Clinical Sports Medicine Update

Outcomes of the Latarjet Procedure Versus Free Bone Block Procedures for Anterior Shoulder Instability

A Systematic Review and Meta-analysis

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Background: Free bone block (FBB) procedures for anterior shoulder instability have been proposed as an alternative to or bail-out for the Latarjet procedure. However, studies comparing the outcomes of these treatment modalities are limited.

Purpose: To systematically review and perform a meta-analysis comparing the clinical outcomes of patients undergoing anterior shoulder stabilization with a Latarjet or FBB procedure.

Study Design: Systematic review and meta-analysis; Level of evidence, 4.

Methods: PubMed, Embase, and the Cochrane Library databases were systematically searched from inception to 2019 for human-participants studies published in the English language. The search was performed according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement including studies reporting clinical outcomes of patients undergoing Latarjet or FBB procedures for anterior shoulder instability with minimum 2-year follow-up. Case reports and technique articles were excluded. Data were synthesized, and a random effects meta-analysis was performed to determine the proportions of recurrent instability, other complications, progression of osteoarthritis, return to sports, and patient-reported outcome (PRO) improvement.

Results: A total of 2007 studies were screened; of these, 70 studies met the inclusion criteria and were included in the meta-analysis. These studies reported outcomes on a total of 4540 shoulders, of which 3917 were treated with a Latarjet procedure and 623 were treated with an FBB stabilization procedure. Weighted mean follow-up was 75.8 months (range, 24-420 months) for the Latarjet group and 92.3 months (range, 24-444 months) for the FBB group. No significant differences were found between the Latarjet and the FBB groups in the overall random pooled summary estimate of the rate of recurrent instability (5% vs 3%, respectively; P = .09), other complications (4% vs 5%, respectively; P = .892), progression of osteoarthritis (12% vs 4%, respectively; P = .077), and return to sports (73% vs 88%; respectively, P = .066). American Shoulder and Elbow Surgeons scores improved after both Latarjet and FBB, with a significantly greater increase after FBB procedures (10.44 for Latarjet vs 32.86 for FBB; P = .006). Other recorded PRO scores improved in all studies, with no significant difference between groups.

Conclusion: Current evidence supports the safety and efficacy of both the Latarjet and FBB procedures for anterior shoulder stabilization in the presence of glenoid bone loss. We found no significant differences between the procedures in rates of recurrent instability, other complications, osteoarthritis progression, and return to sports. Significant improvement in PROs was demonstrated for both groups. Significant heterogeneity existed between studies on outcomes of the Latarjet and FBB procedures, warranting future high-quality, comparative studies.

Keywords: shoulder instability; bone block; glenoid reconstruction; glenoid augmentation; iliac crest bone graft; distal tibial allograft; Latarjet

The management of anterior glenohumeral instability in the setting of glenoid bone loss remains challenging.[74] Soft tissue procedures have shown inferior results in cases of anterior shoulder instability associated with as little as 13.5% of glenoid bone loss,[31] requiring bone grafting techniques in such cases to restore stability.[17,19,66] Commonly

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used bone block procedures include the Latarjet procedure and the modern Eden-Hybinette procedure.[8,106] The Latarjet procedure achieves stability with the bone block effect of the coracoid process and the sling effect created by the conjoint tendon.[41,106] However, the Latarjet procedure has been criticized for possible postoperative limited range of motion,[66] shoulder dyskinesia,[20] potential neurovascular injury, and a more difficult revision surgery.[99] Also, concerns regarding the development of glenohumeral arthritis after the Latarjet procedure have been raised.[79] Glenoid reconstruction using a free bone block (FBB) has been proposed as an alternative for the Latarjet procedure or as a bail-out after failed Latarjet, with equivalent clinical and radiographic outcomes.[66] However, to our knowledge, no systematic review and meta-analysis has compared the outcomes of the Latarjet and FBB procedures in terms of recurrent instability, other complications, progression of osteoarthritis, and patient-reported outcomes (PROs).

Several open and arthroscopic techniques, using different bone block types, including both autograft and allograft bone blocks, have been described.[‖] Sources of autograft include iliac crest bone graft (ICBG),[¶] distal clavicle,[92] and free partial-thickness coracoid (leaving the conjoint tendon attached to the remaining anatomic coracoid and not transferred with the graft as performed during a Latarjet/Bristow procedure).[7,95] Sources of allograft include the distal tibia,[40,73,75] proximal tibia,[87] distal femur,[87] iliac crest,[2,90,108] and femoral head.[98] The use of autografts may be associated with donor site morbidity, including risk for infection, hematoma, sensory disturbances, and an additional scar.[67] Disadvantages related to the use of allografts include issues related to allograft availability and costs, graft incorporation, and the minimal risk for disease transmission.

In 2014, Sayegh et al[82] published a systematic review on allograft reconstruction for glenoid bone loss in glenohumeral instability. That early review included 4 case series and 4 case reports. Since then, a number of studies have been published investigating the use of FBB for the treatment of anterior shoulder instability. The aim of the current review was to assess the clinical outcomes of anterior shoulder stabilization using FBBs and perform a meta-analysis comparing the outcomes of FBB procedures to those of the Latarjet procedure.

‖References 4, 5, 8, 14, 37, 39, 54, 55, 61, 63, 69, 73, 74, 91, 92, 100.
¶References 6, 8, 27, 59, 66, 83, 89, 96.

