Early functional outcomes after medial meniscal posterior root tear repair

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Background
Meniscal root tears represent a functional loss; therefore, they greatly increase the risk of osteoarthritis. Root re-insertion aims to restore the anatomy and biomechanical function of the knee, reducing the risk of arthritis. Different techniques have been described. Preparation of the bed and instrumentation remains a challenge.
Aim
To demonstrate good early clinical outcomes after root re-insertion using accessory supra-meniscal portal, which helps both preparation and instrumentation of the bed.
Patients and methods
Between January 2019 and August 2019, we operated on 16 patients who met our inclusion criteria, having root tears of the medial meniscus. All patients underwent arthroscopic evaluation and re-insertion of the root tear medial meniscus using heavy braided suture material shuttled through a tibial tunnel and tied over a bone button. An accessory supra-meniscal portal was used to facilitate instrumentation and suture management. All patients were followed up for 2 years, and the Lysholm knee score was used for assessment at the final follow-up.
Results
A total of 16 patients were operated upon and followed up for a mean of 24 months. The mean Lysholm score improved from 73.5±12.61 preoperatively to 93.75±6.90 postoperatively, with a *P* value of 0.001. The mean preoperative and postoperative Lysholm scores were higher for the traumatic tears as compared with degenerative tears. Older patients showed lower functional outcomes.
Conclusion
Root re-insertion helps restore knee function and biomechanics, thereby prevents detrimental arthritis. Younger patients and those who have sustained traumatic injuries are more likely to improve as compared with elder patients and degenerative tears.

Keywords:
medial meniscus, osteoarthritis, re-insertion, root tears, supra-meniscal

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Introduction

Meniscal root injuries alter the knee biomechanics and increase tibiofemoral contact and stress. This is reported to harm the knee and increase the risk of osteoarthritis [1–3], which can be avoided by repair of the root tear [2,3], yielding good clinical outcomes [4,5]. Although partial meniscectomy for those injuries was reported to relieve symptoms, progressive osteoarthritis ensues [6]. Therefore, there is growing interest among surgeons to repair root tears, and various techniques have been described. Some rely on anterior portals [7–9], where caution should be exercised to prevent chondral injury. It is also criticized for difficult instrumentation. Other techniques make use of posterior portals, which allow better visualization and trajectory for instrumentation [10–15]. However, some procedures are lengthy and therefore are time consuming and are both challenging and technically demanding. In this manuscript, we report the results of root repair using an accessory supra-meniscal portal [16], which provides good access to the root for adequate visualization and instrumentation avoiding the risk of chondral injury or the need of using additional posterior portals.

Patients and methods

Between January 2019 and August 2019, we operated on 16 patients who met our inclusion criteria, having root tear of the medial meniscus. Eight patients were males and eight were females. The mean age was 47.62 (33–60) years. Seven were traumatic root tears and nine were atraumatic degenerative. Five patients had no arthroscopic evidence of medial compartment osteoarthritic changes, whereas 11 showed evidence of medial compartment changes. Of the 11 patients, six were Outerbridge [17] grade 1 changes and five were classified as grade 2. The mean operative time was 57.5 min, ranging from 45 to 70 min. We included patients with traumatic tears and symptomatic degenerative tears in young patients with signs of medial compartment overload (subchondral marrow edema of the medial compartment on MRI). We excluded patients with chondral degeneration (grade 3 and more or established osteoarthritis), degenerative root tears in patients with obesity, and varus malalignment. The study followed the standards of our institutional ethical board.

Preoperative

All patients were assessed clinically using the Lysholm score [18] and radiologically using MRI. On the MRI, signs of root tear like ghost medial meniscus on the sagittal cuts, extruded meniscus on coronal cuts, and bright signal at the root were checked and documented. Radiograph long films were obtained to exclude degenerative changes and/or malalignment.

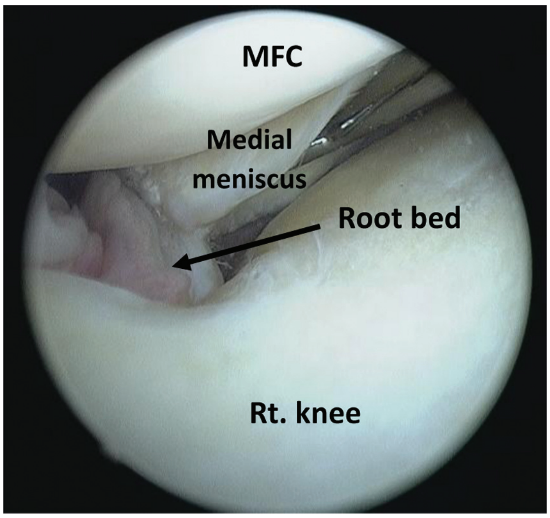
Operative procedure

Informed consent was obtained from all patients. All patients were operated upon in the supine position, under general or spinal anesthesia, and tourniquet control and a side post applied.

