniquet was applied to the proximal thigh. Conventional arthroscopic portals—specifically the high anterolateral and anteromedial parapatellar portals—were established. The knee was then flexed to 90°, and valgus stress was applied to expose the posterior root of the medial meniscus. Anatomically, the posterior root of the medial meniscus inserts anteromedial to the posterior cruciate ligament (PCL), while the lateral root attaches to a distinct transition line separating the central and posterior regions of the medial tibial plateau. This demarcation, visible during arthroscopy, distinguishes the more degenerated central cartilage from the relatively preserved posterior cartilage. The natural resting area of the meniscus, referred to as the "meniscal track," corresponds to the posterior cartilage of the medial tibial plateau. This region is characterized by a slight downward slope, which helps reduce compressive forces. To facilitate optimal healing, the cartilage over the meniscal root footprint was debrided using a shaver and electrocautery, creating a suitable surface for reattachment of the meniscus. The torn meniscal root was then identified and secured using a self-retrieving suture passer with two No. 2-0 FiberWire sutures in a simple cinch stitch configuration. A retrograde ACL tibial guide was used to determine the tunnel position at the meniscal root footprint, and a tibial tunnel was created to a depth of 10 mm using a 4 mm reamer. The sutures were passed through the tibial tunnel with the knee in full extension and fixed with 4.5 mm PopLok® knotless suture anchors (ConMed). The integrity of the repair was confirmed using a probe [Figure 1].

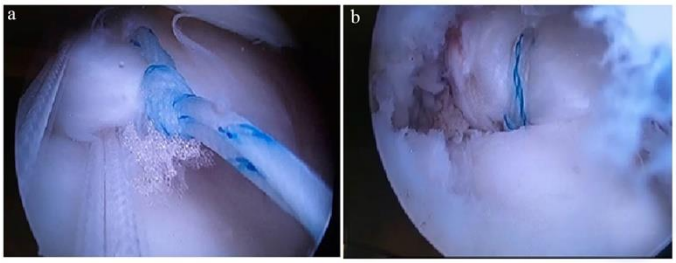

Figure 1. (a) Simple cinch stitch configuration; (b) Transtibial pullout repairing

A knee brace was applied for six weeks following surgery. The knee was kept fully immobilized during the first two postoperative weeks. Thereafter, passive range of motion (ROM) exercises were initiated, starting with flexion up to 90 degrees and gradually progressing to full passive ROM by the end of the sixth week. During this period, patients were permitted to ambulate using two crutches, strictly maintaining a non-weight-bearing status. Emphasis was placed on maintaining full knee extension during ambulation. Subsequently, partial weight bearing was introduced in a controlled manner. The use of the knee brace and crutches was tapered as tolerated. The rehabilitation protocol aimed to achieve normal walking by 12 weeks postoperatively and to allow the resumption of physical activities by 16 weeks.

Clinical evaluation of the outcome

The patients' surgical outcomes were evaluated clinically and radiologically. The clinical outcomes were evaluated using the Lysholm knee scoring scale, which was assessed both before the operation and at the final follow-up session. The Lysholm knee scoring scale evaluates eight categories, including knee swelling (10 points), knee locking (15 points), knee instability (25 points), knee pain (25 points), need for walking support (5 points), squatting (5 points), limping (5 points), and ability to climb stairs (10 points). Moreover, each patient received a score on a 0–100 point scale, with higher scores indicating better knee status. Knee status was classified as follows: poor (Lysholm score <64), fair (Lysholm score 65-83), good (Lysholm score 84-90), and excellent (Lysholm score 91-100).[18]

Radiologic evaluation of the outcome

Radiological evaluation was conducted for all patients who underwent postoperative MRI (n = 16), involving a comparison of meniscal extrusion before and after surgery. MRI scans were performed using a 1.5-Tesla system (Aera, Siemens, Erlangen, Germany). A musculoskeletal radiologist with one year of experience in the field interpreted all images. The radiologist also verified the quality and adequacy of MRI images obtained from external facilities.

Meniscal extrusion was assessed on mid-coronal images, selected by cross-referencing with midline sagittal images at the level of the medial tibial plateau. Extrusion, both preoperatively and postoperatively, was defined as the distance between the most medial edge of the meniscal body and the most medial cortex of the medial tibial plateau, excluding osteophytes [Figures 2 and 3].[19,20]

All measurements were performed using the Persian Gulf PACS viewer system by two independent observers on two separate occasions, six weeks apart. The inter-rater and intra-rater reliability of the measurements were 0.92 and 0.94, respectively, as determined by Cronbach's alpha coefficient. Due to the nature of image access through patients' electronic medical records, blinding of the radiologist during the second round of image assessments was not feasible.

