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ORIGINAL ARTICLE

A Comparative Study of Functional Outcomes of Rotator Cuff Repairs Using Arthroscopy Versus Mini-Open Techniques

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Abstract

Background: Rotator cuff tears are among the most prevalent shoulder pathologies, with an estimated prevalence of 20.7% in the general population. Surgical management has evolved from open techniques to mini-open and all-arthroscopic approaches. Despite favourable outcomes reported for both, comparative data on functional outcomes using standardised instruments such as the DASH score remain limited, particularly in Indian clinical settings. **Objectives:** To compare the functional outcomes of rotator cuff repairs performed using arthroscopy versus mini-open techniques as measured by the DASH score, VAS pain scores, and postoperative rehabilitation progress. **Methods:** This prospective, hospital-based comparative study was conducted at Vydehi Institute of Medical Sciences, Bangalore, from April 2023 to April 2024. Thirty patients with supraspinatus and/or infraspinatus tendon tears (Snyder grade ≥3) were randomly assigned to arthroscopic (n=15) or mini-open (n=15) repair groups using the sealed envelope method. All surgeries were performed by the same surgical unit, and all patients followed a standardised three-phase rehabilitation protocol. **Results:** Both techniques showed significant improvements over time. Preoperative and early postoperative DASH scores were similar ($p>0.05$). Arthroscopy showed significantly lower DASH scores at 3 months (17.60 ± 11.64 vs. 23.60 ± 10.90; $p=0.02$), 6 months (11.80 ± 12.03 vs. 15.33 ± 10.25; $p=0.03$), and 12 months (4.53 ± 5.90 vs. 7.60 ± 5.19; $p=0.04$). Mini-open surgery had lower VAS pain scores at 3 months ($p=0.04$) and 6 months ($p=0.01$), though pain equalized by 12 months ($p=0.43$). Rehabilitation outcomes were comparable, with all patients achieving "Excellent" ratings by 6 months. **Conclusion:** Both techniques effectively restore shoulder function. Arthroscopy offers superior long-term functional recovery, while mini-open provides better intermediate-term pain relief. The choice should be individualised based on patient factors, tear characteristics, and surgeon expertise.

Keywords: Rotator cuff repair, Arthroscopy, Mini-open repair, DASH score, Functional outcome, VAS pain score, Shoulder surgery

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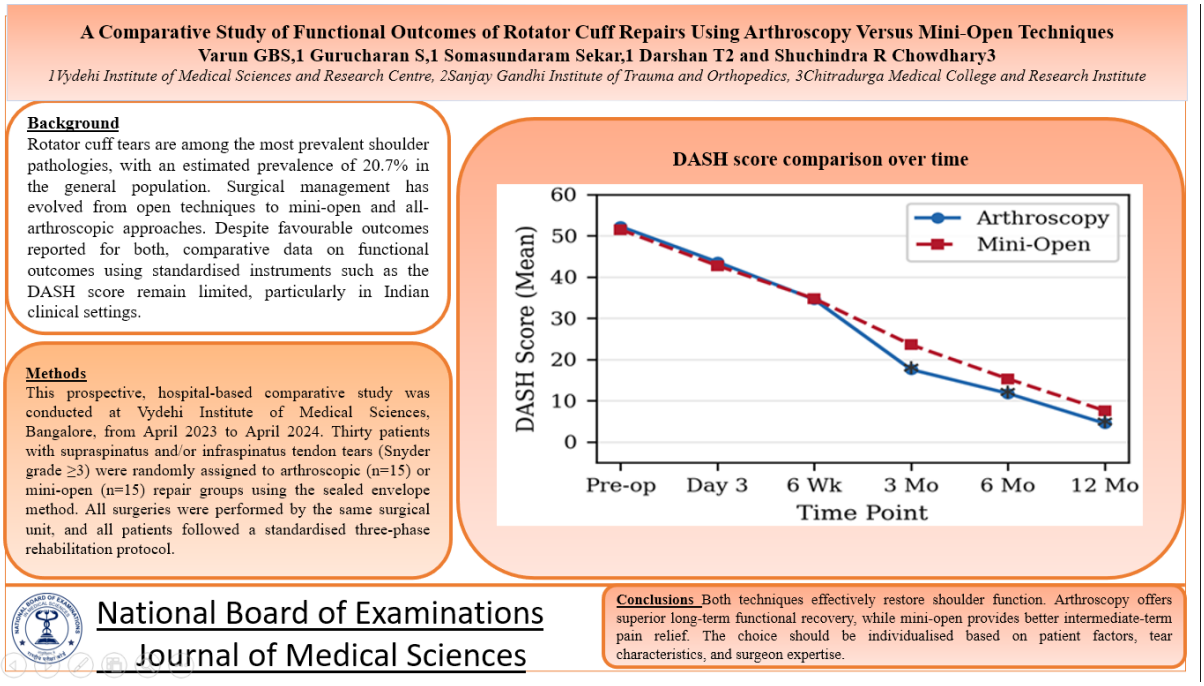
Graphical Abstract