Diagnostic arthroscopy was started through standard anterolateral and anteromedial portals to confirm the diagnosis and tear reparability and to assess degenerative chondral changes (Fig. 1). Pie-crusting to release the medial ligament is routinely done to increase the posterior working space. Attention is then drawn to the preparation of the meniscal root bed. The overlying articular cartilage is abraded by a combination of shaver and curette down to a bleeding surface to promote healing (Fig. 2).

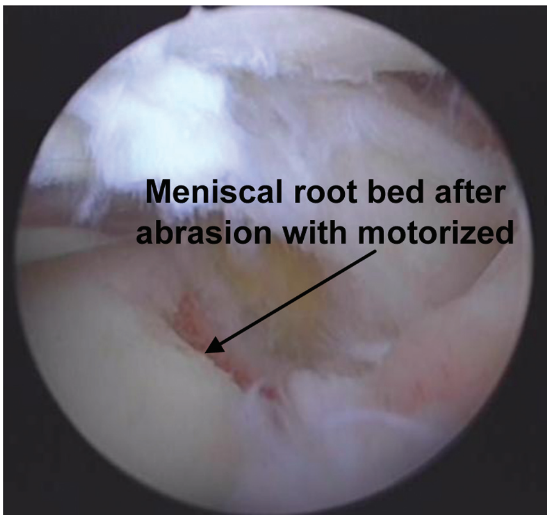
An accessory supra-meniscal is then established as described by Seifeldin and Khedr [16]. This portal gives a good trajectory for instrumentation to take bites into the posterior root and serves as a parking portal for sutures to prevent entanglement (Fig. 3). A curved

Figure 1



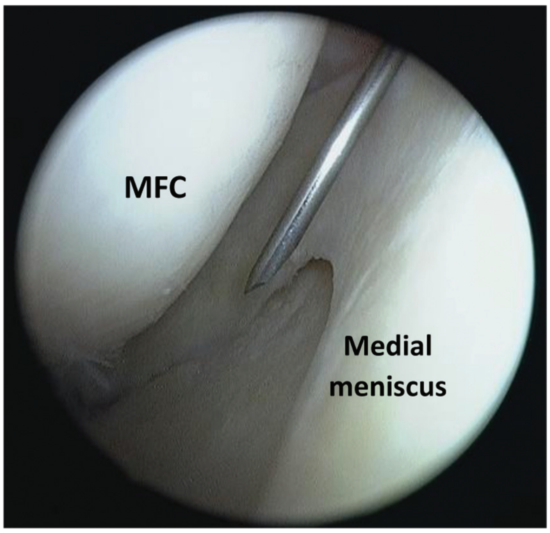
Identification of the root tear medial meniscus on diagnostic arthroscopy of right knee, visualized from standard anterolateral portal.

Figure 2



Meniscal root bed after preparation. Arthroscopic view from anterolateral (AL) portal of the left knee.

Figure 3



Creating the supra-meniscal portal. A spinal needle is shown to guide developing the portal by an outside in technique and checks the trajectory to the meniscal root. This is the right knee viewed from the AL portal.

suture passing device is introduced through the supra-meniscal portal (left curve for a right medial meniscus) to take bites into the meniscal root (Fig. 4). PDS II (polydioxanone) suture is first passed and retrieved to shuttle heavy braided sutures to form either a double cinch (used in 10 patients) (Fig. 5) or horizontal mattress (used in 6 patients) configuration (Fig. 6).

An anterior cruciate ligament guide is used to pass a beath pin to create the tibial tunnel. The pin should exit in the prepared bed (more anteriorly and towards the center) (Fig. 7). After creating the tibial tunnel by drilling over the pin, PDS is used to shuttle the free tails of the heavy braided sutures (Fig. 8). Meniscal reduction is confirmed (Fig. 9). The sutures are finally tied over a bone button.

