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ORIGINAL ARTICLE

Joint Preservation or Alignment Correction? A Comparative Study of Medial Meniscus Root Repair and HTO with Partial Meniscectomy": A Retrospective Comparative Study

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ABSTRACT

Objectives: This retrospective cohort study was done to assess Knee functions after root tear of the posterior horn of the medial meniscus management with root tear repair or with high tibial osteotomy (HTO) with partial meniscectomy.

Methods: Twenty-four patients had a posterior horn root tear, with a range of age between 38 and 56 years old. Participants in this study were classified into two groups: one received transtibial root repair, while the other underwent HTO with partial meniscectomy. Regular clinical and functional outcomes were monitored through one-year follow-up. The study aimed to compare the clinical and functional outcome for both groups.

Results: There was no noteworthy difference between the two groups concerning function and pain scores. The root repair group (1) showed a higher rate of preserving joint function and slowing osteoarthritis progression in patients with isolated root tears and minimal malalignment. However, its success depends on proper healing and biomechanical factors, but Group 2 (HTO + Meniscectomy) is effective for addressing pain and overload in patients with significant varus deformity in short follow-up but it increases cartilage wear and increases the progression of arthritis.

Conclusion: Root tear of medial meniscus can be treated by repair only in acute traumatic tear with no malalignment or osteoarthritis in knee, while HTO with partial meniscectomy in degenerative chronic tears with malalignment or osteoarthritis in knees,

Level of evidence: retrospective cohort, level of evidence (IV)

Keywords: Root Tear; medial meniscus; Root Repair; HTO; Meniscectomy

INTRODUCTION

The medial meniscus serves as a vital component in knee joint stability and load distribution. Tears at its posterior root, particularly of the posterior horn, can significantly disrupt knee biomechanics, leading to increased joint contact pressures and accelerated cartilage degeneration. If left untreated, such injuries often result in poor clinical outcomes and a heightened risk of osteoarthritis progression [1][2].

Traditionally, management strategies for posterior medial meniscus root tears (PMMRTs) have included nonoperative approaches or partial meniscectomy. However, these methods have been associated with suboptimal results, including persistent pain and functional limitations. Recent studies have highlighted that nonoperative management or partial meniscectomy for PMMRTs often leads to arthritis progression, poor clinical outcomes, and a high rate of conversion to total knee arthroplasty [3][4].

In contrast, surgical interventions such as transtibial pullout repair aim to restore the native anatomy and function of the meniscus.

This technique has demonstrated favorable outcomes, particularly in patients with acute traumatic tears. A study comparing the results of the first group pullout repairs for medial meniscus posterior root tears found that patients undergoing repair experienced significant improvements in clinical outcomes [5].

The second group of patients presenting degenerative PMMRTs treated with high tibial osteotomy (HTO) combined with partial meniscectomy has emerged as a viable treatment option. HTO aims to offload the medial compartment, thereby reducing pain and delaying the progression of osteoarthritis. Favorable clinical results have been reported following HTO for medial meniscus posterior root tears in knees with irreparable degenerative root tear [6][7].

This retrospective cohort study seeks to evaluate and compare the clinical and functional outcomes of two distinct surgical approaches—transtibial root repair and HTO with partial meniscectomy in the management of posterior horn medial meniscus root tears. By analyzing patient-reported outcomes and objective measures of knee function over a one-year follow-up period, this study aims to provide insights into the efficacy of joint preservation versus alignment correction strategies in this patient population.

The hypothesis of this study is that the group of patients with HTO with partial meniscectomy will provide effective pain relief and functional improvement in patients with PMMRTs, as in the root repair group.

This study aims to compare the clinical and functional outcomes of two surgical approaches—transtibial medial meniscus root repair and high tibial osteotomy (HTO) with partial meniscectomy for the treatment of posterior horn medial meniscus root tears (MMRTs).

METHODS

A retrospective study was conducted at Zagazig University Hospital from May 2020 to August 2024, involving 24 patients with MMRT with two years of follow-up, divided into two groups. The first group underwent arthroscopic transtibial root repair for 12 patients, and the second group had HTO with partial meniscectomy in 12 patients.

