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ORIGINAL ARTICLE

Arthroscopic Meniscal Root Repair

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Abstract

Background: **A meniscal root tear is a radial rupture that occurs within 1 cm of the insertion of the meniscal horn. Meniscal root injuries account for 10.1% of all meniscectomies performed arthroscopically. It has been established as an independent factor in the development and progression of osteoarthritis. The development of degenerative changes in articular cartilage has been linked to stresses that exceed physiological limits.**

Objectives: **This work evaluates the technique, results, and complications of Arthroscopic repair of meniscal root tears using the trans-osseous suturing technique.**

Methods: **This prospective case series study, conducted from January 2020 to November 2021, included 40 patients between the ages of 20 and 50 who were discovered to have a recent meniscal root tear.**

Results: **The most prevalent mode of trauma was twisting injury (50%), symptoms of duration were six months, follow-up duration was 18 months, and the most frequent tear type was IIa (60%) followed by IV (25%), the last one was IIb 15%. There was a statistically significant difference between the Lysholm score preoperatively and postoperatively (p-value <0.001).**

Conclusion: **Arthroscopic repair using trans osseous pull-out sutures effectively treats medial meniscus posterior root tears. It improves knee function scores and meniscal integrity. Proper tear bed and edge preparation, a 7 mm tibial tunnel, and a precise re-implantation point are essential for successful outcomes.**

Keywords: Meniscal Root Tear; Osteoarthritis; Arthroscopic Repair; Trans-Osseous Repair; Meniscal Injuries

1. Introduction

Tears at the lateral meniscal roots usually occur at the same time as ruptures of the anterior cruciate ligament (ACL), and they were observed in between 7% and 12% of individuals who have had a tear in their ACL. [1]

The absence of meniscal hoop stress is a result comparable to that of an entire meniscectomy; this may occur when the posterior root of the lateral meniscus completely ruptures or detaches from the meniscus. [2]

A decreased tibio-femoral area of contact and a rise in contact stresses might lead to the progression of early-onset degenerative osteoarthritis. [3]

Repair, compared to meniscectomy, has been shown in several long-term clinical trials to be a more effective technique for preventing osteoarthritis.[3] Therefore, preserving the meniscus and considering refixation are often reasonable approaches to regaining its function. [4]

Although the significance of meniscal root tears has long been recognized, it is only in the past decade that surgical techniques have advanced to enable routine management of these injuries. [5]

The aim is to improve symptoms and prevent progressive joint failure that may occur if left untreated. However, it has only just in recent years been recognized as a significant disease, and numerous therapeutic options, such as non-operative therapy, partial or sub-total meniscectomies, and root restoration, have been documented in the literature. Nevertheless, in recent years, several researchers have started looking at the attachments of the meniscal roots. As a result of these findings, anatomical restoring of the meniscus's contact with the bone has been suggested to avoid abnormal load transfer and extensive meniscal translation, eventually preventing osteoarthritis. [5]

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This study aims to evaluate the technique, findings, and complications of Arthroscopic repair of meniscal root tears using the transosseous suturing technique.

2. Patients and methods

This prospective case-series study was carried out at Sayed Galal Hospital, Al Azhar University, Cairo, from January 2020 to November 2021.

Inclusion criteria: Age 20-50 and discovered with recent meniscal root tear.

The exclusion criteria were advanced O.A. knee (Grade 3 or 4 on plain X-ray), an old tear lasting more than six months, knee malalignment, inflammatory arthropathies, and skeletally immature individuals.

Each participant was exposed to a comprehensive history of taking, a history of prior surgical intervention on the ankle of interest, and a thorough general and local examination. Palpation is performed to assess tenderness and range of motion, and a neurovascular examination,

Radiology: X-ray: knee A/P and lateral views to exclude bony injuries and advanced osteoarthritis and MRI as the gold standard for diagnosis.

All patients have explained the surgery, and informed consent was obtained to be included in the study before surgical interference.

All patients received spinal anesthesia with the preoperative antibiotic administered before the placement of the tourniquet; after the onset of anesthesia, cephazolin 1gm was our pre-op. Prophylactic antibiotic.

