Outcomes of Arthroscopic Capsular Release in the Beach-Chair Versus Lateral Decubitus Position

A Systematic Review

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Background: Arthroscopic capsular release (ACR) for the treatment of adhesive capsulitis of the shoulder can be performed in either the beach-chair (BC) or lateral decubitus (LD) position.

Purpose: To determine the clinical outcomes and recurrence rates after ACR in the BC versus LD position.

Study Design: Systematic review; Level of evidence, 4.

Methods: A systematic review using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines was performed by searching PubMed, Embase, and the Cochrane Library databases for studies reporting clinical outcomes of patients undergoing ACR in either the BC or LD position. All English-language literature from 1990 through 2017 reporting on clinical outcomes after ACR with a minimum 3-month follow-up were reviewed by 2 independent reviewers. Recurrence rates, range of motion (ROM) results, and patient-reported outcome (PRO) scores were collected. Study methodological quality was evaluated using the modified Coleman Methodology Score (MCMS).

Results: A total of 30 studies (3 level 1 evidence, 2 level 2 evidence, 4 level 3 evidence, 21 level 4 evidence) including 665 shoulders undergoing ACR in the BC position (38.1% male; mean age, 52.0 ± 3.9 years; mean follow-up, 35.4 ± 18.4 months) and 603 shoulders in the LD position (41.8% male; mean age, 53.0 ± 2.3 years; mean follow-up, 37.2 ± 16.8 months) were included. There were no significant differences in overall mean recurrence rates between groups (BC, 2.5%; LD, 2.4%; P = .81) or in any PRO scores between groups (P > .05). There were no significant differences in improvement in ROM between groups, including external rotation at the side (BC, 36.4°; LD, 42.8°; P = .91), forward flexion (BC, 64.4°; LD, 79.3°; P = .73), abduction (BC, 77.8°; LD, 81.5°; P = .82), or internal rotation in 90° of abduction (BC, 40.8°; LD, 45.5°; P = .70). Significantly more patients in the BC group (91.6%) underwent concomitant manipulation than in the LD group (63%) (P < .0001). There were significantly more patients with diabetes in the LD group (91.6%) versus the BC group (9.6%) (P < .0001).

Conclusion: Low rates of recurrent shoulder stiffness and excellent improvements in ROM can be achieved after ACR in either the LD or BC position. Concomitant manipulation under anesthesia is performed more frequently in the BC position compared with the LD position.

Keywords: arthroscopic surgery; arthroscopic; shoulder; adhesive capsulitis; capsular release; beach-chair position; lateral decubitus position

Adhesive capsulitis of the shoulder (ACS), commonly referred to as frozen shoulder, is diagnosed in 2% to 5% of the general population and up to 20% of patients with diabetes.3,5,13,21,26,37 ACS is an inflammatory condition of the shoulder joint characterized by the spontaneous onset of pain and significant limitation of both passive and active range of motion (ROM).33,43 Primary or idiopathic ACS usually occurs without any apparent cause, while secondary ACS may occur after trauma (acute mechanism of injury), after surgery, or with systemic diseases such as diabetes mellitus, rheumatoid arthritis, or thyroid disorders.5,33,43 Surgical treatment is advised when symptoms are resistant to nonoperative treatment, including the use of nonsteroidal anti-inflammatory drugs, intra-articular steroid
injections, physical therapy, nerve blocks, and/or manipulation under anesthesia (MUA).4,5,21,26 Surgical interventions include open release, arthroscopic capsular suspension (ACR), and combinations of ACR with MUA.20,42

ACR can be performed in the beach-chair (BC) position1 as well as in the lateral decubitus (LD) position.11,27 Typically, surgeon preference for patient positioning is based on training, experience and the intended procedure.11,20 The benefits of the BC versus LD position during arthroscopic shoulder stabilization have been debated in the literature,11,20 and both techniques allow for good outcomes with low complication rates.20 The BC position offers an easier setup because of the supine to upright placement of the patient, giving the surgeon the option to transfer to an open procedure if necessary, while the advantages of the LD position include better visualization and instrument access for certain procedures and a decreased risk of cerebral hypoperfusion.27 Studies2,26 have shown that ACR performed in the BC position results in both rapid short-term improvement and promising long-term outcomes with improved pain relief and ROM compared with the patient’s contralateral shoulder.11 Similarly, some studies4,5,18 have shown significantly improved ROM and pain relief when ACR is performed in the LD position. However, the potential effect of patient positioning and its relation to clinical outcomes has not yet been evaluated for patients undergoing ACR for frozen shoulder.

The purpose of this study was to systematically review the literature comparing the clinical outcomes of ACR in the BC versus LD position. We hypothesized that there would be no significant differences in clinical outcomes between the 2 groups.

METHODS

Literature Search

The methods of this study are similar to those of a previous systematic review comparing the BC versus LD position.20 This systematic review was conducted according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines using a PRISMA checklist. Two independent reviewers (J.W.B., D.A.H.) searched PubMed, Embase, and the Cochrane Library databases up to November 20, 2017. The following search phrase was used: (arthroscopy OR arthroscopic) AND shoulder AND adhesive capsulitis AND capsular release. A total of 106 studies were reviewed by title and/or abstract to determine study relevance based on inclusion and exclusion criteria. Inclusion criteria consisted of studies that reported clinical outcomes of ACR in either the BC or LD position (level of evidence, 1-4). Studies that detailed both open/conservative treatment and arthroscopic cases but separated their results clearly by group were included, with only the data from the arthroscopic cases included in this analysis. Studies that analyzed open surgery or did not clearly specify the surgical technique were excluded. Additional exclusion criteria included biomechanical studies, novel technique studies, scientific meeting abstracts/proceedings, and systematic reviews/meta-analyses.