Inclusion criteria: Radiological or intraoperative findings of posterior horn medial meniscal root tear. Varus malalignment is less than 4-5 degrees, and patients with early osteoarthritis grade one have no other ligament of the knee affected. These findings were observed in patients aged from 34 to 53 years.

Exclusion criteria: Patients with varus malalignment more than 5 degrees, patients who are not fit for surgery, radiological signs of severe osteoarthritis, patients with prior knee surgery, and patients with other ligamentous injury

In this study, we will use a combination of MRI and weight-bearing full-length radiographs to evaluate medial meniscus root tears and lower limb alignment. MRI, particularly proton density-weighted and T2-weighted sequences, is essential for detecting root tears, with key indicators including the "ghost sign," meniscal extrusion exceeding 3 mm, and visible gap formation at the root attachment [8-9]. Additionally, weight-bearing long-leg X-rays will be used to assess overall limb alignment, capturing images from the hip to the ankle while the patient stands in a neutral position. Critical alignment parameters such as the mechanical axis deviation (MAD), medial proximal tibial angle (MPTA), and hip-knee-ankle (HKA) angle will be measured to determine varus or valgus alignment changes before and after treatment [10]. (Fig.1-2-3)

Anesthesia, positioning, and surgical technique for both groups

Spinal anesthesia was used in all cases after ceftriaxone 1gm was intravenously injected half an hour before operation. The patient's leg was sterilized and draped, and a tourniquet was applied.

Knee arthroscope plays a crucial role in the preoperative evaluation of medial meniscus root tears and alignment correction procedures, such as high tibial osteotomy (HTO). It allows direct visualization of the meniscus, confirming the presence, location, and severity of root tears

while also identifying any associated cartilage damage or synovitis [8]. Additionally, it helps assess the integrity of the anterior and posterior cruciate ligaments, detecting subtle instability that may influence surgical planning [9]. Arthroscopy is also useful for evaluating cartilage wear, often graded using the Outerbridge classification, which aids in deciding between joint preservation through root repair or alignment correction via HTO with partial meniscectomy [10]. Furthermore, knee arthroscopy enables surgeons to perform minor interventions such as debridement or partial meniscectomy if necessary, offering real-time confirmation of MRI and radiographic findings [11]. Despite advancements in imaging techniques, arthroscopy remains the gold standard for intra-articular assessment, ensuring that surgical decisions are tailored to each patient's condition (Fig 4) [12].

Surgical technique for transtibial root repair

After knee scope was done, the first step involves preparing the root attachment site by debriding the posterior tibial plateau to remove fibrous tissue and create a bleeding surface, which enhances healing Next, a transtibial tunnel is created by inserting a guide pin through the anteromedial tibia, directing it toward the anatomical root footprint, followed by drilling a tunnel (typically 4.5–6 mm in diameter) to allow for suture passage. Non-absorbable sutures, such as No. 2 FiberWire, are then passed through the meniscus using a suture-passing device and pulled through the tibial tunnel, where they are secured using a cortical fixation button on the tibial cortex. The repair is then assessed by cycling the knee through a full range of motion to ensure proper tension and stability before closing the arthroscopic portals and applying a sterile dressing. Postoperatively, patients are placed in a knee brace, with non-weight-bearing recommended for the first 4–6 weeks to protect the repair, followed by a gradual transition to weight-bearing and physical therapy to restore function and minimize meniscal extrusion (Fig 5,6).

Surgical technique for high tibial osteotomy with meniscectomy

Arthroscopic evaluation is first performed to assess the meniscal damage and remove unstable meniscal tissue while preserving as much healthy meniscus as possible. Preoperative imaging and intraoperative fluoroscopy guide the osteotomy planning, ensuring accurate correction angles. A controlled medial opening wedge osteotomy is then performed using an oscillating saw, carefully preserving the lateral cortex to maintain stability. The osteotomy is gradually opened to achieve the desired realignment, and a locking plate, such as a Tomofix, is used for fixation. Once alignment and fixation are confirmed with fluoroscopy, the surgical sites are closed, and a sterile dressing is applied. Postoperatively, patients follow a structured rehabilitation protocol, initially remaining non-weight-bearing for 4–6 weeks before progressing to gradual weight-bearing and strength exercises to restore knee function (Fig 7).