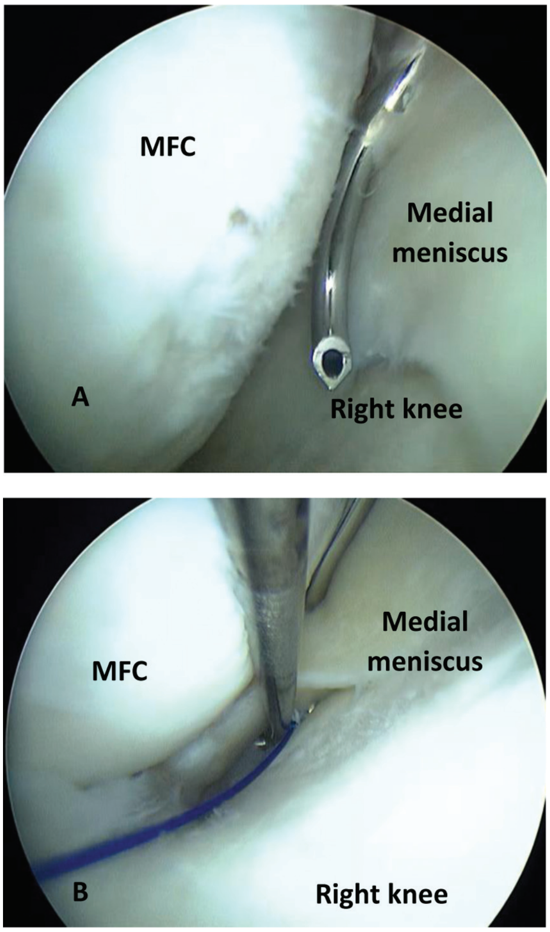
Postoperative

An extension brace is applied for 4 weeks. Early isometric quadriceps exercise and achieving full knee extension are strongly encouraged. Patients are not allowed to bear weight for 6 weeks. Flexion range is permitted to 70° for the first 6 weeks and gradually increased to 120 thereafter. This is followed by a gradual muscle strengthening and balancing program. Deep squats are not allowed before 3–4 months.

Routine anticoagulation was prescribed for at least 3 weeks and up to 6 weeks guided by the patients' status and comorbidities. Cryotherapy was highly advised to reduce swelling and pain in the first 1–2 weeks after arthroscopy.

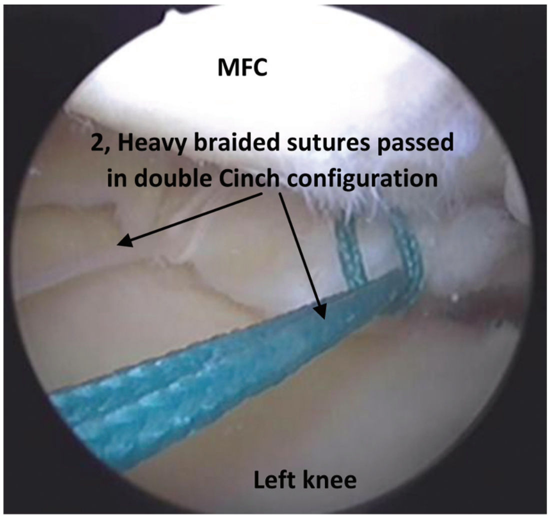
Tegner Lysholm's score was evaluated at the final follow-up at 24 months.

Figure 4



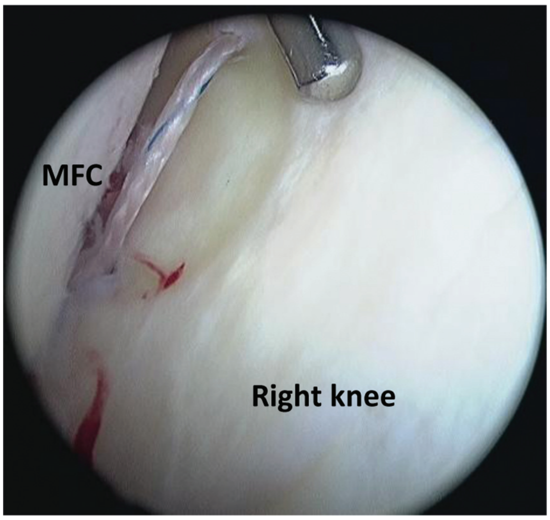
(a) The suture Lasso in the medial compartment at the root MM. (b) the suture Laso rotated to penetrate meniscal tissue and PDS introduced into knee.

