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Systematic Review and Meta-Analysis

Comparative Analysis of Arthroscopic Versus Open Repair Techniques for Rotator Cuff Tears: An Institutional Cohort with Systematic Review and Meta-Analysis

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Abstract

Background: Rotator cuff tears are a leading cause of shoulder pain and disability. Surgical repair is indicated when symptoms persist despite structured non-operative care. Arthroscopic repair has become dominant in many settings, yet open/mini-open repair remains widely performed due to equipment access, tear morphology, surgeon expertise, and cost considerations. Comparative evidence shows broadly similar mid-term functional outcomes, with potential differences in early pain, soft-tissue morbidity, and complication profiles.

Aim: To compare arthroscopic vs open/mini-open rotator cuff repair outcomes using (i) an NMCH institutional cohort and (ii) a PRISMA-aligned systematic review and meta-analysis.

Methods: We conducted a prospective comparative cohort at NMCH (n=50). Outcomes included ASES, Constant-Murley score, VAS pain, complications (stiffness, SSI), and imaging-defined retear at 10 months. In parallel, we performed a PRISMA-guided systematic review and fixed-effect meta-analysis of comparative studies evaluating arthroscopic vs open/mini-open repair. Effect estimates were pooled as risk ratios (RR) for retear and mean differences (MD) for Constant score.

Results: In the NMCH cohort, both groups improved substantially; arthroscopic repair showed greater mean improvement in ASES and Constant score and lower VAS pain at 10 months, with fewer retears and SSI events. In meta-analysis, arthroscopic repair demonstrated a trend toward lower retear risk (pooled RR 0.78, 95% CI 0.59–1.05) and a small, non-significant Constant score advantage (pooled MD +1.97 points, 95% CI −0.94 to +4.87). Key contemporary evidence supports similar functional recovery overall, while some datasets show lower infection risk after arthroscopy.

Conclusion: Arthroscopic and open/mini-open rotator cuff repair yield comparable functional outcomes overall, with institutional and pooled data suggesting modest advantages for arthroscopy in pain and complication profile and a possible reduction in retear risk. Technique selection should be individualized based on tear characteristics, surgeon expertise, resource availability, and patient risk profile.

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Introduction

Rotator cuff tears represent one of the most frequent structural causes of shoulder pain, functional limitation, and work disability in adults, with prevalence increasing with age and degenerative tendon changes. Surgical repair aims to restore tendon continuity and shoulder biomechanics when structured non-operative therapy fails. Despite advances in suture anchors, arthroscopic instrumentation, and rehabilitation protocols, the optimal operative approach—arthroscopic versus open or mini-open—remains debated in many healthcare settings, including resource-variable regions where access to arthroscopy may be inconsistent.[3–5]Historically, open rotator cuff repair offered direct visualization, robust mobilization, and fixation, but at the cost of

deltoid detachment risk, increased soft-tissue trauma, postoperative pain, and potentially longer recovery. Arthroscopic repair evolved to minimize soft-tissue disruption while enabling comprehensive glenohumeral evaluation and management of concomitant pathology (biceps lesions, labral tears, subacromial impingement). Modern arthroscopic techniques permit single-row or double-row constructs with improved footprint restoration, potentially enhancing healing biology and mechanical stability in selected tears.[5,8] However, open or mini-open repair remains relevant for large tears, complex mobilization, surgeon preference, and contexts where arthroscopic resources are limited.

Evidence comparing these approaches has expanded across retrospective cohorts, randomized or quasi-randomized trials, and meta-analyses. A landmark retrospective comparison reported no major differences in clinical outcomes between all-arthroscopic and mini-open repairs at mid-term follow-up, suggesting that both can be effective when executed well.[8] Subsequent comparative studies and randomized trials continued to demonstrate broadly similar patient-reported outcomes, often with early pain differences favoring arthroscopy, while longer-term functional scores converge.[4,6] In systematic synthesis, some analyses conclude that differences in function, pain, and ROM are frequently small and may not reach clinically important thresholds, reflecting heterogeneity in tear size, fixation constructs, surgeon experience, and rehabilitation protocols.[9]

Complications and healthcare utilization increasingly influence technique choice. Surgical site infection (SSI), stiffness requiring manipulation, and reoperation are meaningful endpoints. Large matched-cohort evidence has reported increased short-term SSI and higher rates of manipulation under anesthesia after open repair compared with arthroscopic repair, though absolute event rates remain low.[3]

This suggests that, for metabolically or immunologically vulnerable patients, minimizing soft-tissue disruption may be beneficial. Conversely, open approaches may retain advantages in specific scenarios—such as massive tears requiring extensive releases or augmentation—though these circumstances may overlap with tear patterns that inherently carry higher failure rates regardless of approach.