Introduction

Rotator cuff tears are among the most frequent musculoskeletal pathologies encountered in orthopaedic practice. Estimates suggest that 20.7% of the total adult population (ages 18–87) experience at least one traumatic or degenerative rotator cuff tear, with prevalence increasing significantly with advancing age. The primary symptoms include chronic pain, muscle weakness, and loss of shoulder function, leading to significant disability and decreased quality of life [3].

Once conservative treatment has been exhausted, three primary surgical options are available: mini-open surgery, arthroscopically assisted mini-open procedures, and all-arthroscopic rotator cuff repair [1–3]. Arthroscopic repairs are increasingly regarded as the standard of care, with their incidence growing sixfold over the past two decades [1–3].

Although mini-open procedures have produced favourable results, concerns persist regarding increased early postoperative pain, deltoid injury, and the risk of arthrofibrosis. Recent technological advances have led to a preference for arthroscopic repair, despite its higher cost [4,5]. For many years, the mini-open repair was considered the gold standard, with satisfactory to excellent outcomes in 90% of patients [6]. However, many surgeons now favour arthroscopy for its association with expedited healing, enhanced aesthetic outcomes, diminished postoperative pain, reduced deltoid morbidity, shorter hospital stays, and faster recovery.

To date, limited randomised studies have compared these two approaches using standardised composite functional outcome instruments such as the DASH score. This study was conducted to compare the functional outcomes of rotator cuff repairs using arthroscopy versus mini-open techniques over a 12-month follow-up period.

Materials and Methods

Study Design

This was a prospective, hospital-based comparative study.

Study Period

The study was conducted from April 2023 to April 2024.

Study Setting

The study was carried out in the Department of Orthopaedics, Vydehi Institute of Medical Sciences and Research Centre, Whitefield, Bangalore, Karnataka, India.

Study Population and Sample Size

The sample size was determined through a formal a priori power calculation using the formula: $N = 2SD^2(Z\alpha/2 + Z\beta)^2/d^2$, based on mean DASH score differences from the study by van der Zwaal et al. (66 ± 3 vs. 71 ± 3.5) [7]. At 99% confidence limit ($Z\alpha/2 = 2.58$) and 90% statistical power ($Z\beta = 1.28$), a minimum of 13 patients per group was required. With 10% non-response adjustment, 15 patients per group were included, yielding a total sample size of 30. This sample size was specifically powered to detect a clinically meaningful difference in DASH scores between groups. Patients were randomly assigned to two groups using the sealed envelope method.

Inclusion Criteria

Patients aged 18–70 years with supraspinatus and/or infraspinatus tendon tears (Snyder grade ≥3) confirmed on MRI, with impingement and Type 2 or 3 acromion morphology, and willing to provide informed consent.

Exclusion Criteria

Glenohumeral instability, acromioclavicular joint arthritis, restricted glenohumeral movement (FF<90°) due to adhesive capsulitis or glenohumeral arthritis, rheumatoid arthritis, patients medically unfit or unwilling for surgery, and age <18 or >70 years.

Surgical Techniques

All surgeries were performed at a single centre by surgeons from the same orthopaedic unit, minimising inter-surgeon variability. For the arthroscopic group, the arthroscope was inserted via a posterior portal with lateral and posterolateral working portals. The tear was mobilised and repaired using suture anchors. The choice between single-row and double-row fixation was made intraoperatively based on tear size, morphology, tissue quality, and footprint coverage, reflecting standard clinical decision-making. For the mini-open group, a 5-cm lateral incision was made at the anterior acromion margin with blunt deltoid splitting, axillary nerve preservation, and partial bursectomy. The core repair steps (anchor placement, suture passage, knot tying, and footprint preparation) were identical in both groups.