Figure 5



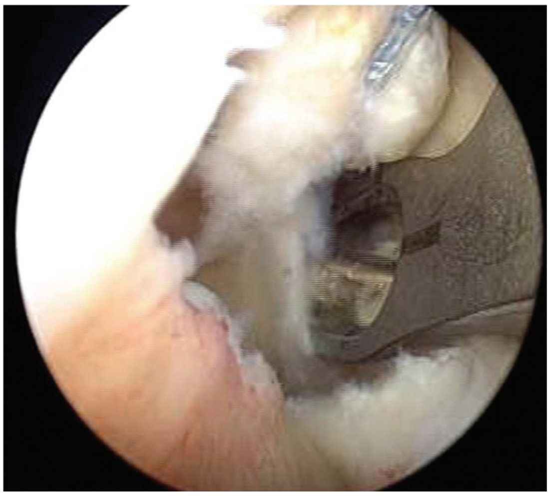
Left knee anterolateral (AL) portal view showing two heavy braided suture material (of different colors) in a cinch fashion after being shuttled through the meniscus.

Figure 6



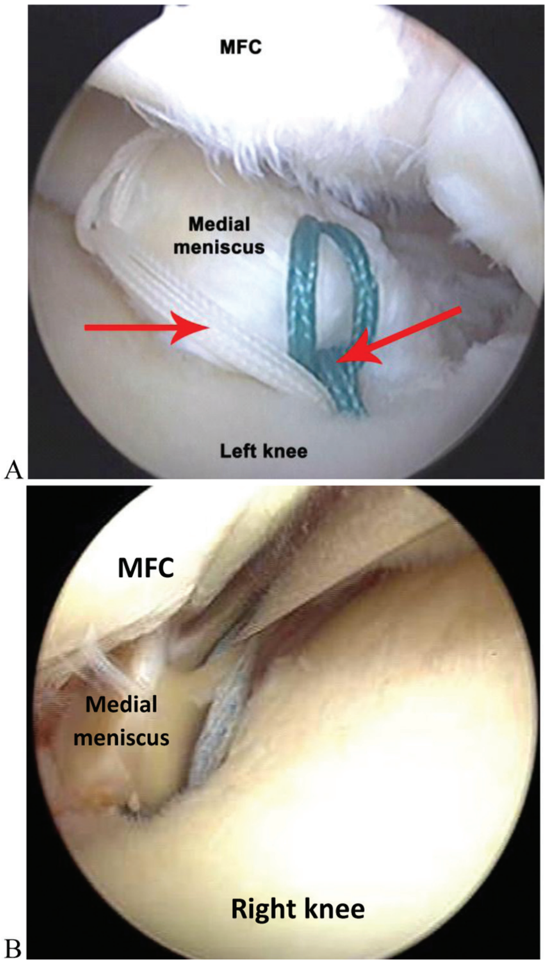
Anterolateral (AL) view right knee showing transverse mattress configuration.

Figure 7



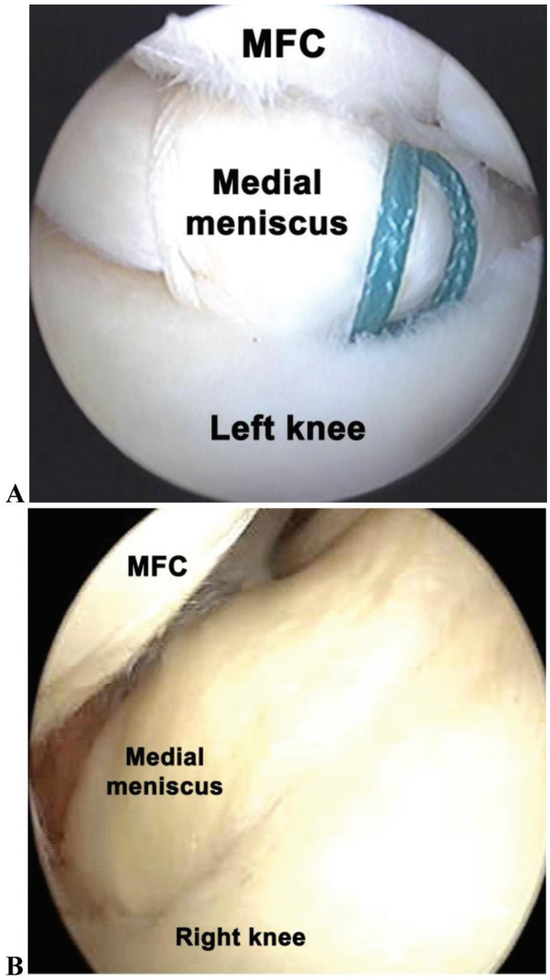
Right knee anterolateral (AL) portal view showing the flat ACL guide used to drill the tibial guide pin in the root foot print.

