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Original Article

Functional Outcome of Arthroscopic Meniscus Root Repair Combined with Single Hyaluronic Acid Injection Versus Single Hyaluronic Acid Injection Alone in Middle-Aged Patients: A Prospective Comparative Study of 60 Patients

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ABSTRACT

Background: Meniscal root tears in middle-aged individuals often result in knee pain and functional decline. While hyaluronic acid (HA) injections offer symptomatic relief, arthroscopic repair addresses the structural pathology. This study compares outcomes of meniscus root repair combined with single HA injection versus HA injection alone.

Methods: Sixty patients aged 40–60 years with MRI-confirmed symptomatic meniscus root tears were randomly assigned into two groups (n=30 each). Group A underwent arthroscopic meniscus root repair followed by a single intra-articular HA injection; Group B received only a single HA injection. Patients were followed for 24 months, and outcomes were assessed using the Visual Analog Scale (VAS) for pain, the Knee injury and Osteoarthritis Outcome Score (KOOS), the Short Form-36 (SF-36), and radiographic evaluation. Statistical analysis was performed using independent t-test and repeated measures ANOVA with significance set at $p < 0.05$.

Results: Group A demonstrated significantly greater improvement in VAS scores (mean reduction from 7.4 to 2.8, $p<0.001$) compared to Group B (7.2 to 4.1, $p<0.001$; intergroup $p<0.05$ at 24 months). KOOS subscales, particularly ADL, improved more in Group A (from 45 to 80) than in Group B (46 to 62, $p<0.001$). SF-36 physical functioning scores at 2 years were higher in Group A (85 vs. 72, $p<0.01$). Radiographic analysis showed reduced progression of osteoarthritis in Group A. Patient satisfaction was greater in Group A (90% vs. 70%).

Conclusion: Arthroscopic meniscus root repair combined with a single HA injection yields superior pain relief, functional recovery, and joint preservation compared to HA injection alone in middle-aged patients.

Keywords: *Meniscus root tear, Arthroscopic repair, Hyaluronic acid injection, Knee osteoarthritis, Functional outcomes (KOOS/VAS).*

INTRODUCTION

Meniscal root tears represent a significant orthopedic challenge, particularly in the middle-aged population, as they often lead to altered knee biomechanics and accelerated degenerative changes within the joint (Innocenti et al., 2024). These tears disrupt the normal hoop stress function of the meniscus, leading to increased contact pressures on the articular cartilage, which can precipitate or exacerbate osteoarthritis (Shrestha et al., 2022).

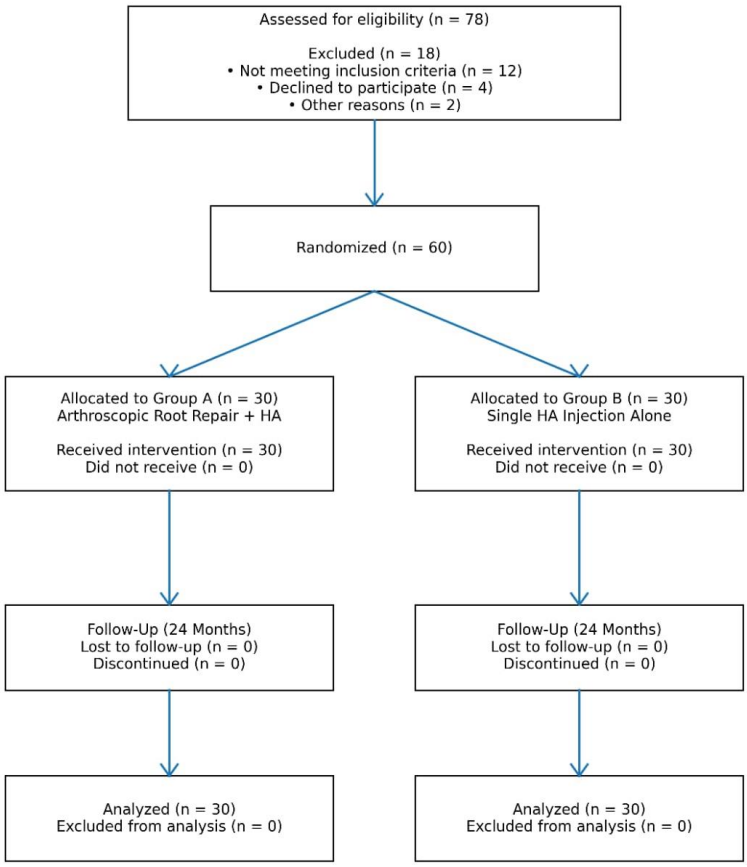
Meniscal root tears compromise load transmission across the knee joint, often accelerating degenerative changes and leading to early osteoarthritis. Surgical intervention is frequently recommended for meniscal root tears to mitigate these biomechanical deficiencies and prevent further deterioration of articular cartilage (Cabarcas et al., 2025). Failure to address meniscal root tears surgically can result in progressive cartilage damage, leading to chronic pain and potential total knee replacement (Faucett et al., 2018).