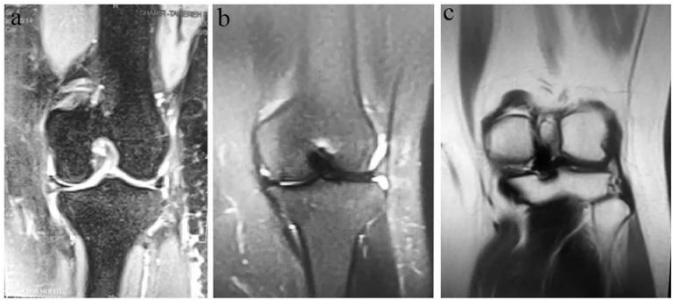

Figure 2. (a) Preoperative radiograph of a 49-year-old female with a degenerative medial meniscus posterior root tear; (b) Postoperative radiograph of the same patient 53 months after surgery; (c) Postoperative MRI of the same patients 53 months after operation

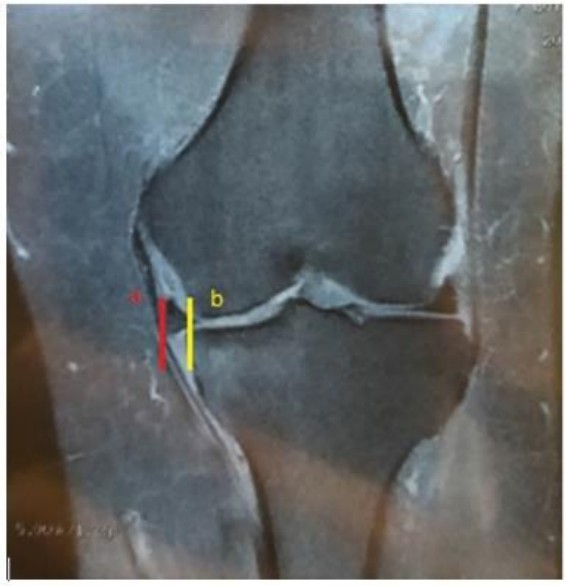

Figure 3. Line (a) shows the most medial portion of the meniscal body and line (b) demonstrates the most medial portion of the medial plateau cortex; The distance between the two lines is regarded as the meniscal extrusion

Statistical analysis

Statistical analysis was performed using SPSS for Windows, Version 16.0 (SPSS Inc., Chicago, IL, USA). Descriptive variables were reported as mean ± standard deviation (SD) or as frequency and percentage, as appropriate. Preoperative and postoperative data were compared using the Wilcoxon signed-rank test. Spearman's correlation coefficient was used to evaluate potential associations between variables. A p-value of < 0.05 was considered statistically significant.

Results

This study included 16 patients, comprising 14 females and 2 males. The mean age of the participants was 50.9 ± 11.0 years (range: 25–65 years), and the mean body mass index (BMI) was 28.9 ± 3.2 kg/m^2 (range: 23–36 kg/m^2). The mean follow-up duration was 19.7±14.8 months, with a range of 12 to 58 months. Patient characteristics are summarized in [Table 1].

Table 1. Characteristic features of patients who underwent surgical treatment for degenerative meniscal root tear

Variable	Mean ± SD or Number (%)
Age (year)	50.9±11
Sex	
• *Male*	2 (12.5)
• *Female*	14 (87.5)
Laterality	
• *Right*	4 (25)
• *left*	12 (75)
BMI (kg/m2)	28.9±3.2
Symptom duration (Months)	14.4±14.6
Follow-up (Month)	19.7±14.8

Data are shown as mean ± standard deviation or number (%)

Prior to surgery, the mean Lysholm score was 49.6±11.5 (range: 36–76), whereas at the final follow-up, the mean score had improved to 79.1±11.0 (range: 52–96), representing a statistically significant difference ($p < 0.001$). A detailed analysis of the Lysholm Knee Scoring Scale revealed improvement across all subdomains [Table 2].

Based on the overall Lysholm Knee Scoring Scale, postoperative knee status was classified as poor in one patient, fair in ten patients, good in two patients, and excellent in three patients.

Postoperative meniscal extrusion decreased in 12 out of 16 patients who underwent follow-up MRI, while an increase was observed in the remaining four patients [Table 3].

The mean meniscal extrusion measured 5.7±1.8 mm (range: 3.0–8.5 mm) before surgery and 3.4±2.5 mm (range: 0–8.5 mm) after surgery, demonstrating a statistically significant reduction ($p = 0.008$).

Among the patients with increased postoperative meniscal extrusion, knee function was rated as excellent in one patient

(Case 9), reasonable in one patient (Case 16), and fair in the remaining two patients (Cases 4 and 11).

