

A COMPARATIVE ANALYSIS OF FUNCTIONAL OUTCOMES BETWEEN INSIDE-OUT AND ALL-INSIDE ARTHROSCOPIC TECHNIQUES IN MENISCAL TEAR REPAIR

Dr. Abhishek Salgaonkar^{1*}, Dr. P. Thiagarajan², Dr. Ganesh M T³

¹*Department of Orthopedics, Sree Balaji Medical College and Hospital, Chennai, India.

²M.S.Orthopaedics Professor, Sree Balaji Medical College and Hospital, Chennai 600044, Tamil Nadu ,India.Email Id:- pthiagu@yahoo.com

³Assistant Professor Department of Orthopedics, Sree Balaji Medical College and Hospital, Chennai, India.

*Corresponding Author: Dr. Abhishek Salgaonkar, absalgaonkar05@gmail.com

ABSTRACT

Introduction: Meniscal preservation has become the preferred treatment for repairable meniscal tears because of its role in maintaining knee biomechanics and preventing early osteoarthritis. Among the available techniques, inside-out and all-inside arthroscopic repairs are widely used, but their comparative functional outcomes remain an area of interest.

Aim: To compare the functional outcomes of inside-out and all-inside arthroscopic techniques for meniscal tear repair.

Methodology: This prospective comparative study was conducted in the Department of Orthopaedics, Sree Balaji Medical College and Hospital, over 18 months. A total of 46 patients with repairable meniscal tears were enrolled and equally divided into two groups: inside-out repair (n=23) and all-inside repair (n=23). Patients underwent preoperative clinical and MRI evaluation followed by arthroscopic repair. Functional outcomes were assessed using the Lysholm Knee Score and International Knee Documentation Committee (IKDC) score, with follow-up at 3 and 6 months. Statistical analysis was performed using SPSS version 25, and a p-value <0.05 was considered significant.

Results: Both groups showed significant postoperative improvement in functional outcomes. Good-to-excellent Lysholm scores were achieved in 89.1% of patients. The inside-out group demonstrated a slightly higher postoperative IKDC score (91.64 ± 4.74) than the all-inside group (88.75 ± 6.99). The all-inside technique required significantly less operative time (64.65 vs. 92.96 minutes) and fewer fixation devices. Complication rates were low, with no neurovascular injuries observed.

Conclusion: Both inside-out and all-inside arthroscopic meniscal repair techniques provide excellent functional outcomes with low complication rates. The all-inside technique offers the advantages of shorter operative time and fewer fixation devices, whereas the inside-out technique remains an effective option for complex tears. The choice of technique should be individualized based on tear characteristics and surgeon expertise.

KEYWORDS: Meniscal tear, Arthroscopic meniscal repair, Inside-out technique, All-inside technique, Lysholm Knee Score, IKDC score, Functional outcome.

INTRODUCTION

The knee joint is one of the most complex and highly functional synovial joints in the human body, playing a crucial role in weight-bearing, stability, and locomotion. The medial and lateral menisci are essential fibrocartilaginous structures that contribute significantly to load transmission, shock absorption, joint stability, lubrication, and proprioception.¹ Meniscal injuries are among the most common orthopaedic and sports-related knee injuries, accounting for a substantial proportion of arthroscopic knee surgeries performed worldwide. These injuries can result from acute traumatic events, particularly in young and physically active individuals, or from degenerative changes associated with ageing.^{2,3} Advances in magnetic resonance imaging (MRI) and arthroscopic techniques have greatly improved the diagnosis and management of meniscal tears, with increasing emphasis on preserving the meniscus to maintain long-term knee function and prevent degenerative joint disease.^{3,4}

Structurally, the menisci consist predominantly of type I collagen fibres arranged circumferentially, allowing them to convert compressive loads into circumferential hoop stresses that distribute forces evenly across the tibiofemoral joint.^{5,6} The medial meniscus is more firmly attached to the joint capsule and medial collateral ligament, making it less mobile and more susceptible to injury than the lateral meniscus. The vascularity of the injured region plays a critical role in determining the healing potential following meniscal repair.^{7,8}