METHODS

Data Sources and Searches

This systematic review was performed in line with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. PubMed, Embase, and the Cochrane Library were systematically searched for relevant articles from inception to December 19, 2019. The reference lists of original and review articles were also screened. The search was limited to English-language articles or articles with English translation. The search strategy combined the following search terms: ((“glenoid” OR “glenohumeral” OR “shoulder instability”) AND (“*graft*” OR “bone block” OR reconstruct* OR augment* OR “Latarjet”)).

Selection Criteria

Predefined eligibility criteria were clinical trials and observational studies (cohort studies and case series) that reported clinical outcomes after anterior shoulder stabilization using the Latarjet procedure or an FBB procedure. We included studies with a sample size of at least 5 patients and a minimum 2-year follow-up. We excluded (1) studies not providing PROs or recurrence rate, (2) studies reporting the use of bone blocks in the setting of shoulder arthroplasty, (3) case reports and technique articles reporting the outcomes of fewer than 5 patients, and (4) medical conference abstracts. Investigations from the same institutions were separately reviewed to identify studies likely reporting on the same cohort of patients. When these were identified, the most comprehensive study was included, while the rest were omitted after mutual discussion and consensus agreement.

Data Extraction and Quality Assessment

The initial screening of records was performed based on titles and abstracts. Three reviewers (R.G., E.D.H., D.M.K.) reviewed the articles and extracted manuscripts independently. Discrepancies were resolved by mutual discussions. The following information was extracted: publication year, study design, level of evidence, mean patient age, sample size, surgical approach, graft type (autograft/allograft), graft origin (eg, iliac crest, distal tibia), follow-up (minimum, mean, and range), previous surgeries, radiographic and clinical outcomes, complications, and specific

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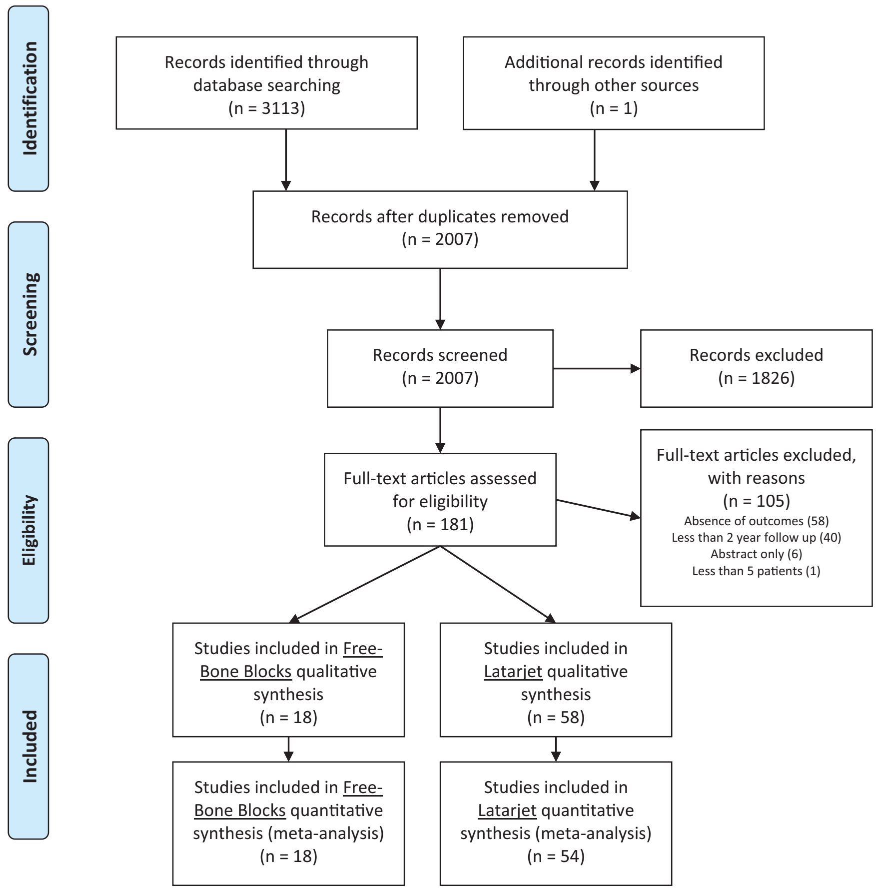

Figure 1. Flowchart using the PRISMA (Preferred Reporting Items for Systematic Meta-Analyses) guidelines. Includes 2 studies directly comparing Latarjet and a free bone block procedure and therefore included in the quantitative analysis of both groups.

remarks. We corresponded with study authors to provide additional information when necessary.