Figure 8



Left knee viewed from anterolateral (AL) portal showing heavy braided sutures shuttles into the tibial tunnel in: (a) cinch configuration, (b) in horizontal mattress configuration.

Figure 9



Confirming meniscal root reduction. (a) When cinch configuration is used, (b) horizontal mattress configuration.

Statistical methods

Data were coded and entered using the statistical package for the Social Sciences (SPSS), version 26 (IBM Corp., Armonk, New York, USA). Data were summarized using mean, SD, median, minimum, and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were done using the nonparametric Mann–Whitney test. For comparison of serial measurements within each patient, the nonparametric Wilcoxon signed-rank test was used [19]. Correlations between quantitative variables were done using the Spearman correlation coefficient [20]. *P* values less than 0.05 were considered statistically significant.

Results

A total of 16 patients were operated upon and followed up for a mean of 24 months. The mean preoperative Tegner Lysholm score was 73.5±12.61, ranging from 44 to 85.

Three patients were good, nine were considered fair, and four had poor knee scores.

None of our patients had a positive Mc-Murrays test or had any effusion or catching/locking at the final follow-up. Two of our patients still experienced medial joint line tenderness and pain with stairs, squatting, and walking long distances. They showed inferior Lysholm scores. Both were degenerative tears with grade 2 medial compartment changes at the time of the index procedure. The mean±SD postoperative Lysholm score at the final follow-up was 93.75 ±6.90. A total of 14 patients were excellent on the Lysholm score, 1 was good, and one had fair results. This shows a statistically significant improvement as compared with the preoperative Lysholm score after root repair, with a *P* value of less than 0.001 (Table 1).

When we compared the traumatic degenerative patients as two different subsets, we found that the mean preoperative and postoperative Lysholm scores were higher for the traumatic group. Furthermore, the amount of improvement was marginally higher for the traumatic patients as compared with those with degenerative tears; this was not statistically significant, with a *P* value of 0.758 preoperatively and 0.299 postoperatively. We also found that the mean age for traumatic patients was statistically lower, with *P* value of 0.002, as compared with the degenerative group, which showed a higher mean age (Table 2).

The mean age was 47.63±6.65 years. We found a linear regression relationship between age and postoperative Lysholm score. Increasing age was associated with a lower postoperative Lysholm score, with *P* value of 0.028 (Fig. 10).

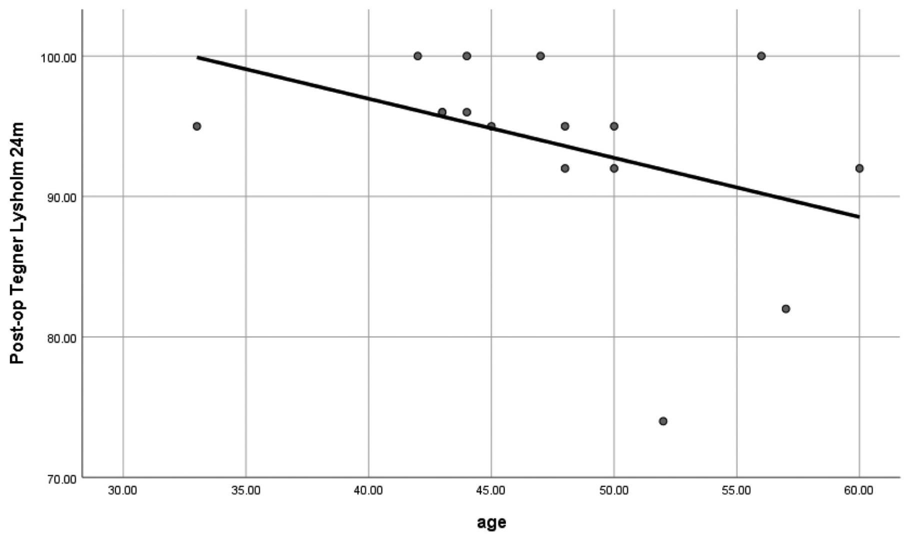
Table 1 The mean preoperative and postoperative Lysholm score showing statistical improvement after root re-insertion