The participant was lying supine on the operating table with side support at the level of mid-thigh used to stabilize the patient to the operating table; this position helps during the step of assessing the medial meniscus so we can easily make the limb in valgus positioning of the knee. The distal footrest is also used to maintain the affected knee at 90° of knee flexion with the ability to make the leg hang down freely or lie on the operator's knee according to the steps done. They achieved a figure of 4 positions by pulling the patient slightly towards the unaffected side. A pneumatic tourniquet was applied high on the thigh, and the time was recorded. Figure 1

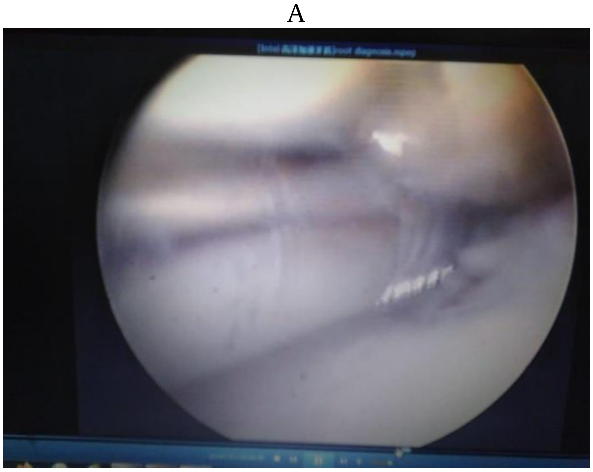
Figure 1. Position of the patient.

Operative procedure:

A reconstruction of the medial meniscal root that is arthroscopically aided and uses a modified Mason-Allen suture arrangement can be performed with a traditional knee arthroscopy setup. A diagnostic arthroscopy is conducted to determine any additional pathology present. The viewing is primarily done through the anterolateral portal, while the instrumentation is carried out through the anteromedial portal. A hook probe is utilized to verify the existence of a tear in the medial meniscus root. Figure 2A In some cases, A crustiness of the deep collateral ligament on the medial side may be required to increase working space and avoid unintentional chondral injuries. Monofilament sutures are passed via the meniscus using a 45° Spectrum sutures-passing hook (ConMed, Largo, FL), and Orthocord sutures (DePuy Mitek, Raynham, MA) are passed using typical arthroscopic shuttling procedures in a modified Mason-Allen sutures configurations.

The posterior-medial border of the meniscus serves as the first point of entry for the suture-passing hook as it is advanced from inferiority to superior. The monofilament sutures are then taken out via the medial portal after being guided through to the superior portion of the meniscus. Then, utilizing customary surgical methods, an Orthocord suture is passed. The same Orthocord stitching shuttles from the upper portion of the meniscus to the lower half of the meniscus during the 2nd pass, generating a vertical mattress stitch Figure 2B. The suture-passing hook is placed immediately anterior to the first pass. An extra Orthocord suture is put through the meniscus during the 3rd pass, which is carried out immediately medial to the mattress suture. The modified Mason-Allen suture arrangement is complete, with three strands emerging from the meniscus's bottom portion and one from its top.

Once the position of the medial meniscal root has been established, a 1-cm socket is created via retrograde drilling via the anteromedial tibia using an ACL guide (Arthrex, Naples, FL) and a 6-mm Flip Cutter drill (Arthrex). Figure 2C A nitinol sutures-passing wire (Arthrex) is subsequently threaded up the tunnel and into the socket once the guide has been withdrawn. The previously inserted meniscal sutures are shuttled down into the socket and pulled out via the anterior part of the tibia, and the wire is recovered through the medial portal. Figure 3


A

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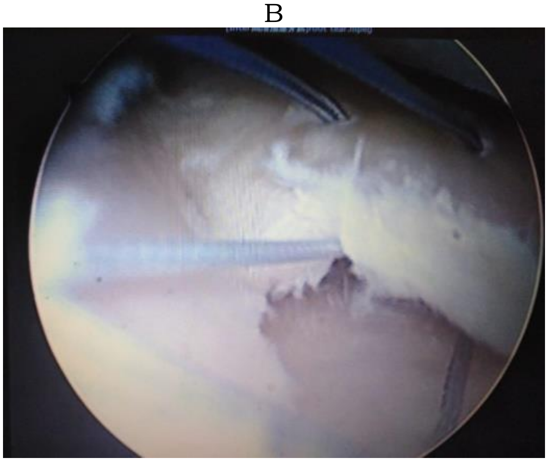
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Figure 2. Provides an arthroscopic view of the right knee through the lateral portal (A) highlighting a tear at the root of the posterior horn of the medial meniscus, (B) illustrating the process of arthroscopic view showing medial meniscus (MM) posterior root tear while scratching the meniscal undersurface after refreshing the tear using the shaver and (C) demonstrating the suturing process for repairing a posterior medial meniscus root tear

