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Inside-Out Arthroscopic Meniscal Repair: A Prospective Analysis of Clinical and Functional Outcomes

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ABSTRACT

Background: *Meniscal tears are common in young, active patients and are important for long-term knee health because the menisci protect cartilage and maintain joint mechanics; even partial tissue loss can accelerate degeneration. Current practice, therefore prioritizes meniscal repair when feasible, and the inside-out technique remains a versatile, cost-efficient option.*

Methods: *This prospective observational study was conducted at NITOR, Dhaka, Bangladesh from July, 2024 to June, 2025 and enrolled consecutive adults with symptomatic, MRI-confirmed meniscal tears undergoing arthroscopic inside-out repair. Baseline demographics and injury details were recorded, MRI and arthroscopy documented tear characteristics, and operative variables, including meniscus repaired, tear type, concomitant ACL reconstruction, sutures, and operative time, were captured. Patients were followed at 6 weeks, 3, 6, and 12 months, assessing VAS pain, IKDC, Lysholm, and ROM, with complications recorded; results were summarized descriptively in SPSS v26.0.*

Results: *Among 35 patients, the mean age was 27.9 ± 6.2 years; most were male, 31 (88.6%), with a mean BMI of 24.6 ± 2.9 kg/m²; the right knee was involved in 20 (57.1%), and the median injury-to-surgery interval was 28 weeks (IQR 16–44). Non-contact pivoting sports injury was the commonest mechanism, 21 (60.0%), and ACL injury was absent in 27 (77.1%). Medial tears predominated, 23 (65.7%), mainly longitudinal vertical, 16 (45.7%), with red-white zone involvement in 19 (54.3%); mean operative time was 78 ± 16 minutes. Outcomes improved to 12 months, VAS 6.8 to 1.3, IKDC 42 to 82, Lysholm 51 to 91, and complications occurred in 8 (22.9%), most commonly stiffness, 3 (8.6%).*

Conclusion: *Inside-out arthroscopic meniscal repair produced marked 12-month improvements in pain, function, and ROM with acceptable complications, supporting it as a viable meniscus-preserving option when combined with timely referral and structured rehabilitation.*

Keywords: *Inside-out meniscal repair, Arthroscopy, and Meniscal tear*

I. INTRODUCTION

Meniscal tears represent some of the most common intra-articular knee injuries in young, active individuals and are now recognized as critical determinants of long-term joint health, rather than merely sources of "mechanical symptoms." The menisci, which are fibrocartilaginous structures, distribute load, enhance joint congruity, contribute to rotational stability, and protect articular cartilage by maintaining hoop stress. Even minor

tissue loss can significantly alter contact mechanics and accelerate cartilage degeneration.[1] As a result, current management strategies emphasize meniscal preservation whenever possible, with decisions guided by tear pattern, chronicity, tissue quality, and vascular zone. Repair is preferred for peripheral longitudinal and bucket-handle tears, as well as for repairable tears associated with ligamentous instability.[2,3] Advances in surgical techniques, suture constructs, and biologic augmentation methods, including trephination, rasping, marrow stimulation, and adjuncts, have broadened the indications for repair and enhanced healing potential in selected cases.[4,5] Meniscal injuries affect individuals across a broad age range, with a particularly high incidence among athletes and workers exposed to pivoting, squatting, and trauma. Systematic reviews commonly report baseline incidence rates in the tens per 100,000 person-years, with substantially higher rates in high-risk sporting populations.[2,6] In South Asia, knee injuries resulting from sports, occupational activities, and road traffic accidents are prevalent. However, prospective, procedure-specific outcomes research in this region remains limited, and local expectations are often inferred from high-income countries with different rehabilitation resources and return-to-work demands. This is significant because meniscectomy, although effective for rapid symptom relief in selected cases, is consistently linked to a higher risk of osteoarthritis compared to meniscal preservation, as demonstrated in comparative clinical studies.[7,9] These issues are especially pertinent in Bangladesh, where young patients often present with symptomatic tears during their most productive years, making the optimization of long-term function a matter of socioeconomic importance. The inside-out arthroscopic technique is widely considered the gold standard among meniscal repair options due to its versatility across various tear patterns, capacity for dense suture placement with strong fixation, and relative cost-efficiency compared to some device-dependent all-inside systems. However, it necessitates accessory posteromedial or posterolateral incisions and careful protection of neurovascular structures.[6,10] Comparative studies indicate that, for common indications such as bucket-handle tears, long-term functional outcomes and failure rates of inside-out and all-inside techniques are generally similar. Differences are more pronounced in complication rates and resource requirements than in patient-reported outcomes.[9,10] Despite this, there is a lack of context-specific prospective data from Bangladesh, particularly using standardized clinical and functional endpoints. This study therefore aims to prospectively assess pain, function, and knee motion following inside-out meniscal repair.

