Open Versus Arthroscopic Latarjet for Recurrent Anterior Shoulder Instability

A Systematic Review and Meta-analysis

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Background: The open Latarjet (OL) procedure and arthroscopic Latarjet (AL) procedure are able to treat recurrent anterior shoulder instability (RASI) with high success rates.

Purpose: To evaluate the clinical efficacy and postoperative revisions and complications between the OL and AL procedures in the treatment of RASI.

Study Design: Systematic review; Level of evidence, 3.

Methods: MEDLINE, Embase, and the Cochrane Library were searched to retrieve and include cohort studies comparing the OL and AL procedures for RASI. Clinical outcomes were compared, and results were reported as odds ratios (ORs) or mean differences (MDs) with 95% CIs.

Results: Eleven clinical trials with 1217 patients were included. There were no differences between the procedures in pain score, Rowe score, Walch-Duplay score, external rotation, persistent apprehension, instability, recurrence, revisions attributed to recurrent instability, overall complications, wound infection, hematoma, graft complications, screw-related complications, or osteoarthritis. When compared with the OL procedure, the AL procedure had a significantly lower nonunion rate (OR, 9.92; 95% CI, 1.71 to 57.71; $P = .01$); however, the AL procedure had a longer operation time (MD, –24.49; 95% CI, –48.44 to –0.54; $P = .05$), lower Western Ontario Shoulder Instability Index score (MD, 97.27; 95% CI, 21.91 to 172.63; $P = .01$), higher revision rate (OR, 0.39; 95% CI, 0.16 to 0.95; $P = .04$), and greater screw deviation (MD, –6.41; 95% CI, –10.25 to –2.57; $P = .001$).

Conclusion: For most outcome measures, no difference was seen between the OL and AL procedures. The AL procedure had a lower Western Ontario Shoulder Instability Index score and a higher revision rate and appeared to have a significant learning curve. However, the AL procedure resulted in a lower nonunion rate.

Keywords: open Latarjet; arthroscopy; anterior shoulder instability; meta-analysis

The Latarjet procedure, named after its inventor, Dr Michel Latarjet,[23] was first proposed in 1954; then in 1958, Helfet[12] described a similar procedure that he attributed to Bristow. Since then, clinicians often use the term "Bristow-Latarjet procedure" to describe this coracoid osteotomy and transfer surgery. The principle of the Latarjet procedure is to transfer the coracoid bone block with the conjoint tendon to the anterior and inferior glenoid through the split window of the subscapularis. Upon completion of the surgery, the unstable shoulder joint can be enhanced by combined effects, including increased glenoid width, increased tension in the lower third of the subscapularis, as well as the sling effect of the conjoint tendon at the abduction and external rotation position.[24]

After decades of clinical practice, the Latarjet procedure has been proven to be an effective and reliable procedure for the treatment of recurrent anterior shoulder instability (RASI), especially for patients with glenoid bone loss or bipolar bone loss (humeral head and glenoid) or anterior irreparable capsular ligament injury, and to serve as a salvage procedure in the setting of failed primary soft tissue repair.[33,35] However, concerns have been raised regarding the potential complications with this procedure, including nonunion, infection, and hardware problems. According to the relevant reports, the overall postoperative complication rate of the Latarjet procedure is about 15%.[6,11,25]

With the improvements in arthroscopic techniques, Dumont et al[8] and Lafosse et al[22] made the earliest attempt

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of an arthroscopic Latarjet (AL) procedure and achieved satisfactory clinical outcomes. Nowadays, an increasing number of open Latarjet (OL) procedures are being performed arthroscopically. Growing evidence has indicated that the AL procedure is able to achieve similar clinical results to the OL procedure with advantages of smaller incisions, fewer complications, faster bone graft healing, quicker rehabilitation, and the ability to address other shoulder pathologies at the same time.[4,11] However, there have been concerns about the learning curve of the technically challenging AL procedure, which may lead to a higher complication rate owing to the difficulty of bone graft positioning and screw orientation under arthroscopy.[2,33]

To date, few systematic reviews have been conducted on cohort studies comparing the OL procedure with the AL procedure for the treatment of RASI.[14,17,30] Some reviews have been confined to the description of results without data comparison.[14,30] A 2019 systematic review and meta-analysis included only 6 studies with small sample sizes.[17]

With accumulation of emerging evidence, the aim of this study was to conduct a quantitative meta-analysis of cohort studies comparing the OL and AL procedures for the treatment of RASI to evaluate clinical outcomes and complications. Our hypothesis was that the AL would result in similar clinical outcomes to the OL.