	Mean	SD	*P* value
Preoperative Tegner Lysholm	73.50	12.61	<0.001
Postoperative Tegner Lysholm 24 months	93.75	6.90	

Table 2 Comparing traumatic and degenerative tears

	Traumatic (deg.)										
	Traumatic					Degenerative					
	Mean	SD	Median	Minimum	Maximum	Mean	SD	Median	Minimum	Maximum	*P* value
Age	42.57	4.65	43.00	33.00	48.00	51.56	5.20	50.00	44.00	60.00	0.002
Preoperative Tegner Lysholm	78.29	2.29	79.00	76.00	81.00	69.78	16.08	76.00	44.00	85.00	0.758
Postoperative Tegner Lysholm 24 months	96.14	1.77	96.00	95.00	100.00	91.89	8.84	92.00	74.00	100.00	0.299

Figure 10



A regressive relationship between age and final postoperative Lysholm score.

Table 3 Correlation between sex and outcomes

	Sex										
	Female					Male					
	Mean	SD	Median	Minimum	Maximum	Mean	SD	Median	Minimum	Maximum	*P* value
Postoperative Tegner Lysholm 24 months	95.00	6.02	95.50	82.00	100.00	92.50	7.89	95.00	74.00	100.00	0.442

There was no difference whether clinically or statistically between male and female patients regarding functional outcomes, with *P* value of 0.442 (Table 3).

The mean±SD time from injury to operation in the traumatic group was 4.43±2.07 weeks. Furthermore, our results did not show any clinical or statistical correlation between the time interval between injury to surgery and clinical outcomes (*P*=0.441).

There was a statistically significant correlation between degenerative tears and the finding of medial compartment osteoarthritic changes (*P*=0.005), whereas traumatic tears were mostly associated with normal cartilage on arthroscopy. Of seven traumatic root tears, only two were associated with grade 1 arthritic changes; however, of nine degenerative tears, four had grade 1 arthritis and five had grade 2 changes.

Discussion

Root tears dysfunction the meniscus, and despite initial symptom relief experienced by patients after a partial meniscectomy, several authors demonstrated increased stresses on the cartilage in cadaver models and progressive osteoarthritic changes on radiographs [6]. Those findings motivated surgeons to attempt root repair. As the root is difficult to access, the repair is challenging, and surgeons use different techniques, each with its advantages and disadvantages. However, patient selection is of great importance and influences outcomes after root repair. Traumatic tears, degenerative tears with more than or equal to grade 3 osteoarthritic changes, and/or more than or equal to 5° varus deformity are generally associated with poor functional outcomes and patient satisfaction unless concomitant high tibial osteotomy is performed [21].

In our series, we studied 16 patients with root tears and found a statistically significant improvement in the postoperative Lysholm score as compared with the preoperative score. This is consistent with the series of Kim *et al.* [9], Moon *et al.* [21], and Seo *et al.* [22]. The mean preoperative Lysholm score was lower for traumatic cases as compared with degenerative cases; however, this was statistically nonsignificant. On the contrary; the mean postoperative Lysholm score was higher for traumatic cases, showing greater improvement as compared with degenerative cases, but this was not statistically significant. To the authors' knowledge, our series is the first to report functional outcomes stratified based on the type of tear whether traumatic or degenerative and we were able to show greater improvement for the traumatic patients as compared with the degenerative subset. We also found a significant correlation between the finding of medial compartment osteoarthritis and degenerative tears.

In the series of Seo *et al.* [22], they relied on second-look arthroscopy to objectively report the healing rates of root repair. This is considered a strength in their study; however, we believe the technique they relied on explains their relatively low healing rates and somewhat the impression on questionability of the value of root repair. It is also worth noting that of the 21 cases they included, many have received a concomitant procedure for a coexisting knee pathology, which in itself is a source of bias, and only 11 underwent a second-look arthroscopy.

In their series, the mean Lysholm score preoperatively was much lower than in our study, and a higher proportion of degenerative cases could account for this. Their mean postoperative Lysholm score was lower compared with our results; however, we had a longer average follow-up [22].