Data collected included surgical technique, occurrence of concomitant manipulation at the time of ACR, ROM at latest follow-up, recurrence rate of ACS, complications, and patient-reported outcome (PRO) scores. ROM parameters included external rotation at the side (ER-S), external rotation in 90° abduction (ER-ABD), forward flexion (FF), abduction (ABD), and internal rotation in 90° abduction (IR-ABD). PRO measures included the Constant-Murley score (CMS),30 the visual analog scale (VAS) for pain, and the American Shoulder and Elbow Surgeons (ASES) score.51

Study Methodology Assessment

The modified Coleman Methodology Score (MCMS) was used to evaluate study methodology quality.9 The MCMS has a scaled potential score ranging from 0 to 100. Scores ranging from 85 to 100 are excellent, 70 to 84 are good, 55 to 69 are fair, and <55 are poor. Other factors including disclosures, year of publication, and region/country of origin were also recorded.

Statistical Analysis

Weighted means and standard deviations were calculated for numerical demographic data (age and follow-up). Additionally, weighted means and weighted improvements were calculated for all ROM parameters and PRO scores based on the included studies. To test for normality, the Shapiro-Wilk test was performed. We used nonparametric statistics, specifically the Mann-Whitney U test, to calculate differences in improvements between groups in ROM results, PRO scores, and MCMS values. Chi-square tests were used to determine significant differences in the proportion of recurrence, concomitant manipulation, complications, and

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patients with diabetes by surgical position, with $P < .05$ considered statistically significant. All data analyses were performed using RStudio Version 1.1.456.38

RESULTS

A total of 30 studies (3 level 1 evidence, 2 level 2 evidence, 4 level 3 evidence, 21 level 4 evidence), including 14 BC position studies (47\%§) and 16 LD position studies (53\%), met inclusion criteria (Figure 1).

Study Characteristics

Demographics. The studies included 665 shoulders undergoing ACR in the BC position (mean age, 52.0 ± 3.9 years [range, 23-87 years]; 38.1\% male) and 603 shoulders undergoing ACR in the LD position (mean age, 53.0 ± 2.3 years [range 21-80 years]; 41.8\% male). Follow-up was available in 88.9\% of shoulders, with a mean follow-up duration of 35.4 ± 18.4 months in the BC group (range, 6-106 months) and 37.2 ± 16.8 months in the LD group (range, 3-168 months) (Tables 1 and 2).

Recurrence Rates. The mean overall recurrence rates at latest follow-up were not significantly different between the BC and LD groups, with a recurrence rate of 2.5\% in the BC position group (range, 0\%-14.3\%) versus 2.4\% in the LD position group (range, 0\%-20\%) ($P = .81$).

Cause. The causation for undergoing ACR in each position is included in Figure 2. Of the patients undergoing ACR in the BC position, 445 (66.9\%) were considered idiopathic, 64 (9.6\%) had diabetes, 85 (12.8\%) were postsurgical, 63 (9.5\%) were posttraumatic, and 8 (1.2\%) had impingement (Table 1). Of the patients undergoing ACR in the LD position, 362 (60.0\%) were considered idiopathic, 135 (22.4\%) had diabetes, 27 (4.5\%) were postsurgical, 37 (6.1\%) were posttraumatic, 21 (3.5\%) were “systemic,” 5 (0.8\%) had hypothyroidism, 3 (0.5\%) had Dupuytren syndrome, and 13 (2.2\%) were secondary

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§References 2, 8, 16, 17, 25, 26, 28, 33, 35, 36, 40, 42, 43, 45.
 References 3-7, 12-14, 18, 19, 22, 30, 32, 34, 39, 41.
There were significantly more idiopathic ($P = .01$), postsurgical ($P < .001$), and posttraumatic ($P = .03$) patients in the BC group than the LD group, and there were significantly more patients with diabetes in the LD group than the BC group ($P < .0001$). Among studies that reported mean follow-up, there were no significant differences between the BC and LD groups in follow-up duration.

### Modified Coleman Methodology Score

The mean MCMS of all 30 studies was 63.7 (BC, 65.1; LD, 62.6), indicating fair methodology (Appendix Table A1). There were no significant differences between the BC and LD position studies in the MCMS (65.1 $\pm$ 5.7 and 62.6 $\pm$ 5.5, respectively; $P = .18$).

### Surgical Technique

There were 2 studies (2 LD position) that performed ACR by release of only the rotator cuff interval and the constricted coracohumeral ligament, 1 study (1 BC position) by release of the superior edge of the subscapularis, 12 studies (8 BC position, 6 LD position) by release of the anterior capsule, 11 studies (6 BC position, 5 LD position) by release of the posterior capsule, 1 study (1 LD position) by release of the anterior capsule, and 5 studies (3 BC position, 2 LD position) by release of the posterior capsule, 1 study (1 LD position) by release of the posterior capsule, and 5 studies (3 BC position, 2 LD position) by release of the posterior capsule, and 5 studies (3 BC position, 2 LD position) by release of the posterior capsule, and 5 studies (3 BC position, 2 LD position) by release of the posterior capsule.