METHODS

Search Strategy

This quantitative meta-analysis was performed in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines and Assessing the Methodological Quality of Systematic Reviews guidelines.[29] Two investigators (Z.D. and Y.Z.) searched the MEDLINE/PubMed database, the Cochrane Library, and the Embase database from inception to July 2022 to identify relevant studies that compared the OL procedure with the AL procedure for the treatment of RASI. The search terms included "Latarjet," "open," "arthroscopic," and "arthroscopy," which were combined using the Boolean operators AND or OR. No restrictions were imposed, and the reference lists of retrieved articles and reviews were also screened. A third investigator (Y.L.) acted as the judge if there was any disagreement.

Eligibility Criteria

The inclusion criteria were as follows: (1) clinical studies, including randomized controlled trials (RCTs), prospective cohort studies, retrospective cohort studies, and case-control studies, comparing the clinical outcomes of the OL procedure with the AL procedure; (2) publication in a peer-reviewed journal; (3) full text of studies available; and (4) English language. The exclusion criteria were as follows: (1) incomplete data; (2) letters, comments, editorials, case reports, conference abstracts, or review articles; (3) cadaveric or biomechanical studies; and (4) free bone block transfer procedures that did not include coracoid with an attached conjoint tendon sling.

Data Extraction

The relevant data were extracted from the studies by using a standard data extraction form. Two investigators (Z.D. and Y.Z.) collected the desired information independently. The main characteristics were as follows: first author's name, publication year, country, sample size, mean age, sex, duration from first dislocation to surgery, follow-up, study design, and level of evidence.

Methodological Quality of Evidence

The methodological quality of evidence of the studies was evaluated with the Newcastle-Ottawa Scale (NOS),[34] which is a 9-point scale covering the selection of the study population, comparability between study groups, and measurement of exposure factors. Scores are graded as excellent (7-9), good (5-6), satisfactory (4), or unsatisfactory (0-3).

Meta-analysis of Outcomes

The outcomes measured focused on the following items:

- Operation time
- Postoperative pain based on the visual analog scale (VAS) score
- Functional outcomes: Rowe score, Walch-Duplay score, Western Ontario Shoulder Instability Index (WOSI) score, and range of motion in external rotation

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- Shoulder stability: persistent apprehension (noted on physical examination), overall postoperative instability (including all incidences of recurrent dislocations or subluxations), recurrence rate for complete dislocation, overall revision rate, revisions attributed to recurrent instability, and screw divergence (alpha angle: formed by the tangent to the glenoid and the line joining the centers of the heads of the screws in the bone block measured on the same anteroposterior radiograph[26])
- Complications: overall complication rate, nonunion, wound infection, hematoma, graft resorption, graft complications, screw complications (eg, breakage, backing out), and osteoarthritis (OA)

Statistical Analysis

All statistical analyses were performed using Review Manager (for Macintosh, Version 5.3; Nordic Cochrane Centre; Cochrane). The heterogeneity among studies was quantified using the I^2 statistic.[13] If the heterogeneity was low ($P > 0.1$; $I^2 < 50\%$), a fixed-effect model was used; otherwise, a random-effect model was used. When possible, sensitivity and subgroup analyses were conducted to identify the source of heterogeneity. Publication bias was visually examined by funnel plots. When the range was given instead of the standard deviation, the method of Hozo et al[15] was used to calculate the standard deviation. Results were reported as odds ratios (ORs) for dichotomous outcomes and as mean differences (MDs) for continuous outcomes, with a 95% CI. $P < .05$ was considered statistically significant.

