Original Article With Video Illustration

Arthroscopic Arthrolysis for Recalcitrant Frozen Shoulder: A Lateral Approach

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Purpose: The purpose of this study was to evaluate a new all-arthroscopic technique in the management of recalcitrant globally stiff frozen shoulders. This adopts an initial extra-articular approach followed by intra-articular entry to perform a 360° capsular release. **Methods:** Ten patients with global adhesive capsulitis were prospectively evaluated. All patients had not improved after undergoing a minimum of 6 months of physiotherapy, and 5 received intra-articular injections of steroids. The mean age was 47 years (range, 33 to 56 years). Patients were examined preoperatively and postoperatively for range of motion. A Constant score and visual analog scale score for pain were recorded. We described an all-arthroscopic technique by entering the subacromial space laterally and opening the rotator interval from the outside in, followed by a complete 360° capsular release and biceps tenotomy. **Results:** The mean follow-up was 42 months (range, 18 to 90 months), and the mean Constant score improved from 21 to 72 ($P < .01$). Preoperative abduction improved from a mean of 40° to 165°, elevation improved from 55° to 175°, and external rotation improved from 6° to 58°. The visual analog scale pain score improved from 7 to 1.6, and all patients reported an excellent outcome after surgery. There were no complications particularly regarding axillary nerve injury, fracture, or infection. **Conclusions:** This study shows a combined extra-articular and intra-articular approach that is controlled and anatomic and achieves excellent results that were maintained at the midterm. The technique permits anatomic debridement of the rotator interval, enabling excellent intra-articular access, a circumferential capsular release, and biceps tenotomy. There were no complications, and no manipulations were required, which pose a risk of creating soft-tissue lesions, fractures, or dislocations. We recommend this 360° capsular release technique for releasing globally stiff shoulders where the surgeon is experienced in arthroscopy. **Level of Evidence:** Level IV, therapeutic case series.

The term "frozen shoulder" was introduced by Codman[1] in 1934 and has since been known by several names including *capsulite rétractile*,[2] periarthritis, tendinitis of the short rotators, adhesive capsulitis,[3] and contracted shoulder.[4] It is considered to affect 2% to 5% of the general population.[5,6]

The natural history of the disorder was originally believed to be benign and self-limiting, with a complete resolution of symptoms. However, we have found that there exists a subgroup of patients who continue to have persistent pain and severe stiffness despite maximal conservative management. This particular group presents with a globally decreased range of motion that has failed to respond to physiotherapy, steroid injections, or distension arthrography. Surgical treatment for these patients may take the form of manipulation under anesthesia (MUA) followed by arthroscopic evaluation of the shoulder.[7,8] In these

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markedly stiff shoulders, there is an increased risk of dislocation, fracture, and inadvertent soft-tissue injury after MUA because of the force necessary to disrupt the adhesions.[7] An alternative to simple MUA is an arthroscopic release of the adhesions in the glenohumeral joint and subacromial space followed by manipulation of the joint. In our experience, this can present problems with a difficult or occasionally impossible intra-articular entry and the risk of glenoid or humeral articular cartilage damage.

The purpose of this study was to evaluate the use of a new technique in the management of recalcitrant globally stiff frozen shoulders. Our hypothesis was that the complications and technical difficulties of conventional adhesive capsulitis surgery for globally contracted shoulders could be minimized by adopting an all-arthroscopic technique but starting from an extra-articular entry portal.

METHODS

Between March 2003 and March 2009, 10 consecutive patients with 1° or 2° globally stiff frozen shoulders for which nonoperative treatment failed were managed using our technique. All patients had undergone a minimum of 6 months of conservative treatment. Inclusion criteria required the diagnosis of adhesive capsulitis according to Codman's description as modified by Zuckerman et al.[9] (Table 1). In addition, all patients had examination findings of a globally restricted range of motion indicating pan-capsular involvement.

We excluded patients who had evidence of glenohumeral joint arthritis on radiography and those who underwent supplementary procedures during the same surgery (e.g., rotator cuff tears requiring repair).

All patients underwent a detailed history and examination, and a Constant and Murley score and visual analog scale (VAS) score for pain were recorded.

