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A prospective study on functional analysis and outcome of frozen shoulder following arthroscopic capsular release in resistant cases

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ABSTRACT

Background: Frozen shoulder or adhesive capsulitis, is characterized by pain and restricted shoulder motion, significantly impairing daily function. Assessment of functional outcomes after arthroscopic capsular release is essential to evaluate treatment efficacy and guide rehabilitation

Methods: This prospective observational study evaluated the efficacy of arthroscopic capsular release in 32 patients aged 45–60 years with refractory frozen shoulder. Patients with rotator cuff injuries or intra-articular fractures were excluded. Preoperative and postoperative assessments at 1, 3 and 6 months included range of motion (ROM), pain via Visual Analogue Scale (VAS), functional outcomes using Constant–Murley and ASES scores and quality of life measured by EQ-5D.

Results: This study demonstrated significant improvements in shoulder ROM across all planes at 6 months (abduction: 65.2° to 140.3°, flexion: 70.4° to 145.8°, $p<0.001$). VAS scores decreased markedly from 7.8 to 1.0 ($p<0.001$). Functional scores improved substantially: Constant–Murley from 28.5 to 85.4, ASES from 32.7 to 88.2 and EQ-5D index from 0.45 to 0.91 (all $p<0.001$). Patients with primary etiology showed better functional recovery than secondary cases (Constant–Murley 88.2 vs. 79.4, $p=0.003$). Complications were minimal and transient.

Conclusions: Arthroscopic capsular release is a safe and effective intervention for frozen shoulder unresponsive to conservative treatment, resulting in significant pain relief, improved shoulder function and enhanced quality of life. Primary adhesive capsulitis patients experience superior outcomes. Further research with extended follow-up is warranted to optimize rehabilitation protocols.

Keywords: Adhesive capsulitis, Arthroscopy, Quality of life, Range of motion, Shoulder joint

INTRODUCTION

Frozen shoulder, medically known as adhesive capsulitis, is a common clinical condition characterized by progressive pain and significant restriction of active and passive ROM of the shoulder joint.[1] It causes considerable functional impairment, adversely limiting activities of daily living (ADL) and work-related tasks. Hallmark features include stiffness, movement-related chronic pain and gradual loss of mobility, typically progressing through distinct clinical freezing, frozen and thawing phases.[2] Frozen shoulder affects around 2 to 5% of the population, predominantly individuals aged 40 to 60 years.[3] It may be primary (idiopathic) or secondary. Secondary frozen shoulder can follow postoperative or posttraumatic conditions, including rotator cuff repair, proximal humerus fracture or neurological or thyroid pathologies.[4] Its prevalence is higher in patients with coexisting systemic conditions such as diabetes mellitus, thyroid disorders and cardiovascular disease, which are implicated in pathogenesis and prognosis.[5] Although frozen shoulder is generally self-limiting, full symptom resolution does not always occur and some patients develop persistent symptoms refractory to conservative treatment. Many experiences spontaneous resolution over months to years. No universally accepted therapeutic intervention is

currently available.[6] Physical therapy and corticosteroid injections are the initial treatments preferred by most surgeons before referral for surgery. When conservative management fails, surgery is the last resort. Among surgical interventions, arthroscopic capsular release is an effective treatment across etiologic groups of frozen shoulder.[7] Its natural history involves prolonged disability and pain, severely impairing quality of life and functional independence. The lack of universally accepted therapeutic protocols and variable response to treatment modalities pose challenges in clinical management. Assessment of functional outcomes after arthroscopic capsular release is essential to evaluate treatment efficacy and guide rehabilitation. Conservative management remains the initial approach for frozen shoulder, especially in the early freezing phase. It includes physical therapy to restore ROM and reduce stiffness and corticosteroid injections to relieve inflammation and pain.[8] Although effective in many cases, these interventions are less effective in resistant cases with capsular fibrosis and contracture. Patients with comorbidities such as diabetes often respond poorly to conservative therapy, necessitating alternative treatments. Assessment of functional outcomes after arthroscopic capsular release is essential to evaluate treatment efficacy and guide rehabilitation. Validated scoring systems such as the Constant–Murley Score and American Shoulder and Elbow Surgeons (ASES) Score are widely used.[9,10] The Constant–Murley Score assesses pain, ADL, ROM and strength, while the ASES Score combines patient-reported pain and function with physician-measured mobility and strength. These systems standardize outcome measurement and enable comparison across studies. Quality of life (QoL) is affected in patients with frozen shoulder because of chronic pain, functional limitation and psychological distress.[11] PROMs provide insights into broader effects and the benefits of arthroscopic capsular release. Surgical treatment improves shoulder function and QoL by alleviating pain and restoring independence in ADL and occupational tasks.

