



Original Article

Functional Outcome of Meniscus Root Repair in Middle-Aged Population and Its Role in Preventing Progression of Osteoarthritis: A Longitudinal Study

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ABSTRACT

Background: Meniscal root tears disrupt knee biomechanics, accelerating cartilage degeneration and osteoarthritis (OA). This study evaluates functional outcomes and the progression of OA following arthroscopic meniscus root repair in middle-aged patients over a 3-year period.

Materials and Methods: Fifty patients aged 40–60 years with MRI-confirmed symptomatic meniscus root tears underwent arthroscopic repair using the transtibial pullout technique. Exclusion criteria included Kellgren-Lawrence (K-L) grade >3, severe comorbidities, and ligamentous instability. Knee Injury and Osteoarthritis Outcome Score (KOOS), Visual Analogue Scale (VAS), and Short Form-36 (SF-36) scores were assessed at baseline, 1, 2, and 3 years. Radiographs were evaluated annually using the K-L grading scale.

Results: Mean KOOS score improved from 42 at baseline to 77 at 3 years ($p < 0.001$). VAS scores decreased from 7.1 to 2.9 ($p < 0.001$), and SF-36 physical functioning scores showed sustained improvement. Only 12% showed radiographic OA progression by one grade. No re-tears or major complications occurred. Patient satisfaction was high (88%).

Conclusion: Arthroscopic meniscus root repair in middle-aged patients yields sustained improvement in pain and function, and may slow OA progression. This supports early surgical intervention in this demographic to preserve joint function.

Keywords: Meniscus root tear, osteoarthritis, arthroscopy, functional outcome, middle-aged, KOOS, VAS.

INTRODUCTION

The integrity of the meniscal root is vital to the biomechanical stability of the knee joint. Root tears, particularly in the posterior horn of the medial meniscus, can mimic the effects of total meniscectomy by disrupting load transmission and increasing tibiofemoral contact pressures. This disruption in load distribution significantly increases the risk of early osteoarthritic degeneration, highlighting the critical role of the meniscus in joint health [1]. Consequently, these injuries often necessitate surgical intervention to restore meniscal function and mitigate the progression of degenerative changes within the knee [2]. Studies have shown that timely meniscal root repair can improve patient-reported outcomes and potentially slow the progression of osteoarthritis, even in cases with pre-existing radiographic evidence of the condition [3]. The transtibial pull-out technique is a commonly employed arthroscopic repair method for meniscal root tears, utilizing sutures fixed with cortical buttons or bio-absorbable anchors to re-establish meniscal stability [4].

In middle-aged individuals (40–60 years), the interplay between mechanical instability and age-related degeneration heightens the risk of accelerated osteoarthritis (OA).

While conservative treatment and intra-articular injections are often pursued in early OA, they do not address the biomechanical deficiency. Conversely, meniscal root repair has demonstrated significant success in preventing degenerative changes in a substantial proportion of patients, with some studies reporting no progression in osteoarthritis

grade in up to 84% of cases [5]. Furthermore, clinical outcomes often continue to improve beyond six months post-surgery, with some patients experiencing significant gains in IKDC scores even between 6 and 12 months, indicating a prolonged recovery trajectory and the importance of extended follow-up[6]. Therefore, ongoing research aims to further delineate the optimal timing and patient selection criteria for meniscus root repair, especially in the context of varying degrees of articular cartilage degeneration[6].

Arthroscopic repair of meniscal root tears has been shown to restore meniscal function and potentially alter the trajectory of joint degeneration. This restoration of normal contact pressure within the tibiofemoral compartment is crucial for mitigating cartilage degradation and preventing the onset or progression of osteoarthritis [6,7]. Such tears, defined as radial tears within 1 cm of the meniscal attachment or bony avulsions, compromise hoop stresses and lead to increased tibiofemoral contact pressures, functionally mimicking a total meniscectomy [8]. This results in altered joint mechanics and accelerated cartilage degeneration[9], underscoring the necessity of effective surgical intervention to restore biomechanical integrity and prevent further deterioration[10]. Biomechanical testing confirms that medial meniscus posterior root tears are functionally equivalent to total meniscectomy, leading to abnormally high contact pressures and altered knee kinematics, which can be reliably restored through root repair[2]. Anatomical meniscal root repairs, particularly with a transtibial pullout technique, have been biomechanically proven to restore mean and peak contact pressures in the medial compartment, effectively reversing the meniscectomy-like state [11]. These repairs are critical for maintaining the circumferential tension of the meniscus, which is essential for proper load distribution across the knee joint[12]. This longitudinal study investigates the outcomes of such repairs in a middle-aged population over a 3-year follow-up period, focusing on functional scores, pain relief, and radiographic progression of OA. Specifically, this research aims to evaluate the long-term efficacy of arthroscopic meniscus root repair in preserving joint function and mitigating degenerative changes in patients between 40 and 60 years of age, thereby addressing a critical gap in the understanding of outcomes in this demographic.