Total range of motion was measured and recorded preoperatively, intraoperatively, and postoperatively with a goniometer. This was performed by seating the patient on the examination couch and measuring forward flexion in the sagittal plane, abduction in the coronal plane, and external rotation with the elbows at the patient's side and flexed to 90°. Internal rotation was measured based on the spinal level that could be reached by the patient's thumb.

TABLE 1. *Diagnostic Criteria for Frozen Shoulder*

Insidious onset
Painful restriction of active and passive elevation <100°
True shoulder pain
External rotation <50% of opposite side
Night pain
Normal radiographs

Statistical Analysis

Descriptive statistics (mean, standard deviation) were used for range-of-motion measurements. To evaluate the statistical significance of changes in measured variables between the preoperative and postoperative values, a Wilcoxon signed rank test was used.

Surgical Technique

We obtained informed consent from all patients before surgery. The patient undergoes an interscalene brachial plexus block that is supplemented by general anesthesia. He or she is positioned in the beach-chair position and the arm prepared and draped. The shoulder is examined, and the range of motion is recorded and compared with the opposite side. The arm is placed in longitudinal sterile skin traction at 2.5 kg with the shoulder flexed (as determined by preoperative stiffness) and with 20° of abduction.[10]

A midlateral subacromial portal (portal C)[10] is used for initial arthroscopic entry (Video 1, available at www.arthroscopyjournal.org). The cannula and trocar are advanced into the subacromial space and the arthroscope introduced. An anterolateral instrument portal (portal D) is then created 1 cm inferior and lateral to the anterolateral edge of the acromion by use of an outside-in technique (Fig 1). A soft-tissue shaver is introduced and the coracoacromial ligament identified. This important landmark can then be followed down to its origin to lead us to the coracoid process. The coracoid process is debrided superolaterally with a radiofrequency wand (VAPR; DePuy Mitek, Cardiff, Wales), and the coracohumeral ligament is located and detached from the coracoid. The debridement is then extended laterally to completely ablate this structure from the rotator interval. This serves both to remove the primary restriction of external rotation and to open the rotator interval and permit intra-articular access. Throughout the procedure, it is important to maintain a good flow of fluid to ensure adequate cooling of the joint because the radiofrequency device is used for extensive periods.

By the use of a combination of the radiofrequency probe and a soft-tissue shaver, the upper border of the subscapularis tendon is exposed, followed by a release on both its anterior and posterior surfaces (Fig 2).

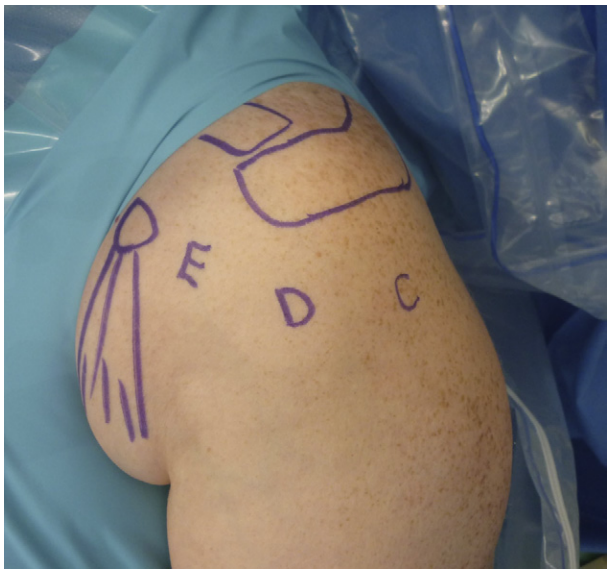

Figure 1. Arthroscopic portals used with patient in beach-chair position (left shoulder). Portal C represents the midlateral subacromial portal, portal D is the anterolateral portal, and portal E is the anterior rotator interval portal.[10] The posterior portal (portal A) is not shown.