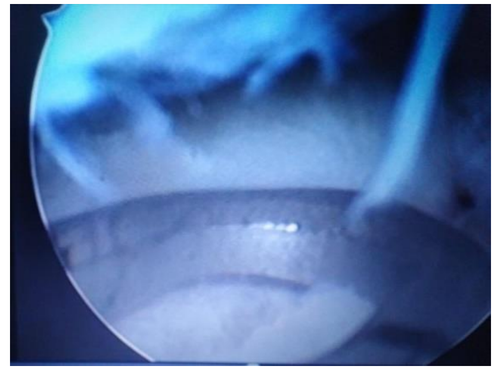


Figure 3. Arthroscopic view showing ACL guide

During the shuttle procedure, it is advised to use a 5.0-mm 55-mm long blue cannula (Smith & Nephew, Andover, MA) at the medial portal to prevent a soft-tissue bridge. To decrease the meniscal root in the socket, stress is given to the free ends of the meniscus sutures. After that, the sutures are threaded through an Arthrex 3.5-mm stitch button and fastened over the front tibia. An arthroscopic knot pusher is advised for minimally invasive procedures to guarantee the correct button seating and knot security. Figure 4 Standard surgical methods seal the arthroscopic portals and the anteromedial incisions. A dry sterile dressing and a knee immobilizer are then administered. A physical therapist-supervised postoperative approach includes avoiding weight bearing in extension with progressive flexion. Figure 5

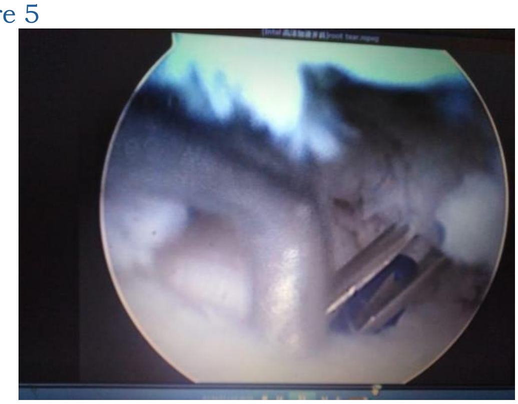


Figure 4. Presents an arthroscopic view illustrating the passage of sutures through the tibial tunnel and their subsequent tying over a button located on the anterior cortex of the tibia. This procedure is specifically performed for the repair of the posterior root of the medial meniscus

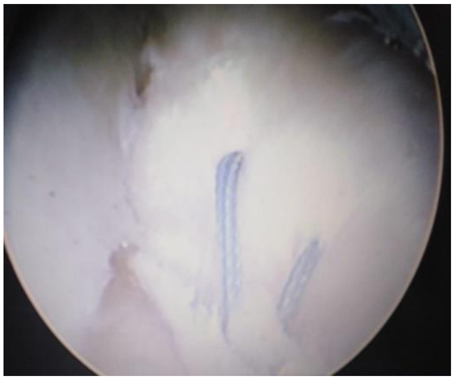


Figure 5. Arthroscopic view showing root repair final view

Postoperative care:

Dressing, wound inspection, and suction drain removal were done 48 hours after surgery. Monitor for post-op complications and a clear explanation of the instructions, precautions, and emergency contact information.

The strip and stitches were removed about 10 to 14 days post-op, by which time the wound had healed well enough to allow baths and showers.

Post-op. Analgesics: Pethidine 50-100 mg ampoule intramuscular was given when required for 2-3 days, with diclofenac sodium 50 mg 3 times daily. We used Intravenous Cefazolin 1 gm /8 hourly for three days as postoperative antibiotics:

Enoxaparin sodium 40 mg once per day subcutaneously was used as DVT prophylaxis starting 12 hours postoperatively for 14 days.

Ice treatment was begun as soon as possible after surgery to reduce edema.

Participants were unable to bear weight on crutches for six weeks following surgeries. A hinged knee brace was worn for six weeks, with the leg wholly extended. After the operation, participants were told to perform straight leg lifting and quadriceps muscle strengthening activities throughout the day. Until they reached 135°, participants were permitted a rise in active range of motion by 30° every two weeks. At six weeks, gradual weight bearing began. Three months following surgery, entire flexion and squatting were permitted. Six months after the operation, recipients were back to their normal activities.