Quality assessment was performed through use of the Methodological Index for Non-randomized Studies (MINORS) checklist[45] and the Newcastle-Ottawa Quality Assessment Scale (NOS).[88] Baseline comparisons of patient characteristics between groups were evaluated by weighted means, independent t tests, and 2-proportion z tests. Studies were expected to have high levels of heterogeneity due to nonidentical patient populations, varying indications for surgery, variable surgical techniques, and inconsistent definitions of outcomes. Therefore, we used the DerSimonian-Laird method[28-30,44] to calculate pooled effect sizes. Heterogeneity was evaluated using the I^2 value,[44] and the 95% CI was used to report all pooled statistics. Binomial data were assessed using a random effects meta-analysis of proportions to synthesize rates of recurrent instability, other complications, progression of osteoarthritis, and return to sports. Continuous data were analyzed via random effects meta-analysis of pooled means to report differences in PROs including the visual analog scale for pain (VAS) score, Rowe score, American Shoulder and Elbow Surgeons (ASES) score, Western Ontario Shoulder Instability Index (WOSI), Subjective Shoulder Value for Sports (SSVS), Constant score, University of California, Los Angeles, shoulder score, Walch-Duplay, Simple Shoulder Test, Oxford Shoulder Instability Score, Disabilities of the Arm, Shoulder and Hand score, Oxford Shoulder Score, and Single Assessment Numeric Evaluation (SANE). Only PROs with a minimum of 2 studies in each treatment group reporting on change from preoperative to postoperative scores were analyzed in the meta-analysis. Outliers were defined as studies with effects that had an upper bound of the 95% CI that was lower than the minimum pooled effect or studies with effects that had a lower bound of the 95% CI that was higher than the maximum pooled effect. Outliers were then removed from the pooled analysis to minimize distortion of results. Forest plots were used to present summarized results of the meta-analyses. Statistical significance was determined as $P < .05$. All statistical analyses were performed by use of R software (version 3.6.2).

RESULTS

Literature Selection

A literature search of the PubMed, Embase, and Cochrane Library databases was performed, yielding a total of 3113 studies. After removal of duplicates, a total of 2007 abstracts were identified. After evaluation of the title,

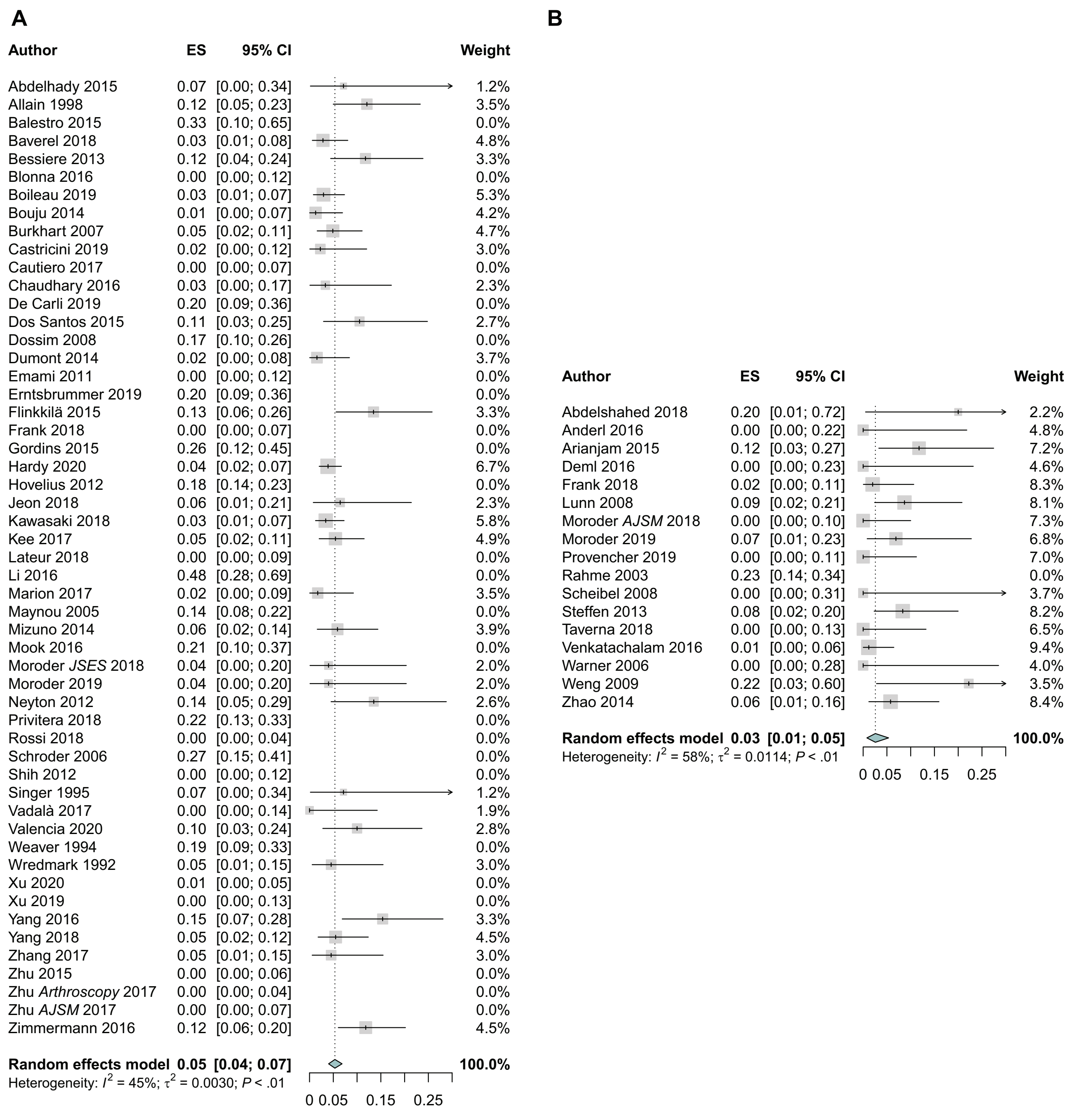

Figure 2. Random effects model for proportion of patients undergoing (A) a Latarjet procedure or (B) a free bone block procedure who had experienced recurrent instability. ES, effect size.