Care is taken with this anterior release not to stray too medially and too inferiorly due to the potential of muscle adhesions to the subscapular and axillary nerves, respectively. The release is extended medially under the coracoid to ensure good tendon excursion and therefore restore maximal external rotation. The

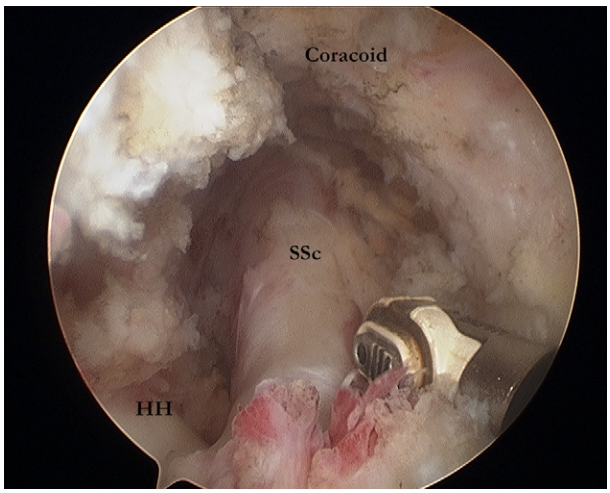

Figure 2. Release of subscapularis adhesions under coracoid. The radiofrequency device is entering through the anterolateral portal (portal D) in the right shoulder while the surgeon is viewing from the midlateral portal (portal C). (HH, humeral head; SSc, subscapularis.)

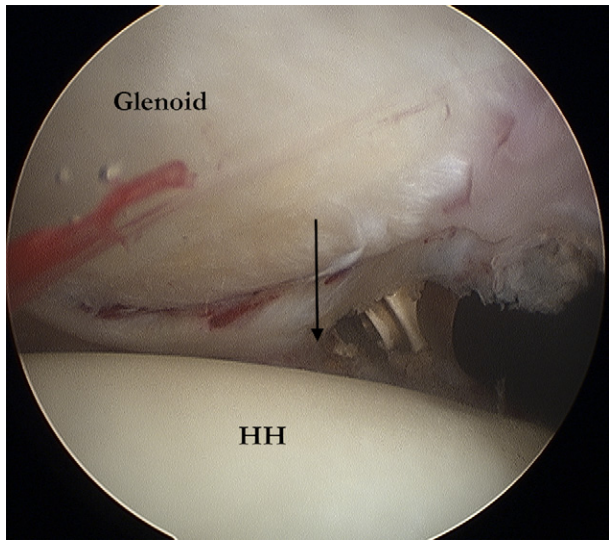

Figure 3. Anteroinferior capsular release with instrument in anterior portal (portal E) in right shoulder. The arthroscope is passing through the rotator interval through the midlateral portal (portal C). The arrow shows the capsular release inferior to the labrum. (HH, humeral head.)

articular side of the subscapularis is also freed from adhesions extending between the muscle and the capsule and glenoid neck as inferiorly as possible. This careful but extensive release is an important step in re-establishing external rotation.

Next, the anterior border of the supraspinatus is exposed and debrided of any inflamed and contracted tissue, and the biceps tendon undergoes tenotomy. At this stage, the tissues of the rotator interval have been debrided and the subscapularis tendon freed from adhesions. We then proceed with a 360° capsular release, which requires a supplementary anterior portal (portal E)[10] to be created (using an outside-in technique) to gain better instrument access to the capsule.

The radiofrequency device is introduced through the anterior portal (portal E), and the arthroscope remains in the midlateral portal (portal C). This new orientation for the radiofrequency device allows an anteroinferior capsular release to be performed while one is carefully preserving the labral tissue (Fig 3). The arthroscope enables good views of this release through the now open rotator interval. Once this anteroinferior release is completed as far as possible, a superior capsular release is performed. This can be extended down the posterior capsule as far as the 8-o'clock position. This requires the arthroscope to be passed through the rotator interval and oriented to view posteriorly. The radiofrequency device is maintained in the anterior portal for this.