II. METHODS

This prospective observational study was conducted at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh, over one year from July, 2024 to June, 2025. Consecutive patients undergoing arthroscopic inside-out meniscal repair for symptomatic meniscal tears were enrolled after informed consent. Eligible participants were adults with MRI evidence of a meniscal tear and clinical features consistent with meniscal pathology, who were scheduled for arthroscopic repair using the inside-out technique. Patients with advanced osteoarthritis, inflammatory arthropathy, significant ipsilateral knee pathology that would confound outcome assessment, or inability to comply with follow-up were excluded. Baseline data were recorded using a structured case report form, including demographics (age, sex, BMI, occupation), injury details (mechanism, side, injury-to-surgery interval), and preoperative clinical findings (effusion grading and associated ACL status). MRI was reviewed to document meniscus involved, tear location and vascular zone. Intraoperatively, tear configuration was confirmed arthroscopically, and operative variables were captured, including meniscus repaired (medial, lateral, both), tear type, concomitant ACL reconstruction, number of sutures, and operative time. Postoperative management followed standard institutional rehabilitation, and patients were reviewed at 6 weeks, 3 months, 6 months, and 12 months. Outcomes were assessed using pain on a visual analogue scale (VAS, 0–10), International Knee Documentation Committee (IKDC) subjective score, Lysholm score, and knee range of motion (flexion and extension deficit). Complications were prospectively recorded, including stiffness, infection, hemarthrosis, persistent swelling, and sensory symptoms. Data were analyzed descriptively using SPSS (v 26.0), continuous variables were summarized as mean ± SD or median (IQR) as appropriate, and categorical variables as frequency and percentage.

III. RESULTS

Table 1 shows a young cohort with a mean age of 27.9 ± 6.2 years, predominantly male, 31 (88.6%), and a near-normal mean BMI of 24.6 ± 2.9 kg/m². Manual workers, 12 (34.3%), and students, 10 (28.6%), formed the largest occupational groups. The right knee was more commonly involved, 20 (57.1%), and the median injury-to-surgery interval was 28 weeks (IQR 16–44). [Table 1]

Table 1: Baseline demographic and anthropometric profile of participants undergoing inside-out arthroscopic meniscal repair (N = 35)

Variable	Category / Unit	n (%)
Age (years)	Mean ± SD	27.9 ± 6.2
Sex	Male	31 (88.6%)
	Female	4 (11.4%)

BMI (kg/m²)	Mean ± SD	24.6 ± 2.9
Occupation	Student	10 (28.6%)
	Manual worker	12 (34.3%)
	Office job	8 (22.9%)
	Athlete	3 (8.6%)
	Other	2 (5.7%)
Knee side	Right	20 (57.1%)
	Left	15 (42.9%)
Injury-to-surgery interval (weeks)	Median (IQR)	28 (16–44)

Table 2 indicates that non-contact pivoting sports injuries were the leading mechanism, 21 (60.0%), followed by road traffic accidents, 6 (17.1%). Most patients had mild-to-moderate effusion, 24 (68.6%) combined, and associated ACL injury was uncommon overall, with 27 (77.1%) showing no ACL injury; partial and complete ACL tears were each present in 4 (11.4%). [Table 2]

Table 2: Injury mechanism, baseline clinical presentation, and associated ACL status on preoperative evaluation (N = 35)

Variable	Category / Unit	n (%)
Mechanism of injury	Non-contact pivoting sports injury	21 (60.0%)
	Contact sports	5 (14.3%)
	Road traffic accident	6 (17.1%)
	Fall	2 (5.7%)
	Twist during daily activity	1 (2.9%)
Effusion	None	8 (22.9%)
	Mild	14 (40.0%)
	Moderate	10 (28.6%)
	Severe	3 (8.6%)
Associated ACL injury	None	27 (77.1%)
	Partial tear	4 (11.4%)
	Complete tear	4 (11.4%)