### TABLE 1

Beach-Chair Position Study Characteristics$^a$

| Author (Year) | Shoulders, n | Follow-up, mo | Duration of Symptoms, mo | Patient Age, y | Male Sex | Dominant Shoulder | Recurrence | Cause, n |
|---------------|--------------|---------------|--------------------------|----------------|----------|------------------|------------|---------|
| Barnes$^2$ (2016) | 140 | NA | 7 | 56 | 45 (33.8) | NA | 0 (0.0) | Id: 140 |
| Cinar$^8$ (2010) | 28 | 54.1 | 8.9 | 50 | 2 (7.7) | NA | 4 (14.3) | Id: 13 |
| Diwan$^{16}$ (2005) | 40 | NA | NA | NA | NA | NA | 2 (5.0) | Id: 40 |
| Elhassan$^{17}$ (2010) | 115 | 46 | 9 | 49 | 60 (52.2) | 62 (53.9) | 7 (6.1) | Id: 25 |
| Lafortes$^{25}$ (2012) | 10 | 36 | 19 | 47 | 3 (30.0) | NA | NA | |
| Liem$^{28}$ (2008) | 22 | 52.5 | NA | 51.9 | 12 (54.5) | 13 (59.1) | 0 (0.0) | Id: 11 |
| Le Lievre$^{26}$ (2012) | 49 | 7 | NA | 61 | 19 (44.2) | NA | 0 (0.0) | Id: 49 |
| Mubark$^{33}$ (2015) | 40 | NA | NA | 48.2 | 11 (27.5) | NA | 0 (0.0) | Id: 36 |
| Nicholson$^{35}$ (2003) | 68 | 36 | 7.3 | 50 | 27 (39.7) | 32 (47.1) | 0 (0.0) | Id: 26 |
| Ranalletta$^{36}$ (2017) | 32 | 63 | 18 | 49.6 | 10 (31.3) | 13 (40.6) | 0 (0.0) | Id: 32 |
| Snow$^{40}$ (2009) | 48 | 5 | NA | 51 | 14 (29.2) | NA | NA | |
| Warner$^{42}$ (1996) | 23 | 39 | 12 | 48 | 11 (47.8) | NA | NA | Id: 23 |
| Waszczykowski$^{43}$ (2014) | 27 | NA | NA | 51.6 | 10 (37.0) | 15 (55.6) | NA | Id: 27 |
| Yamaguchi$^{45}$ (2002) | 23 | 22.4 | 12.4 | 48 | 7 (35.0) | NA | 1 (4.3) | Id: 6 |
| Total | 665 | 35.4 $\pm$ 18.4 | 9.3 $\pm$ 3.3 | 52.0 $\pm$ 3.9 | 231 (38.1) | 135 (51.2) | 14 (2.5) | |

$^a$“Total” is reported as weighted mean $\pm$ SD for all studies. DM, diabetes mellitus; Id, idiopathic; Imp, impingement; NA, not available; PS, postsurgical; PT, posttraumatic.

$^b$Data are reported as mean.

$^c$Data are reported as n (%).
| Author (Year) | Shoulders, n | Follow-up, mo | Duration of Symptoms, mo | Patient Age, y | Male Sex | Dominant Shoulder | Recurrence | Cause, n |
|--------------|--------------|--------------|--------------------------|----------------|----------|------------------|------------|----------|
| Baums³ (2007) | 30 | 36 | 12 | 50 | 14 (46.7) | 18 (60.0) | 0 (0.0) | Id: 30 |
| Berghs⁴ (2004) | 25 | 14.8 | 13.6 | 50.8 | 12 (48.0) | 12 (48.0) | 5 (20.0) | Id: 18 |
| Castellarin⁵ (2004) | 40 | 42 | 8.5 | 53.6 | 10 (25.0) | NA | 0 (0.0) | Id: 26 |
| Chen⁶ (2010) | 70 | 28 | NA | 56 | 31 (41.9) | NA | NA | Id: 53 |
| Cho⁷ (2016) | 37 | 48.4 | 11.3 | 55.6 | 12 (32.4) | 17 (45.9) | 0 (0.0) | Id: 20 |
| Cvetanovich¹² (2018) | 27 | 44.4 | 16.2 | 54.8 | 6 (22.2) | 13 (48.1) | 2 (7.4) | Id: 17 |
| Dattani¹³ (2013) | 100 | NA | 9.3 | 54.3 | 40 (40.0) | NA | 1 (1.0) | Id: 81 |
| De Carli¹⁴ (2012) | 23 | NA | NA | 54 | 9 (39.1) | NA | NA | Id: 19 |
| Fernandes¹⁸ (2013) | 18 | 66.33 | 9.33 | 53.6 | 4 (22.2) | 10 (55.6) | NA | Id: 4 |
| Fernandes¹⁹ (2015) | 10 | 6.9 | 9 | 52.9 | 1 (10.0) | 5 (50.0) | 0 (0.0) | Id: 6 |
| Gerber²² (2001) | 45 | 26 | 8 | 50.8 | 37 (82.2) | 21 (46.7) | NA | Id: 9 |
| Mehta³⁰ (2014) | 42 | NA | 8.4 | 54.5 | 18 (42.9) | NA | 0 (0.0) | Id: 21 |
| Miyazaki³² (2017) | 56 | 65 | 15.3 | 51.2 | 14 (27.0) | 28 (54.0) | 2 (3.6) | Id: 8 |
| Mukherjee³⁴ (2017) | 28 | NA | 6.3 | 48.1 | 18 (64.3) | 11 (39.3) | 0 (0.0) | Id: 20 |
| Segmüller³⁹ (1995) | 26 | 13.5 | NA | 50 | 14 (58.0) | 10 (41.7) | NA | Id: 16 |
| Tsai⁴¹ (2017) | 26 | 28.2 | 7.5 | 51.2 | 11 (42.3) | NA | 0 (0.0) | Id: 10 |
| **Total** | **603** | **37.2 ± 16.8** | **10.2 ± 2.9** | **53.0 ± 2.3** | **251 (41.8)** | **145 (48.0)** | **10 (2.4)** | **278 (46.0)** |

²⁴Total² is reported as weighted mean ± SD for all studies. DM, diabetes mellitus; DU, Dupuytren syndrome; HT, hypothyroidism; Id, idiopathic; NA, not available; PS, postsurgical; PT, posttraumatic; Sec, secondary; Sys, systematic.

²⁵Data are reported as mean.

²⁶Data are reported as n (%).