Postoperative Rehabilitation Protocol

All patients in both groups followed a standardised three-phase postoperative rehabilitation protocol supervised by the same physiotherapy team. The acute phase (weeks 0–6) comprised pain management, immobilisation in an abduction brace, and passive range of motion exercises. The recovery phase (weeks 6–12) focused on scapular stabilisation, active-assisted range of motion, and progressive strengthening. The functional phase (months 3–12) included advanced strengthening, eccentric exercises, and activity-specific training. This standardisation ensured that rehabilitation was not a confounding variable between groups.

Outcome Measures

The primary outcome measure was the DASH (Disabilities of the Arm, Shoulder, and Hand) score, a validated 30-item self-administered patient-reported outcome measure (PROM). The DASH score was assessed preoperatively and at Day 3, 6 weeks, 3 months, 6 months, and 12 months. As the DASH is self-administered by the patient, investigator scoring bias was inherently minimised. Secondary outcomes included the Visual Analog Scale (VAS) for pain, also patient-reported, and postoperative rehabilitation grading (Poor, Fair, Good, Excellent) assessed by the clinical team. Blinding of patients to their surgical technique was not feasible given the different incision sizes; however, the reliance on self-administered PROMs as primary and key secondary outcomes mitigated assessor bias.

Statistical Analysis

Data were analysed using SPSS version 22. Continuous variables were expressed as mean ± SD with independent t-test. Categorical data were represented as frequencies with chi-square test. A p-value <0.05 was considered statistically significant.

Results

The study population consisted of 30 patients equally distributed between groups. Baseline demographics are presented in Table 1 and Figure 1. No significant differences were found in age (p=0.14) or sex distribution (p=0.71), confirming successful randomisation and baseline comparability between groups.

Table 1. Baseline demographics

	Arthro (n=15)	**Mini-Open (n=15)**	**p**
Age group			0.14
20–35	8	5	
36–50	2	7	
51–70	5	3	
Sex			0.71
Male	8	9	
Female	7	6	

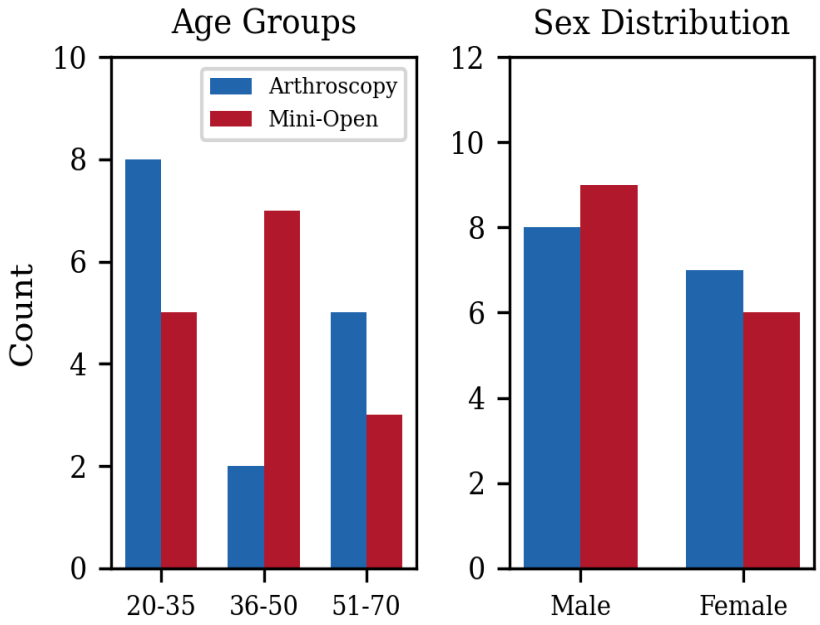


Figure 1. Age and sex distribution

Table 2 and Figure 2 present DASH score comparisons. Preoperative scores were equivalent (p=0.84). Significant arthroscopic superiority emerged at 3 months (p=0.02), 6 months (p=0.03), and 12 months (p=0.04).