Table 3 demonstrates that medial meniscal tears predominated, 23 (65.7%), with longitudinal vertical tears as the most frequent arthroscopic pattern, 16 (45.7%), followed by bucket-handle tears, 9 (25.7%). Posterior horn involvement was common, 21 (60.0%), and the red-white zone accounted for the majority of tears, 19 (54.3%), while white-white zone tears were infrequent, 4 (11.4%). Concomitant ACL reconstruction was performed in 4 (11.4%), and mean operative time was 78 ± 16 minutes. [Table 3]

Table 3: Meniscal tear characteristics, vascular zone distribution, and key intraoperative details of inside-out repair (N = 35)

Variable	Category / Unit	n (%)
Meniscus	Medial	23 (65.7)
	Lateral	10 (28.6)
	Both	2 (5.7)
Tear type (arthroscopy)	Longitudinal vertical	16 (45.7)
	Bucket-handle	9 (25.7)
	Radial	4 (11.4)
	Horizontal	3 (8.6)
	Complex	3 (8.6)
Tear location (MRI)	Posterior horn	21 (60.0)
Vascular zone (MRI)	Red-red	12 (34.3)
	Red-white	19 (54.3)
	White-white	4 (11.4)
Concomitant procedure	ACL reconstruction, n (%)	4 (11.4)
Operative time (min)	Mean ± SD	78 ± 16

Table 4 shows consistent clinical improvement over follow-up: mean VAS pain fell from 6.8 ± 1.2 at baseline to 1.3 ± 0.8 at 12 months, while IKDC improved from 42 ± 9 to 82 ± 7 and Lysholm from 51 ± 11 to 91 ± 6. Range of motion improved in parallel, with mean flexion increasing from 118 ± 15° to 138 ± 6°, and mean extension deficit reducing from 4.0 ± 3.0° to 0.5 ± 1.0° by 12 months. [Table 4]

Table 4: Serial changes in pain, functional scores, and knee range of motion from baseline to 12 months after meniscal repair (N = 35)

Outcome measure	Baseline	6 weeks	3 months	6 months	12 months
VAS pain (0–10), Mean ± SD	6.8 ± 1.2	3.9 ± 1.1	2.6 ± 1.0	1.8 ± 0.9	1.3 ± 0.8
IKDC (0–100), Mean ± SD	42 ± 9	55 ± 10	66 ± 9	74 ± 8	82 ± 7
Lysholm (0–100), Mean ± SD	51 ± 11	67 ± 10	78 ± 9	86 ± 8	91 ± 6

ROM flexion (°), Mean ± SD	118 ± 15	124 ± 12	131 ± 10	136 ± 8	138 ± 6
Extension deficit (°), Mean ± SD	4.0 ± 3.0	2.0 ± 2.0	1.2 ± 1.6	0.8 ± 1.2	0.5 ± 1.0

Table 5 shows an overall complication rate of 8 (22.9%), meaning most patients had no postoperative complications, 27 (77.1%). The most common complication was knee stiffness requiring supervised physiotherapy, 3 (8.6%), while superficial infection, hemarthrosis requiring aspiration, persistent swelling, and transient saphenous-nerve distribution numbness each occurred infrequently, 1–2 cases (2.9%–5.7%). [Table 5]

Table 5: Postoperative complications following inside-out arthroscopic meniscal repair (N = 35)

Complication	n (%)
Any complication	8 (22.9%)
Knee stiffness requiring supervised physiotherapy extension	3 (8.6%)
Superficial portal or incision infection	1 (2.9%)
Hemarthrosis requiring aspiration	1 (2.9%)
Persistent swelling, conservative management	2 (5.7%)
Transient saphenous-nerve distribution numbness	1 (2.9%)
No complication	27 (77.1%)