MATERIALS AND METHODS

Study Design and Participants:

This prospective observational study included 50 patients aged 40 to 60 years with symptomatic posterior meniscus root tears confirmed via MRI.

Inclusion criteria: Age 40–60 years

- Clinical and MRI evidence of meniscal root tear
- Kellgren–Lawrence (K-L) grade ≤ 3

Exclusion criteria:

- Advanced OA (K-L grade 4)
- Ligamentous instability
- Inflammatory arthritis
- Prior knee surgeries

Surgical Procedure:

All patients underwent arthroscopic transtibial pullout repair under spinal anesthesia. The root was anatomically reattached using 2 suture loops passed through a tibial tunnel, fixed with a cortical button. Anatomic restoration was confirmed arthroscopically.

Rehabilitation Protocol:

- 0–6 weeks: Non-weight-bearing with a hinged brace (0–90°)
- 6–12 weeks: Gradual weight-bearing with quadriceps strengthening
- After 12 weeks: Full weight-bearing, functional training

Outcome Measures:

1. Pain: Visual Analog Scale (VAS) at baseline, 1, 2, and 3 years
2. Function: Knee injury and Osteoarthritis Outcome Score (KOOS)
3. Quality of Life: Short Form-36 (SF-36) – Physical functioning subscale
4. Radiographic Evaluation: Standing AP radiographs for K-L grading annually
5. Satisfaction: 5-point Likert scale
6. Complications: Surgical or functional

Statistical Analysis:

Paired t-tests were used to compare baseline and follow-up scores. Statistical significance was set at $p < 0.05$. Descriptive statistics summarized demographic and radiographic data.

RESULTS

Demographics:

- Mean age: 51.2 years

- Gender distribution: 54% male, 46% female
- 60% had baseline K-L grade 1 or 2

Pain and Function:

- VAS: Decreased from 7.1 (baseline) to 2.9 (3 years), $p < 0.001$
- KOOS: Improved from 42 to 77 (3 years), with major gains at 1 year (72) sustained thereafter
- SF-36 Physical: Increased from 55 to 80 over the study period ($p < 0.01$)

Radiographic Progression:

- At baseline, 60% had mild OA (K-L 1–2)
- At 3 years, only 12% progressed by one grade
- No patient progressed to K-L grade 4

Complications and Satisfaction:

- Minor postoperative swelling in 4 patients, resolved with conservative care
- No re-tears or need for revision surgery
- Satisfaction: 88% reported being “satisfied” or “very satisfied” at final follow-up

DISCUSSION

This study's findings corroborate previous research highlighting the effectiveness of arthroscopic meniscal root repair in improving patient-reported outcomes and preventing radiographic progression of osteoarthritis[13]. Specifically, significant improvements in VAS, KOOS, and SF-36 scores demonstrate durable pain relief and functional recovery over a three-year period in a middle-aged cohort, aligning with outcomes observed in broader patient populations[4].

This study reinforces the role of meniscus root repair in halting the mechanical cascade that leads to osteoarthritis. The favorable outcomes observed in this middle-aged cohort, characterized by significant improvements in pain, function, and a low rate of OA progression, provide strong evidence for the efficacy of this intervention in preserving joint health[14,15]. These findings underscore the clinical importance of addressing meniscus root tears promptly to restore biomechanical function, thereby mitigating the long-term degenerative effects associated with untreated tears[16].

The data demonstrate that not only is pain reduced and function improved, but structural progression is also limited. These findings are aligned with prior studies by LaPrade et al. and Chung et al[17], confirming that anatomical root repair reduces joint overload and preserves cartilage health.