²⁷Cause was listed but unclear.
Additional Procedures

This was then followed by gentle manipulation of the shoulder joint in 22 studies (12 BC position, 10 LD position) by 360° capsulectomy, and 12 studies (4 BC position, 8 LD position) by 270° capsulectomy, and 12 studies (4 BC position, 2,25,26,35, 8 LD position) by 360° capsulectomy. Additionally, 7 studies (2 BC position, 5 LD position) clearly stated that no concomitant manipulation was performed, while 1 LD study did not clearly state whether concomitant manipulation was performed. In the BC group, no patients underwent an additional surgical intervention to address bone fractures, rotator cuff or biceps tendon tears, loose bodies, subacromial depression, or arthritis. One study including patients in the LD position reported 2 cases of biceps tenodesis, and another study reported performing bursoscopy for any patient with posttraumatic shoulder stiffness. Overall, there were significantly more patients in the BC group (91.6%) who underwent associated manipulation compared with those in the LD group (63%) (P < .0001).

Complications

A total of 28 studies (13 BC position, 15 LD position) reported on postoperative complications. In the BC group, 2 patients experienced postoperative complications,
including 1 study reporting 1 patient who experienced prolonged postoperative pain, which was eventually treated with a corticosterone injection in the subacromial space (n = 1; 3.1%). Another study found 1 patient to experience diffuse brachial plexopathy after arthroscopic release (n = 1; 4.3%). However, there were no postoperative complications related to the procedure, including axillary nerve dysfunction, instability, or infection, reported in the 13 BC studies.†† Of the 15 LD studies, 3 studies described complications. An LD study reported 1 case of delayed healing of the posterior portal and 1 case of postoperative hematoma, both of which did not require subsequent surgical treatment (n = 2; 6.6%). Another LD study described complications including radial neurapraxia in 2 patients and axillary neurapraxia in 1 patient (who had undergone manipulation for release of the inferior capsule), 2 cases of reflex sympathetic dystrophy, 1 rotator cuff injury, and 1 case of acromioclavicular pain (n = 7; 12.5%). There were 2 cases of articular cartilage scuffing in an LD study: 1 of the glenoid and 1 of the humeral head (n = 2; 7.1%).‡‡ Otherwise, there were no further complications in 12 of the 15 LD studies.†† Overall, there were significantly more postoperative complications reported in patients undergoing ACR in the LD position (1.9%) compared with the BC position (0.3%) (P < .001).

### Reporting Outcomes

The most commonly used outcome measures were the CMS, VAS for pain, and ASES score (Table 3). A total of 16 studies (8 BC position, 8 LD position) reported CMS values. In addition, 3 studies reported only individual parameters of the CMS. A BC study reported only mean improvement in

| Author (Year) | VAS | SANE | SRQ | Likert | UCLA | CMS | SSV | ASES | SF-36 | SST | OSS | EQ-5D |
|---------------|-----|------|-----|--------|------|-----|-----|------|------|-----|-----|-------|
| Barnes2 (2016) | –   | –    | +   |        | –    | –   | –   | –    | –    | –   | –   | –     |
| Cinar8 (2010)  | –   | –    | –   |        | +    | –   | –   | –    | –    | –   | –   | –     |
| Diwan16 (2005) | –   | –    | –   |        | –    | –   | –   | –    | –    | –   | –   | –     |
| Elhassan17 (2010) | + | –    | –   |        | –    | +   | –   | –    | –    | –   | –   | –     |
| Lafortune25 (2012) | + | –    | –   |        | –    | +   | –   | –    | –    | –   | –   | –     |
| Liem8 (2008)   | –   | –    | +   |        | –    | –   | –   | –    | –    | –   | –   | –     |
| Le Lievre26 (2012) | 0 | –    | –   |        | –    | –   | –   | –    | –    | –   | –   | –     |
| Mubark33 (2015) | –   | –    | –   |        | –    | –   | –   | –    | –    | –   | –   | –     |
| Nicholson35 (2003) | + | –    | –   |        | –    | –   | –   | –    | –    | –   | –   | –     |
| Ranalletta36 (2017) | + | –    | –   |        | –    | –   | –   | –    | –    | –   | –   | –     |
| Snow40 (2009)  | –   | –    | –   |        | –    | –   | –   | –    | –    | –   | –   | –     |
| Warner16 (1996) | –   | –    | –   |        | +    | –   | –   | –    | –    | –   | –   | –     |
| Waszczykowski41 (2014) | – | –    | –   |        | –    | –   | –   | –    | –    | –   | –   | –     |
| Yamaguchi45 (2002) | + | –    | –   |        | –    | –   | –   | –    | –    | –   | –   | –     |

**a** indicates that the outcome measure was used, “–” indicates that the outcome measure was not used, and “0” indicates that the outcome measure was reported using a different scale or individual parameter. ASES, American Shoulder and Elbow Surgeons; CMS, Constant-Murley score; EQ-5D, EuroQol 5D questionnaire; OSS, Oxford Shoulder Score; SANE, Single Assessment Numeric Evaluation; SF-36, 36-Item Short-Form Health Survey; SRQ, Shoulder Rating Questionnaire (L’Insalata score); SST, Simple Shoulder Test; SSV, Subjective Shoulder Value; UCLA, University of California, Los Angeles; VAS, visual analog scale.

††References 2, 8, 16, 17, 25, 26, 28, 33, 35, 36, 40, 42, 45.
‡‡References 5-7, 12-14, 18, 19, 22, 30, 39, 41.
CMS values, 1 LD study\(^5\) reported only the normalized CMS percentage, and another LD study\(^12\) reported only postoperative outcome scores; these studies were consequently excluded from the analysis. There were 9 studies (4 BC position,\(^{28,33,42,45}\) 5 LD position\(^5,6,7,12,34,41\)) that reported ASES scores. Moreover, 11 studies (5 BC position,\(^8,28,33,36,42\) 4 LD position\(^5,6,14,22,30,34,39\)) reported only median ROM parameters\(^13\) to make statistical comparisons. Additionally, 2 studies\(^{13,41}\) that reported only median ROM parameters\(^13\) and listed only preoperative passive ROM under anesthesia\(^41\) were excluded from the analysis. Another study\(^40\) was excluded from the analysis because the external rotation and internal rotation measures were graded on a scale of 10, as described in the CMS.