There was no significant correlation between the preoperative Lysholm score and the degree of preoperative meniscal extrusion (r = 0.112, p = 0.62). Similarly, no significant association was found between the improvement in Lysholm score and the reduction in meniscal extrusion (r = 0.192, p = 0.47).

Table 2. Comparing the preoperative and postoperative items of Lysholm knee scaling score

Item	Number	Mean ± SD	P-value
Pain			
• *Pre*	16	4.4±5.1	0.002
• *Post*	16	16.3±5.3	
Instability			
• *Pre*	16	14.4±6.3	0.001
• *Post*	16	23.4±2.4	
Lacking			
• *Pre*	16	12.1±3.7	0.01
• *Post*	16	14.7±1.2	
Swelling			
• *Pre*	16	6.4±3.7	0.06
• *Post*	16	8.3±2.5	
Limping			
• *Pre*	16	3.5±0.9	0.13
• *Post*	16	4.1±1	
Stair climbing			
• *Pre*	16	3.3±3.6	0.09
• *Post*	16	5±3	
Squatting			
• *Pre*	16	1.6±1.8	0.08
• *Post*	16	2.4±1.9	
Walking support			
• *Pre*	16	4.3±1.5	0.1
• *Post*	16	4.8±0.7	
Total			
• *Pre*	16	49.6±11.5	<0.001
• *Post*	16	79.1±11	

Data are demonstrated by mean ± standard deviation. P<0.05 is considered significant

Table 3. The detailed demonstration of meniscal extrusion before and after treating degenerative medial meniscus posterior root tear with the transtibial pullout technique

Patient ID	Preoperative meniscal extrusion (mm)	Postoperative meniscal extrusion (mm)
1	6.5	0
2	6.25	3.5
3	3.75	2.4
4	6.5	8.5
5	8	4.75
6	8.5	2.7
7	7.5	4.25
8	8.25	3
9	4.5	5.75
10	5	0

Table 3. Continued		
11	4	5
12	3	0
13	6	5
14	3	0
15	6	5
16	4	5

Discussion

In this study, the clinical and radiological outcomes of transtibial pullout repair for degenerative medial meniscus posterior root tears were evaluated in a cohort of 16 patients. The findings demonstrated a substantial improvement in mean Lysholm scores at the final postoperative follow-up, with all subdomains of the scale showing progress. Postoperative MRI revealed a reduction in meniscal extrusion in 12 out of 16 patients. However, no significant correlation was found between the improvement in Lysholm score and the reduction in meniscal extrusion.

Several previous studies have reported the outcomes of meniscal root tear treatment using the transtibial pullout technique. Kim et al.[21] retrospectively compared the outcomes of medial meniscus root tears treated with medial meniscectomy (n = 28) versus arthroscopic transtibial pullout repair. The majority of tears in their study were traumatic. In the repair group, meniscal extrusion was reduced from 3.1 mm to 2.9 mm, and partial or complete meniscal healing was observed in 93.3% of patients. Although both groups showed significant improvement in clinical scores, the repair group demonstrated superior outcomes in terms of Lysholm and International Knee Documentation Committee (IKDC) scores, as well as reduced progression of joint degeneration. Based on these findings, the authors recommended arthroscopic transtibial pullout repair as the preferred treatment for meniscal root tears.[21]

Moon et al. retrospectively evaluated the outcomes of transtibial pullout repair for medial meniscus root tears in 51 patients. The study did not differentiate between traumatic and degenerative etiologies. After a mean follow-up of 33 months, all clinical scores showed significant improvement. However, average meniscal extrusion increased from 3.6 mm to 5.0 mm postoperatively. Poorer clinical outcomes were associated with varus malalignment greater than 5° and the presence of Outerbridge grade 3 or 4 chondral lesions.[22]

Seo et al. retrospectively evaluated the outcomes of arthroscopic pullout suture repair in 21 patients with medial meniscus posterior root tears, including both traumatic and degenerative cases. Second-look arthroscopy was performed in 11 of these patients. Notably, individuals with central meniscal extrusion (greater than 3 mm) were excluded from the study. The mean Lysholm score improved from 56.1 preoperatively to 83.0 at the final follow-up. However, no cases of complete meniscal healing were observed on arthroscopic evaluation. The authors emphasized the need for further studies to explore the discrepancy between substantial clinical improvement and limited radiological healing.[23]