To complete the posteroinferior release, a final posterior portal (portal A) is created and the radiofrequency wand introduced (Fig 4). To assist in visualization in this region, the humeral head can be displaced anteriorly with manual pressure. The inferior release is completed with the radiofrequency wand under direct vision and applied close to and directed toward the bone of the inferior glenoid neck to avoid damage to the axillary nerve (Fig 5). Applying manual lateral traction to the humerus at this stage also improves exposure. Throughout the entire 360° capsular release, the labrum is left intact (Fig 6). At the conclusion of the procedure, the shoulder is gently assessed for range of motion to ensure the adequacy of the release. If any restriction to motion is felt during this examination, then the instruments are reintroduced to ensure that the release is complete. If there are any subacromial or subdeltoid adhesions that may be limiting motion, these can be released as well at this time.

Postoperatively, the patients were managed with oral analgesia once the effects of the brachial plexus block had subsided. Physical therapy was commenced immediately with the aim of maintaining the range of motion attained intraoperatively. This takes the form of encouraging full passive and active range of motion as tolerated.

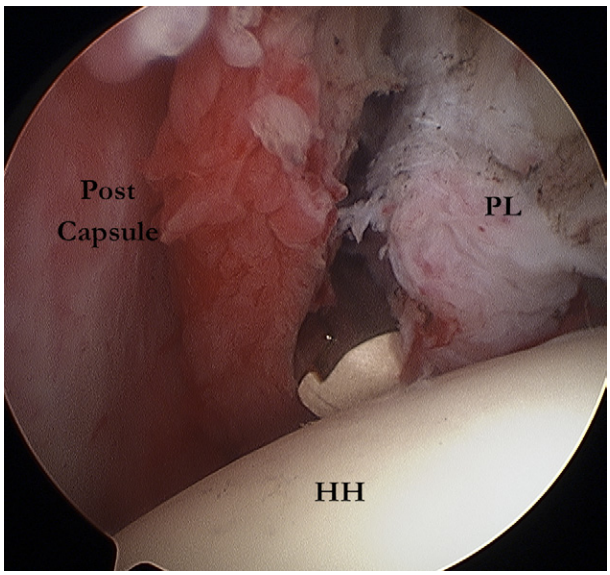

FIGURE 4. Posterior (Post) capsular release with radiofrequency probe in standard posterior portal (portal A) while viewing through rotator interval from midlateral portal (portal C). The extensive synovitis and preservation of the labral tissue should be noted. (HH, humeral head; PL, posterior labrum.)

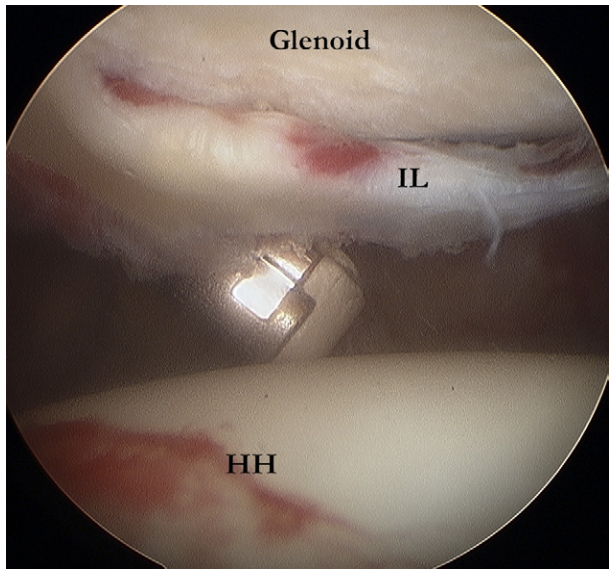

FIGURE 5. Inferior capsular release in right shoulder. The radiofrequency probe is entering from the posterior portal (portal A) with the arthroscope viewing superiorly through the rotator interval from the midlateral portal (portal C). Lateral traction is applied to the humerus manually to improve exposure. (HH, humeral head; IL, inferior labrum.)