Weighted means and weighted improvements in ROM parameters are presented in Table 5, with individual study results available in Appendix Tables A3 to A6. For the BC group, mean ROM improved from preoperatively to postoperatively, including FF (87.6° to 148.8°; \(P < .0001\)), ABD (71.0° to 148.8°; \(P < .0001\)), ER-S (13.7° to 50.2°; \(P < .0001\)), and IR-ABD (14.3° to 55.1°; \(P = .002\)). For the LD group, mean ROM improved from preoperatively to postoperatively, including FF (84.8° to 164.1°; \(P < .0001\)), ABD (70.9° to 152.4°; \(P < .0001\)), ER-S (15.8° to 58.7°; \(P < .0001\)), and IR-ABD (16.5° to 62.0°; \(P = .002\)). There were no significant differences in the preoperative to postoperative mean improvement in ROM between groups, including FF (BC, 64.4°; LD, 79.3°; \(P = .73\)), ER-S (BC, 36.4°; LD, 42.8°; \(P = .91\)), ABD (BC, 77.8°; LD, 81.5°; \(P = .82\)), and IR-ABD (BC, 40.8°; LD, 45.5°; \(P = .70\)).

Conflict of Interest

Only 3 studies\(^{3,12,16}\) (10%) reported on a conflict of interest, whereas the remaining 27 studies (90%) did not report on any conflicts or disclosures. Furthermore, 2\(^{12,16}\) of the 3 studies that reported a conflict of interest were both in the BC position group, while 1 study\(^12\) was in the LD position group.

Country of Origin

A total of 13 studies were published outside of Europe,\(^{**}\) 4 studies were published outside of South America,\(^{18,19,32,36}\) 4 studies were published outside of Australia,\(^{2,16,26,39}\) 5 studies were published outside of the United States,\(^{12,17,35,42,45}\) and 4 studies were published outside of Asia (Appendix Table A1).\(^{5,7,34,41}\)

| Table 4 | PRO Scores\(^a\) |
| --- | --- | --- |
| PRO Measure | Preoperative | Postoperative |
| CMS | | |
| Beach chair (n = 295) | | |
| Weighted mean | 31.5 | 82.5 |
| Weighted improvement | 51.0 | |
| Lateral decubitus (n = 259) | | |
| Weighted mean | 35.2 | 81.0 |
| Weighted improvement | 45.8 | |
| VAS | | |
| Beach chair (n = 248) | | |
| Weighted mean | 7.1 | 0.78 |
| Weighted improvement | 6.3 | |
| Lateral decubitus (n = 191) | | |
| Weighted mean | 7.8 | 0.94 |
| Weighted improvement | 6.8 | |
| ASES | | |
| Beach chair (n = 140) | | |
| Weighted mean | 32.0 | 89.8 |
| Weighted improvement | 57.8 | |
| Lateral decubitus (n = 116) | | |
| Weighted mean | 36.5 | 91.8 |
| Weighted improvement | 55.3 | |

\(^a\)ASES, American Shoulder and Elbow Surgeons; CMS, Constant-Murley score; PRO, patient-reported outcome; VAS, visual analog scale.
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| TABLE 5 | ROM Results* |
|---------|--------------|
| ROM Parameter | Preoperative, deg | Postoperative, deg |
| External rotation at the side | | |
| Beach chair (n = 547) | | |
| Weighted mean | 13.7 | 50.2 |
| Weighted improvement | 36.4 | |
| Lateral decubitus (n = 411) | | |
| Weighted mean | 15.8 | 58.7 |
| Weighted improvement | 42.8 | |
| Forward flexion | | |
| Beach chair (n = 525) | | |
| Weighted mean | 87.6 | 152.0 |
| Weighted improvement | 64.4 | |
| Lateral decubitus (n = 244) | | |
| Weighted mean | 84.8 | 164.1 |
| Weighted improvement | 79.3 | |
| Abduction | | |
| Beach chair (n = 387) | | |
| Weighted mean | 71.0 | 148.8 |
| Weighted improvement | 77.8 | |
| Lateral decubitus (n = 304) | | |
| Weighted mean | 70.9 | 152.4 |
| Weighted improvement | 81.5 | |
| Internal rotation in 90° of abduction | | |
| Beach chair (n = 145) | | |
| Weighted mean | 14.3 | 55.1 |
| Weighted improvement | 40.8 | |
| Lateral decubitus (n = 180) | | |
| Weighted mean | 16.5 | 62.0 |
| Weighted improvement | 45.5 | |

*ROM, range of motion.

DISCUSSION

The principal findings of this study are as follows: (1) the reported clinical outcomes after ACR are similar for patients undergoing surgery in either the BC or LD position, with no significant differences in ROM findings, PRO scores, or recurrence rates between groups; (2) concomitant MUA is performed more frequently in patients undergoing surgery in the BC versus LD position; and (3) complication rates are higher in patients undergoing surgery in the LD position.

When nonoperative treatment fails, improvements in ROM and pain relief as well as the restoration of normal joint function can be achieved safely and effectively with ACR in either the BC or LD position.\(^{2,4,5,12,18,21,23,26,44}\) However, there is a lack of evidence of the gold standard ACR technique, as the current literature describing outcomes of patients after capsular release is limited to case series or retrospective comparative studies.\(^{12,21}\) With such variability in arthroscopic techniques for capsular release, it is imperative to recognize other variables of surgery, such as the effect of patient positioning. While the benefits and clinical outcomes of both the BC and the LD positions have been discussed and reported in the literature for arthroscopic anterior shoulder stabilization, no studies have compared the outcomes for ACR.\(^{20}\)