RESULTS

Search Results

The initial literature search ended up with 426 studies. After removal of duplicates, the remaining articles were screened by inclusion and exclusion criteria, and 232 studies were evaluated by full text for assessment of eligibility. This review included a total of 11 clinical trials (12 articles; the Kordasiewicz et al[20,21] study was published in 2 parts) (Figure 1).[¶]

Study Characteristics

Demographic characteristics and other details of the studies are summarized in Table 1. The 11 studies were performed in 7 countries, involving 1217 participants: 579 treated with the OL procedure and 638 treated with the AL procedure. The age, sex ratio, and instability measures of the patients were similar between the cohorts at baseline ($P > .05$). The 11 studies included 6 prospective cohort studies (level 2 evidence) and 5 retrospective cohort studies (level 3 evidence). The NOS scores of the studies indicated excellent quality of evidence (for NOS scoring details, see Supplemental Table S1, available separately).

[¶]References 1, 3, 5, 16, 18, 21, 26-28, 31, 36.

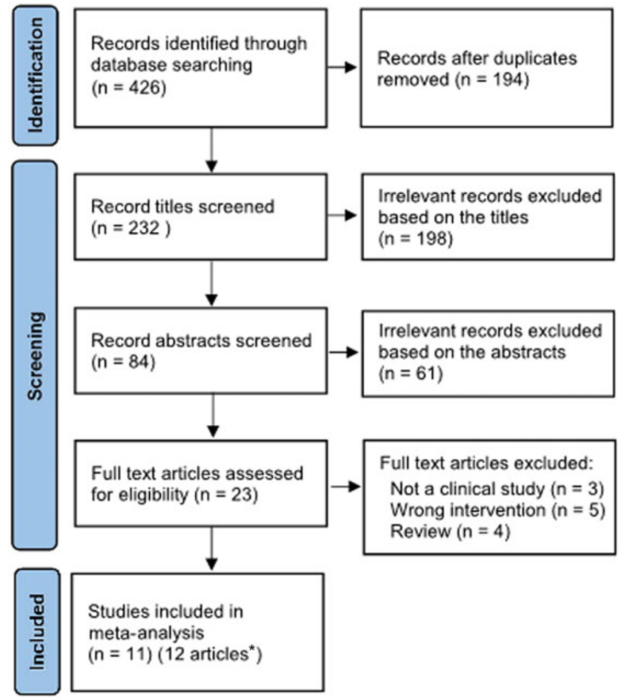

Figure 1. Flowchart of study selection. *One study was published in 2 parts.

Results of Meta-analyses

The results of the meta-analysis are summarized in Table 2. The forest plots for all analyses can be found in the Supplemental Material (available separately).

Operation Time and Postoperative Pain. The operation time was reported in 4 studies[5,21,26,36] consisting of 150 OL procedures and 172 AL procedures. With the OL procedure, the mean operation time was 93.3 minutes; with the AL procedure, the mean operation time was 112.3 minutes. Based on the heterogeneity, the random-effect model was used for analysis ($I^2 = 93\%$; $P < .00001$). The AL procedure required a longer operation time than the OL procedure, with the difference approaching significance (MD, –24.49; 95% CI, –48.44 to –0.54; P = .05).

The VAS score for pain was reported in 5 studies[1,16,21,26,28] at the last follow-up, but the Nourissat et al[28] study was excluded, as the mean VAS scores were presented without standard deviations or ranges. There were 157 OL procedures and 161 AL procedures in the remaining 4 studies. The random-effect model was used for analysis ($I^2 = 85\%$; $P = .0002$). There was no statistically significant difference in VAS score between the procedures at the last follow-up (MD, 0.36; 95% CI, –0.75 to 1.46; $P = .52$).

Functional Outcomes. The Rowe score was reported in 4 studies[1,3,21,36] consisting of 129 OL procedures and 158 AL procedures. The random-effect model was used for analysis

TABLE 1
Characteristics of the Studies Included in This Systematic Review and Meta-analysis[a]