Biomechanical studies have demonstrated that the menisci transmit approximately 50–70% of the load across the knee during extension and up to 85% during flexion. Loss of meniscal tissue following meniscectomy significantly increases contact stress on the articular cartilage, accelerating cartilage degeneration and predisposing patients to early osteoarthritis.⁹ Consequently, the treatment philosophy has shifted from routine meniscectomy toward meniscal preservation whenever feasible, especially in younger and active individuals.^{9,10}

Meniscal tears occur with an estimated annual incidence of 60–70 cases per 100,000 population and are frequently associated with anterior cruciate ligament (ACL) injuries in traumatic cases. Risk factors include increasing age, obesity, repetitive kneeling or squatting, and participation in high-impact sports.¹¹ Tear morphology, location, chronicity, and tissue quality are important determinants of treatment selection. Vertical longitudinal tears located within the vascular peripheral zone are ideal candidates for repair, whereas complex and degenerative tears often require partial meniscectomy.¹²

With advances in arthroscopic surgery, several repair techniques have been developed to preserve meniscal tissue. Among these, the inside-out and all-inside arthroscopic techniques are the most widely practiced.^{13,14} The inside-out technique has long been regarded as the gold standard because of its high fixation strength, reliable healing rates, and excellent long-term clinical outcomes. However, it requires additional posterior incisions and carries a greater risk of neurovascular injury.^{15,16}

The success of meniscal repair is primarily evaluated through functional outcome measures such as the Lysholm Knee Score, International Knee Documentation Committee (IKDC) score, Tegner Activity Scale, and Knee Injury and Osteoarthritis Outcome Score (KOOS). These validated scoring systems assess pain relief, restoration of knee stability, return to physical activity, and overall patient satisfaction following surgery.¹⁵⁻¹⁷

Although several comparative studies have reported satisfactory healing rates and functional outcomes with both inside out and all-inside techniques, controversy persists regarding their relative advantages in terms of fixation strength, complication rates, rehabilitation, and long-term clinical outcomes. Therefore, a direct comparison of these two commonly employed arthroscopic repair techniques is essential to provide evidence-based guidance for selecting the optimal surgical approach in patients with meniscal tears.

AIM

- To assess and compare the functional outcomes of Inside-Out versus All-Inside arthroscopic techniques in the repair of meniscal tears

OBJECTIVES

- 1) To assess the functional outcomes following arthroscopic repair of meniscal tears using the inside-out and all-inside techniques.
- 2) To compare the complication rates associated with each technique, including neurovascular injury, and infection.

METHODOLOGY

The study was conducted after obtaining approval from the Institutional Ethics Committee of Sree Balaji Medical College and Hospital. Written informed consent was obtained from all participants before enrolment, and strict confidentiality of patient information was maintained throughout the study.

The present study was conducted as a prospective comparative study in the Department of Orthopaedics at Sree Balaji Medical College and Hospital (SBMCH) over a period of 18 months, comprising a 12-month patient enrolment period followed by a minimum postoperative follow-up of 6 months.

Patients presenting to the Orthopaedic Outpatient Department (OPD) and Emergency Department with clinically suspected meniscal injuries were screened for eligibility. A total of 46 patients with MRI-confirmed meniscal tears requiring arthroscopic repair were enrolled using purposive sampling after obtaining written informed consent. Patients were equally allocated into two groups: 23 underwent inside-out arthroscopic meniscal repair and 23 underwent all-inside arthroscopic meniscal repair. Eligible patients included those with bucket-handle or unstable vertical longitudinal tears involving the red-red or red-white vascular zones, with or without concomitant anterior cruciate ligament (ACL) reconstruction. Patients with cruciate ligament deficiency, knee instability, degenerative, complex, or anterior horn meniscal tears, repairs using meniscal arrows or screws, those unwilling to participate, and those lost to follow-up were excluded.