Early surgical repair may be especially valuable in middle-aged patients, who are often in a transitional phase between high functional demand and increasing degenerative risk. Moreover, the consistently high patient satisfaction rates observed throughout the follow-up period further validate the clinical utility of this reparative approach for meniscal root tears[3]. The sustained improvements in functional scores, coupled with minimal radiographic progression of osteoarthritis, suggest that early intervention with arthroscopic root repair can effectively alter the natural history of meniscal root tears in this demographic[18]. Furthermore, the data indicates that meniscal root repair serves as a viable alternative to partial meniscectomy, which has been associated with a higher likelihood of requiring total knee arthroplasty within five years[19]. The low complication rate and high satisfaction further underscore the clinical relevance of the technique. This is particularly pertinent given that younger, more active patients are often better candidates for such repairs due to their reduced structural degeneration of the knee and higher physical demands[4,11]. While age and other demographic characteristics have not been directly correlated with functional outcomes in some studies, the preservation of the native meniscus through repair can significantly improve long-term joint health and function, especially in active individuals[20]. The significant improvements in pain scores, functional outcomes, and quality of life observed in this study align with previous research indicating that meniscal root repair restores the shock-absorbing function of the meniscus, thereby preventing the progression of osteoarthritis[4]. The observed radiographic stability, with only 12% of patients showing progression in Kellgren-Lawrence grade at three years, supports the efficacy of root repair in mitigating degenerative changes, contrasting with the more rapid progression typically seen in untreated tears or after meniscectomy [6]. This sustained radiographic stability is crucial given that untreated root tears often lead to rapid progression of osteoarthritis and subchondral insufficiency fractures[21]. The success of these repairs in mitigating degenerative changes highlights the critical role of preserving meniscal integrity, particularly in light of studies indicating that repairable tears have increased significantly in recent decades[22].

Limitations

- Absence of a non-surgical or placebo control group limits comparative inference
- Moderate sample size
- Long-term OA progression beyond 3 years remains unknown

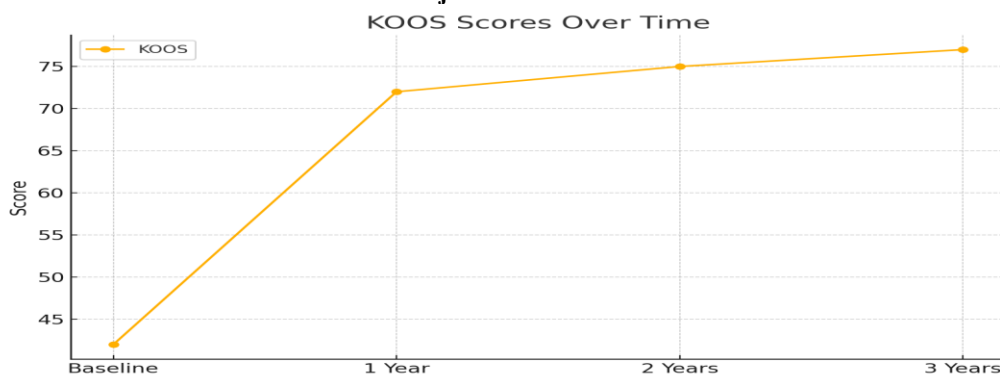
CONCLUSION

This study demonstrates that arthroscopic meniscal root repair effectively improves patient-reported outcomes and significantly reduces the progression of osteoarthritis over a three-year follow-up period [20,23]. These positive results

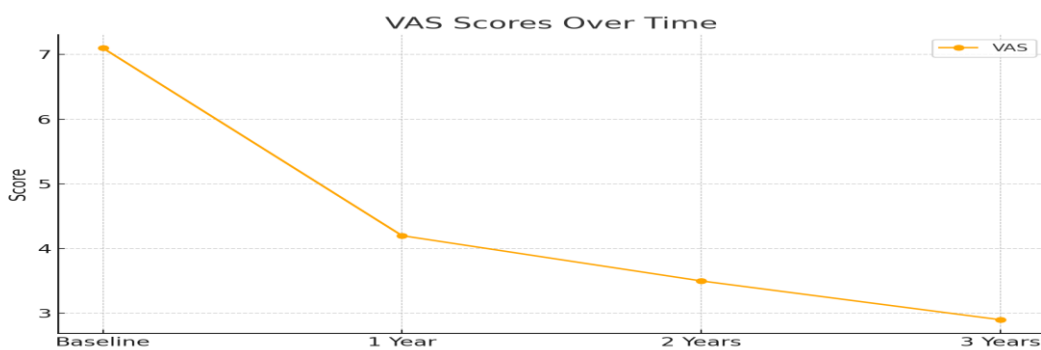
provide a strong basis for recommending arthroscopic meniscal root repair as a definitive treatment, particularly for middle-aged patients who are experiencing symptoms from these injuries. Further investigation into long-term outcomes, particularly beyond three years, and comparisons with non-surgical interventions would provide a more comprehensive understanding of its efficacy and durability [4]. Moreover, future studies incorporating biomechanical analyses could further elucidate the mechanisms through which root repair restores meniscal function and protects articular cartilage [24]. Additional research could also explore the integration of advanced regenerative techniques, such as collagen matrix wrapping or minced cartilage procedures, to augment meniscal repair outcomes and potentially enhance long-term durability [25,26].