Follow-up appointments were scheduled for 2 weeks, 6 weeks, 3 months, 6 months, 9 months, and finally, one year, resulting in a total follow-up period of one year. Crutches were used for up to 2 weeks. Partial weight-bearing activities and a progressive increase in range of motion were initiated based on the individual's pain tolerance. Quadriceps training in the form of closed kinetic chain exercises commenced immediately.

Postoperative assessments were conducted every three months throughout the one-year follow-up period using the Lysholm scoring system, Tegner's objective, and subjective knee form. Follow-up visits were scheduled for four weeks, four months, and 12 months. These visits included clinical and radiological evaluations.

Statistical analysis:

SPSS version 20 (Statistical Package for the Social Sciences) was used for data management and statistical analysis. The Kruskal-Wallis, Wilcoxon, logistic regression analysis, Chi-square, and Spearman's correlation tests of significance have been employed, among others. Depending on the kind of data (parametric and non-parametric) for all variables, the presentation and analysis of the data had to be carried out. A p-value less than 0.05 (5%) was considered statistically significant.

3. Results

Patient characteristics are presented in Table 1.

Table 1. Demographic data of the patient

		DESCRIPTIVE STATISTICS (N=40)
AGE		40.9±6.8
SEX	Female	32 (80%)
	Male	8 (20%)
BMI (KG/M^2)		30±4.2
MODE OF TRAUMA	Twisting injury	20 (50%)
	Direct trauma	10 (25%)
	Hyperflexion	10 (25%)
SYMPTOMS DURATION (MONTHS)		6 (2.3-12)
FOLLOW-UP DURATION (MONTHS)		16 (12.3-18)
TEAR TYPE	IIa	24 (60%)
	IIb	6 (15%)
	IV	10 (25%)

Data are presented as mean ± SD or number (%). BMI: body mass index.

Regarding the Lysholm score, there is a significant variation among the three instances. Tegner's score indicated a considerable rise over time; therefore, a substantial variance existed among the three occasions. There was almost no variation among the three timings for K-L (x-ray grade). Table 2

Table 2. Lysholm score, Tegner, K-L X-ray grade between different times and Showing Standard

Deviation of Lyslom score of cases preoperative after 3 months and last follow-up visit

		PRE-OPERATIVE N=40	6 MONTHS POSTOPERATIVE N=40	FINAL FOLLOW UP N=40	P VALUE			
					Among 3 times	Pre vs 6m	Pre vs Final	6m vs Final
LYSHOLM SCORE	Mean ± SD	53.3±21.1	82.6±12.5	88.1±8.5	<0.001*	<0.001*	<0.001*	0.002*
TEGNER SCORE	Median (IQR)	2 (1.3-4.8)	3 (3-5)	3 (3-5)	<0.001*	<0.001*	<0.001*	<0.001*
K-L (X-RAY GRADE)	Grade 0	8 (20%)	8 (20%)	8 (20%)	0.135	0.157	0.157	1
	Grade I	26 (65%)	24 (60%)	24 (60%)				
	Grade II	6 (15%)	8 (20%)	8 (20%)				
LYSHOLM GRADE	Poor	26 (65%)	4 (10%)	0 (0%)	<0.001*	<0.001*	<0.001*	<0.001*
	Fair	12 (30%)	12 (30%)	10 (25%)				
	Good	0 (0%)	12 (30%)	12 (30%)				
	Excellent	2 (5%)	12 (30%)	18 (45%)				

	Pain	Instability	Locking	Swelling	Climbing	Squatting	Limping	Support	Total
PRE	11.25	18.75	5	7	6	1	4	3.5	56.5
AFTER3 MONTHS	15	20	10	10	10	3	5	5	78
LAST FOLLOW UP	20	21.25	13.75	10	10	4	5	5	89

Data are presented as mean ± SD or Median (IQR). Repeated measures ANOVA test for parametric quantitative data between the three times followed by post hoc LSD analysis between every two times. Friedman’s test for ordinal qualitative data between the three times followed by Wilcoxon signed rank test between every two times; *: Significance level at P value < 0.05.

Case No.1:

Forty-four years old female patient got a twisting injury to her knee. He complained of continuous pain as well as effusion of his right knee. He used to take analgesics together with topical ointments, but with no improvement.