All patients underwent detailed preoperative clinical evaluation, including history, physical examination, McMurray test, Apley compression test, joint line tenderness, range of motion assessment, plain radiographs, and magnetic resonance imaging (MRI). MRI findings were confirmed during arthroscopy. All surgeries were performed under spinal or general anesthesia using standard arthroscopic techniques through anterolateral and anteromedial portals. A systematic diagnostic arthroscopy was followed by meniscal repair using either the inside-out or all-inside technique.

Postoperatively, patients received standard antibiotic prophylaxis, routine wound care, and a structured rehabilitation protocol comprising progressive range-of-motion exercises, gradual weight bearing, muscle strengthening, and return to sports over a period of 4–6 months. Functional outcomes were assessed using the Lysholm Knee Score and the International Knee Documentation Committee (IKDC) score. Patients were followed up at 3 and 6 months to evaluate knee function, range of motion, stability, and postoperative complications. Clinical, operative, and follow-up data were recorded using a structured case record proforma for subsequent statistical analysis.

The collected data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 25.0. Descriptive statistics were expressed as mean, standard deviation, frequency, and percentage. Continuous variables were compared using paired and independent Student's t-tests, while categorical variables were analyzed using the Chi-square test. A p-value of less than 0.05 was considered statistically significant.

RESULT

A total of 46 patients were included in the study, with 23 patients each in the all-inside and inside-out repair groups. The majority of patients belonged to the 20–30 years (19/46, 41.3%) and 31–40 years (17/46, 37.0%) age groups. Males

predominated the study population, accounting for 34 (73.9%) patients, while 12 (26.1%) were females. Road traffic accidents were the most common mechanism of injury (21/46, 45.7%), followed by slip and fall (16/46, 34.8%), Kabaddi-related injuries (5/46, 10.9%), and football-related injuries (4/46, 8.7%). The right knee was more frequently involved than the left, with 27 (58.7%) and 19 (41.3%) cases, respectively. The baseline demographic and clinical characteristics were comparable between the two study groups. (Refer Table 1)

Table 1 Baseline Demographic and Clinical Characteristics of the Study Population

Variable	Category	All-Inside (n=23)	Inside-Out (n=23)	Total (n=46)
Age Group (years)	20–30	9	10	19
	31–40	9	8	17
	41–50	4	5	9
	51–60	1	0	1
Gender	Male	18	16	34
	Female	5	7	12
Mode of Injury	Road Traffic Accident (RTA)	12	9	21
	Sports – Kabaddi	2	3	5
	Slip and Fall	8	8	16
	Sports – Football	1	3	4
Side Involved	Right	14	13	27
	Left	9	10	19

The mean duration of symptoms before surgery was 3.96 ± 1.75 months in the inside-out group and 5.70 ± 5.44 months in the all-inside group.

Medial meniscal tears were observed in 14 (30.4%) of the 46 patients, with an identical distribution in both groups. Seven patients (30.4%) in each of the all-inside and inside-out groups had medial meniscal tears, while the remaining 16 patients (69.6%) in each group did not have medial tears, indicating comparable distribution between the two techniques. Lateral meniscal tears were present in 11 (23.9%) patients overall. They were more frequently observed in the inside-out group (8 patients; 34.8%) than in the all-inside group (3 patients; 13.0%). The remaining 35 (76.1%) patients had no lateral meniscal tear.