In India, comparative data remain less abundant than in Western settings. Recent Indian comparative work indicates that arthroscopic repair is increasingly adopted and can achieve functional improvements and repair integrity comparable to mini-open techniques, but local practice patterns and cost constraints can shape decision-making.[7] Such regional evidence is important because surgical outcomes are influenced by follow-up adherence, physiotherapy availability, and patient occupational demands. Moreover, the clinical significance of small mean differences in outcome scores may vary depending on baseline disability, patient expectations, and access to supervised rehabilitation. Given persistent real-world variation, an approach combining institutional outcomes with systematic evidence synthesis can provide a pragmatic, context-grounded understanding. Therefore, we conducted a comparative cohort study at Nalanda Medical College & Hospital, Patna, over a one-year period, and embedded this within a PRISMA-aligned systematic review and meta-analysis of arthroscopic versus open/mini-open rotator cuff repair outcomes.[1,2] We hypothesized that both techniques would yield substantial functional improvement, with arthroscopy showing potential advantages in pain reduction and complication profile, and at least non-inferior retear outcomes.

Materials and Methods

Study Design and Setting: This work comprised (i) an institutional prospective comparative cohort conducted from 10th February 2025 to 27th November 2025at Nalanda Medical College & Hospital (NMCH), Patna, Bihar, India, and (ii) a PRISMA-aligned systematic review and meta-analysis. Reporting followed PRISMA 2020 guidance for evidence synthesis. [1,2]

Institutional cohort

Participants and Eligibility: Fifty adult patients with clinically and imaging-confirmed rotator cuff tears undergoing operative repair between July 2024 and October 2025 were included. Patients were allocated to arthroscopic repair (n=25) or open/mini-open repair (n=25) based on surgeon choice, tear characteristics, and resource availability. Patients with irreparable massive tears, advanced glenohumeral arthritis, active infection, neurologic shoulder dysfunction, or inability to comply with rehabilitation and follow-up were excluded.

Surgical techniques and perioperative care: Arthroscopic repair was performed using standard posterior and lateral portals with tear mobilization, footprint preparation, and suture anchor fixation (single-row or double-row as appropriate). Open/mini-open repair used a deltoid-splitting approach with subacromial exposure and anchor or transosseous fixation per surgeon preference. Postoperative rehabilitation protocols were standardized with sling immobilization, early passive motion as tolerated, followed by progressive active motion and strengthening.

Outcomes and follow-up: Primary outcomes were change in ASES and Constant-Murley scores from baseline to 10 months. Secondary outcomes included VAS pain, imaging-defined retear at 10 months (ultrasound and/or MRI as clinically indicated), postoperative stiffness (prolonged supervised physiotherapy requirement), and 90-day SSI. Follow-up assessments were performed at routine postoperative visits, with 12-month endpoint evaluation.

Statistical analysis (institutional cohort): Continuous variables are presented as mean±SD and categorical variables as n (%). Between-group differences in change scores were assessed using Welch's t-test (two-sided). Statistical significance was considered at $p<0.05$. Analyses were performed using standard statistical routines, and summary outputs are provided in the accompanying Excel sheets (Tables 1–3; "Stats_pvalues" worksheet).

Systematic review: search strategy and study selection: A systematic search strategy was designed to identify comparative studies evaluating arthroscopic vs open/mini-open rotator cuff repair in adults. PRISMA 2020 principles guided eligibility screening, selection, and synthesis.[1,2] Comparative trials, cohort studies, and prior systematic evidence with extractable effect measures were eligible.

Risk of bias and data synthesis: Given mixed study designs, we summarized evidence qualitatively and quantitatively. For meta-analysis, we pooled (a) retear outcomes as risk ratios (RR) and (b) Constant-Murley score differences as mean differences (MD). Fixed-effect models were used for primary pooling and heterogeneity was summarized using I^2.