RESULTS

Ten patients fulfilled our inclusion criteria with globally restricted shoulder movement resistant to conservative management. There were 7 female and 3 male patients with a mean age of 47 years (range, 33 to 56 years). The mean duration of frozen shoulder for all patients was 19 months

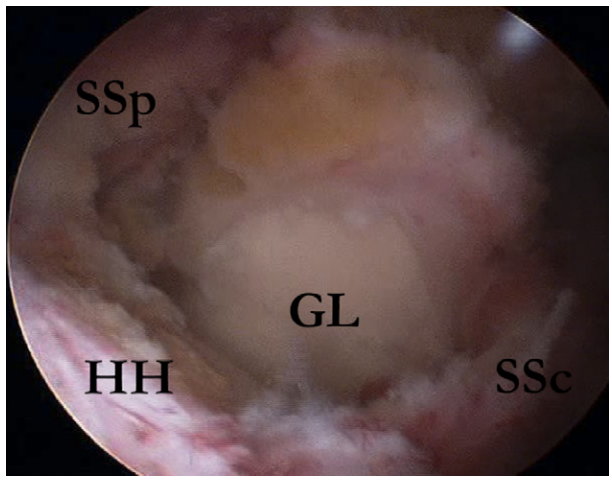

FIGURE 6. Final 360° capsular release and biceps tenotomy as viewed from midlateral portal (portal C). (GL, glenoid; HH, humeral head; SSc, subscapularis; SSp, supraspinatus.)

Table 2. *Patient Details*

Patient	Sex	Age	Time Since Onset	Prior Treatments
1	F	52	3 yr	Decompression calcific deposit in 2003, subacromial decompression in 2004, injection in 2006
2	M	56	3 yr	Bankart repair in 2003
3	F	46	1 yr	3 injections
4	M	47	6 mo	Latarjet 20 yr earlier
5	F	49	3 yr	Fracture in 2004, internal fixation in 2004, total shoulder prosthesis in December 2007
6	F	33	2 yr	Previous fracture managed conservatively
7	F	38	1 yr	2 injections
8	M	41	1 yr	Previous cuff repair
9	F	52	8 mo	3 injections
10	F	56	6 mo	1 injection

(range, 6 to 36 months), and 5 patients had received previous injections (mean, 2; range, 1 to 3). Six patients had undergone previous shoulder surgery or had proximal humeral fractures (Table 2).

Preoperative data collection showed mean flexion of 55° (range, 30° to 100°); abduction, 40° (range, 30° to 90°); and external rotation, 6° (range, −10° to 30°). The mean overall Constant score was 21, with a mean pain score of 3.5 (range, 0 to 5); activity, 6.6 (range, 2 to 14); range of motion, 10.2 (range, 6 to 18); and strength, 0.8 (range, 0 to 8). The mean VAS score for pain was 7.5 (range, 6 to 9) (Table 3).

At 3 months postoperatively, all patients were reexamined and repeat measurements were performed. Mean flexion improved to 175° ($P < .01$); abduction, 165° ($P < .01$); and external rotation, 58° ($P < .01$). The mean Constant score improved to 72 ($P < .01$), and the VAS pain score decreased to 1.6 ($P < .01$), with 2 patients reporting that they were completely pain free. All patients were pleased with the outcome of the surgery and would have this performed again. The clinical outcomes were maintained at the latest clinical follow-up visits at a mean of 3 years (range, 18 to 90 months).

DISCUSSION

Patients with global shoulder stiffness and pain remain a difficult group of patients to satisfactorily treat. The overwhelming majority have been subject to prolonged conservative management, often with repeated injections, or they have a history of previous surgery or trauma. The globally reduced range of motion and marked pain that these patients endure render them unable to perform most occupations and even simple day-to-day activities.

In this recalcitrant group, many surgeons prefer to perform MUA followed by glenohumeral joint arthroscopy.[7,8] For these very stiff shoulders, we believe that this runs an unacceptably high risk of fracture, dislocation, or inadvertent soft-tissue injuries, including chondral lesions, labral lesions, and rotator cuff tears.[7,11] This is because of the large

Table 3. *Preoperative Scores*

	Range of Motion				Constant Score					
Patient	Flexion (°)	Abduction (°)	ER (°)	IR	Pain	Activity	ROM	Strength	Total	VAS Score
1	90	90	10	Buttock, 2	0	14	18	8	40	8
2	30	30	0	Lateral thigh, 0	5	4	4	0	13	7
3	70	40	30	Buttock, 2	5	8	10	0	23	9
4	60	30	30	GT, 0	5	4	10	0	19	9
5	100	60	0	Waist, 6	0	8	22	0	30	8
6	40	30	−5	LS junction, 4	5	6	8	0	19	7
7	30	30	−10	LS junction, 4	5	8	8	0	21	6
8	30	30	−10	Buttock, 2	5	4	6	0	15	7
9	45	30	10	LS junction, 4	0	8	8	0	16	8
10	55	30	5	Buttock, 2	5	2	8	0	15	6
Mean	55 (25.2)	40 (20)	6 (14.5)		3.5	6.6	10.2	0.8	21.1	7.5

NOTE. Standard deviations are shown in parentheses.