Table 2. DASH scores (Mean ± SD)

Time	Arthro	Mini-Open	p
Pre-op	52.27±10.29	51.53±8.92	0.84
Day 3	43.67±9.90	42.80±8.64	0.80
6 Wk	34.60±9.96	34.80±11.41	0.96
3 Mo	17.60±11.64	23.60±10.90	**0.02***
6 Mo	11.80±12.03	15.33±10.25	**0.03***
12 Mo	4.53±5.90	7.60±5.19	**0.04***

**p<0.05*

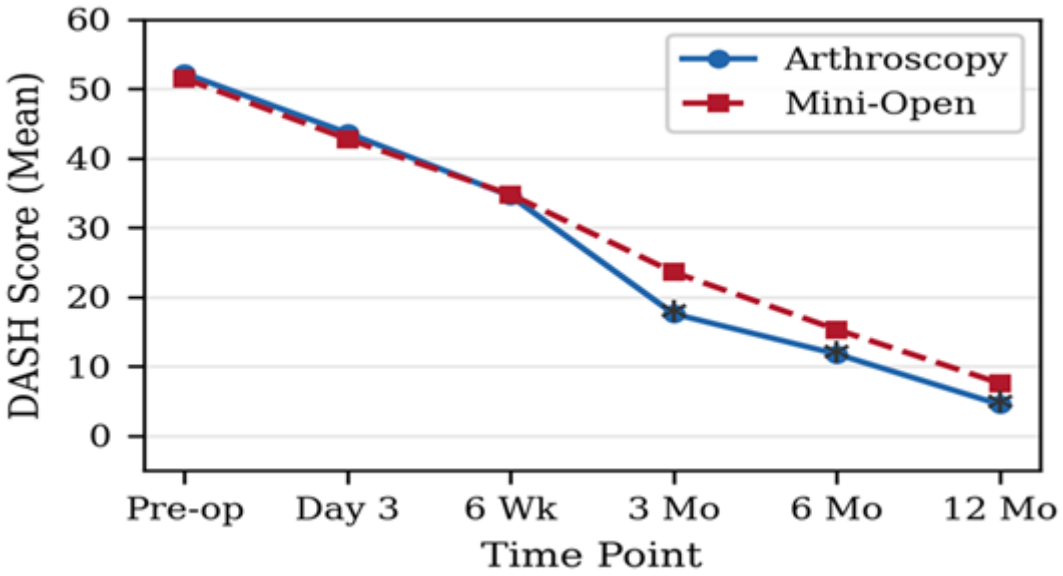


Figure 2. DASH score comparison over time

Table 3 and Figure 3 present VAS pain scores. Mini-open showed significantly lower pain at 3 months (p=0.04) and 6 months (p=0.01), equalizing by 12 months (p=0.43).

Table 3. VAS pain scores (Mean ± SD)

Time	Arthro	Mini-Open	p
Pre-op	7.27±0.96	6.93±1.10	0.38
Day 3	5.60±1.12	5.27±0.96	0.39
6 Wk	4.07±1.03	4.07±1.28	1.00
3 Mo	3.60±1.12	2.93±1.22	**0.04***
6 Mo	2.47±1.41	1.22±1.55	**0.01***
12 Mo	1.20±0.86	0.93±0.96	0.43