Lead Author (Year)	Country	No. of Patients (M:F)	Age, y,	Time to Surgery, mo	Follow-up, mo	Study Design	LOE	NOS Score
Ali (2020)[1]	Turkey	OL: 15 (12:3) AL: 33 (29:4)	OL: 28 ± 10 AL: 30 ± 7	NA	OL: 30.5 (24-45) AL: 30.4 (24-50)	RCS	3	9
Bonnevialle (2021)[3]	France	OL: 22 (21:1) AL: 17 (14:3)	OL: 21.2 ± 4.8 AL: 22.3 ± 5.3	NA	12	RCS	3	9
Cunningham (2016)[5]	Switzerland	OL: 36 (34:2) AL: 28 (24:4)	OL: 25.0 ± 9.2 AL: 26.0 ± 7.6	OL: 9 AL: 12	OL: 6.3 ± 7.0 AL: 7.0 ± 4.6	PCS	2	8
Hurley (2021)[16]	USA	OL: 72 (32:40) AL: 30 (25:5)	OL: 30 ± 10.5 AL: 32 ± 12.3	NA	OL: 53.9 ± 27 AL: 46.2 ± 26	RCS	3	8
Hurley (2021)[18]	USA	OL: 110 (95:15) AL: 40 (34:6)	OL: 30.7 ± 11.5 AL: 28.4 ± 9.6	NA	3	RCS	3	8
Kordasiewicz (2018, 2017)[20,21,b]	Poland	OL: 48 (45:2) AL: 62 (55:7)	OL: 28 (18-59) AL: 26 (16-44)	OL: 49.9 (6-180) AL: 57.5 (4-228)	OL: 54.2 AL: 23.4	RCS	3	8
Marion (2017)[26]	France	OL: 22 (16:6) AL: 36 (29:7)	OL: 26.7 ± 7.8 AL: 27.3 ± 7.5	NA	29.8 ± 4.4	PCS	2	9
Metais (2016)[27]	France	OL: 104 (NA) AL: 222 (NA)	26.0 ± 8.9	NA	22.7 ± 4.1	PCS	2	7
Nourissat (2016)[28]	France	OL: 85 (NA) AL: 99 (NA)	NA	NA	12	PCS	2	8
Russo (2017)[31]	Italy	OL: 21 (NA)[c] AL: 25 (NA)[c]	NA	NA	12	PCS	2	7
Zhu (2017)[36]	China	OL: 44 (32:12) AL: 46 (36:10)	OL: 34.8 ± 11.5 AL: 32.1 ± 10.3	OL: 36.5 ± 50.0 AL: 45.0 ± 122.0	>24	PCS	2	8

[a]AL, arthroscopic Latarjet; F, female; LOE, level of evidence; M, male; NA, not available; NOS, Newcastle-Ottawa Scale; OL, open Latarjet; PCS, prospective cohort study; RCS, retrospective cohort study.
[b]Study published in 2 parts.
[c]Overall: 43 male and 3 female patients.

TABLE 2
Results of Meta-analyses of Outcome Measures[a]

Outcome Measure	No. of Studies	No. of Patients	OR or MD (95% CI)	I^2, %	*P*
Operation time	4	322	–24.49 (48.44 to –0.54)	93	.05
VAS score	4	318	0.36 (–0.75 to 1.46)	85	.52
Functional outcomes					
Rowe score	4	287	0.75 (–3.68 to 5.18)	78	.74
Walch-Duplay score	2	149	2.93 (–5.30 to 11.16)	58	.48
WOSI score	2	106	97.27 (21.91 to 172.63)	35	.01 [b]
External rotation	4	303	6.23 (–2.47 to 14.93)	76	.16
Shoulder stability					
Persistent apprehension	5	638	0.58 (0.16 to 2018)	65	.42
Instability	8	948	0.99 (0.39 to 2.53)	0	.98
Recurrence rate	5	414	1.04 (0.30 to 3.66)	0	.95
Overall revision rate	5	586	0.39 (0.16 to 0.95)	0.85	.04 [b]
Revisions due to recurrent instability	6	472	1.27 (0.45 to 3.54)	0	.65
Screw divergence (alpha angle)	5	306	–6.41 (–10.25 to –2.57)	67	.001 [b]
Complications					
Overall complications rate	7	858	1.10 (0.70 to 1.74)	9	.67
Nonunion	3	204	9.92 (1.71 to 57.71)	0	.01 [b]
Wound infection	3	540	1.08 (0.32 to 3.64)	0	.90
Hematoma	2	390	3.69 (0.60 to 22.82)	0	.16
Graft resorption	2	158	2.63 (0.07 to 97.33)	65	.60
Graft complications	6	756	0.69 (0.15 to 3.24)	57	.64
Screw complications	3	432	0.86 (0.28 to 2.65)	0	.80
Osteoarthritis	2	94	2.25 (0.63 to 7.99)	0	.21

[a]MD, mean difference; OR, odds ratio; VAS, visual analog scale; WOSI, Western Ontario Shoulder Instability Index.
[b]Significant differences.