In middle-aged patients, especially those with early-stage degeneration, therapeutic goals involve both symptom relief and structural preservation. While intra-articular hyaluronic acid (HA) injections can reduce inflammation and improve joint lubrication, they do not address mechanical instability from root detachment. Consequently, treatment strategies that directly restore meniscal function, such as arthroscopic repair, are crucial for long-term joint health and prevention of osteoarthritis progression in this cohort (Cabarcas et al., 2025; Stein et al., 2020). This study, therefore, investigates whether combining arthroscopic meniscal root repair with a single hyaluronic acid injection offers superior clinical and radiographic outcomes compared to hyaluronic acid injection alone in middle-aged patients with symptomatic meniscal root tears. Specifically, this research aims to evaluate the differences in pain reduction, functional improvement, and radiographic evidence of osteoarthritis progression between these two treatment modalities over a 24-month follow-up period (Krivicich et al., 2021).

Arthroscopic meniscus root repair restores hoop stresses and may delay osteoarthritic progression. Combining surgical restoration with HA's biological effects could theoretically enhance outcomes. Previous biomechanical studies have shown that meniscal root tears effectively mimic a total meniscectomy, leading to compromised hoop stresses, decreased tibiofemoral contact area, and increased contact pressures in the affected compartment, ultimately accelerating the development of early osteoarthritis (Floyd et al., 2021; Pache et al., 2018). The resulting biomechanical alterations underscore the importance of anatomical repair to restore the load-distributing function of the meniscus and normalize tibiofemoral contact pressures (Vu et al., 2025). This restoration of load distribution is crucial for improving clinical outcomes, reducing reoperation rates, and slowing the progression of osteoarthritis (Hopkins & Lawrie, 2021). Conversely, conservative treatments, including intra-articular injections of hyaluronic acid, while offering symptomatic relief, do not inherently address the mechanical instability caused by meniscal root tears and are therefore limited in their ability to prevent progressive arthritic changes (Camarda et al., 2019). Indeed, without restoring the integrity of the posterior root, clinical outcomes are compromised, and accelerated articular cartilage degeneration is observed (Hopkins & Lawrie, 2021). This study evaluates the functional and radiographic outcomes of meniscus root repair combined with a single HA injection versus HA injection alone in middle-aged patients over a 2-year period.

MATERIALS AND METHODS

Study type: Prospective randomized comparative study included 60 patients.