Statistical Analysis

The Statistical Program for Social Science (SPSS) (version 24) was used to code, enter, and process the data on a computer. Following tabular and diagrammatic representation of the data, the results were interpreted. We used the following descriptive statistics: mean, standard deviation, range, frequency, and percentage.

RESULTS

The study examined 24 patients, evenly divided into two groups, to compare the outcomes of transtibial root repair and high tibial osteotomy (HTO) with meniscectomy. The majority of patients were female (70.83%), with an average age of 43.5 years. The BMI ranged between 26 and 31 kg/m², with most patients classified as overweight (70.8%). The most common mechanism of injury was twisting (33.3%), followed by rising from a chair (29.2%) and squatting (20.8%). The median time before surgery was 12 months, with some patients waiting up to 60 months before intervention.

Following surgical treatment, significant functional improvements were observed across

both groups. Limping was reduced, with a higher percentage of patients reporting no limp postoperatively. Pain levels also decreased notably, with fewer patients experiencing discomfort during daily activities ($p < 0.05$). Additionally, the need for assistive walking devices was significantly reduced, with most patients no longer requiring canes postoperatively ($p < 0.05$).

Knee swelling also improved, particularly in patients who underwent HTO, where the majority experienced only mild or no swelling postoperatively ($p < 0.05$). Stair climbing ability showed substantial progress, with patients demonstrating greater ease and reduced dependency post-surgery ($p < 0.001$). Squatting ability remained stable across both groups, though minor improvements were noted ($p < 0.05$).

The Lysholm knee score, which assesses overall knee function, showed a remarkable increase postoperatively, rising from approximately 59 to 86 in Group 1 and from 58 to 85 in Group 2 ($p < 0.001$). These findings highlight a substantial improvement in knee mobility, pain relief, and functional independence after treatment (Tables 1,2,3)

Table (1): Summary of the studied patients

Characteristics	Group (1) Root Repair	Group (2) HTO+Menisectomy
No. of Patients	12	12
Sex		
Female	9(75%)	8(66.67%)
Male	3(25%)	4(33.33%)
Age	43-53 (Mean 48)	34-48 (Mean 41)
Time before surgery		
<12months	9(75%)	4(33.33%)
>12months	3(25%)	8(66.67%)
Operative time	30-60 Minute	60-90 Minute

Table (2): Distribution of the studied patients according to rehabilitation time

	Mean ± SD	Range
Rehabilitation time (months)	3.08 ± 1.06	2 – 6
Less than 3 months	19 patients	79.17%
Group (1)	10 patients	83.33%
Group (2)	9 patients	75%
3-6 months	5patients	20.83%
Group (1)	2patients	16.67%
Group (2)	3patients	25%

Rehabilitation time ranged from 2 to 6 months with a mean 3.08 months. About 58% of patients with injury were rehabilitated for three months

Table 3: Group-wise Comparison of Clinical Outcomes

Outcome	Group1 (n=12) Pre-op	Group1 (n=12) Post-op	Group2 (n=12) Pre-op	Group 2 (n=12) Post-op	P-value
Limp Score (Mean ± SD)	1.67 ± 0.9	0.42 ± 0.5	2.00 ± 1.0	0.75 ± 0.6	<0.05
Support Score (Mean ± SD)	0.25 ± 0.43	0.08 ± 0.28	0.33 ± 0.48	0.00 ± 0.00	<0.05
Pain Score (Mean ± SD)	3.5 ± 1.1	2.0 ± 0.8	3.3 ± 1.0	2.2 ± 0.9	<0.05
Swelling Score (Median, IQR)	2 (1-2)	1 (1-2)	2 (1-3)	1 (1-2)	<0.05
Stair Climbing Score (Median, IQR)	1 (1-2)	1 (1-2)	2 (1-3)	1 (1-2)	<0.001
Squatting Score (Median, IQR)	1 (1-2)	1 (1-2)	1 (1-2)	1 (1-2)	<0.05
Total Lysholm Score (Mean ± SD)	59.42 ± 9.21	86.21 ± 7.51	58.77 ± 7.41	85.0 ± 9.11	<0.001