The mean follow-up duration was comparable between the two surgical groups. Patients in the inside-out group had a mean follow-up of 16.78 ± 3.07 months, while those in the all-inside group had a mean follow-up of 16.83 ± 3.27 months. The Lysholm knee score demonstrated favorable functional outcomes in both surgical groups. Overall, 22 (47.8%) patients achieved a good outcome, 19 (41.3%) had an excellent outcome, and 5 (10.9%) had a fair outcome. In the all-inside group, 11 (47.8%) patients had good, 9 (39.1%) had excellent, and 3 (13.0%) had fair results, while in the inside-out group, 11 (47.8%) had good, 10 (43.5%) had excellent, and 2 (8.7%) had fair outcomes. (Refer Figure 1)

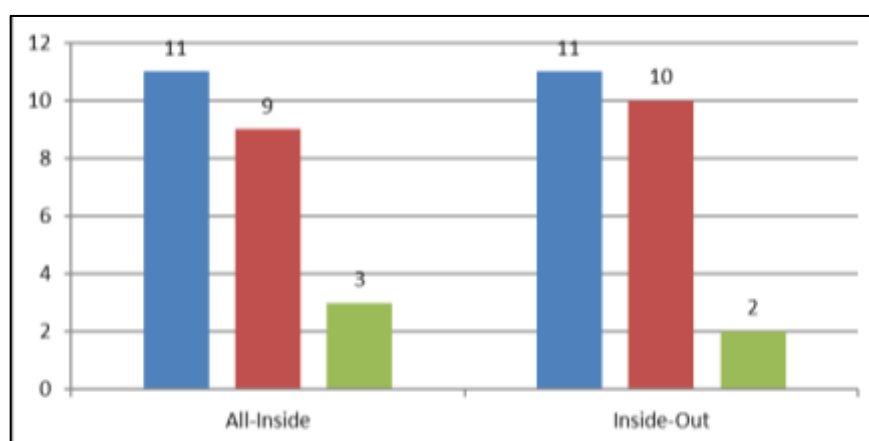


Figure 1 - Lysholm Grade

The mean preoperative IKDC score was comparable between the two groups, with 55.44 ± 8.55 in the inside-out group and 55.06 ± 7.87 in the all-inside group. Following surgery, both groups demonstrated marked improvement in knee function. The mean postoperative IKDC score increased to 91.64 ± 4.74 in the inside-out group and 88.75 ± 6.99 in the all-inside group, indicating excellent functional recovery with both techniques. The mean duration of surgery was 92.96 ± 10.86 minutes for the inside-out technique and 64.65 ± 9.50 minutes for the all-inside technique. The mean number of sutures/anchors used was 4.26 ± 1.36 in the inside-out group and 3.09 ± 0.79 in the all-inside group.

Among the 46 patients, 23 (50.0%) underwent concomitant ACL reconstruction, with a similar distribution between the all-inside (11 patients) and inside-out (12 patients) groups. Bucket-handle tears were the most common tear type, observed in 25 (54.3%) patients, while 21 (45.7%) had longitudinal tears. Regarding tear location, 25 (54.3%) tears were located in the red-red zone and 21 (45.7%) in the red-white zone. The posterior horn was the most frequently involved site, affecting 32 (69.6%) patients, followed by the middle horn in 10 (21.7%) and the anterior horn in 4 (8.7%) patients. Overall, the distribution of ACL reconstruction, tear type, tear zone, and horn involvement was comparable between the two surgical groups. (Refer Table 2)

Table 2 Tear Characteristics and Associated ACL Reconstruction Among Study Groups (n = 46)

Variable	Category	All-Inside (n=23)	Inside-Out (n=23)	Total (n=46)
ACL Reconstruction	Yes	11	12	23
	No	12	11	23
Tear Type	Longitudinal	10	11	21
	Bucket Handle	13	12	25
Tear Zone	Red-Red	14	11	25
	Red-White	9	12	21
Horn Involved	Anterior	2	2	4
	Middle	5	5	10
	Posterior	16	16	32