(I^2 = 78%; P = .004). There was no statistically significant difference in Rowe score between the procedures at the last follow-up (MD, 0.75; 95% CI, –3.68 to 5.18; P = .74).

The Walch-Duplay score was reported in 4 studies,[3,5,21,28] but 2 studies[5,28] were excluded because their Walch-Duplay scores were presented without standard deviations or ranges. There were 70 OL procedures and 79 AL procedures in the remaining 2 studies.[3,21] The random-effect model was used for analysis (I^2 = 58%; P = .12). There was no statistically significant difference in Walch-Duplay score between the procedures at the last follow-up (MD, 2.93; 95% CI, –5.30 to 11.16; P = .48).

The WOSI score was reported in 3 studies,[1,26,28] but the study of Nourissat et al[28] was excluded because its WOSI score was presented in the form of percentage, which was different from the other 2 studies, without a standard deviation or range. There were 37 OL procedures and 69 AL procedures in the remaining 2 studies. The fixed-effect model was used for analysis owing to low heterogeneity (I^2 = 35%; P = .21). The OL procedure achieved a higher WOSI score than the AL procedure at the last follow-up (MD, 97.27; 95% CI, 21.91-172.63; P = .01).

External rotation range of motion at the final follow-up was reported in 4 studies[3,5,21,36] consisting of 150 OL procedures and 153 AL procedures. The random-effect model was used for analysis (I^2 = 76%; P = .006). There was no statistically significant difference in external rotation between the procedures at the last follow-up (MD, 6.23; 95% CI, –2.47 to 14.93; P = .16).

Shoulder Stability. Persistent apprehension at the last follow-up was reported in 5 studies[1,5,21,27,36] consisting of 247 OL procedures and 391 AL procedures. The random-effect model was used for analysis (I^2 = 65%; P = .03). There was no statistically significant difference in persistent apprehension between the procedures at the last follow-up (OR, 0.58; 95% CI, 0.16-2.18; P = .42).

Postoperative instability at the last follow-up was reported in 8 studies[1,5,16,18,21,26,27,36] consisting of 451 OL procedures and 497 AL procedures. The fixed-effect model was used for analysis (I^2 = 0%; P = .90). There was no statistically significant difference in postoperative instability between the procedures at the last follow-up (OR, 0.99; 95% CI, 0.39-2.53; P = .98).

The recurrence rate was reported in 5 studies[1,5,16,21,36] consisting of 215 OL procedures and 199 AL procedures. The fixed-effect model was used for analysis (I^2 = 0%; P = .71). There was no statistically significant difference in recurrent rate between the procedures at the last follow-up (OR, 1.04; 95% CI, 0.30-3.66; P = .95).

The overall revision rate at the last follow-up was reported in 5 studies[1,5,21,26,27] consisting of 225 OL procedures and 361 AL procedures. The fixed-effect model was used for analysis (I^2 = 0%; P = .85). The overall revision rate at the final follow-up was significantly higher in AL procedures than in OL procedures (OR, 0.39; 95% CI, 0.16-0.95; P = .04).

The revisions attributed to recurrent instability at the last follow-up were reported in 6 studies[1,5,16,21,26,36] consisting of 237 OL procedures and 235 AL procedures. The fixed-effect model was used for analysis (I^2 = 0%; P = .74). There was no statistically significant difference in revisions attributed to recurrent instability between the procedures at the last follow-up (OR, 1.27; 95% CI, 0.45-3.54; P = .65).