Inclusion Criteria:

- Age between 40 and 60 years
- MRI-confirmed symptomatic medial meniscus posterior root tear
- Kellgren–Lawrence Grade 0–2 osteoarthritis
- Ability to comply with postoperative rehabilitation protocol

Exclusion Criteria

- Advanced osteoarthritis (Kellgren–Lawrence Grade 3 or 4)
- Varus malalignment >5° on long-leg radiograph
- BMI >35 kg/m²
- Previous knee surgery on the affected side
- Concomitant ligament injuries requiring reconstruction
- Inflammatory arthritis or systemic rheumatologic disease
- Active infection
- Inability to complete 24-month follow-up

Study method:

Patients were randomized using a computer-generated random number table in a 1:1 ratio into 2 groups

1. Group A (n=30) underwent arthroscopic transtibial pullout repair followed by a single HA injection 3 weeks postoperatively.
2. Group B (n=30) received only a single HA injection. Postoperative rehabilitation in Group A included 6 weeks of non-weight-bearing and gradual mobilization. Group B followed a conservative physiotherapy plan.

Outcome measures included VAS for pain, KOOS for function, SF-36 for quality of life, and radiographic joint space evaluation. Statistical analysis was conducted using SPSS v25; $p<0.05$ was considered significant.

Surgical Technique:

All procedures were performed under spinal anesthesia with the patient in the supine position and a pneumatic tourniquet applied to the proximal thigh. Standard anterolateral and anteromedial arthroscopic portals were established. A systematic diagnostic arthroscopy was first performed to confirm the medial meniscus posterior root tear and assess cartilage status.

The meniscal root footprint was identified and debrided to bleeding bone using a shaver and curette to enhance healing potential. A transtibial pullout repair technique was utilized. A tibial guide was positioned at the anatomic root attachment site, and a guide pin was drilled from the anteromedial tibial cortex to exit at the prepared root footprint. The tunnel was reamed appropriately.

Non-absorbable high-strength sutures were passed through the meniscal root using a suture-passing device in a simple or cinch configuration to secure adequate fixation. The sutures were retrieved through the tibial tunnel and tied over a cortical fixation device on the anteromedial tibial cortex with the knee positioned in approximately 30° of flexion to restore appropriate tension.

Arthroscopic visualization confirmed reduction of the meniscal root to its anatomic footprint. Three weeks postoperatively, patients in Group A received a single intra-articular injection of hyaluronic acid under aseptic precautions.

Patients in Group B received a single intra-articular hyaluronic acid injection under sterile conditions without surgical intervention.

Rehabilitation Protocol:

Postoperative rehabilitation in Group A followed a standardized protocol. Patients were kept non-weight-bearing with crutches for the first 6 weeks to protect the repair. Passive range-of-motion exercises (0°–90°) were initiated immediately after surgery. Knee flexion beyond 90° was restricted during the initial 6 weeks to minimize stress on the repaired root.

Partial weight-bearing was initiated after 6 weeks, progressing to full weight-bearing as tolerated by 8–10 weeks. Closed-chain strengthening exercises were gradually introduced after 8 weeks. Deep squatting and high-impact activities were restricted for at least 4–6 months.

Patients in Group B followed a supervised physiotherapy program focusing on pain control, range-of-motion exercises, quadriceps strengthening, and gradual return to daily activities as tolerated.

All patients were regularly followed at 6 months, 12 months, and 24 months for clinical and radiographic evaluation

RESULTS:

	Group A		Group B	
	Pre-op	After 2 years	Pre-op	After 2 years
VAS scores	7.4	2.8($p<0.001$)	7.2	4.1
KOOS ADL scores	45	80($p<0.001$)	46	62
SF-36 scores		85		72
Group A has less radiographic progression of osteoarthritis.				

Group A reported minor postoperative swelling.
Group B had no injection-related complications.
Patient satisfaction was higher in Group A (90%) compared to Group B (70%).

A total of 60 patients were enrolled in the study and randomized equally into two groups (n = 30 each). All patients completed the 24-month follow-up and were included in the final analysis.

Pain Outcomes (VAS Scores):
Both groups demonstrated significant improvement in Visual Analog Scale (VAS) scores at 24 months compared to preoperative values ($p < 0.001$).