METHODS

This prospective observational study was conducted over a period of 12 months at the Department of Orthopedics, a tertiary care center in Bangalore, Karnataka from July 2024 to June 2025, with a follow-up duration of six months. A total of 32 patients diagnosed with frozen shoulder, aged between 45 and 60 years, were included based on specific inclusion criteria such as post-trauma or post-surgery-related stiffness and failure to achieve global range of motion after gentle manipulation under anesthesia. Patients with rotator cuff injury, significant labral injury, injury to the long head of the biceps or intra-articular fractures were excluded. Ethical approval was obtained from the Institutional Ethical Committee and informed written consent was secured from all participants. Data collection involved detailed history taking through a semi-structured questionnaire and thorough physical examination. Preoperative assessment of shoulder range of motion was performed and postoperative functional outcomes were evaluated using the Constant–Murley and American shoulder and elbow surgeons (ASES) scoring systems at 1, 3 and 6 months. The Constant–Murley score assessed pain, activities of daily living, strength and range of motion, with higher scores indicating better function. Health-related quality of life was measured using the EQ-5D questionnaire, covering mobility, self-care, usual activities, pain/discomfort and anxiety/depression.

The operative procedure was performed under combined general and regional anesthesia with patients positioned laterally. Arthroscopic capsular release was carried out using standard portals with visualization through a 25° or 30° arthroscope. Synovial proliferative material was debrided using a motorized shaver, followed by systematic capsular release beginning at the rotator cuff interval and progressing circumferentially to the anterior, inferior and posterior capsules while preserving the labrum and subscapularis tendon. Intra-articular bleeding was controlled using an arthroscopy pump maintaining a constant pressure of 60 mmHg and hypotensive anesthesia. Postoperatively, patients were supported with a sling and derotation wedge and commenced on a structured physiotherapy regimen starting 15 days after surgery, emphasizing gentle mobilization, passive range of motion and progressive strengthening once pain-free motion was restored.

Statistical analysis was performed using SPSS version 22.0. Normality was assessed with the Shapiro–Wilk test. Descriptive statistics included means and standard deviations for quantitative variables and frequencies and proportions for categorical variables. Inferential analyses involved Chi-square or Fisher's exact tests for categorical associations, paired t-tests or Wilcoxon signed-rank tests for within-group comparisons and independent t-tests or Mann–Whitney U tests for between-group comparisons. A significance level of $p<0.05$ was applied throughout the analysis.

RESULTS

The mean age of the patients was 52.3±4.2 years. The study population comprised 18 males and 14 females. The right side was affected in 20 patients, while the left side was involved in 12 patients. The mean duration of symptoms was 26.5±3.8 months (Table 1). The preoperative and postoperative ROM showed progressive improvement across all movements during follow-up. Mean shoulder abduction increased from 65.2±12.4° preoperatively to 95.5±10.2° at 1 month, 120.1±9.8° at 3 months and 140.3±8.7° at 6 months ($p<0.001$). Similarly, mean flexion improved from 70.4±13.1° preoperatively to 100.3±11.5° at 1 month, 125.7±10.4° at 3 months and 145.8±9.1° at 6 months ($p<0.001$). Extension also demonstrated significant gains, increasing from 30.5±8.7° before surgery to 45.8±7.6°, 60.3±6.9° and 70.2±5.8° at 1, 3 and 6 months respectively ($p<0.001$). Internal rotation improved from the L3 vertebral level preoperatively to