*$p<0.05$

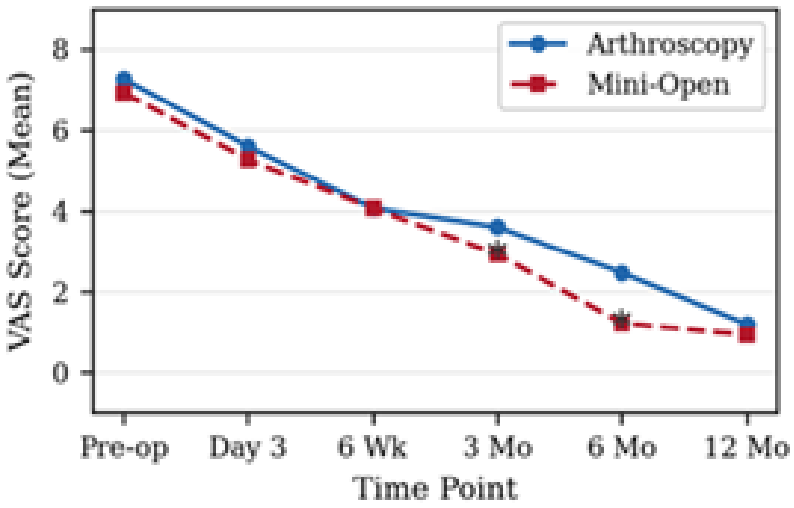


Figure 3. VAS pain score comparison over time

Table 4 and Figure 4 present rehabilitation outcomes. By 6 and 12 months, all patients in both groups achieved "Excellent" ratings (p=1.00).

Table 4. Post-operative rehabilitation

Time	Arthroscopy	Mini-Open	p
Day 3	P:3 F:12	P:4 F:11	0.67
6 Wk	F:2 G:7 E:6	F:4 G:5 E:6	0.61
3 Mo	G:8 E:7	G:9 E:6	0.71
6 Mo	E:15	E:15	1.00
12 Mo	E:15	E:15	1.00

P=Poor; F=Fair; G=Good; E=Excellent

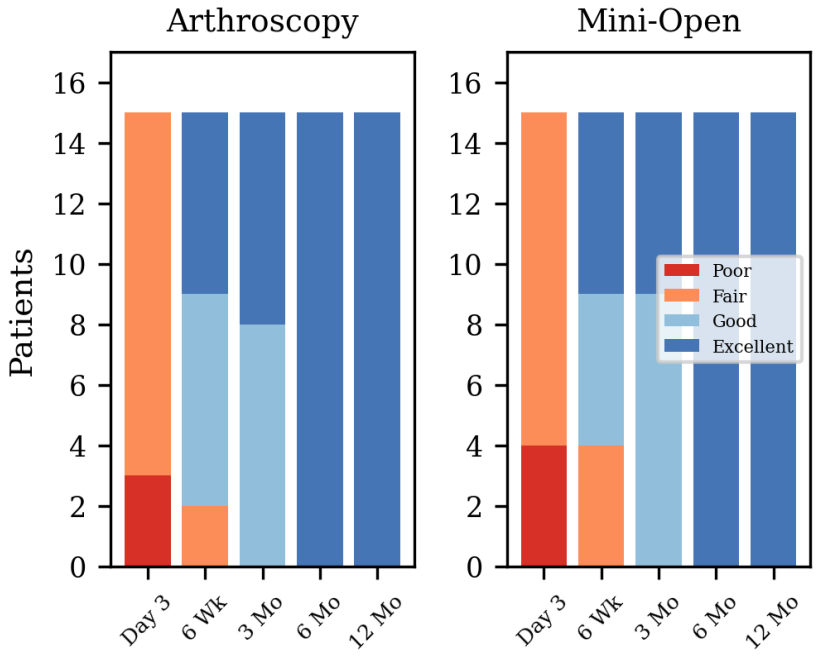


Figure 4. Rehabilitation outcomes by group

Table 5 and Figure 5 present DASH score classification. By 12 months, all arthroscopic patients achieved Minimal Disability; one mini-open patient remained in Moderate Disability (p=0.31).

Table 5. DASH score classification

Time	Arthroscopy	Mini-Open	p
Pre-op	C:4 S:9 M:2	C:3 S:11 M:1	0.59
Day 3	C:1 S:7 M:7	S:8 M:7	0.30
6 Wk	S:6 M:9	S:4 M:9 N:2	0.71
6 Mo	M:4 N:11	M:4 N:11	1.00
12 Mo	N:15	M:1 N:14	0.31