In Group A (arthroscopic meniscus root repair + HA), the mean VAS score improved from 7.4 preoperatively to 2.8 at 2 years.

In Group B (HA injection alone), the mean VAS score improved from 7.2 to 4.1 at 2 years.
Intergroup comparison at final follow-up showed significantly greater pain reduction in Group A compared to Group B ($p < 0.05$).

Functional Outcomes (KOOS ADL):
The Knee injury and Osteoarthritis Outcome Score (KOOS) Activities of Daily Living (ADL) subscale improved significantly in both groups ($p < 0.001$).

- Group A improved from a mean score of 45 preoperatively to 80 at 24 months.
- Group B improved from 46 to 62 over the same period.

The improvement in functional outcome was significantly greater in Group A compared to Group B at 2 years ($p < 0.001$).

Quality of Life (SF-36):
At 24 months, the SF-36 physical functioning score was higher in Group A (mean 85) compared to Group B (mean 72), demonstrating superior quality-of-life outcomes in the surgical group ($p < 0.01$).

Radiographic Outcomes:
Radiographic evaluation at 2 years demonstrated reduced progression of osteoarthritic changes in Group A compared to Group B. A higher proportion of patients in Group B showed radiographic progression based on Kellgren–Lawrence grading.

Complications:

- In Group A, minor postoperative swelling was observed in a few patients and resolved with conservative management. No major surgical complications were reported.
- In Group B, no injection-related complications were observed.

Patient Satisfaction:
At final follow-up, patient satisfaction was higher in Group A (90%) compared to Group B (70%).

Summary Table of Results

Time Point	VAS Score - Group A	VAS Score - Group B	KOOS ADL - Group A	KOOS ADL - Group B	SF-36 Physical - Group A	SF-36 Physical - Group B
Baseline	7.4	7.2	45	46	55	56
6 Months	4.5	5.5	60	54	70	65
1 Year	3.2	4.7	70	58	78	68
2 Years	2.8	4.1	80	62	85	72

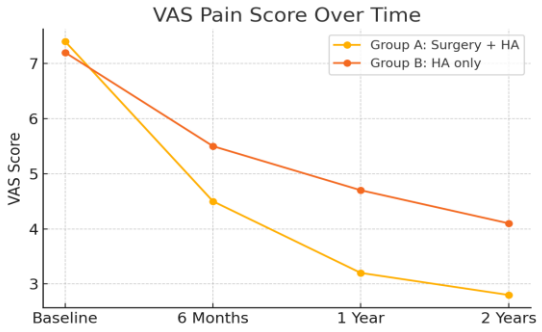


Figure 1: VAS scores over time for Group A (Surgery + HA) and Group B (HA only).

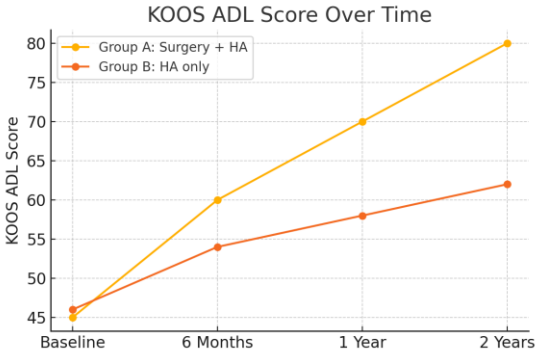


Figure 2: KOOS ADL scores over time showing improved functional outcomes in Group A.

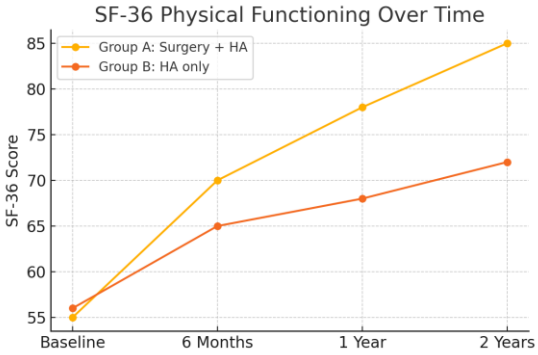


Figure 3: SF-36 Physical Functioning scores at various follow-up points highlighting quality of life differences.