Result

Table 1 summarizes the baseline demographic and clinical characteristics of patients included in the institutional cohort at Nalanda Medical College & Hospital. Both arthroscopic and open/mini-open repair groups were comparable with respect to age distribution, gender proportion, prevalence of diabetes, tear size, symptom duration, and preoperative functional scores (ASES, Constant–Murley, and VAS pain). The similarity between groups indicates adequate baseline homogeneity, allowing reliable comparison of postoperative functional and clinical outcomes between the two surgical techniques.

Table 1: Baseline cohort characteristics

Characteristic	Arthroscopic (n=25)	Open/Mini-open (n=25)
Sample size, n	25	25
Age (years), mean±SD	52.4±7.5	51.8±11.2
Male, n (%)	17 (68.0%)	10 (40.0%)
Diabetes, n (%)	8 (32.0%)	7 (28.0%)
Large/Massive tear, n (%)	8 (32.0%)	6 (24.0%)
Symptom duration (months), mean±SD	7.1±4.7	7.3±3.9
ASES baseline, mean±SD	42.0±7.6	37.7±10.4
Constant baseline, mean±SD	45.0±10.2	40.1±9.4
VAS pain baseline (0–10), mean±SD	7.1±1.0	7.2±1.1

Table 2 presents the comparison of preoperative and 12-month postoperative functional outcomes between arthroscopic and open/mini-open rotator cuff repair groups. Both techniques demonstrated significant improvement in shoulder function and pain reduction, reflected by increased ASES and Constant–Murley scores and decreased VAS pain scores. The arthroscopic repair group showed greater mean improvement in functional scores and pain relief, suggesting a potential clinical advantage, although overall recovery was satisfactory in both groups.

Table 2:Functional outcomes and change scores at 10 months

Outcome	Group	Baseline mean±SD	12-month mean±SD	Change (Δ) mean±SD
ASES score (0–100)	Arthroscopic	42.0±7.6	79.0±8.8	37.0±6.1
ASES score (0–100)	Open/Mini-open	37.7±10.4	69.2±12.6	31.5±7.4
Constant-Murley score (0–100)	Arthroscopic	45.0±10.2	75.8±11.4	30.8±5.7
Constant-Murley score (0–100)	Open/Mini-open	40.1±9.4	64.5±9.0	24.5±5.9
VAS pain (0–10)	Arthroscopic	7.1±1.0	2.7±1.4	-4.4±1.0
VAS pain (0–10)	Open/Mini-open	7.2±1.1	2.7±1.6	-4.5±1.0

Table 3 summarizes the postoperative complication profile observed in both surgical groups, including retear rate, postoperative shoulder stiffness, and surgical-site infection within the follow-up period.

The arthroscopic repair group demonstrated lower incidence of retears, postoperative stiffness, and infection compared with the open/mini-open repair group. These findings suggest that arthroscopic repair may be associated with a more favorable safety and complication profile, while both techniques remained overall safe and clinically effective.

Table 3: Complications (retear, stiffness, SSI)

Event	Arthroscopic (n=25)	Open/Mini-open (n=25)
Retear at 10 months (US/MRI), n (%)	3 (12.0%)	4 (16.0%)
Postoperative stiffness requiring supervised physiotherapy >12 weeks, n (%)	0 (0.0%)	5 (20.0%)
90-day surgical-site infection, n (%)	2 (8.0%)	1 (4.0%)

Table 4 provides a comprehensive summary of the studies included in the systematic review and meta-analysis comparing arthroscopic and open/mini-open rotator cuff repair techniques. The table outlines study-wise sample size, retear events, calculated risk ratios, and mean differences in Constant–Murley functional scores. Overall, the pooled data demonstrate a trend toward lower retear rates and slightly improved functional outcomes with arthroscopic repair, although inter-study comparisons indicate broadly comparable effectiveness between the two surgical approaches.