Postoperative range of motion was satisfactory in both groups. The mean knee flexion was $128.17 \pm 7.95^\circ$ in the inside-out group and $130.26 \pm 7.74^\circ$ in the all-inside group, indicating slightly greater flexion in patients treated with the all-inside technique. The mean extension lag was $1.22 \pm 1.35^\circ$ in the inside-out group compared to $0.83 \pm 1.19^\circ$ in the all-inside group, suggesting marginally better restoration of full knee extension following all-inside repair. (Refer Table 3)

Table 3 Comparison of Postoperative Range of Motion Between Surgical Techniques

Parameter	Inside-Out (Mean $\pm$ SD)	All-Inside (Mean $\pm$ SD)
Knee Flexion (degrees)	128.17 ± 7.95	130.26 ± 7.74
Extension Lag (degrees)	1.22 ± 1.35	0.83 ± 1.19

Postoperative complications were infrequent in both groups. Surgical site infection occurred in only one patient (2.2%), belonging to the inside-out group, while no infections were observed in the all-inside group. No neurovascular injuries were reported in either group. Device failure occurred in one patient (2.2%) in the all-inside group, with no cases in the inside-out group. Re-tear was observed in two patients (4.3%), with one case each in the all-inside and inside-out groups. Overall, both surgical techniques demonstrated a low complication rate and favorable safety profile.

Preoperative IKDC scores were comparable between the inside-out and all-inside groups ($p = 0.877$). Postoperatively, the inside-out group demonstrated a significantly higher mean IKDC score than the all-inside group (91.64 ± 4.74 vs. 88.75 ± 6.99 ; $p = 0.047$). Mean postoperative knee flexion was slightly greater in the all-inside group; however, the difference was not statistically significant ($p = 0.372$). The all-inside group exhibited a significantly lower extension lag compared with the inside-out group ($0.83 \pm 1.19^\circ$ vs. $1.22 \pm 1.35^\circ$; $p = 0.031$). Lysholm grade distribution was comparable between the two techniques, with no statistically significant difference ($p = 0.081$), indicating that both procedures achieved similarly favorable functional outcomes. (Refer Table 4)

Table 4 - Comparison of Functional Outcomes Between Inside-Out and All-Inside Arthroscopic Meniscal Repair

Parameter	Inside-Out (Mean $\pm$ SD / n)	All-Inside (Mean $\pm$ SD / n)	Test Statistic	p-value
IKDC Preoperative Score	55.44 ± 8.55	55.06 ± 7.87	$t = 0.156$	0.877
IKDC Postoperative Score	91.64 ± 4.74	88.75 ± 6.99	$t = 2.645$	0.047
Knee Flexion ($^\circ$)	128.17 ± 7.95	130.26 ± 7.74	$t = -0.902$	0.372
Extension Lag ($^\circ$)	1.22 ± 1.35	0.83 ± 1.19	$t = 3.043$	0.031

Lysholm Grade	Excellent: 10	Excellent: 9	$\chi^2 = 0.953$	0.081
	Good: 11	Good: 11		
	Fair: 2	Fair: 3		

DISCUSSION

The present prospective comparative study evaluated the functional outcomes of inside-out and all-inside arthroscopic meniscal repair techniques in 46 patients. Both groups were comparable with respect to age, sex, mechanism of injury, tear characteristics, and associated anterior cruciate ligament (ACL) reconstruction, allowing a reliable comparison of postoperative outcomes. The majority of patients were young adults below 40 years of age with a male predominance, reflecting the epidemiological pattern of meniscal injuries reported by **Arnoczky and Warren**,⁸ **Walker and Erkman**,¹⁸ and **Shelbourne et al**,¹², who observed that meniscal tears commonly occur in young, physically active individuals following traumatic knee injuries.

Road traffic accidents constituted the most common mechanism of injury in the present study, followed by slip-and-fall injuries, indicating the increasing contribution of high-energy trauma to meniscal injuries in developing countries. Bucket-handle tears were the predominant tear pattern, and most tears involved the red-red or red-white vascular zones and the posterior horn of the meniscus. These findings are consistent with the observations of **Morgan et al**,¹⁹ and **Arnoczky and Warren**,⁸ who emphasized that longitudinal and bucket-handle tears in vascular zones are ideal candidates for arthroscopic repair because of their superior healing potential.