abstract, and, if necessary, full manuscript, a total of 76 studies meeting inclusion criteria were selected for further evaluation. Of these studies, 6 were removed from the quantitative analysis due to the high likelihood of reporting on the same cohort of patients as other studies.[47,48,53,75,77,78] There were 52 studies reporting on outcomes of the Latarjet procedure,[#] 16 studies reporting on the outcomes of FBB procedures,[**] and 2 studies directly comparing Latarjet and FBB procedures.[40,67] One study was supplied to us by the authors,[75] as our search produced only a presentation abstract of the study. The PRISMA flow diagram is presented in Figure 1.

Free Bone Blocks. There were 16 case series, level 4 studies (n = 544 shoulders)[**]; 1 cohort, level 3 study (n = 50 shoulders)[40]; and 1 randomized controlled, level 1 study (n = 29 shoulders).[66] There were 6 studies reporting on the use of allografts (2 distal tibial,[40,75] 3 iliac crest,[2,90,108] and

[#]References 1, 3, 9-11, 13, 15, 16, 18, 21, 22, 24, 26, 32-36, 38, 42, 43, 46, 50-52, 56, 57, 60, 62, 64, 65, 68, 70-72, 80, 84-86, 93, 95, 97, 101-105, 107, 109-112.

[**]References 2, 6-8, 27, 59, 66, 73, 76, 83, 89, 90, 95, 96, 98, 108.

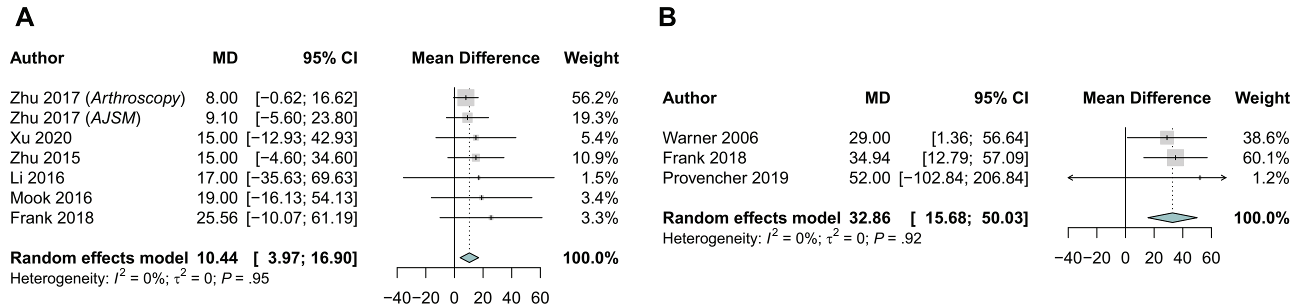

Figure 3. Forest plots presenting the change in the American Shoulder and Elbow Surgeons scores in (A) patients who underwent a Latarjet procedure and (B) patients who underwent a free bone block procedure. MD, mean difference.

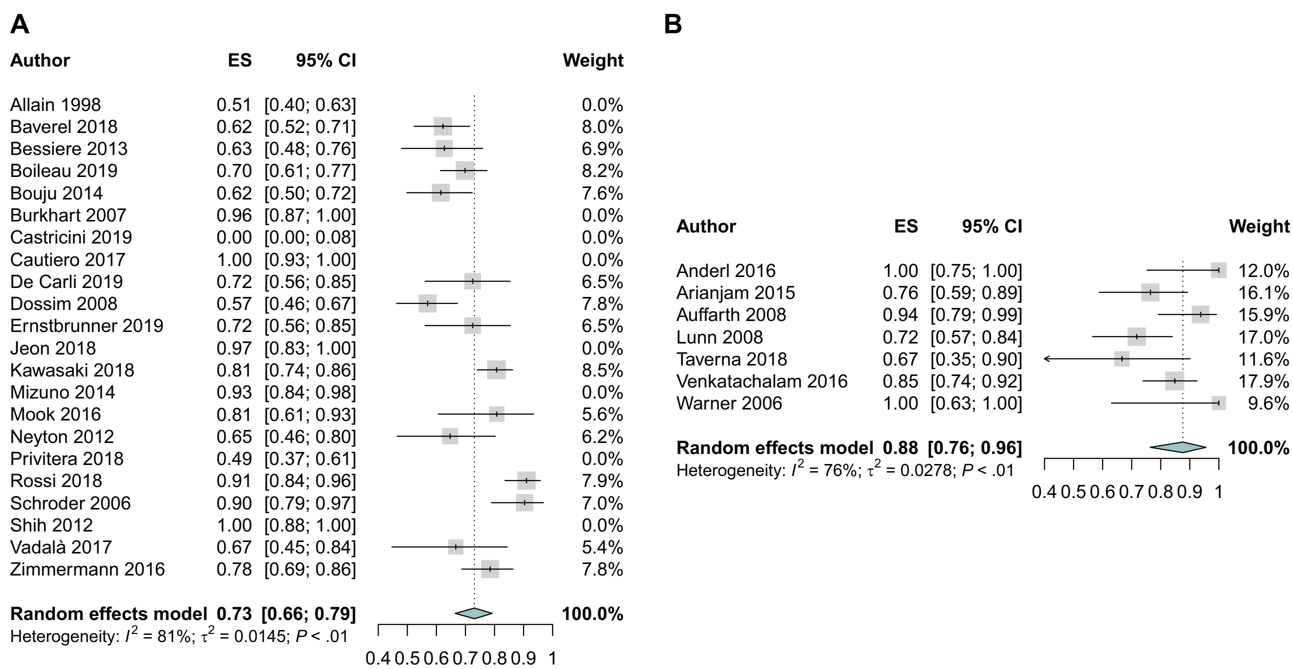

Figure 4. Random effects model for proportion of patients undergoing (A) a Latarjet procedure or (B) a free bone block procedure who returned to sports after the procedure. ES, effect size.