The alpha angle at the last follow-up was reported in 5 studies[1,5,26,31,36] consisting of 138 OL and 168 AL procedures. The random-effect model was used for analysis (I^2 = 67%; P = .02). The alpha angle in OL procedures was significantly smaller than that in AL procedures postoperatively (MD, –6.41; 95% CI, –10.25 to –2.57; P = .001), indicating more parallel screw placement in the OL procedures.

Complications. The overall postoperative complication rate was reported in 7 studies[1,5,16,18,21,26,27] consisting of 407 OL procedures and 451 AL procedures. The fixed-effect model was used for analysis (I^2 = 9%; P = .36). There was no statistically significant difference in overall complications rate between the procedures at the last follow-up (OR, 1.10; 95% CI, 0.70-1.74; P = .67). Subgroup analysis was conducted given the involvement of different complications, such as instability and nonunion.

Nonunion at the last follow-up was reported in 3 studies[1,21,31] consisting of 84 OL procedures and 120 AL procedures. The fixed-effect model was used for analysis (I^2 = 0%; P = .61). The postoperative nonunion rate was significantly higher in OL procedures than in AL procedures (OR, 9.92; 95% CI, 1.71-57.71; P = .01).

Postoperative wound infection was reported in 3 studies[5,18,27] consisting of 250 OL procedures and 290 AL procedures. The fixed-effect model was used for analysis (I^2 = 0%; P = .90). There was no statistically significant difference in wound infection between the procedures (OR, 1.08; 95% CI, 0.32-3.64; P = .90).

Postoperative hematoma was reported in 2 studies[5,27] consisting of 140 OL procedures and 250 AL procedures. The fixed-effect model was used for analysis (I^2 = 0%; P = .33). There was no statistically significant difference in hematoma between the procedures (OR, 3.69; 95% CI, 0.60-22.82; P = .16).

The graft resorption at the last follow-up was reported in 2 studies[1,21] consisting of 63 OL procedures and 95 AL procedures. The random-effect model was used for analysis (I^2 = 65%; P = .09). There was no statistically significant difference in graft resorption between the procedures (OR, 2.63; 95% CI, 0.07-97.33; P = .60).

Graft complications at the last follow-up were reported in 6 studies[1,5,18,21,26,27] consisting of 335 OL procedures and 421 AL procedures. The random-effect model was used for analysis (I^2 = 57%; P = .04). There was no statistically significant difference in graft complications between the procedures (OR, 0.69; 95% CI, 0.15-3.24; P = .64).

Screw complications at the last follow-up were reported in 3 studies[1,26,27] consisting of 141 OL and 291 AL procedures. The fixed-effect model was used for analysis (I^2 = 0%; P = .76). There was no statistically significant difference in screw complications between the procedures (OR, 0.86; 95% CI, 0.28-2.65; P = .80).

OA at the last follow-up was reported in 2 studies[1,31] consisting of 36 OL procedures and 58 AL procedures. The fixed-effect model was used for analysis (I^2 = 0%; P = .51). There was no statistically significant difference in

OA between the procedures (OR, 2.25; 95% CI, 0.63-7.99; *P* = .21).

DISCUSSION

The results of this meta-analysis indicate that the OL and AL procedures had similar outcomes regarding aspects of postoperative pain, function, and complications. However, when compared with OL, AL had a lower nonunion rate but a longer operation time, a lower WOSI score, a higher overall revision rate, and greater screw divergence. In contrast, Hurley et al[17] reported lower persistent apprehension in OL but no statistically significant difference in overall revision rate and operation time. We have included all their studies and added more studies, and the conclusions are more convincing theoretically.

Theoretically, minimally invasive arthroscopic surgery is less painful for patients in the short term postoperatively. Yet, few studies reported the pain sores immediately after surgery and in the short term. Only the VAS score at the final follow-up was compared, and there was no difference concerning postoperative pain in the long term. Three functional scoring systems were used for the comparison between the OL procedure and AL procedure, and no differences were found in Rowe score and Walch-Duplay score. The WOSI score was presented in the form of a questionnaire, which is the patient's subjective evaluation of the stability of the shoulder joint, without a doctor's physical examination. No dislocation is regarded as stable, which reduces the interference of the evaluator's subjective judgment. The WOSI score is reliable for evaluating the stabilization of the shoulder joint postoperatively, and it has been proven to be more sensitive than the Walch-Duplay score in assessing patient satisfaction.[19] However, just 2 cohorts[1,26] were included for analysis. Based on the small sample size and a relative low evidence level, the conclusion that the OL procedure is superior in WOSI score to the AL procedure may be not that affirmative. Both procedures achieved satisfactory functional outcomes with a similar range of motion at the last follow-up.