Jung *et al.* [12] reported on 13 patients who underwent root repair using suture anchors. Their sample size was close to our study; however, their follow-up time was slightly longer (average 30.8 months). They relied on a high posteromedial portal for foot print preparation and anchor placement. We believe it is time consuming, technically demanding, and carries a risk to the neurovascular structures. Our technique is safe, quicker, and less technically demanding. They propose that their technique avoids the use of tibial tunnels, which is a proposed cause of failure of repair or lax healing owing to the wind-shield effect on the suspension suture material [12]. However, our results were comparable to their functional outcomes, with very close postoperative Lysholm scores.

They also used MRI to assess healing and meniscal reduction and reported no decrease in the amount of meniscal extrusion [12]. We owe this to their technique, which does not use tunnels. Root repair through a tunnel allows for part of the root to become buried into the tunnel and helps restore hoop stresses in the meniscus, maximizes the chance of healing due to bigger contact surface area, and better reduces the meniscus to a more anatomical position, therefore minimizing tibiofemoral contact stresses and subsequent osteoarthritis.

In their technique, the knots were tied and left intra-articular [12]. We believe this could give rise to symptoms like knee pain, catching, and squeaking, all of which could be a source of patient dissatisfaction. They used fiber-wire of the anchor for the repair; this is a strong suture material comparable to the suture material we used in our series [12]. We agree with their view that this is superior to PDS suture used in other series and yields more superior results.

Root repair is believed to reduce the progression of osteoarthritis by reducing contact stresses. However, in many patients, a simple meniscectomy improved function and even Lysholm score [23]. Our study so as many others lacks a comparative and a control group to compare outcomes of root repair together with partial meniscectomy and nonoperative treatment. We believe that patient selection is of extreme importance and that a more meticulous selection of which patients to undergo root repair should reflect better outcomes.

Moon *et al.* [21] performed root repair of the medial meniscus on 77 patients, a much bigger sample size than most of the series, and assessed prognostic factors. They relied on the pull-out suture technique using PDS no 2 sutures. They also performed routine medial release by pie-crusting of the deep MCL to avoid chondral injury during instrumentation. Similar to our study, they used a suture Laso to pass sutures into the meniscal tissue [21]. However, they made a single pass through the meniscus and drilled two tunnels. We believe two tunnels carry the risk of tunnel blow out and a single pass carries a higher risk of repair failure. These factors could explain the difference between our results and their series. They also introduced the suture Laso through the standard anteromedial portal; we believe that our supra-meniscal portal described by Seifeldin and Khedr *et al.* [16] provides a better trajectory to the meniscal root for preparation of the bed and instrumentation of the meniscus.

Our final mean Lysholm score (93.75±6.90) is higher than their means score of 83.2±16.1. This we explain by the fact that we relied on heavy braided suture material as compared with the PDS, which slowly loses 40% of its tensile strength. The other reason is their postoperative protocol of putting the knee into a cylindrical cast for 2 weeks postoperative delaying the start of the range-of-motion exercises [21].In this series, we have not performed MRI to assess healing, and this may be held as a weakness against our study. Moon *et al.* [21] assessed patients with MRI and found that root repair failed not just to reduce meniscal extrusion but to prevent further extrusion. Of 31 patients, 20 showed increased extrusion even postoperatively. Lee *et al.* [24] considered that MRI is suboptimal to evaluate meniscal healing to the bone after root repair and emphasized the role of second-look arthroscopy. Therefore, Moon and colleagues concluded that despite a 90% healing rate on MRI in their series, the healing was lax to allow further meniscal extrusion, in particular, if a concomitant high tibial osteotomy was not performed to unload the medial compartment [19].

In the series of Kim *et al.* [9], they demonstrated a reduction in meniscal extrusion after root repair. This could be explained by the high rate of healing (17 out of 30) on MRI and good quality healing on second-look arthroscopy (nine of 14).

Conclusion

Root re-insertion has been shown to significantly improve function. However, more objective assessment tools like second-look arthroscopy and postoperative MRI assessment question the success of root re-insertion. The presence of coexisting underlying cartilage damage and/or varus deformity further affects outcomes. The literature lacks long-term studies and trials on large samples to verify the value of root repair. Further work currently under study is comparing performing only root repair versus root repair with concomitant high tibial osteotomy, postoperative assessment using MRI, and second-look arthroscopy in selected patients.

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The manuscript has been reviewed by both authors, who believe that it is genuine and suitable for submission.

Both authors have contributed significantly to the study design, performing surgeries, data collection, and writing and revising the manuscript.

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Conflicts of interest
There are no conflict of interest.

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