There are critical differences between the LD and BC positions. Some of the reasons for preference in patient positioning during arthroscopic shoulder procedures include familiarity with a given setup, cost of the setup, ability of conversion to an open procedure, anesthesia, orientation, visualization, and accessibility.\(^{20}\) ACR in the BC position has been described without direct release of the inferior capsule because of difficult access and proximity of the axillary nerve but instead is addressed with manipulation at the end of the case.\(^{1,12}\) Additionally, there is no consensus about the safety of MUA because of the reported iatrogenic complications, such as hemarthrosis, rotator cuff tendon tears, glenoid labral detachment, glenohumeral ligament ruptures, superior labrum anterior-posterior lesions, and humeral fractures.\(^{20}\) However, the ability to convert to an open procedure when needed may be beneficial for extremely stiff shoulders.\(^{21}\) Conversely, the LD position improves visibility of the anterior, posterior, inferior, and superior aspects of the glenohumeral joint, allowing perhaps easier release of the inferior capsule, which may alleviate the need for concomitant MUA to complete the release.\(^{12,25}\) In this analysis, 0.3% of patients undergoing ACR in the BC position experienced postoperative complications. There was 1 study\(^{36}\) that reported 1 patient experiencing prolonged postoperative pain, which was eventually treated with a corticosterone injection in the subacromial space, and another study\(^{45}\) found 1 patient to experience diffuse brachial plexopathy after arthroscopic release. Otherwise, there were no reports of postoperative complications such as axillary nerve dysfunction, infections, instability, or fractures in any patients undergoing ACR in the BC position. Conversely, postoperative complications occurred in 1.9% of patients undergoing ACR in the LD position, including 1 case of delayed healing of the posterior portal, 1 case of postoperative hematoma,\(^{3}\) 2 cases of radial neurapraxia (which were suggested to have originated during the interscalene anesthetic block), 1 case of axillary neurapraxia (which was suggested to have resulted from manipulation), 2 cases of reflex sympathetic dystrophy, 1 case of rotator cuff injury, 1 case of acromioclavicular pain.\(^{32}\) 1 case of articular cartilage scuffing of the glenoid, and 1 case of articular cartilage scuffing of the humeral head.\(^{34}\) While overall this complication rate is low in the LD position, perhaps the BC position is advantageous in this regard. Notably, the recurrence rates were comparable in both surgical positions, including 2.5% in the BC position and 2.4% in the LD position.

Although statistically insignificant, patients who underwent ACR in the LD position had higher weighted improvements in all ROM parameters than those in the BC position. The presence of higher weighted improvements in ROM in the LD position studies may be attributed to the greater ability to visualize and confidently release the
inferior capsule, eliminating the need for manipulation. This is supported by the finding that significantly more patients underwent associated MUA in the BC group (91.6%) compared with the LD group (63%). Therefore, this may be an important factor for surgeons to consider when performing ACR. However, these trends in ROM are insignificant and are primarily descriptive. Moreover, the weighted improvements in ASES and VAS scores were very similar between the 2 positions.

The exact cause of ACS remains unclear, although it has been associated with diabetes, thyroid diseases, rheumatoid arthritis, Dupuytren disease, trauma, and shoulder surgery.15,21 Cinar et al18 compared the results of ACR in diabetic versus idiopathic patients and found that CMS values were worse in patients with diabetes. The most frequent predisposing factor leading to frozen shoulder is diabetes mellitus, with an incidence of frozen shoulder in patients with diabetes between 10% and 36%.15,21 Despite the lack of significant differences in postoperative outcomes between groups, the causation in the LD versus BC group, particularly the difference in patients with diabetes included, should be considered when interpreting these results.

Limitations

This study is not without limitations. Notably, a majority of the included studies were retrospective cohort studies; therefore, selection bias is a potential confounding factor. In addition, there were multiple causes present in each study that may affect the clinical outcomes, and there was also a high variance of validated outcome scores reported in each study. Because of the inconsistency of reporting outcomes, significant differences were not demonstrated between surgical positions because of the small sample size of patients with overlapping outcomes. It should also be considered that reporting bias may be present throughout the included studies. The heterogeneity between studies is also an appreciable limitation of this review. Follow-up duration was inconsistent, with some studies not providing any information regarding the mean follow-up duration. The surgical technique of capsular release and use of MUA were also inconsistent, and patient demographics varied between studies. The large number of patients in the BC group who were noted as “idiopathic” could be because of poor history taking and/or a lack of inclusion of causation for ACS, which would partially explain the significant increase in patients with diabetes in the LD group. Finally, 10% of the included studies reported conflicts of interest due to financial relationships with supporting institutions, which, although unlikely, may provide the authors with motivation to produce certain results.

CONCLUSION

Low rates of recurrent shoulder stiffness and excellent improvements in ROM can be achieved after ACR in either the LD or BC position. Concomitant MUA is performed more frequently in the BC position compared with the LD position.

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APPENDIX

| TABLE A1 | Table A1 (continued) |
|---|---|
| **Author (Year)** | **MCMS (0-100)** | **Country of Origin** |
| **Beach chair** | | |
| Barnes2 (2016) | 66 | Australia |
| Cinar8 (2010) | 64 | Turkey |
| Diwan16 (2005) | 74 | Australia |
| Elhassan17 (2010) | 59 | USA (MA) |
| Lafortes25 (2012) | 69 | France |
| Lienm (2008) | 69 | Germany |
| Le Lievre26 (2012) | 63 | Australia |
| Mubark3 (2007) | 59 | Egypt |
| Nicholson23 (2003) | 61 | USA (IL) |
| Ranalletta28 (2017) | 78 | Argentina |
| Snow30 (2009) | 61 | UK |
| Warner32 (1996) | 62 | USA (PA) |
| Waszczykowski33 (2014) | 61 | Poland |
| Yamaguchi34 (2002) | 65 | USA (MO) |