The position of the bone graft has a great influence on the postoperative clinical outcome, recurrence rate, and complication rate. If the bone graft is too lateral or surpasses the glenoid surface, the incidence of postoperative shoulder joint OA will increase significantly. Yet, if the bone graft is too medial, it will increase the risk of postoperative recurrence and dislocation.[9] There is no evidence supporting that either the OL procedure or the AL procedure has a better bone graft position.[5,7] Actually, it is difficult to define the optimal bone graft position, and its description varies among studies. In view of the differences in definition and standard, the optimal bone graft was not analyzed in this meta-analysis.[31]

Our study showed that screw orientation (alpha angle) after the OL procedure was more ideal as compared with the AL procedure. If the alpha angle is too large, the screw will not be able to remain parallel to the articular surface, thereby leading to unbalanced internal and external pressure of the bone graft and possibly resulting in a higher risk of bone graft nonunion. This may explain the higher overall revision rate in the AL procedure, although a lower nonunion rate was found for the AL procedure. It is possible that the arthroscopic technique could be less aggressive for graft-healing potential, but it also could be related to a surgeon's learning curve in the open procedure. This could be an effect of graft preparation and fixation during the arthroscopic procedure, but this conclusion needs more investigation. Besides, only 1 study mentioned nerve injury: suprascapular nerve in 2 patients and musculocutaneous nerve in 1. All happened in the AL group.[27] Because of the limited data, we could not get any confirmed conclusion from a single study.

Although the OL procedure is featured with multiple merits, its drawbacks, such as a larger incision and a higher nonunion rate, should not be ignored. Arthroscopic surgery has a lower nonunion rate and the potential advantage of a faster recovery. The drawbacks of the AL procedure are also obvious. It takes more operation time and a longer learning curve for the surgeon. Learning curve analysis proved that the early group (first 25 cases of AL in a consecutive series of 103 shoulders) had longer operating times and greater rates of complications than the latter group (25 patients), and it was consistent with our results, which might be the cause of higher revision surgery for the AL procedure.[2] Valsamis et al[32] found that specialist shoulder surgeons required 30 to 50 AL procedures to attain steady-state operative efficiency, during which there would be improvement in bone graft positioning. Only surgeons who are expected to undertake the AL in high volume should consider adopting this procedure.[10,32] Besides, the direct costs of the AL procedure have been shown to be double that of the OL procedure (€2335 vs €1040).[30] The economic factor is also one to consider when the surgeon needs to make a decision on the selection of surgical method.

Limitations

The limitations of the present meta-analysis should be acknowledged. First, all 11 studies were cohort studies with a relatively low level of evidence and a small sample size, which can introduce potential biases for meta-analysis. Second, some data were missing or could not be extracted. Parts of the results appeared to be heterogeneous and were not able to be eliminated by sensitivity or subgroup analyses. In this meta-analysis, we included only high-quality studies and applied the random-effect model for meta-analysis, which might mildly influence the reliability of the results. Third, the follow-up time varied among studies; therefore, only data of the last follow-up were extracted for analysis. Moreover, many of the studies had a mean follow-up <2 years,[3,5,18,27,28,31] and some indexes that might change in long-term results, such as OA, showed no statistical differences in the current results. Besides, surgeons performing the AL technique were high-volume experienced surgeons. Also, many of the forest plots had very small numbers of studies (2 in some instances). Large, well-designed RCTs are still needed to validate the findings of this research.

CONCLUSION

The OL procedure and AL procedure showed comparable clinical results. The OL procedure has better screw orientation and a lower revision rate. The AL procedure has a higher union rate but is subjected to a significant technical challenge. The selection of the surgical procedure can be comprehensively determined according to the clinician's surgical proficiency, preference, patient conditions, and other factors. Larger RCTs are still needed to determine the difference in efficacy between the procedures.

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