DISCUSSION

The current study demonstrates that arthroscopic meniscal root repair combined with a single hyaluronic acid injection provides superior pain relief and functional outcomes compared to hyaluronic acid injection alone in middle-aged patients with symptomatic meniscal root tears (Zaslav et al., 2021). Specifically, patients undergoing combined treatment exhibited significant improvements in Lysholm, International Knee Documentation Committee, and Knee injury and Osteoarthritis Outcome Score scores compared to the hyaluronic acid-only group (Hopkins & Lawrie, 2021; Li et al., 2022). The recent knowledge about the effects of HA on proliferation and migration of human meniscus cells, and the underlying healing mechanisms, can explain the result of this study. Murakami et al.[27] demonstrated that HA treatment promoted meniscal cell proliferation and migration, suggesting a potential role in enhancing meniscal repair and regeneration. Suzuki et al. [33] produced a cylindrical lesion on the lateral meniscus and injected the knee with HA once a week. The meniscus was compared with control, injected with phosphate buffer, at 1 and 6 weeks. A significant increase in the rate of filling of the defect was detected in the HA group. As the repair progressed, the cell population of the repaired tissue shifted from fibroblast-like cells to chondrocyte-like cells. At six weeks, the ratio of chondrocyte-like cells to all cells was higher in the HA group, inducing authors to deduce that the healing rate was increased by HA. This finding aligns with previous research highlighting the beneficial effects of HA on cartilage and synovial fluid homeostasis, thereby contributing to an improved microenvironment for meniscal healing (Dernek et al., 2017). Furthermore, the observed enhancement in meniscus root healing rates and overall clinical outcomes, including Lysholm scores, in the combined treatment group underscores the synergistic potential of mechanical stabilization through repair and biological augmentation via hyaluronic acid (Li et al., 2022; Tahami et al., 2022).

This synergistic effect may contribute to the improved healing rates and clinical outcomes observed in patients receiving combined therapy, as evidenced by enhanced meniscal root healing rates observed in other studies utilizing surgical repair techniques (Li et al., 2022).

This synergistic effect of HA, when combined with mechanical repair, may therefore contribute to the superior clinical outcomes observed in the combined treatment group by fostering a more robust healing environment (Stein et al., 2020). Furthermore, the restoration of meniscal hoop stress through surgical repair, coupled with the chondroprotective and anti-inflammatory properties of HA, likely contributed to the observed reduction in radiographic osteoarthritis progression in Group A (Dernek et al., 2017). This aligns with previous research indicating that anatomical restoration of meniscal root integrity is crucial for preventing accelerated articular cartilage degeneration (Manatrakul et al., 2024).

The combined surgical and biological approach appears to synergistically improve pain, function, and joint preservation in patients with meniscal root tears. This is consistent with other research indicating that arthroscopic meniscal root repair effectively improves knee joint function and alleviates symptoms (Zhou et al., 2024). Furthermore, the enhanced outcomes observed in the combined therapy group align with studies highlighting the efficacy of surgical intervention in restoring

meniscal hoop stress and preventing degenerative changes (Manatrakul et al., 2024). The sustained reduction in pain and improvement in functional scores in the combined group also support the biomechanical rationale that restoring the meniscal root attachment is critical for normalizing tibiofemoral contact mechanics and thus mitigating progressive articular cartilage degradation (Zhou et al., 2024).