T12 at 1 month, T7 at 3 months and T5 at 6 months (p<0.001). External rotation likewise increased from 20.3±6.5° preoperatively to 35.4±5.7°, 50.2±5.1° and 60.7±4.8° at 1, 3 and 6 months respectively (p<0.001). Overall, all parameters showed statistically significant improvement when preoperative values were compared with those at 6 months (Table 2). Pain assessment using the VAS demonstrated a marked and progressive reduction following surgery. The mean preoperative VAS score was 7.8±1.2, indicating severe pain. This decreased to 4.2±1.0 at 1 month postoperatively, further improving to 2.1±0.8 at 3 months and to 1.0±0.5 at 6 months, reflecting minimal residual pain. The reduction in pain between the preoperative period and 6 months postoperatively was statistically highly significant (p<0.001) (Table 3). Functional outcome scores demonstrated substantial and progressive improvement over the postoperative follow-up period. The mean Constant–Murley score increased from 28.5±6.8 preoperatively to 52.3±7.1 at 1 month, 70.8±6.3 at 3 months and 85.4±5.5 at 6 months (p<0.001). Similarly, the mean ASES score improved from 32.7±7.4 before surgery to 58.9±6.8 at 1 month, 75.3±6.0 at 3 months and 88.2±4.6 at 6 months (p<0.001). Health-related quality of life, as assessed by the EQ-5D index, also showed significant gains, rising from 0.45±0.12 preoperatively to 0.68±0.10 at 1 month, 0.82±0.08 at 3 months and 0.91±0.05 at 6 months (p<0.001). Overall, all functional scores demonstrated statistically significant improvement when preoperative values were compared with those at 6 months postoperatively (Table 4). At 6 months postoperatively, the CMS differed significantly according to etiology. Patients with primary etiology achieved a higher mean CMS of 88.2±4.3, whereas those with secondary etiology had a lower mean score of 79.4±5.1. This difference was statistically significant on independent t-test analysis (p=0.003), indicating better functional outcomes among patients with primary etiology compared to those with secondary causes. No major intraoperative complications reported. Minor postoperative complications in 2 patients (6.25%) including transient neurological symptoms, resolved with conservative management. No cases of infection or reoperation within 6 months (Table 5).

Table 1: Demographic and baseline characteristics (N=32).

Variables	Value
Age (in years), mean±SD	52.3±4.2
Gender (M/F)	18/14
Side affected (Right/Left)	20/12
Duration of symptoms (months), mean±SD	26.5±3.8
Etiology	Primary: 22 (68.75%) Secondary: 10 (31.25%)

SD–Standard deviation, M–Males, F–Females.

Table 2: Preoperative and Postoperative Range of Motion (ROM) (Mean±SD).

Movements	Pre-op (°)	1 Month (°)	3 Months (°)	6 Months (°)	P-value (Pre-op vs 6 Months)
Abduction	65.2±12.4	95.5±10.2	120.1±9.8	140.3±8.7	<0.001
Flexion	70.4±13.1	100.3±11.5	125.7±10.4	145.8±9.1	<0.001
Extension	30.5±8.7	45.8±7.6	60.3±6.9	70.2±5.8	<0.001
Internal rotation	L3 vertebral level	T12 vertebral level	T7 vertebral level	T5 vertebral level	<0.001
External rotation	20.3±6.5	35.4±5.7	50.2±5.1	60.7±4.8	<0.001

Table 3: Pain assessment (VAS Score) (Mean±SD).

Timepoints	VAS score
Preoperative	7.8±1.2
1 month post-op	4.2±1.0
3 months post-op	2.1±0.8
6 months post-op	1.0±0.5
P value (pre-op vs 6 months)	<0.001

Table 4: Functional scores.

Scores	Pre-op Mean±SD	1 Month Mean±SD	3 Months Mean±SD	6 Months Mean±SD	P-value (pre-op vs 6 months)
Constant-Murley Score	28.5±6.8	52.3±7.1	70.8±6.3	85.4±5.5	<0.001
ASES Score	32.7±7.4	58.9±6.8	75.3±6.0	88.2±4.6	<0.001
EQ-5D Index	0.45±0.12	0.68±0.10	0.82±0.08	0.91±0.05	<0.001

Table 5: Association between etiology and postoperative constant-murley score at 6 months.

Etiology	Mean CMS±SD	P value (Independent t-test)
Primary	88.2±4.3	0.003*
Secondary	79.4±5.1	

*p value<0.05

DISCUSSION

The demographic profile of the 32 patients in this study (mean age 52.3±4.2 years; 18 males, 14 females) aligns with prior reports, reflecting a middle-aged population typically affected by adhesive capsulitis. Unlike most studies demonstrating female predominance, this cohort had a slight male majority, potentially attributable to regional demographic variations or sample size differences.[12-15] The mean symptom duration in this study (26.5±3.8 months) was notably longer than that reported by Mahajan et al (8.8 weeks) and Mukherjee et al (6.3 months), likely reflecting differences in inclusion criteria and healthcare access.[14,15] This extended duration may contribute to more chronic capsular fibrosis, influencing recovery trajectories. The predominance of primary etiology (68.75%) contrasts with the equal distribution of primary and secondary causes reported by Alazabi et al and the higher secondary etiology proportions in Cvetanovich et al possibly due to stricter exclusion criteria or regional epidemiology in the current study.[12,13]