1 femoral head allograft)[98], and 12 studies reporting on the use of autografts (10 iliac crest[††] and 2 free partial-thickness coracoid autograft[7,95]). Studies are presented in detail with MINORS and NOS scores in the Appendix (available in the online version of this article).

Latarjet. There were 29 case series, level 4 studies (n = 1620 shoulders)[‡‡]; 22 level 3 studies (n = 2193 shoulders)[§§]; 2 level 2 studies (n = 82 shoulders)[60,93]; and 1 level 1 studies (n = 25 shoulders).[67] Studies are presented in detail with MINORS and NOS scores in the Appendix (available online).

[††]References 6, 8, 27, 59, 66, 67, 76, 83, 89, 96.

[‡‡]References 1, 3, 9, 11, 15, 16, 18, 22, 24, 33-36, 38, 42, 51, 56, 57, 65, 68, 70, 72, 84, 86, 101, 102, 107, 109, 110.

[§§]References 10, 13, 21, 26, 32, 40, 43, 46, 50, 52, 62, 64, 71, 80, 85, 95, 97, 103-105, 111, 112.

Patient Demographics

Free Bone Blocks. There were 623 shoulders treated with an FBB stabilization procedure for anterior shoulder instability. Weighted mean age at the time of the procedure was 27.8 years (range, 15-63 years). At least 56% (n = 349/623) of shoulders had a previous stabilization procedure; of these, 77 had a failed Latarjet. Weighted mean follow-up for FBB patients was 92.3 months (range, 24-444 months).

Latarjet. There were 3917 shoulders treated with a Latarjet procedure for anterior shoulder instability. Weighted mean age at the time of the procedure was 27.6 years (range, 14-85 years). At least 15% (n = 575/3917) had a documented previous stabilization procedure, which was significantly lower than that of the FBB group ($P < .001$). Weighted mean follow-up for patients undergoing

TABLE 1
Recurrent Instability

	n (%)
Free bone block procedures	
Dislocation	20 (3.2)
Subluxation	5 (0.8)
Apprehension[a]	5 (0.8)
Latarjet procedure	
Dislocation	92 (2.2)
Subluxation	105 (2.7)
Apprehension[a]	84 (2.1)
Instability not defined	19 (0.5)

[a]In some studies, it was unclear whether patients with apprehension included all or some of the patients who had subluxation or dislocation.

a Latarjet procedure was 75.8 months (range, 24-420 months). No statistically significant differences between groups were reported in regard to age and mean follow-up (P = .811 and P = .761, respectively).

Surgical Characteristics

Free Bone Blocks. Of patients undergoing stabilization with FBB, 452 patients underwent an open procedure, and 157 patients underwent an arthroscopic procedure; the surgical approach was not reported in a single study consisting of 14 patients.[27] A total of 173 patients underwent stabilization with an allograft (distal tibia, n = 81; iliac crest, n = 83; femoral head, n = 9), whereas 450 patients were treated with an autograft (ICBG, n = 332; free coracoid, n = 118).

Latarjet. A total of 3543 patients underwent an open Latarjet procedure compared with 374 patients treated using an arthroscopic Latarjet procedure.

Outcomes

Recurrent Instability. The overall random pooled summary estimate of the proportion of patients who underwent an FBB procedure with recurrent postoperative instability was 3% (95% CI, 1%-5%; I^2 = 58%), whereas that of patients who underwent a Latarjet procedure was 5% (95% CI, 4%-7%; I^2 = 45%) (Figure 2). No statistically significant difference was found in terms of recurrent instability between the 2 groups (P = .09). Of note, the definition of recurrent instability varied across studies; some studies did not define recurrent instability,[2,60,94] whereas others defined recurrent instability as dislocation[95]; dislocation and subluxation[7,27,40,83,89,90]; or dislocation, subluxation, and apprehension.[6,8,59,73,96,98,108] More details can be found in Table 1 and in the online Appendix.

Patient-Reported Outcomes. Improvement in PROs was observed across all studies reporting on Latarjet and FBB procedures. ASES scores significantly improved after both Latarjet and FBB procedures, with a significantly greater increase in patients undergoing FBB procedures (10.44 for Latarjet vs 32.86 for FBB; P = .006) (Figure 3). Other PROs including VAS, Rowe, WOSI, SSVS, and SANE showed improvement after both Latarjet and FBB procedures, with no significant difference between the groups in terms of the magnitude of score increases (P = .625, P = .401, P = .143, P = .366, and P = .776, respectively). Forest plots presenting changes in PRO scores for the VAS, Rowe, WOSI, SSVS, and SANE are available in the online Appendix.