Abbreviations: ER, external rotation; IR, internal rotation; GT, greater trochanter; LS, lumbosacral; ROM, range of motion; VAS, visual analog scale.

lever arm involved and the closed uncontrolled nature of the maneuver. This is especially true in cases where the capsule is diffusely contracted rather than just in an isolated capsular region. An alternative to this initial MUA is to perform a subtotal arthrolysis by use of a posterior portal to gain intra-articular entry. In cases where the posterior capsule is contracted and involved in the disease process, we believe that it can be very difficult and occasionally impossible to gain intra-articular access. A forced entry also brings with it the risk of causing osteochondral injury. Once intra-articular entry is gained, an instrument is usually introduced through the rotator interval and a subtotal arthrolysis performed, sparing the inferior capsule because of the perceived risk of axillary nerve injury.[12,13] The release can then be completed with MUA to forcibly break the remaining inferior capsular contractures.

We believe that in these shoulders with a global capsular contracture, a safer and more controlled approach is achieved through the use of arthroscopy, commencing with a lateral extra-articular viewing portal followed by an anterolateral instrument portal. Once the subacromial space has been entered, it is vital to identify anatomic landmarks, of which the coracoacromial ligament and coracoid are fundamental. Locating these structures also leads us directly to the coracohumeral ligament, which is the most commonly implicated and diseased structure in this disorder.[14] It can be released in a controlled fashion from its origin on the coracoid and the rotator interval opened safely and its borders defined. Our results in this small series showed no complications, and this compares favorably with those publications that have looked at complications using alternative methods of release.[7,11,15,16]

A further advantage is gained from being in the anterior shoulder region in that it is possible to perform an extensive subscapularis release to help regain maximal external rotation. This also preserves the subscapularis tendon, which some authors advocate dividing.[17] Furthermore, the opening of the rotator interval provides excellent access to the joint for both the arthroscope and instruments to begin the anterior capsular release. The 360° capsular release is then achieved by progressively releasing the capsule anteriorly and then moving the instrument portal or the arthroscope to improve both viewing and instrument access to the remaining areas of the capsule. In contrast to other authors, we find that the posterior capsular release is necessary in these cases of global stiffness where an internal rotation deficit exists.[12,16,18]

One area of concern for many arthroscopic surgeons is the risk of injury to the axillary nerve with an inferior capsular release. By performing the inferior release last, we have a better overall view of the capsule in this region and can perform this release more safely. The instrument is maintained under direct vision while remaining on the bone of the inferior glenoid neck throughout, and we avoid straying too medially with the knowledge that the nerve lies on average 12 mm from the glenoid rim in this region.[19] A deltoid contraction can serve as a warning as to the close proximity of the nerve when one is using the radiofrequency wand, and therefore caution should be exercised with further dissection. An assistant applying abduction and lateral traction for the final inferior capsular release provides further improved visualization and affords better protection to the nerve by moving this away from the glenoid neck.[20]

Global shoulder stiffness also is one of the few clinical scenarios where we perform a biceps tenotomy, and our rationale for this is to reduce the risk of any further scarring or adhesions within the shoulder. No patients subsequently developed a Popeye sign or complained of any cosmetic or functional problem with the biceps. We believe that the biceps undergoes self-tenodesis in the bicipital groove because of the surgery and the inflammatory component of this disorder.

Both the Constant score component for pain and the VAS pain measurements showed large improvements as a result of surgery. This likely reflects the ablation of the diseased tissue, but there may be an element of joint nociceptive denervation because of the magnitude of the release that serves to improve the patient's pain.