C=Crippled; S=Severe; M=Moderate; N=Minimal

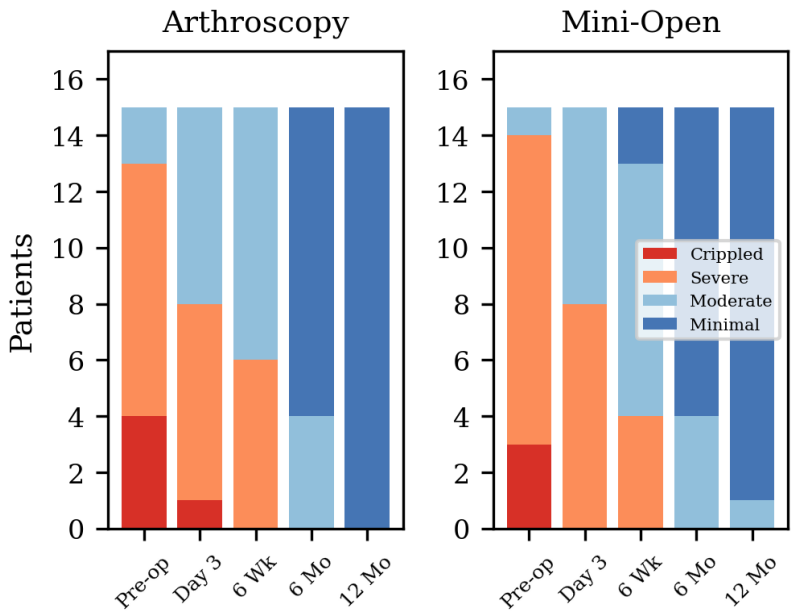


Figure 5. DASH score classification by group

Discussion

This prospective comparative study found that both arthroscopic and mini-open rotator cuff repair techniques effectively restore shoulder function, with distinct temporal differences in recovery patterns.

Functional Outcomes

The DASH score revealed no significant preoperative or early postoperative differences, confirming baseline equivalence. By three months, statistically significant arthroscopic superiority emerged. The arthroscopic group demonstrated a total improvement of 47.74 points (from 52.27 to 4.53 at 12 months), and the mini-open group showed an improvement of 43.93 points (from 51.53 to 7.60). Both groups clearly exceeded the established minimum clinically important difference (MCID) for DASH of 10–15 points, confirming clinically meaningful improvement with both techniques.

However, the between-group differences at significant time points were 6.0 points at 3 months, 3.53 points at 6 months, and 3.07 points at 12 months. These inter-group differences fall below the traditional MCID threshold, indicating that while the differences are statistically significant, the clinical magnitude of the between-group difference is modest. Both groups achieved clinically excellent outcomes; arthroscopy reached that level more rapidly and completely. The clinical relevance lies in the consistent trend of arthroscopic superiority across three consecutive time points rather than the absolute magnitude of any single difference.

These findings are consistent with Liu et al. (2017) and van der Zwaal et al. (2013), who reported earlier arthroscopic benefits [7,8]. In contrast, Migliorini et al. (2023) found no difference in a meta-analysis [9], whereas Sakha et al. (2021) indicated better patient-reported outcomes with arthroscopy [10].

Pain Outcomes

The mini-open group reported significantly lower pain at 3 and 6 months. This dissociation between superior functional outcomes (DASH) and lower

intermediate pain (VAS) in the mini-open group reflects the fact that these instruments assess fundamentally different constructs. The DASH is a composite 30-item measure capturing disability across daily activities, work, and recreation, while the VAS is a unidimensional pain intensity measure.

The mini-open technique's blunt deltoid splitting involves a single incision with muscle-sparing fibre separation, which may produce less localised inflammatory response than arthroscopy's multiple portal insertions, intra-articular fluid distension, and capsular manipulation. However, arthroscopy's minimally invasive nature results in less overall soft tissue disruption, superior intra-articular visualisation, and better tendon mobilisation — advantages that translate into superior long-term functional restoration.

Crucially, the pain advantage is transient: VAS scores equalised by 12 months (1.20 vs. 0.93, p=0.43), consistent with Sharma et al. (2024) [11] and Ji et al. (2015) [12]. This suggests the intermediate pain reflects a short-lived inflammatory response rather than a structural problem, whereas the functional difference reflects cumulative biomechanical advantages of the minimally invasive approach. This dissociation has important implications for preoperative counselling: patients prioritising early pain control may benefit from mini-open repair, while those prioritising long-term function may be better served by arthroscopy.