TABLE 2
Complications
(Not Related to Recurrent Anterior Instability)[a]

	n (%)
Free bone block procedures	
Persistent pain	19 (3)
Donor site hypoesthesia (autograft)	10 (1.6)
Donor site pain (autograft)	3 (0.5)
Hardware failure	3 (0.5)
Graft fracture	3 (0.5)
Postoperative hematoma	2 (0.3)
Subscapularis failure	2 (0.3)
Donor site superficial infection	2 (0.3)
Surgical site infection	2 (0.3)
SLAP lesion indicating repair	1 (0.2)
Posterior dislocation	1 (0.2)
Unknown revision procedure	1 (0.2)
Latarjet procedure	
Hardware failure/removal	56 (1.4)
Surgical site infection	26 (0.7)
Graft fracture/dislocation	22 (0.6)
Postoperative hematoma	19 (0.5)
Persistent pain	12 (0.3)
Frozen shoulder/adhesive capsulitis	9 (0.2)
Total shoulder arthroplasty due to arthritis	7 (0.2)
Musculocutaneous nerve neuropathy	4 (0.1)
Unknown revision procedure	3 (0.1)
Humeral fracture during manipulation	1 (0.03)
Complex regional pain syndrome	1 (0.03)
Axillary nerve palsy	1 (0.03)
Clavicle fracture	1 (0.03)
Other neuropathy	1 (0.03)

[a]SLAP, superior labral anterior and posterior.

Athletes and Return to Sports. A total of 23 studies (9 FBB studies[6-8,59,66,67,90,95,96] and 14 Latarjet studies[||||]) reported return to sports rates. Return to sports rates were 73% for Latarjet (95% CI, 66%-79%; I^2 = 81%) and 88% for FBB (95% CI, 76%-96%; I^2 = 76%) (Figure 4). No significant difference was found between groups in pooled return to sports rates (P = .066).

Other Complications (Not Instability-Related). There were 49 complications reported after FBB procedures.[¶¶] Persistent pain and donor site morbidity were the most common complications of the FBB procedure. We noted that 3 of the 8 studies reporting on the use of ICBG autografts reported variable rates of donor site discomfort, hypoesthesia, or superficial donor site infection.[59,66,96]

A total of 163 complications were reported after the Latarjet procedure. Hardware failure/removal, surgical

[||||]References 3, 18, 36, 50, 51, 64, 65, 70, 72, 80, 84, 85, 93, 112.
[¶¶]References 2, 6, 8, 40, 59, 66, 67, 89, 90, 95, 96, 108.