This study has several shortfalls, most notably the sample size of patients involved. This is predominantly because of the small number of patients presenting within the study period with truly global shoulder stiffness resistant to conservative measures who fulfilled the study criteria. The senior author reviews up to 800 new patient shoulder referrals per year, of which 20 to 30 have a diagnosis of isolated adhesive capsulitis. Only those patients who met our strict inclusion and exclusion criteria were included in the study, which reduces this modest group even further. This group therefore represents only a small percentage of the shoulder pathology seen in the unit that ultimately requires surgery (>500 shoulder procedures performed per year by the senior surgeon).

Table 4. *Postoperative Scores at 3 Months*

	Range of Motion				Constant Score					
Patient	Flexion (°)	Abduction (°)	ER (°)	IR	Pain	Activity	ROM	Strength	Total	VAS Score
1	180	180	70	Waist (L3), 6	15	16	34	23	88	2
2	160	150	70	Buttock, 2	10	12	26	16	64	3
3	180	180	60	Waist (L3), 6	15	14	32	14	75	1
4	170	150	60	LS junction, 4	15	18	28	18	79	0
5	180	175	50	Waist (L3), 6	10	16	34	14	74	2
6	175	160	40	Lateral thigh, 0	15	14	22	10	61	0
7	170	170	60	LS junction, 4	10	16	28	17	71	2
8	175	165	60	LS junction, 4	10	16	28	16	70	3
9	180	150	70	LS junction, 4	15	18	26	16	75	2
10	180	170	40	Lateral thigh, 0	15	16	22	10	63	1
Mean	175 (6.7)	165 (12.0)	58 (11.4)		13	15.6	28	15.4	72	1.6

Abbreviation: ER, external rotation; IR, internal rotation; LS, lumbosacral; VAS, visual analog scale.

We do not have figures for the incidence of all frozen shoulders in the geographic catchment region during that period; however, all globally stiff resistant shoulders presenting to the senior surgeon were included in the study. Because this study was used to assess our outcomes for this new technique, there was no comparison group with which we could more accurately evaluate our results in comparison with more established techniques. We used the Constant score to assess the patients for pain, movement, and strength both preoperatively and postoperatively. The strength measurement was considered to be 0 unless the patient could perform strength testing at 90° of abduction in the scapular plane. This was only achievable in 1 patient, and as such, a modified Constant score omitting this component could be used when comparing outcomes of surgery. Regarding the scores at 3 months postoperatively, the fact that strength scores were now recordable added a mean of 15 points to each final score.

In addition, the etiologies of the patients undergoing surgery in our series represent a wide spectrum of causes, which could be considered a heterogeneous group with which to make comparisons with other studies. Our data show that regardless of cause, the described technique facilitates a complete release and improvement in motion and pain that was maintained at the most recent follow-up. Subgroup analysis was not performed because of the size of the cohort; however, the poorest result seen in our series was in the treatment of a post-traumatic frozen shoulder (patient 6). This is a difficult subgroup to return to normal function, especially where there has been bony malunion; however, other authors have reported good overall success in such cases.[15] Because no comparative group was available, we consulted the published literature to assist in drawing conclusions and found that our technique and results compare favorably with other series.[15,21] In particular, it provides a useful technique in the post-traumatic shoulder where a further MUA runs the very real risk of refracturing the proximal humerus.

Finally, our follow-up scores were all obtained at a minimum of 3 months postoperatively. The range of follow-up was 18 to 90 months, with a mean of 42 months. All patients had maintained their 3-month range of motion at their most recent follow-up and remained delighted with the outcome, and as such, further scoring was not performed (Table 4).

CONCLUSIONS

This study shows a combined extra-articular and intra-articular approach that is controlled and anatomic and achieves excellent results that were maintained at the midterm. The technique permits anatomic debridement of the rotator interval, enabling excellent intra-articular access, a circumferential capsular release, and biceps tenotomy. There were no complications, and no manipulations were required, which pose a risk of creating soft-tissue lesions, fractures, or dislocations. We recommend this 360° capsular release technique for releasing globally stiff shoulders where the surgeon is experienced in arthroscopy.

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