Significant improvements in range of motion (ROM) were observed across all planes at six months postoperatively, consistent with prior findings. Abduction improved from 65.2° to 140.3°, flexion from 70.4° to 145.8°, extension from 30.5° to 70.2°, internal rotation from L3 to T5 vertebral level and external rotation from 20.3° to 60.7° ($p<0.001$). These results parallel the substantial ROM gains reported by Alazabi et al,who used numeric scales and by Cvetanovich et al who documented sustained improvements over a minimum two-year follow-up.[12,13] Mahajan et al and Mukherjee et al similarly demonstrated significant ROM increases, with the latter showing superior gains in the arthroscopic group compared to corticosteroid treatment.[14,15] Variability in absolute ROM values across studies likely reflects differences in measurement methods, follow-up durations and baseline patient characteristics, including symptom chronicity and severity.

Pain relief, as measured by VAS scores, showed a progressive and significant decline from 7.8±1.2 preoperatively to 1.0±0.5 at six months, corroborating the consistent pattern of pain reduction following arthroscopic release documented by Cvetanovich et al and Mukherjee et al.[13,15] Notably, Mukherjee et al, observed delayed pain relief in the surgical group compared to corticosteroid injections, potentially due to postoperative surgical pain, a factor not explicitly addressed in other studies.[15] Functional outcomes improved markedly, with the CMS increasing from 28.5±6.8 to 85.4±5.5, ASES scores from 32.7±7.4 to 88.2±4.6 and EQ-5D indices from 0.45±0.12 to 0.91±0.05 at six months (all $p<0.001$). These findings are consistent with Alazabi et al's postoperative Constant score improvements and Cvetanovich et al's excellent ASES scores at long-term follow-up.[12,13] Mahajan et al and Mukherjee et al also reported significant functional gains, with the latter demonstrating earlier and superior improvements in the arthroscopic group relative to corticosteroid treatment.[14,15] Differences in absolute functional scores may be influenced by baseline severity, follow-up duration and scoring systems used. Etiological analysis revealed significantly better CMS outcomes in patients with primary adhesive capsulitis (88.2±4.3) compared to secondary causes (79.4±5.1, $p=0.003$), aligning with clinical expectations that secondary adhesive capsulitis, particularly diabetes-related, is more refractory. Cvetanovich et al and Mukherjee et al found no significant outcome disparities between diabetic and non-diabetic patients, possibly due to sample size limitations or effective surgical techniques mitigating systemic effects.[13,15] Complication rates were low, with no major intraoperative events and minor transient neurological symptoms in 6.25% of patients resolving conservatively. This safety profile concurs with Cvetanovich et al Mahajan et al and Mukherjee et al who reported minimal complications.[13-15] The requirement for manipulation under anesthesia in 7% of patients in Cvetanovich et al highlights individual variability in fibrosis and rehabilitation adherence.[13] The transient neurological symptoms observed highlight the necessity for meticulous surgical technique given the proximity of neurovascular structures.

Variations in treatment modalities and follow-up durations across studies influence outcome interpretation. The current study and Alazabi et al, focused exclusively on arthroscopic capsular release with follow-ups up to six months and two years, respectively.[12] Cvetanovich et al reported sustained outcomes at a minimum two-year follow-up emphasizing lateral decubitus positioning without manipulation under anesthesia.[13] Mahajan et al and Mukherjee et al incorporated comparative groups receiving conservative management or corticosteroid injections, demonstrating accelerated and superior benefits with surgery.[14,15] Differences in surgical positioning, postoperative rehabilitation protocols and patient compliance likely contribute to outcome variability.

CONCLUSION

This study demonstrates that arthroscopic capsular release is an effective and safe surgical intervention for patients with frozen shoulder refractory to conservative management. Significant improvements were observed in

shoulder range of motion, pain reduction, functional outcomes as measured by the Constant–Murley and ASES scores and health-related quality of life over a six-month postoperative period. Patients with primary adhesive capsulitis showed better functional recovery compared to those with secondary etiologies. The low complication rate further supports the procedure's safety profile. These findings underscore the value of arthroscopic capsular release in restoring shoulder function and improving quality of life in patients with persistent frozen shoulder, particularly when conservative treatments fail. Future studies with longer follow-up and larger sample sizes may further validate these outcomes and optimize postoperative rehabilitation protocols.

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