Both surgical techniques produced excellent functional outcomes. Approximately 89.1% of patients achieved good-to-excellent Lysholm scores, while postoperative IKDC scores improved markedly in both groups. The inside-out group demonstrated a slightly higher postoperative IKDC score (91.64 ± 4.74) than the all-inside group (88.75 ± 6.99). These findings agree with the studies by **Barber and Herbert**²⁰ and the systematic review by **Nepple et al**,²¹, who concluded that inside-out and all-inside repairs provide comparable healing rates and functional outcomes when appropriate patient selection is ensured. Similarly, **Morgan et al**,¹⁹ reported success rates of 80–90% following inside-out meniscal repair, which closely corresponds with the favorable outcomes observed in the present study.

One of the major differences between the two techniques was operative time. The all-inside technique required significantly less operative time (64.65 minutes) than the inside-out technique (92.96 minutes), consistent with the findings of **Barber and Herbert**²⁰ and **Randa Elmallah et al**,²², who reported that all-inside repair reduces surgical duration by eliminating accessory incisions and simplifying suture deployment. The inside-out technique also required a greater number of sutures than the all-inside technique, reflecting the differences in fixation methods. Despite the longer operative time, the inside-out technique continues to provide excellent fixation strength, particularly for posterior horn and complex tears, as highlighted by **Becker et al**.²³

Postoperative rehabilitation outcomes were satisfactory in both groups. Knee flexion exceeded 128° in both techniques, and extension lag was minimal, indicating near-normal restoration of knee range of motion. Similar findings have been reported by **Logan et al**,²⁴, who demonstrated equivalent long-term functional recovery following both repair techniques. Although the all-inside group showed slightly better knee flexion and lower extension lag, these differences were clinically small.

The incidence of complications was low in both groups. Only one patient in the inside-out group developed a superficial postoperative infection, one patient in the all-inside group experienced device failure, and one patient in each group had a re-tear. No neurovascular injuries were encountered. These findings are comparable to those reported by **Austin et al**,²⁵, who described a higher risk of neurovascular complications with inside-out repair, and **Barber and Herbert**,²⁰ who reported occasional implant-related complications with all-inside devices. The absence of neurovascular injury in the present study likely reflects meticulous surgical technique and improved instrumentation.

Concomitant ACL reconstruction was performed in half of the patients and was equally distributed between the two groups. Previous studies by **Shelbourne et al**,¹², **Nepple et al**,²¹, and **Krych et al**,²⁶ have demonstrated improved meniscal healing when repair is combined with ACL reconstruction because of enhanced biological healing, which may have contributed to the excellent functional outcomes observed in the present study.

Overall, the findings of the present study are in close agreement with both Indian and international literature. Both inside-out and all-inside arthroscopic meniscal repair techniques provided excellent functional recovery, high rates of patient satisfaction, and low complication rates. While the all-inside technique offered advantages of shorter operative time and fewer fixation devices, the inside-out technique demonstrated slightly superior postoperative IKDC scores and remains an excellent option for complex tear patterns. Therefore, the choice of repair technique should be individualized according to tear characteristics, patient factors, implant availability, and surgeon experience rather than relying solely on the surgical method.

CONCLUSION

The present study demonstrated that both inside-out and all-inside arthroscopic meniscal repair techniques are safe, effective, and reliable methods for the management of meniscal tears, providing excellent functional outcomes with significant improvement in Lysholm and IKDC scores. Although the all-inside technique was associated with shorter operative time and the use of fewer fixation devices, the inside-out technique achieved slightly superior postoperative IKDC scores and continues to be a dependable option, particularly for complex and posterior horn tears. Both techniques showed low complication rates, with no neurovascular injuries observed, highlighting the importance of meticulous

surgical technique and appropriate patient selection. Tear type, tear zone, and concomitant ACL reconstruction did not significantly influence the comparative outcomes. Overall, the findings support meniscal preservation as the preferred treatment strategy, and the choice between inside-out and all-inside repair should be individualized based on tear characteristics, vascular zone, and surgeon expertise.