Figure (1): standing X-ray of both knees

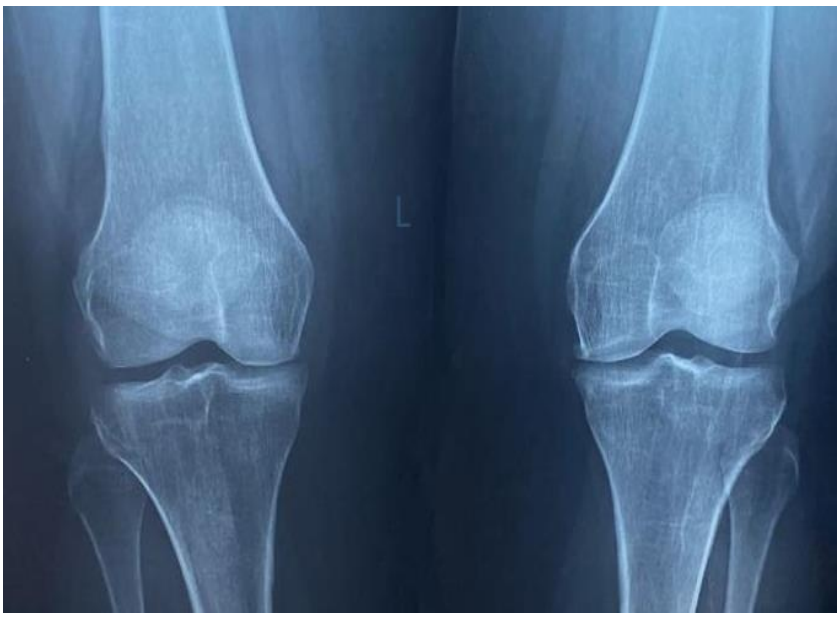

Figure (2): MRI views **(a)** lateral views of knee T2 sequence showing Ghost sign denoting MMRTs **(b)**Frontal views of the knee showing Medial meniscal extrusion

(a)

(b)

Figure (3): Standing Antero-Posterior views of lower limbs to rule out Alignment axis of lower limbs