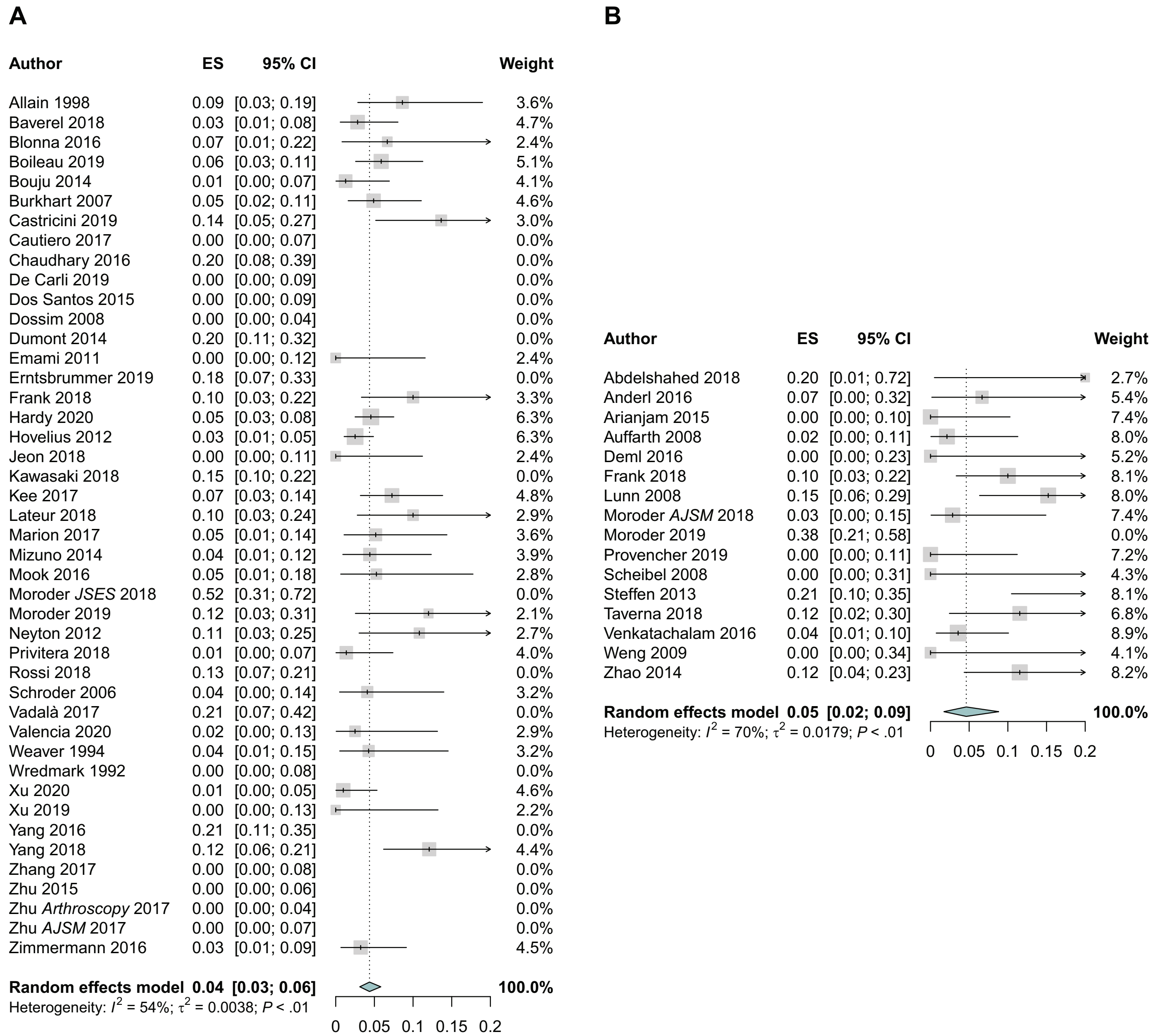

Figure 5. Random effects model for proportion of patients undergoing (A) a Latarjet procedure or (B) a free bone block procedure who experienced a postoperative complication not instability related. ES, effect size.

site infection, graft fracture/dislocation, and postoperative hematoma were the most common complications after the Latarjet procedure. Complications are described in detail in Table 2 and the online Appendix.

Pooled complication rates were 4% for the Latarjet group (95% CI, 3%-6%; $I^2 = 54\%$) and 5% for the FBB group (95% CI, 2%-9%; $I^2 = 70\%$), with no significant difference between groups ($P = .892$) (Figure 5).

Glenohumeral Arthritis. We identified 8 FBB studies that reported on the development of glenohumeral arthritis in a fraction of their patients.[6,8,59,66,83,89,90,108] Most of these studies reported progression of different rates to mild grade 1 arthritis; however, several patients were reported to experience moderate to severe arthritis.[66,89,108] Although progression of glenohumeral arthritis was reported in several studies,[8,59,96] other studies did not find progression of glenohumeral arthritis.[6,108]

We found that 19 Latarjet studies reported progression of osteoarthritis in a total of 197 patients. Only 16 patients were reported to progress to grade 3 instability arthropathy according to the Samilson and Prieto classification.[3,81]

Pooled osteoarthritis rates were 12% for the Latarjet group (95% CI, 8%-16%; $I^2 = 71\%$) and 4% for the FBB group (95% CI, 0%-12%; $I^2 = 80\%$) (Figure 6), with no significant difference between the groups ($P = .077$).

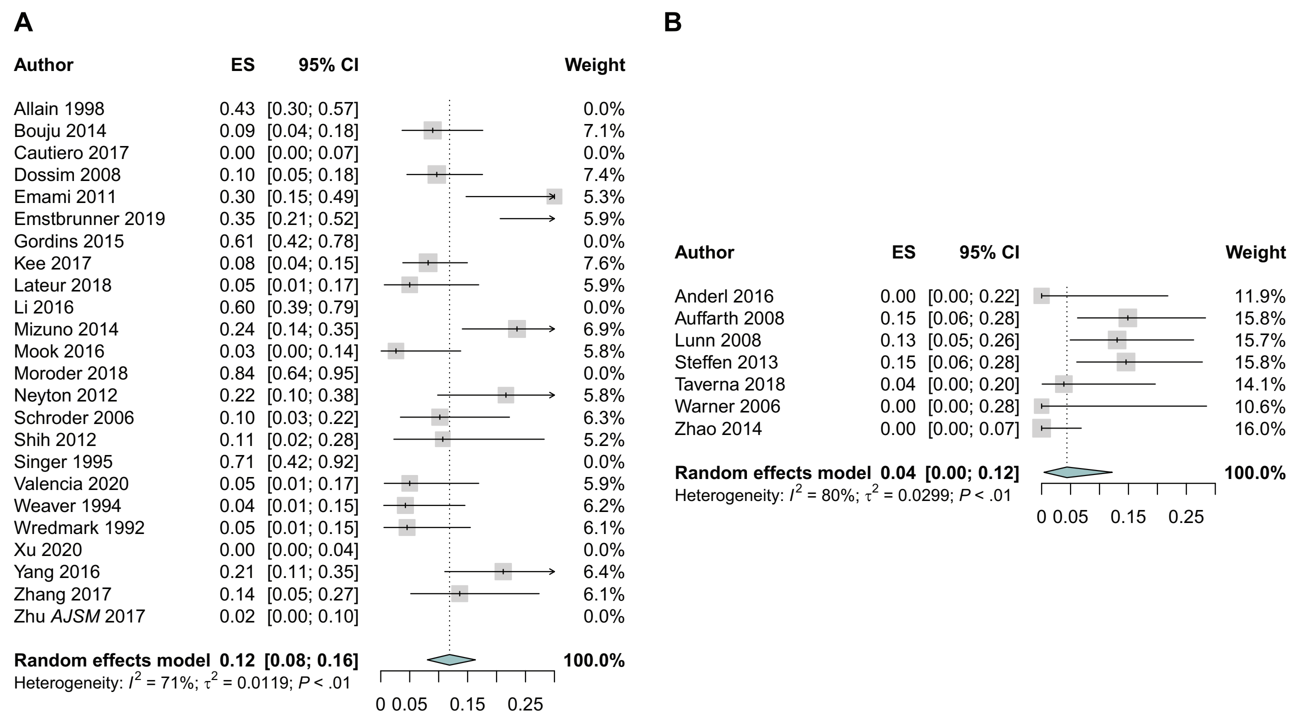

Figure 6. Random effects model for proportion of patients undergoing (A) a Latarjet procedure or (B) a free bone block procedure who were found to have progression of glenohumeral arthritis after the procedure. ES, effect size.