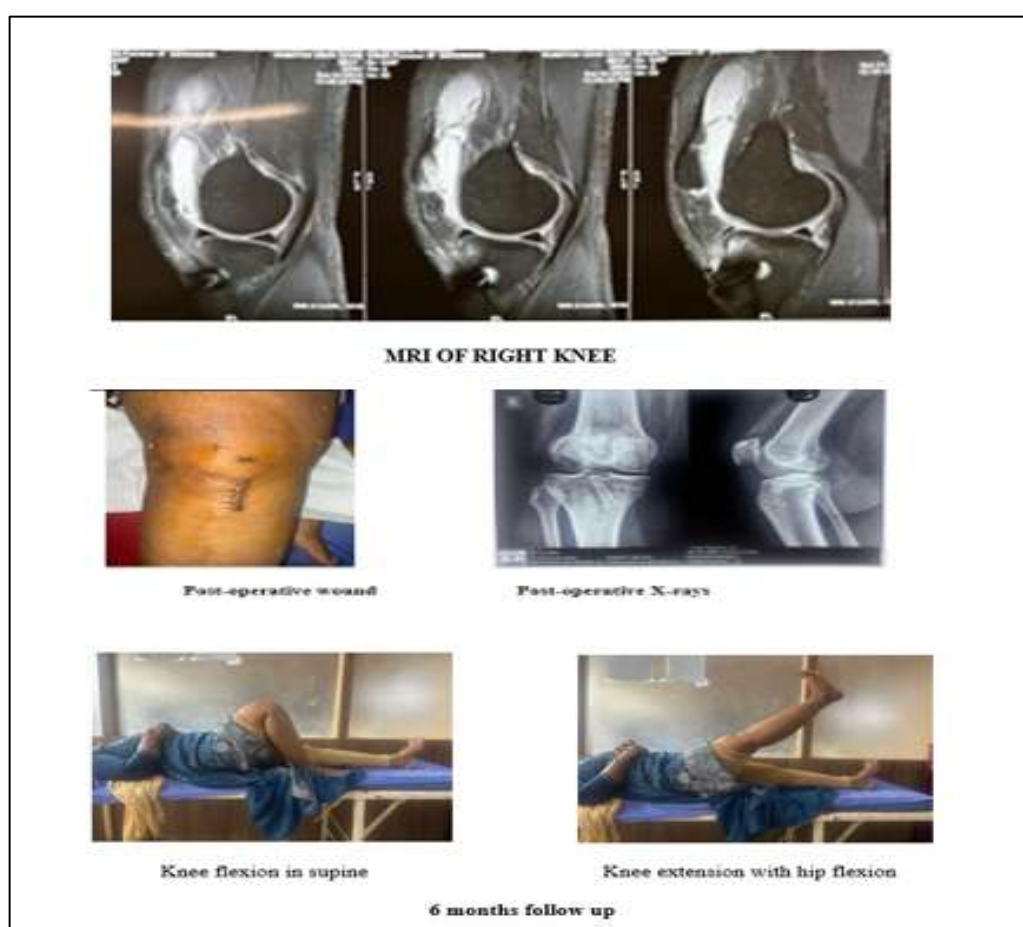
LIMITATIONS

1. The study had a relatively small sample size (46 patients), which may limit the statistical power and generalizability of the findings.
2. The follow-up period was limited to approximately 16–17 months, which may not be sufficient to evaluate long-term meniscal healing, re-tear rates, and the development of osteoarthritic changes.