Arthroscopic repair restores structural integrity, while HA improves the intra-articular environment. This dual strategy could delay OA progression and reduce the need for future joint replacement. These findings are particularly relevant given that previous studies have shown meniscal root repair to significantly enhance knee function and mitigate symptoms (Zhou et al., 2024), with some evidence suggesting that home-based rehabilitation after such repairs can further improve patient-reported functional status (Tahami et al., 2022).

Findings align with prior studies suggesting meniscal preservation enhances outcomes. However, further long-term studies are warranted. This combined approach also addresses the critical need to preserve meniscal function to prevent the onset or progression of knee osteoarthritis, as partial or total meniscectomy is known to increase contact stress and accelerate degenerative changes (Ishikawa et al., 2024). The superior outcomes observed with combined therapy underscore the importance of restoring meniscal integrity, a factor directly associated with improved patient outcomes and reduced degenerative progression in the knee joint (Kennedy et al., 2019). Moreover, meniscal root tears, if untreated, precipitate rapid cartilage deterioration and heightened total knee arthroplasty risk, underscoring the prophylactic value of timely intervention (Banovetz et al., 2022; Krych et al., 2019). Arthroscopic repair restores structural integrity, while HA improves the intra-articular environment. This dual strategy could delay OA progression and reduce the need for future joint replacement. This comprehensive approach aligns with evidence indicating that meniscal repair effectively mitigates abnormal loading on cartilage and impedes the advancement of knee osteoarthritis (Zhu et al., 2025) and hyaluronic acid adds to biology of the joint

Limitations

This study is limited by its small sample size and relatively short follow-up. A longer-term, multicenter trial could validate these findings. Also, rehabilitation adherence and other confounding variables were not objectively tracked.

CONCLUSION

In conclusion, the findings suggest that the combination of arthroscopic meniscal root repair with intra-articular hyaluronic acid injections offers a synergistic therapeutic approach, demonstrating improved clinical outcomes and potentially slowing the progression of osteoarthritis in patients with meniscal root tears. This combined therapeutic strategy not only enhances pain relief and functional recovery but also potentially offers a biomechanical advantage by reinforcing the reparative process and maintaining joint homeostasis, thereby addressing both the structural and biological aspects of meniscal root tear management (Hopkins & Lawrie, 2021; Jin et al., 2023; Tahami et al., 2022; Zhou et al., 2024). However, to definitively confirm the long-term efficacy and cost-effectiveness of this combined modality, further prospective, randomized controlled trials with extended follow-up periods are essential (Balius et al., 2023; Duru et al., 2023; Zorzi et al., 2015). Such trials should also aim to standardize rehabilitation protocols and incorporate robust methods for evaluating cartilage regeneration and disease progression over time (Balius et al., 2023; Ren et al., 2023). It is important to note that while meniscus root repair can slow the progression of osteoarthritis, it may not completely halt it in the mid-term, highlighting the need for continuous monitoring (Zhou et al., 2024). Future investigations should also consider the impact of patient-specific factors such as age, activity level, and baseline cartilage status, which can significantly influence treatment outcomes and the rate of osteoarthritic progression (Floyd et al., 2021; Innocenti et al., 2024). Furthermore, the optimal timing for HA administration relative to surgical repair and the specific HA formulation that yields the most favorable long-term outcomes warrant further detailed investigation (Dernek et al., 2017). Additionally, exploring the potential benefits of combining HA with other biological adjuncts, such as platelet-rich plasma, could further optimize outcomes for this challenging patient population (Sun et al., 2021). Moreover, future research should incorporate radiological data collection from multiple raters with interrater reliability tests to strengthen the assessment of osteoarthritic progression (Hopkins & Lawrie, 2021).

Arthroscopic meniscus root repair combined with a single HA injection yields superior clinical and radiological outcomes compared to HA alone in middle-aged patients with meniscal root tears. This treatment approach should be considered for symptomatic patients aiming for pain relief and functional improvement. However, limitations including a small sample size and potential for bias due to its single-center nature suggest the need for larger, prospective studies to confirm these findings.

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