Krych et al. prospectively evaluated the radiological outcomes of 45 patients with 47 medial or lateral meniscus root tears who underwent transtibial pullout repair. Radiological assessment was performed using MRI obtained at a mean of 6.3 months postoperatively. Both traumatic and degenerative tears were included, while patients with concomitant ligamentous injuries were excluded. Although 98% of the meniscal root tears demonstrated some degree of healing, the mean meniscal extrusion increased from 1.9 mm to 2.6 mm.[24]

Kaplan et al. retrospectively assessed both clinical and radiological outcomes in 18 patients who underwent transtibial pullout repair. The etiology of the tears was not specified. Postoperatively, the IKDC score significantly improved from 45.9 to 76.8, and the Lysholm score increased from 50.9 to 87.1. However, the mean meniscal extrusion also increased, from 4.74 mm to 5.98 mm, and progression of medial compartment cartilage degeneration was observed in all patients.[25]

Feucht et al. conducted a systematic review of seven studies involving 172 patients to evaluate the outcomes of arthroscopic transtibial pullout repair for medial meniscus posterior root tears. After a mean follow-up of 30.2 months, the Lysholm score improved from 52.4 to 85.9. Radiographic assessment revealed progression of osteoarthritis in 64 of 76 patients (84%). MRI evaluation showed a reduction in medial meniscal extrusion in 34 of 61 patients (56%). Based on second-look arthroscopy and MRI findings, healing outcomes were classified as failed in 3% of patients, partial in 34%, and complete in 62%.[26]

A review of the existing literature reveals general agreement regarding improved clinical outcomes following transtibial pullout repair of medial meniscus root tears. However, no clear consensus has been reached concerning radiological outcomes. Notably, long-term patient prognosis—particularly concerning cartilage degeneration—appears to depend more heavily on radiological findings than on clinical scores.[23,27] Based on our observations, the heterogeneous nature of patient populations in

previous studies may underlie the inconsistency in radiological results. Although meniscal extrusion tends to be more pronounced in degenerative tears,[23] prior investigations often included both traumatic and degenerative cases, potentially confounding the interpretation of postoperative changes in extrusion. In contrast, the present study exclusively focused on degenerative posterior root tears of the medial meniscus and demonstrated a significant postoperative reduction in meniscal extrusion. This reduction may serve as a valuable prognostic marker for long-term outcomes. However, no correlation was found between improvement in functional outcomes and reduction in meniscal extrusion. If this finding is confirmed, it may challenge the necessity of surgical techniques designed to minimize extrusion in degenerative posterior root tears.[28] Nonetheless, such a conclusion requires further investigation with larger cohorts and longer follow-up durations, as the impact of residual meniscal extrusion—greater than 3 mm—may represent a negative prognostic factor that becomes apparent only over time.

Despite the inclusion of a homogeneous patient population, this study has several limitations. First, the relatively short follow-up period may not fully capture the long-term progression of cartilage degeneration or the prognostic impact of residual meniscal extrusion. Second, the small sample size limits the statistical power and generalizability of the findings. Additionally, the results cannot be extrapolated to other types of meniscal root tears, such as those involving the lateral or anterior roots. Therefore, further standardized studies with larger cohorts and extended follow-up periods are warranted to validate and expand upon the current findings.

Conclusion

The transtibial pullout technique appears to significantly improve clinical knee function in patients with degenerative posterior root tears of the medial meniscus. Moreover, this technique is associated with a notable reduction in meniscal extrusion. Importantly, functional improvement was observed even in cases where extrusion was not fully reversed. These findings should be interpreted in light of the study's limitations, particularly the short follow-up duration and limited sample size. Further studies with larger cohorts and longer follow-up are necessary to confirm these results and clarify the long-term implications of residual meniscal extrusion.

Acknowledgement

The authors would like to thank the Clinical Research Development Unit, Shahid Beheshti Hospital, Kashan University of Medical Sciences, Kashan, Iran.

Authors Contribution:

Abolfazl Bagherifard: conceived and designed the analysis, collected the data, wrote the paper.

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Mehdi Moghtadaei: collected the data.

Alireza Akbarzadeh Arab: conceived and designed the analysis, collected the data, wrote the paper, contributed data or analysis tools, performed the analysis.

Masih Rikhtehgar: collected the data, wrote the paper.

Mahmoud Jabalameli: wrote the paper.

Declaration of Conflict of Interest: The author(s) do NOT have any potential conflicts of interest for this manuscript.

Declaration of Funding: The author(s) received NO financial support for the preparation, research, authorship, and publication of this manuscript.

Declaration of Ethical Approval for Study: This study was approved by Ethical Committee of Iran University of Medical Sciences, Tehran, Iran (Code: IR.IUMS.FMD.REC.1398.532). Patients provided a general consent at the time of hospitalization to use their medical data for publication.

Declaration of Informed Consent: The authors have no competing interest to declare.

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