On examination, medial joint line tenderness was found. His left knee was otherwise stable, and he had a positive McMurray test. His body mass index was 34 Kg/m2.

Preoperative Lysholm score: 79/100

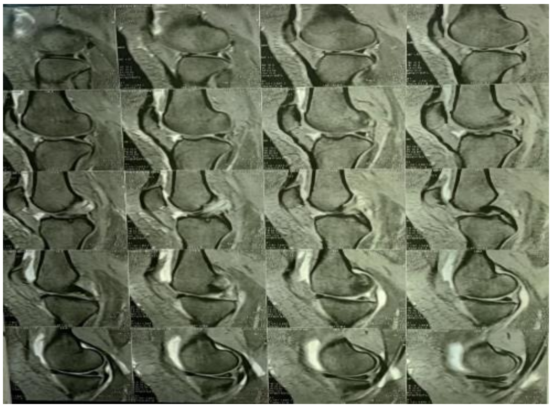
X-ray: Apparent normal, and MRI revealed -posterior medial Meniscal radial extrusion.

Ghost sign: Negative

The patient's knee was scored pre-op: objective Tegner's score was D, Subjective Tegner's score was 32, and Lysholm's score was 45.

After 18 months of follow-up after the surgery, his knee scoring markedly improved, and Tegner's objective score became A, Tegner's subjective score of 84, and Lysholm's 96. (Figure 6) was 84.6%.

A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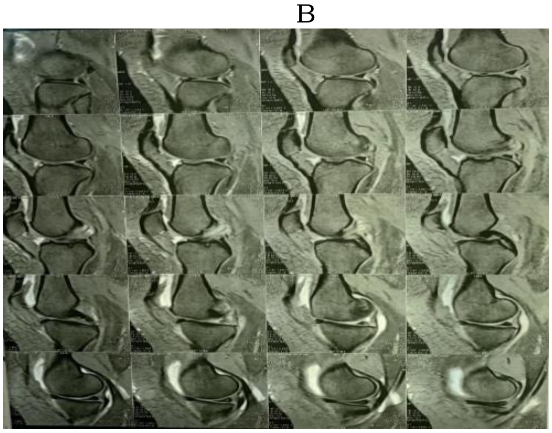


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D1


D2

Figure 6. (A) Pre-op. x-ray, (B) Pre-op MRI case 1, (C) Postoperative X-ray and (D) Follow up at 1 year after surgery (1) Full extension and (2) Full flexion

4. Discussion

Regarding Tegner and Lysholm scores, Lee et al. were similar to our results as they repaired 21 cases of MMPRT utilizing the trans osseous pull-out sutures technique (TPS) and reported that At the final follow-up, the mean preoperative Lysholm knee scores increased from 57.0 to 93.1 ($P < 0.001$). [6]

A comparison of the research among two groups of MMPRT individuals was carried out in 2011 by Kim et al. For the root tear, the first group received partial meniscectomy; the 2nd group received TPS meniscal root tear repair. The Lysholm scores improved more in the repair group, with scores increasing from 56.8 to 85.1 ($P < 0.001$), while the meniscectomy group had an improvement from 56.1 to 81.7 ($P < 0.001$). [7]

Lastly, comparison research between modified-Mason Allen and the two simple suture methods (TPS) for the reconstruction of the MMPRT was carried out by Lee et al. Both scores in the two groups significantly increased, with Lysholm scores improving from 56.1 ± 8.3 to 85.4 ± 3.6 ($P < 0.001$) and Tegner scores improving from 4.3 ± 1 to 4.7 ± 1.4 ($P < 0.05$) in the same group. [8]

Supporting the results of the current work, Ozkoc et al.[9] conducted a study where arthroscopic partial-meniscectomy was conducted on 70 cases with MMPRT. At the most recent follow-up (mean follow-up of 56.7 months), the average before-surgery Kellgren-Lawrence radiograph grading was 3 (ranging from 2 to 4), up compared to a preoperative grading of 2 (ranging from 0 to 3 points). This showed a considerable deterioration. The mean Lysholm score only increased from 53 before surgery to 67 after surgery. While both studies (Ozkoc et al. and the current study) represent opposite ends of the spectrum, the overall outcome difference supports the notion that the trans osseous pull-out suturing technique (TPS) yields much better results. [10]

Contrary to the current work, Kim et al.[4] stated that 9 out of 30 cases who underwent meniscal root tear repair via pull-out sutures technique (TPS) suffered arthritic progression in terms of the K-L grading system; this variation could be attributed to the fact that they included seven patients in their repair group who already had more than grade 2 osteoarthritis on K-L grading system preoperatively. Moreover, their mean age was 55.2 years, in contrast to the current study, which was 40.8 years. Also, their average follow-up duration was 48.5 months, while the current study was 15.75 months.