IV. DISCUSSION

This prospective cohort of 35 patients undergoing inside-out arthroscopic meniscal repair demonstrates clinically meaningful improvement in pain, function, and knee motion across 12 months, with VAS pain decreasing from 6.8±1.2 at baseline to 1.3±0.8 at 12 months, alongside parallel gains in IKDC (42±9 to 82±7) and Lysholm scores (51±11 to 91±6). These trajectories are consistent with the broader evidence base showing that meniscal preservation, when tears are repairable, yields substantial patient-reported outcome improvements and supports longer-term joint health compared with meniscectomy, a principle reinforced by expert consensus recommending meniscus preservation as first-line where feasible.[11] Functional gains of the magnitude observed here also align with long-term pooled evidence indicating durable clinical benefit after meniscal repair, while acknowledging that "success" definitions vary across studies and time-to-failure can extend beyond early follow-up windows.[12] Our cohort's epidemiologic and tear-pattern profile, predominantly young males (mean age 27.9 years, 88.6% male) with non-contact pivoting sports injuries as the leading mechanism (60.0%), and a predominance of medial meniscus involvement (65.7%) with posterior horn location (60.0%), mirrors patterns commonly reported in athletic and working-age populations.[13,14] The inside-out method remains widely regarded as a versatile, cost-effective "gold standard" construct for many tear patterns, particularly in posterior horn tears where robust suture fixation is desired, and its relevance may be amplified in low-resource settings where routine use of all-inside implants is financially constrained.[6,15] At the same time, contemporary meta-analytic evidence suggests broadly comparable healing and functional outcomes between all-inside and inside-out repairs, with all-inside approaches tending to reduce operative time and lower odds of nerve-related complications, an important consideration when counseling patients and standardizing technique.[16] In our study, the low frequency of transient saphenous-nerve distribution numbness (2.9%) and absence of major neurovascular events suggest careful adherence to safe posterior dissection and suture retrieval, although vigilance remains essential because complication reporting thresholds differ across studies.[6.16] A notable contextual feature is the delayed injury-to-surgery interval, with a median of 28 weeks (IQR 16–44), likely reflecting referral pathways and access barriers in Bangladesh. Delay is clinically relevant because more chronic tears may be associated with reduced tissue quality, greater capsular scarring, and rehabilitation challenges, and recent evidence in ACL populations indicates that delayed meniscal repair can adversely affect functional outcomes, supporting efforts to streamline diagnosis and referral where feasible.[17] Tear vascularity distribution in our cohort, mainly red-white zone (54.3%), also matters biologically: a systematic review and meta-analysis found higher healing likelihood for tears in vascular zone 1 compared with zone 2 when repaired with concomitant ACL reconstruction, underscoring why careful patient selection, biologic environment, and rehabilitation strategy are central to optimizing repair biology.[8] Although only 11.4% of our patients underwent concomitant ACL reconstruction, the observed functional improvement remains reassuring; however, biological healing was not directly assessed, and longer follow-up is important given evidence that failures, especially for complex patterns such as bucket-handle tears, can occur beyond the first postoperative year.[12,19] Postoperative complications occurred in 22.9% overall, driven mainly by knee stiffness requiring supervised physiotherapy (8.6%) and persistent swelling managed conservatively (5.7%), with low infection and hemarthrosis rates. These findings emphasize the clinical importance of structured rehabilitation, early identification of motion loss, and standardized infection-prevention pathways, particularly in high-volume public or mixed-resource surgical settings. Our results support inside-out repair as a feasible, effective meniscus-preserving strategy in Bangladesh, while also indicating priorities for future work: longer-term

follow-up, explicit repair integrity endpoints (MRI or second-look where possible), and stratified analyses by tear pattern, vascular zone, and concomitant ligament status.

Limitations of the study: Key limitations of this study are the small single-center sample size (N = 35), the lack of a comparator group such as all-inside repair or partial meniscectomy, and a relatively short follow-up period of 12 months, which may not capture late failures. Furthermore, repair integrity was not routinely assessed using postoperative MRI or second-look arthroscopy. Heterogeneity in tear patterns and the presence of concomitant ACL reconstruction in a minority of cases may also have influenced the outcomes.

V. CONCLUSION

Inside-out arthroscopic meniscal repair in this cohort resulted in significant improvements in pain, functional scores (IKDC, Lysholm), and knee range of motion over 12 months. The procedure demonstrated an acceptable complication profile and a low early failure rate. These results indicate that inside-out repair is a viable, meniscus-preserving option for appropriately selected patients. The findings underscore the importance of timely referral and structured rehabilitation to optimize clinical outcomes.

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