(continued)
### TABLE A2
**PRO Scores**

| Author (Year) | n | Preoperative | Postoperative |
|---------------|---|--------------|---------------|
| **CMS**       |   |              |               |
| Beach chair   |   |              |               |
| Cinar* (2010) | 15| 30.4 ± 6.2   | 82.0 ± 18.2   |
| Id: 13        | 13| 29.6 ± 5.8   | 93.6 ± 10.2   |
| Elhassan17 (2010) | 115| 35 | 86 |
| Lafosse25 (2012) | 10| 21 | 72 |
| Liem35 (2008) | 22| 17.7 | 82.8 |
| Mubark33 (2015) | 40| 36.4 ± 8.63 | 85.8 ± 9.31 |
| Ranalletta36 (2017) | 32| 42.4 | 86 |
| Snow40 (2009) | G1: 27 | 20 | 66 |
|                 | G2: 21 | 23 | 71 |
| Weighted mean  | 295| 31.5 | 82.5 |
| Weighted improvement | 51.0 | |
| **Lateral decubitus** | | | |
| Berghs4 (2004) | 25| 25.3 | 75.5 |
| Chen* (2010) | G1: 41 | 36 | 86 |
|                 | G2: 29 | 38 | 88 |
| De Carli14 (2012) | 23| 37.5 | 91.2 |
| Gerber22 (2001) | 45| 33.3 | 65.5 |
| Mehta30 (2014) | DM: 21 | 36.6 | 84.4 |
|                 | Id: 21 | 38.4 | 88.6 |
| Mukherjee34 (2017) | 28| 29.5 ± 6.2 | 70.2 ± 12.1 |
| Tsai41 (2017) | 26| 44 | 91 |
| Weighted mean  | 259| 35.2 | 81.0 |
| Weighted improvement | 45.8 | |
| **VAS**       |   |              |               |
| Beach chair   |   |              |               |
| Elhassan17 (2010) | 115| 7.5 | 1 |
| Lafosse25 (2012) | 10| 7 | 1.6 |
| Nicholson35 (2003) | 68| 6 | 0 |
| Ranalletta36 (2017) | 32| 7.4 | 1.1 |
| Yamaguchi45 (2002) | 23| 8.1 | 1.2 |
| Weighted mean  | 248| 7.1 | 0.78 |
| Weighted improvement | 6.3 | |
| **ASES**      |   |              |               |
| Beach chair   |   |              |               |
| Liem35 (2008) | 22| 23.5 ± 14.3 | 76.8 ± 19.2 |
| Nicholson35 (2003) | 68| 35.5 | 93 |
| Waszczynski43 (2014) | 27| 25.6 | 91.2 |
| Yamaguchi45 (2002) | 23| 37.1 | 90.9 |
| Weighted mean  | 140| 32.0 | 89.8 |
| Weighted improvement | 57.8 | |
| **(continued)** | |

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**Table A2 (continued)**

| Author (Year) | n | Preoperative, deg | Postoperative, deg |
|---------------|---|-------------------|--------------------|
| **CMS**       |   |                   |                    |
| Tsai41 (2017) | 26| 38 | 90 |
| Weighted mean  | 116| 36.5 | 91.8 |
| Weighted improvement | 55.3 | |
| **Lateral decubitus** | | | |
| Baums3 (2007) | 30| 7 | 2 |
| Chen* (2010) | G1: 41 | 8.4 ± 1.04 | 0 |
|                 | G2: 29 | 8.6 ± 0.98 | 0 |
| Cho7 (2016) | DM: 17 | 7.0 ± 1.8 | 0.5 ± 1.3 |
|                 | Id: 20 | 7.4 ± 1.5 | 0.5 ± 1.0 |
| Mukherjee34 (2017) | 28| 7.1 ± 1.8 | 2.0 ± 1.7 |
| Tsai41 (2017) | 26| 8.2 | 1.7 |
| Weighted mean  | 191| 7.8 | 0.94 |
| Weighted improvement | 6.8 | |
| **VAS**       |   |                   |                    |
| Beach chair   |   |                   |                    |
| Baums3 (2007) | 30| 10 | 60 |
| Berghs4 (2004) | 25| 10.6 | 46.8 |
| Chen* (2010) | G1: 41 | 5 | 77 |
|                 | G2: 29 | 6 | 77 |
| Cho5 (2016) | DM: 17 | 15.0 ± 11.9 | 65.9 ± 6.2 |
|                 | Id: 20 | 15.3 ± 10.3 | 65.8 ± 9.1 |
| Cvetanovich12 (2018) | 27| 28.1 ± 16.3 | 56.8 ± 15.7 |
| De Carli14 (2012) | 23| 20 | 40 |
| Fernandes15 (2013) | 18| 21.9 | 64.4 |
| Fernandes19 (2015) | 10| 10.5 | 40 |
| Gerber22 (2001) | 45| 13.6 | 31.4 |
| Mehta30 (2014) | DM: 21 | 15.8 ± 15.1 | 58 ± 7.8 |
|                 | Id: 21 | 16.6 ± 14.2 | 68 ± 8.1 |
| Miyazaki32 (2017) | 56| 16 | 57 |
| Mukherjee34 (2017) | 28| 39.1 ± 6.2 | 73.4 ± 14.2 |
| Weighted mean  | 411| 15.8 | 58.7 |
| Weighted improvement | 42.8 | |

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**Table A3**

**Range of Motion Results: External Rotation at the Side**

| Author (Year) | n | Preoperative, deg | Postoperative, deg |
|---------------|---|-------------------|--------------------|
| **CMS**       |   |                   |                    |
| Tsai41 (2017) | 26| 38 | 90 |
| Weighted mean  | 116| 36.5 | 91.8 |
| Weighted improvement | 55.3 | |
| **Lateral decubitus** | | | |
| Baums3 (2007) | 30| 35 | 91 |
| De Carli14 (2012) | 23| 48.6 | 88.3 |
| Cho5 (2016) | DM: 17 | 28.1 ± 14.9 | 95.0 ± 8.2 |
|                 | Id: 20 | 30.0 ± 15.4 | 96.7 ± 6.1 |