Arthroscopic meniscus root repair in the middle-aged population offers substantial and durable improvements in function and pain relief. Moreover, it appears to mitigate the radiographic progression of osteoarthritis. This intervention is crucial as root injuries, defined as those within 10 mm of the meniscal tibial insertion, biomechanically mimic a complete meniscectomy, leading to increased peak pressure and reduced contact area within the joint [27]. Such biomechanical alterations predispose the knee to accelerated degenerative changes, making effective repair strategies vital for preserving long-term joint health [28]. By restoring the hoop stress mechanism and distributing axial loads more evenly across the articular cartilage, meniscal root repair effectively prevents the rapid onset and progression of osteoarthritis observed in untreated cases [11]. Furthermore, studies have shown that despite early postoperative medial meniscal extrusion progression, the continuity of repaired posterior roots is maintained, indicating the procedure's structural integrity [13].

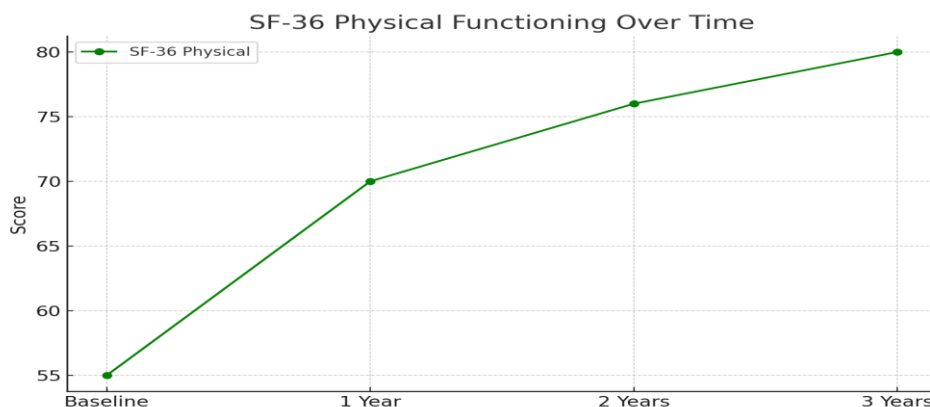
These findings support considering meniscal root repair early in symptomatic patients to preserve long-term knee joint health.



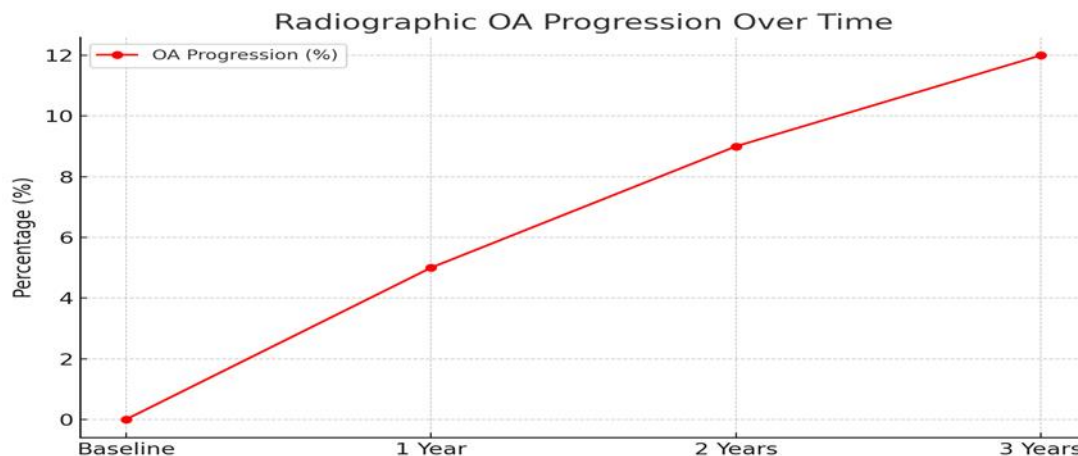
Graph 1: KOOS Scores Over Time



Graph 2: VAS Scores Over Time



Graph 3: SF-36 Physical Functioning Over Time



Graph 4: Radiographic OA Progression Over Time

TABLE 1: Summary Table of Functional and Radiographic Outcomes

Year	KOOS	VAS	SF-36 Physical	OA Progression (%)
Baseline	42	7.1	55	0
1 Year	72	4.2	70	5
2 Years	75	3.5	76	9
3 Years	77	2.9	80	12

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