Case Presentation

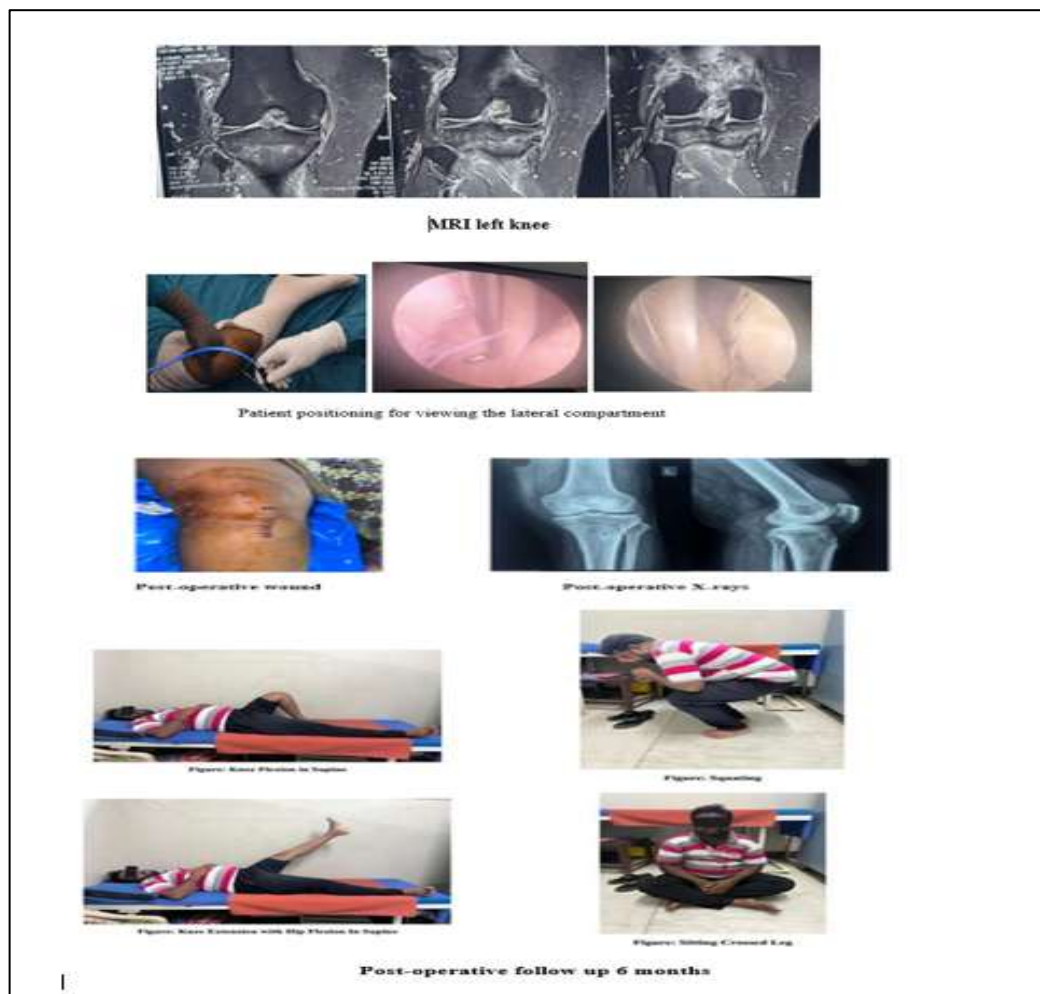
Case 1

- Age/ sex: 34 years / female
- Mode of Trauma: Slip and fall
- Injuries: right Lateral Meniscus injury
- Procedure done: Arthroscopic right inside out technique meniscus Repair
- Post op follow up: 6 months



Case 2

- Age / sex: 36 years / male
 Mode of Trauma: Road Traffic Accident
 Injuries: Left LATERAL Meniscus injury
 Procedure done: Arthroscopic left inside out technique meniscus Repair
 Post op follow up: 6 months



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