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*Data are reported as mean ± SD (when available). ASES, American Shoulder and Elbow Surgeons; CMS, Constant-Murley score; DM, diabetes mellitus; G1, group 1; G2, group 2; Id, idiopathic; PRO, patient-reported outcome; VAS, visual analog scale."
### TABLE A4
Range of Motion Results: Forward Flexion

| Author (Year) | n | Preoperative, deg | Postoperative, deg |
|---------------|---|-------------------|--------------------|
| **Beach chair** | | | |
| Barnes² (2016) | 140 | 96 ± 33 | 156 ± 29 |
| Cinar² (2010) | | 75.3 ± 23.9 | 141.0 ± 19.8 |
| Id: 13 | | 69.2 ± 21.5 | 153.1 ± 19.3 |
| Diwan¹⁶ (2005) | ACR-S: 22 | 78 | 121 |
| ACR-M: 18 | | 97 | 150 |
| Elhassan¹⁷ (2010) | 115 | 97 | 134 |
| Lafosse²⁵ (2012) | 10 | 55 | 175 |
| Liem²⁸ (2008) | 22 | 76 ± 40 | 155 ± 26 |
| Mubark³³ (2015) | 40 | 95 | 160 |
| Ranalletta³⁶ (2017) | 32 | 78.2 ± 18.1 | 171.2 ± 6.2 |
| Snow⁴⁰ (2009) | G1: 27 | 65 | 175 |
| G2: 21 | | 64 | 173 |
| Warner⁴² (1996) | 23 | 91 | 140 |
| Waszczykowski⁴³ (2014) | 27 | 81.9 | 166.3 |
| **Weighted mean** | 525 | 87.6 | 152.0 |
| **Weighted improvement** | | | 64.4 |

**Lateral decubitus**

| Author (Year) | n | Preoperative, deg | Postoperative, deg |
|---------------|---|-------------------|--------------------|
| Chen⁶ (2010) | G1: 41 | 74 | 171 |
| G2: 29 | | 75 | 174 |
| Cho⁷ (2016) | DM: 17 | 90.0 ± 23.2 | 168.8 ± 4.9 |
| Id: 20 | | 95.0 ± 20.6 | 169.5 ± 2.2 |
| De Carli¹⁴ (2012) | 23 | 75 | 174 |
| Fernandes¹⁸ (2013) | 18 | 103.3 | 153.8 |
| Mehta³⁰ (2014) | DM: 21 | 78.1 ± 18.4 | 165.2 ± 10.8 |
| Id: 21 | | 80.2 ± 20.1 | 173.2 ± 6.2 |
| Mukherjee³⁴ (2017) | 28 | 99.8 ± 13.4 | 152.9 ± 14.6 |
| Segmuller³⁹ (1995) | 26 | 90 ± 22 | 137 ± 28 |
| Weighted mean | 244 | 84.8 | 164.1 |
| **Weighted improvement** | | | 79.3 |

*Data are reported as mean ± SD (when available). ACR-M, arthroscopic capsular release–modified; ACR-S, arthroscopic capsular release–standard; DM, diabetes mellitus; G1, group 1; G2, group 2; Id, idiopathic.

### TABLE A5
Range of Motion Results: Abduction

| Author (Year) | n | Preoperative, deg | Postoperative, deg |
|---------------|---|-------------------|--------------------|
| **Beach chair** | | | |
| Barnes² (2016) | 140 | 74 ± 31 | 144 ± 38 |
| Cinar² (2010) | DM: 15 | 56.3 ± 24.0 | 128.3 ± 28.0 |
| Id: 13 | | 66.5 ± 27.5 | 153.0 ± 22.1 |
| Diwan¹⁶ (2005) | ACR-S: 22 | 74 | 114 |
| ACR-M: 18 | | 86 | 146 |
| Lafosse²⁵ (2012) | 10 | 40 | 165 |
| Liem²⁸ (2008) | 22 | 66 ± 31 | 142 ± 43 |
| Mubark³³ (2015) | 40 | 85 | 155 |
| Ranalletta³⁶ (2017) | 32 | 74.5 ± 12.3 | 164.2 ± 8.2 |

*Data are reported as mean ± SD (when available). ACR-M, arthroscopic capsular release–modified; ACR-S, arthroscopic capsular release–standard; DM, diabetes mellitus; G1, group 1; G2, group 2; Id, idiopathic.

### TABLE A6
Range of Motion Results: Internal Rotation in 90° of Abduction

| Author (Year) | n | Preoperative, deg | Postoperative, deg |
|---------------|---|-------------------|--------------------|
| **Beach chair** | | | |
| Cinar² (2010) | DM: 15 | 15.3 ± 5.2 | 34.7 ± 24.7 |
| Id: 13 | | 14.6 ± 11.3 | 67.7 ± 4.4 |
| Liem²⁸ (2008) | 22 | 33 ± 23 | 64 ± 10 |
| Mubark³³ (2015) | 40 | 5 | 55 |
| Ranalletta³⁶ (2017) | 32 | 15.6 ± 14.2 | 62.2 ± 10.1 |
| Warner⁴² (1996) | 23 | 10 | 43 |
| Weighted mean | 145 | 14.3 | 55.1 |
| **Weighted improvement** | | | 40.8 |

**Lateral decubitus**

| Author (Year) | n | Preoperative, deg | Postoperative, deg |
|---------------|---|-------------------|--------------------|
| Castellarin¹ (2004) | 40 | 10 | 40 |
| Chen⁷ (2010) | G1: 41 | 15 | 79 |
| G2: 29 | | 16 | 82 |
| Mehta³⁰ (2014) | DM: 21 | 15.6 ± 11.9 | 56.7 ± 9.2 |
| Id: 21 | | 16.7 ± 12.2 | 64.2 ± 10.1 |
| Mukherjee³⁴ (2017) | 28 | 28.9 ± 6.4 | 50.4 ± 7.5 |
| Weighted mean | 180 | 16.5 | 62.0 |
| **Weighted improvement** | | | 45.5 |

*Data are reported as mean ± SD (when available). DM, diabetes mellitus; G1, group 1; G2, group 2; Id, idiopathic.