Rehabilitation Outcomes

Rehabilitation outcomes were remarkably uniform, with all patients achieving "Excellent" ratings by 6 months. This uniform outcome is itself clinically meaningful, demonstrating that standardised rehabilitation protocols emphasising scapular stabilisation and incremental tendon loading are effective regardless of surgical technique. However, we acknowledge that the ordinal rehabilitation grading system (Poor/Fair/Good/Excellent) has limited granularity and is susceptible to ceiling effects at later follow-up time points. The primary endpoint (DASH score), a validated continuous instrument with demonstrated sensitivity to change, successfully discriminated between groups at 3, 6, and 12 months. Future studies should incorporate more sensitive continuous rehabilitation measures such as the Constant-Murley Score or the ASES score.

Comparative Analysis

DeHaan et al. (2012) reported lower retear rates with double-row repairs (27.2% vs. 43.1%, p=0.057), although functional scores did not differ significantly (ASES: p=0.72; Constant: p=0.65) [13]. Within our arthroscopic group, the choice between single-row and double-row fixation was made intraoperatively based on tear characteristics, reflecting real-world clinical practice. While this introduces potential heterogeneity, DeHaan's null functional findings suggest that the functional outcomes we report are unlikely to be meaningfully confounded by repair configuration. Musil et al. (2006) recommended mini-open for large tears [14].

Barnes et al. (2017) reported superior structural repair integrity with mini-open (91% vs. 60% for arthroscopy) [15]. The absence of postoperative imaging in our study precluded assessment of repair integrity, which is a significant limitation. However, the relationship between structural integrity and functional outcome is not strictly linear — patients with structural retears can still achieve excellent functional results. Nonetheless, without structural data,

we cannot determine whether the functional superiority of arthroscopy will be sustained beyond 12 months, particularly if retear rates differ between techniques.

Clinical Implications

Arthroscopy's long-term functional advantage suggests it may be preferred for patients prioritising sustained shoulder function, such as younger active individuals and manual labourers. The mini-open technique's intermediate pain relief may benefit patients concerned about early postoperative discomfort, and it remains a highly effective option in resource-limited settings where arthroscopic infrastructure is unavailable. Despite the evolution of arthroscopic techniques, the traditional mini-open repair must not be dismissed, as rehabilitation outcomes were comparable and both approaches provide equitable long-term results in daily life activities.

Conclusion

Both arthroscopic and mini-open repair effectively restored shoulder function. Arthroscopic repair demonstrated superior long-term functional recovery (DASH scores at 3, 6, and 12 months), while mini-open repair provided better intermediate-term pain control (VAS at 3 and 6 months). Both groups exceeded the minimum clinically important difference for DASH, confirming clinically meaningful improvement with both techniques, though between-group differences were modest in absolute magnitude. Rehabilitation outcomes were equivalent. Using composite outcome measurements including the DASH score alongside pain measures can assist surgical decision-making. Future research should incorporate larger multicentre cohorts, postoperative imaging to assess repair integrity, blinded outcome assessment, and extended follow-up of 5–10 years to determine long-term durability of these findings.

Limitations

Several limitations should be acknowledged. First, the sample size (n=30), while adequately powered for the primary outcome (DASH score), limits generalisability and precludes meaningful subgroup analyses. Second, this single-centre study at a tertiary care institution may not reflect outcomes achievable in community or rural settings with different infrastructure and expertise. Third, the absence of postoperative imaging (MRI or ultrasound) precluded assessment of structural repair integrity, a critical determinant of long-term success. Fourth, the variable use of single-row and double-row fixation within the arthroscopic group introduces potential heterogeneity, though this reflects pragmatic clinical decision-making. Fifth, blinding of patients was not feasible given different incision sizes, and rehabilitation grading was not performed by blinded assessors, introducing potential performance and detection bias; however, the primary and key secondary outcomes (DASH and VAS) were self-administered patient-reported measures, reducing assessor influence. Sixth, patient satisfaction was not formally evaluated. Seventh, the 12-month follow-up may miss long-term retear risks. Eighth, individual compliance with rehabilitation was not formally tracked. Future studies should employ computer-generated randomisation with centralised allocation concealment, blinded outcome assessors, routine postoperative imaging, objective rehabilitation compliance measures, and follow-up extending to 5–10 years.

Ethical Considerations

The study was approved by the Institutional Ethics Committee of Vydehi Institute of Medical Sciences and Research Centre. Written informed consent was obtained from all participants.

Statements and Declarations

Conflicts of interest

The authors declare no conflict of interest.

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