DISCUSSION

The findings of this systematic review and meta-analysis support the safety and efficacy of both the Latarjet and FBB augmentation procedures in the setting of anterior shoulder instability associated with glenoid bone loss. This meta-analysis did not find significant differences between the Latarjet and FBB procedures in postoperative rates of recurrent instability, other complications, osteoarthritis progression, most PROs, and return to sports.

In this meta-analysis, we reported outcomes of 4540 shoulders after anterior shoulder stabilization using the Latarjet or FBB procedures, with a 3% to 5% rate of postoperative instability. Moreover, at minimum 2-year follow-up, postoperative PROs were significantly improved compared with preoperative scores. Complication rates and progression of glenohumeral arthritis were relatively low, although donor site morbidity is a concern with the use of ICBG.

Although several systematic reviews and meta-analyses have been reported on the Latarjet procedure,[23,49,58] systematic reviews reporting on the outcomes of FBB procedures have been limited. A previous systematic review on FBB procedures published in 2014 by Sayegh et al[82] focused on the use of allografts only, describing only 4 case series and 4 case reports. Of these, only 4 studies, reporting on a total of 64 patients, had a minimum 2-year follow-up. Since 2014, a number of new studies have provided additional details on the outcomes of FBB procedures for the treatment of recurrent shoulder instability in the presence of glenoid bone deficiency.

Only 2 studies in this systematic review directly compared the outcomes of an FBB procedure versus the Latarjet procedure. Frank et al[40] compared the outcomes of distal tibial allograft with the Latarjet procedure and reported no significant difference in outcomes or postoperative range of motion, even though the distal tibial allograft group had a significantly greater preoperative bone loss compared with the Latarjet group. Moroder et al[66] performed a randomized, controlled, prospective study comparing the J-shaped ICBG to the Latarjet procedure. The authors also reported no significant difference in PROs; however, postoperative internal rotation was found to be decreased in the Latarjet group, whereas donor site morbidity was an issue in the ICBG group.

In the current study, the differences between the 2 types of procedures in terms of recurrent instability rates, osteoarthritis progression, and return to sports may be interpreted as borderline significant ($P < .1$). However, the studies included in the analysis had moderate to high heterogeneity. Although the increase in ASES scores was significantly greater with the FBB procedures, all other improvements in PROs were not significantly different between the 2 types of procedures. As previously mentioned, both studies directly comparing Latarjet and bone block procedures did not find a significant difference in instability rates and PROs between surgical groups. As such, further investigations are necessary to determine whether a clinically important difference in PRO improvement exists between the Latarjet and FBB procedures.

When contemplating an FBB procedure, the surgeon and patient should consider several factors. Donor site morbidity can be significant after a stabilization procedure involving the use of a free autograft. ICBG harvesting is associated with gait disturbance within the first few weeks, significant pain, risk of injury to the lateral femoral cutaneous nerve (sensory disturbances estimated at 26.7%), risk for infection including superficial infection (estimated at 6.7%), osteomyelitis, and an additional scar.[25,67] Possible advantages for the use of allografts, such as distal tibia, include a hyaline cartilage interface, a congruent articulation with the humeral head, and avoidance of donor site morbidity.[4,12,74]

Future comparative studies are needed to investigate differences in outcomes between surgical treatment options of shoulder instability in the setting of glenoid bone loss and to make direct comparisons between the different types of autografts and allografts options available.

Limitations

This systematic review and meta-analysis had several limitations. The main limitation is the low level of evidence of most studies included in this review and the relatively high heterogeneity of studies included in the meta-analysis. Additionally, at this time, most studies on anterior stabilization of the shoulder using FBB or Latarjet are limited to retrospective case series with a small sample size. These factors increased the likelihood for bias in the results and limited the number of variables on which meaningful statistical analyses could be performed. However, the large number of patients included in this meta-analysis contributed to a greater statistical power and may support the validity of the results of the study. Another limitation is the lack of studies comparing different types of free bone grafts as well as the limited number of studies comparing outcomes of shoulders stabilized with FBB versus Latarjet. Last, as with any systematic review and meta-analysis, studies may have been missed. However, articles and references were searched manually, and authors were contacted to minimize the possibility of missing studies and relevant data.

CONCLUSION

Current evidence supports the safety and efficacy of both the Latarjet and the FBB procedures for anterior shoulder stabilization in the presence of glenoid bone loss. We found no significant differences between procedures in postoperative rates of recurrent instability, other complications, osteoarthritis progression, and return to sports. Significant improvements in PROs were demonstrated for both groups, and patients undergoing FBB demonstrated a significantly higher ASES score at final follow-up compared with patients treated with Latarjet. Significant heterogeneity existed among studies on outcomes of the Latarjet and FBB procedures, indicating the need for additional high-quality comparative investigations to be conducted in the future.

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