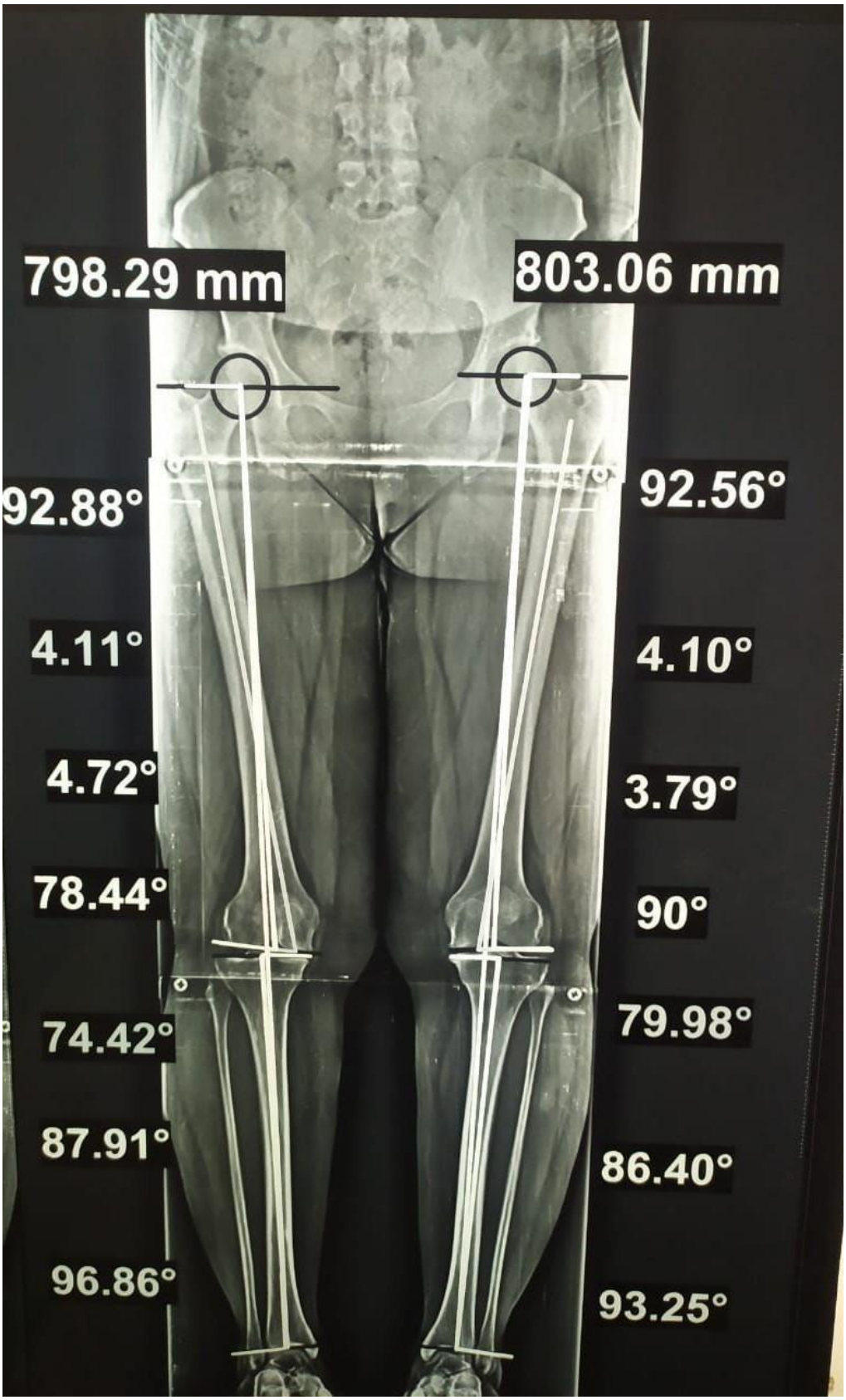

Figure (4): Intraoperative arthroscopic viewing of root tear

Figure (5): Intraoperative technique of transtibial pullout suture for Root repair

Figure (6): Post-operative x-ray views of the knee showing cortical fixation

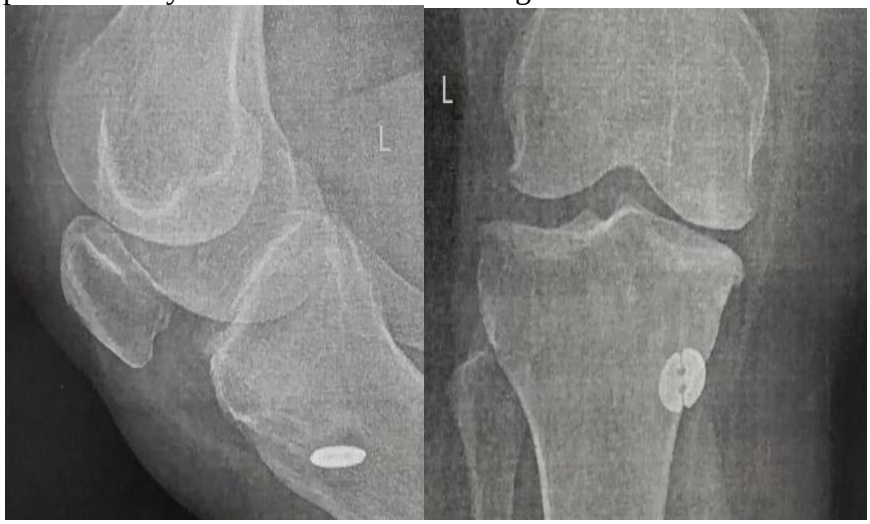

Figure (7): X-ray showing united HTO

DISCUSSION

Several studies have explored the effectiveness of transtibial root repair and high tibial osteotomy (HTO) with partial meniscectomy in managing medial meniscus root tears (MMRTs). Our study findings align with these previous reports while providing additional insights into functional and clinical outcomes.