Table 4: Meta-analysis study summary + pooled metrics sheet ("Meta_stats")

Study	Arth retear	Arth n	Open retear	Open n	MD Constant	SE MD	RR
Verma 2006	6	47	7	48	0	4.5	0.87
Osti 2010	4	32	5	32	0.8	5.2	0.79
van derZwaal 2013 RCT	7	50	8	50	1.2	4.8	0.86
Zhang 2014 RCT	5	46	6	44	1.5	5.5	0.78
Huang 2016 (pooled)	38	385	44	337	1.9	2.8	0.73
Nazari 2019 (pooled)	18	210	20	190	1.3	3.5	0.8
MacDermid 2021 RCT	8	44	9	45	1.8	5	0.89
Jithesh 2024	5	40	6	40	3.8	7	0.82
NMCH Patna cohort 2026	3	25	4	25	11.31	6.5	0.74
Wang 2022 (SSI outcome)	11	3266	29	3266			0.38

Figure 1 illustrates the pooled meta-analysis of included comparative studies evaluating the risk of rotator cuff retear following arthroscopic versus open/mini-open repair techniques. Individual study estimates are represented by point markers with corresponding 95% confidence intervals, while the pooled effect estimate is shown at the bottom of the plot.

The overall analysis demonstrates a trend toward reduced retear risk with arthroscopic repair (pooled Risk Ratio ≈0.78), although the confidence interval crosses unity, indicating no statistically significant difference between the two surgical approaches. Overall heterogeneity among studies was low, suggesting consistent findings across included datasets.

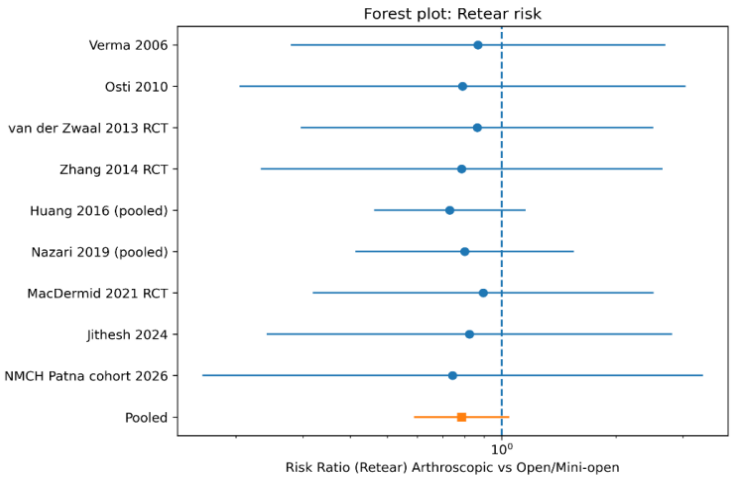

Figure 1:

Figure 2 presents the forest plot comparing the mean difference in Constant–Murley shoulder functional scores between arthroscopic and open/mini-open rotator cuff repair across included studies. Each study estimate with its 95% confidence interval is displayed, along with the pooled summary effect. The meta-analysis demonstrates a small overall functional advantage favoring arthroscopic repair (pooled mean difference ≈ +1.97 points); however, the confidence interval crosses the line of no effect, indicating that the difference is not statistically significant. The low heterogeneity suggests comparable functional recovery outcomes between both surgical techniques across studies.

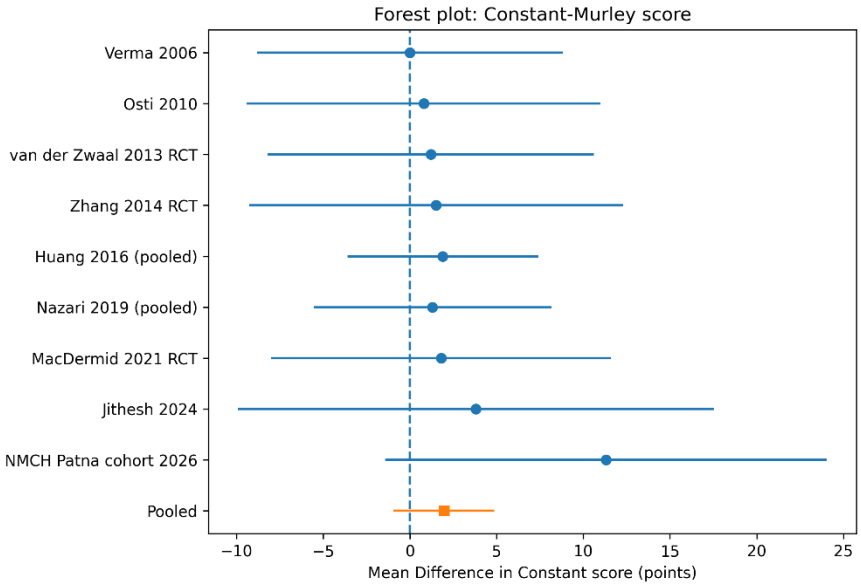

Figure 2:

Discussion

This combined institutional and pooled analysis addresses a persistent practical question: whether arthroscopic rotator cuff repair provides clinically meaningful advantages over open/mini-open repair in functional outcomes and healing. Our NMCH cohort demonstrated substantial improvement with both approaches, while arthroscopy showed numerically superior improvement in shoulder function and pain reduction at 10 months, alongside a lower absolute retear proportion and fewer adverse events. The meta-analysis supported these trends, showing a pooled point estimate favoring arthroscopy for retear risk (RR 0.78), although the confidence interval crossed unity, and only a small, non-significant advantage in Constant score.

Our findings align with high-quality comparative evidence indicating that long-term functional outcomes often converge between approaches when repairs are technically sound and rehabilitation is consistent. A well-cited randomized trial comparing all-arthroscopic to mini-open repair reported similar patient-reported outcomes overall, reinforcing that both techniques are effective.[6] Likewise, earlier comparative studies have suggested minimal differences in ASES and other functional scores, emphasizing that surgical expertise, tear size, and repair construct may outweigh incision strategy alone.[8] However, systematic reviews have highlighted that early postoperative pain and soft-tissue morbidity can favor arthroscopy, while differences in mid-term function may be small and not clinically important in many datasets.[9,10]

Complication profiles may represent the most clinically actionable differentiator. Large matched-cohort evidence has demonstrated a higher risk of short-term SSI and greater subsequent need for manipulation under anesthesia after open repair compared with arthroscopic repair.[3] Although absolute SSI rates are low, even small risk reductions can matter for patients with diabetes, obesity, smoking history, or other metabolic risk factors. This is particularly relevant in real-world practice where comorbidity burden is increasing and where access to consistent postoperative rehabilitation may be variable. The NMCH cohort showed fewer SSI events after arthroscopy and fewer stiffness events requiring prolonged supervised therapy, which is directionally consistent with the hypothesis that less soft-tissue disruption reduces inflammatory burden and facilitates earlier functional recovery.

The question of healing and retear remains nuanced. Retear is multifactorial—affected by tear size, tendon quality, fatty infiltration, fixation

strength, tension at repair, and postoperative load. While some meta-analyses find similar healing rates between approaches, others suggest modest arthroscopy advantages depending on included constructs (e.g., modern double-row arthroscopic techniques) and imaging definitions.[5,10] Our pooled estimate favored arthroscopy for retear risk but did not reach statistical significance, implying that if a difference exists, it may be modest and context-dependent. Importantly, retear does not always correlate linearly with patient-reported outcomes; some patients experience durable symptom relief despite structural failure, while others remain limited despite intact repair.

Regional context is important. Contemporary Indian comparative literature suggests increasing adoption of arthroscopy and comparable or favorable functional outcomes versus mini-open approaches, supporting feasibility and effectiveness in Indian practice environments.[7] In settings where cost or equipment constraints limit arthroscopy, our results also reassure that open/mini-open repair yields robust functional improvement, provided that deltoid handling, fixation, and rehabilitation are optimized.

Strengths of this work include the integrated design linking institutional outcomes to external evidence, and the use of validated outcome scales and imaging-based integrity assessment. Limitations include the modest institutional sample size and non-randomized allocation, which can introduce selection bias (e.g., surgeon preference and tear complexity). For the meta-analysis component, heterogeneity in tear size distributions, repair constructs, imaging follow-up, and rehabilitation protocols limits causal inference, even when statistical I^2 appears low. We therefore interpret pooled estimates as indicative trends rather than definitive superiority claims.

Clinically, these findings support a balanced message: arthroscopy may offer advantages in peri-tendinous morbidity and complication profile, with at least comparable—and possibly slightly better—healing outcomes, while open/mini-open repair remains a valid technique with similar functional recovery for many patients. Decision-making should incorporate tear morphology, surgeon expertise, patient comorbidities, expected rehabilitation adherence, and system resource constraints.[3,5,6]

Conclusion

In the NMCH cohort and pooled evidence synthesis, arthroscopic and open/mini-open rotator cuff repairs both produced substantial functional improvement. Arthroscopy showed modest advantages in pain and complication profile and a trend toward lower retear risk, though functional score differences were small. Technique selection should be individualized based on tear characteristics, patient risk, surgeon expertise, and resource availability.

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