In addition, contrary to the present work, Kim et al.[4] reported arthritic progression in 2 grades (from grade 1 to grade 3), of 3 cases out of 22 who had TPS repair for MMPRT, based on the K-L grading system. This difference could be attributed to the different mean ages, the mean follow-up duration, and the repair technique used.

Kim et al. four applied TPS to 30 cases with MMPRT and reported that the absolute medial meniscal extrusion decreased. The mean extrusion was 3.13 ± 0.36 mm preoperatively, which decreased to 2.94± 0.24 mm at the last follow-up. [7]

Also, Kim et al. [4], in their case series, applied TPS to 22 MMPRT cases. They reported a decline in the meniscal extrusion from 4.3 ± 0.9 mm preoperatively to 2.1 ± 1.0 mm postoperatively (P = 0.42). Although the decrease was about 2.2 mm, they reported it as insignificant. This could be attributed to the surgical technique employed where they applied a single 2.7 mm tibial tunnel in contrast to a 7 mm tunnel in the current study that could allow better pull on the meniscal root and can be reproducible in all cases even if the re-implantation site was not 100% anatomical. [11]

Contrary to the current study, Jung et al. stated in 2012 that in their series of 13 cases of MMPRT, the mid-body of the medial menisci had a mean absolute extrusion of 3.9 mm (preoperative ranging from 2.2 to 7.1 mm) and 3.5 mm (postoperative ranging from 1.2 to 6.1 mm). The reduction in extrusion was not significant. This difference may be attributed to the repair technique, which employed an all-inside repair using anchors. [12]

Also, in contrast to the current study, Moon et al.[13] reported an increase in the absolute meniscal extrusion distance from 3.6 ± 1.2 mm to 5.0 ± 1.7 mm (P\.001). This could be attributed to the difference in the used technique.

Regarding meniscal extrusion, Kim et al.[4] applied TPS to 30 cases with MMPRT and reported that the absolute medial meniscal extrusion decreased. The mean extrusion was 3.13 ± 0.36 mm preoperatively, which decreased to 2.94± 0.24 mm at the last follow-up.

Similarly, Kim et al.[4], in their series of 22 MMPRT repaired with TPS, reported a significant decline in the mean gap size from 3.2 ± 1.1 mm preoperatively to 0.5 ± 0.2 mm postoperatively.

As regards root tear healing rates, Lee et al.[8] reported that out of 21 cases that underwent meniscal root tear (MMPRT) repair using trans osseous pull-out sutures (TPS), 20 cases showed tear healing, 10 of them were confirmed arthroscopically. Only one case failed, and reoperation was done.

Also, Kim et al. [4] applied trans osseous pull-out sutures (TPS) for 30 cases with meniscal root tears (MMPRT). They reported that 93.3% had complete or partial healing of the repaired root tear, and 6.7% had repeated tears.

Moreover, Jung et al.[14] reported a 90 % healing rate out of the 13 cases with meniscal root tear (MMPRT) that were repaired with all inside anchor techniques. 8 % (one case) failed to heal.

A systematic review published by Feucht et al.[15] concluded that arthroscopic transtibial pull-out repair for medial meniscus posterior root tears leads to improved functional outcome scores and prevents the progression of osteoarthritis in most patients during short-term follow-up. The Lysholm score increased from 52.4 to 85.9. Regarding Kellgren-Lawrence grading, 64 out of 76 patients (84%) showed no progression. Magnetic resonance imaging revealed no progression of cartilage degeneration in 84 out of 103 patients (82%), and a reduction in medial meniscal extrusion was observed in 34 out of 61 patients (56%). Second-look arthroscopy indicated complete healing in 62%, partial healing in 34%, and failure to heal in 3% of cases.

5. *Conclusion*

The meniscal integrity and functioning knee scores (Lysholm and Tegner) significantly improved after arthroscopic repair of MMPRT using the TPS technique alongside a configuration of two simple stitches. Utilizing a 7 mm tibial tunnel size and careful preparation of the tear bed and edge improved recovery rates and made the surgical method more reproducible.

Disclosure

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Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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