Both root repair and HTO demonstrated significant pain reduction and functional improvement in our study. The Lysholm knee score improved significantly, increasing from 59.42 ± 9.21 to 86.21 ± 7.51 in the root repair group and from 58.77 ± 7.41 to 85.0 ± 9.11 in the HTO group. This is consistent with Itou et al. [6], who found that patients undergoing HTO for MMRT with moderate varus alignment experienced significant improvements in functional scores.

Similarly, Jing et al. [7] reported that second-look arthroscopy confirmed meniscal healing in root repair patients, reinforcing the positive clinical outcomes observed in our study. Our study further supports findings from Monson et al. [1], who reported that root repair maintains meniscal function and slows the degenerative process, resulting in superior long-term knee preservation.

Limping scores improved significantly postoperatively in both groups, with most patients no longer experiencing a noticeable limp. Our findings align with those of Pache et al. [4], who emphasized that meniscal preservation reduces limping and improves gait mechanics.

Additionally, patients who underwent HTO demonstrated enhanced stair-climbing ability, with significant postoperative improvements ($p < 0.001$). Lee et al. [8] reported similar results, stating that HTO effectively shifts weight-bearing forces, alleviating medial compartment strain and leading to improved functional outcomes.

One of the key differences in our study outcomes was the reduction in knee swelling, which was more prominent in the HTO group. Research by Bhatia et al. (2014) [9] and Lustig [10] indicates that HTO reduces excessive load on the medial compartment, decreasing synovial irritation and joint effusion. This

aligns with our findings, as patients in the HTO group reported significantly lower rates of postoperative swelling compared to the root repair group.

While both procedures provided positive short-term outcomes, the choice of surgical approach must consider long-term joint preservation. Root repair is associated with a lower risk of osteoarthritis progression, particularly in patients with minimal varus malalignment, as reported in studies by Monson et al. [1] and Jing et al. [7]

Conversely, HTO was more effective for patients with significant varus deformity, a finding consistent with Tamura et al. [5] who concluded that HTO alleviates pain but may accelerate cartilage wear over time.

- Root repair is preferred for patients with minimal varus malalignment, as it preserves joint integrity and reduces the risk of osteoarthritis.
- HTO with meniscectomy is recommended for patients with moderate to severe varus deformity, as it redistributes weight-bearing forces and alleviates symptoms, though at the potential cost of cartilage deterioration.

While this study provides important insights, several limitations should be noted. The small sample size (24 patients) limits the generalizability of the findings, and the short follow-up period makes it difficult to assess long-term meniscal healing and arthritis progression. Additionally, the study lacked advanced imaging (MRI or second-look arthroscopy), which could have provided objective confirmation of cartilage preservation. Another limitation is the absence of patient-reported outcome measures (PROMs), such as the KOOS score, which would offer a broader perspective on patient satisfaction and daily function. Furthermore, variability in rehabilitation protocols may have influenced recovery outcomes. To improve future research, larger studies with longer follow-ups, standardized rehabilitation protocols, imaging assessments, and randomized controlled trials (RCTs) are needed to provide stronger evidence on the best surgical approach for MMRT.

CONCLUSIONS

Our study suggests that high tibial osteotomy combined with meniscectomy is a suitable approach for patients with chronic degenerative posterior horn medial meniscus root tears (PHMMRTs), mild osteoarthritis (Grade 1), and varus malalignment. On the other hand, transtibial root repair is more appropriate for patients with acute traumatic PHMMRTs, no signs of osteoarthritis, and proper limb alignment.

Ethics Considerations

This study was ethically approved by the Institutional Review Board (IRB #1031) with approval date, 29 January 2025 in the Faculty of Medicine, Zagazig University Hospital, and patient consent from every case that participated in this research was taken. The study was conducted according to the Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Conflicts of Interest

The authors report no conflicts of interest.

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None declared

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