Return to Sport After Coracoid Bone Block Transfer for Shoulder Instability: A Systematic Review

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Abstract *Background:* Shoulder dislocations can be devastating for an athlete. Coracoid bone block transfer is often used for the treatment of recurrent shoulder instability. *Questions/Purposes:* The primary purpose of this study was to determine the rate and mean time of return to sport in athletes after a coracoid bone block transfer at the pre-operative level of competition, a lower level, or a different level. We also sought to determine how return to sport rates after a coracoid bone block procedure compared with rates after several comparator interventions. Finally, we looked to determine the post-operative clinical outcomes and complications reported after a coracoid

bone block procedure. *Methods:* We systematically searched three databases (PubMed, Embase, and MEDLINE) for studies reporting return to sport after a coracoid bone block procedure. *Results:* A total of 52 studies (with levels of evidence ranging from II to IV) evaluating 2953 shoulders in 2888 patients were included in this systematic review. The mean rate of return to sport at any level was 88.4% (2291 of 2592 patients). However, the rate of return to the pre-operative level was 70.3% (1387 of 1974 patients). The mean time to return to sport was 5.38 months (range 21 days to 36 months). The rate of return to sport was higher after the Latarjet procedure, as compared with Bankart repair (87.0% and 75.8%, respectively). All studies showed improvements in clinical outcome measures after coracoid bone block intervention. The cumulative complication rate was found to be 6.46% (158 of 2446 patients). *Conclusion:* Coracoid bone block transfer allows for a high rate of return to sport, although the rate of return to sport at athletes' pre-operative level is lower. The rate of return to sport after Latarjet procedure is higher in comparison with Bankart repair. Additionally, coracoid bone block transfer is associated with improvements in a number of clinical outcome measures. Common post-operative complications include non-union between bone block and glenoid, hematoma, and infection.

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Introduction

The shoulder joint has the largest range of motion of all joints in the body, which means there is also an inherent bony instability [24, 30, 32, 62]. Anterior glenohumeral

instability is a common clinical presentation, particularly among athletes; the annual rate of shoulder instability events among young athletes has been reported to be as high as 2.8% [51].

Shoulder injuries can be devastating to athletes; a decrease in shoulder function may end an athlete's career [2, 9, 41]. Shoulder instability, characterized by symptomatic subluxation or dislocation of the glenohumeral joint, is increasingly recognized as a problem in athletes, particularly in those returning to sport after injury [4, 41].

Although Bankart repair is widely performed for the management of anterior shoulder instability, the Latarjet procedure, a coracoid bone block procedure, has become a popular treatment, particularly in patients with glenoid bone loss and in contact athletes in whom Bankart repair has failed [41]. First described by French surgeon Michel Latarjet in 1954, the Latarjet procedure involves positioning a coracoid autograft to increase the articular arc of the glenoid [10, 47]. This transfer augments anterior shoulder instability via three mechanisms. First, the coracoid autograft increases the surface area of the glenoid, preventing translation and subsequent dislocation of the humeral head [47]. Second, the conjoint tendon acts as a sling across the humerus, resisting anterior translation when the arm is abducted and externally rotated and reinforcing the capsule anteroinferiorly [10]. Third, the “bumper effect” resulting from reattachment of the labrum and anterior capsule to the glenoid rim is reinforced with the coracoacromial ligament [10].

Another commonly performed coracoid bone block transfer for shoulder instability is the Bristow procedure. Whereas the Latarjet procedure transfers the entire horizontal pillar of the coracoid, the Bristow procedure transfers only the tip, so that the resected coracoid tip is in contact with the anterior glenoid neck through the subscapularis split [35, 37]. Despite frequent mislabeling of operations as “Bristow–Latarjet” procedures, these operations represent distinct coracoid transfer procedures [35].

Coracoid transfer procedures have been shown in the literature to provide excellent long-term results, with rates of recurrent instability ranging from 2 to 14% [60]. A meta-analysis of available observational studies comparing arthroscopic Bankart and open Latarjet procedures suggests Bankart repair poses a greater risk of recurrent instability and redislocation than the Latarjet procedure [2]. Treatment of the athlete with shoulder instability continues to evolve and remains a topic of debate in the literature. The ultimate goal of many of these patients, especially younger athletes, is a return to sport at the pre-injury level [41].

The purpose of this review is to answer the following questions: (1) What are the rate and mean time of return to sport in athletes after a coracoid bone block (Latarjet or Bristow) transfer procedure? (2) What are the rates of return to sport at the pre-operative level, a lower level, and a different level after a coracoid bone block transfer procedure? (3) What is the rate of return to sport after a coracoid bone block procedure, as

compared with other interventions? (4) What are the various pre-operative and post-operative clinical outcome measures reported in the literature for patients undergoing a coracoid bone block procedure? (5) What are the post-operative complications reported in patients after a coracoid bone block procedure?

Methods

Study Design

We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist to conduct a systematic review [54].

Search Strategy and Study Selection

We conducted a literature search using three electronic medical databases, PubMed, Embase, and MEDLINE, from the inception of each to the second week of February 2019, to identify all studies related to patients' return to sport after a coracoid bone block procedure. We used various combinations of relevant search terms, including “athlete,” “return to sport,” “shoulder,” “dislocation,” “instability,” “stabilization,” “Latarjet,” and “Bristow.” We used MeSH and Emtree terms in various combinations to increase search sensitivity (Appendix Table 4). We also reviewed reference lists in the included studies to identify additional relevant studies that met the inclusion criteria.

To be included in this systematic review, studies had to (1) be published in English and have a level of evidence between I and IV, (2) involve human subjects (of any age), (3) involve coracoid bone block transfer used to treat anterior shoulder instability (procedures included open or arthroscopic Latarjet procedure, Bristow procedure, or variations of either), and (4) report proportions of patients returning to sport after intervention. Literature reviews, conference proceedings, expert opinions, nonhuman or cadaver studies, case reports, clinical studies that did not evaluate a coracoid bone block transfer procedure, and studies not reporting rates of return to sport were excluded.

We compiled a list of citations from the comprehensive literature search, and duplicates were removed. Two independent reviewers (I.M.N. and S.V.) performed systematic screenings from the title through the full-text screening stages. Discrepancies were resolved by consensus between the two reviewers. If a consensus could not be reached, the input of a third, senior reviewer (N.S.H) was used to determine the eligibility of the study. Inter-rater agreement was calculated using Cohen's κ statistic [52].

Data Extraction, Synthesis, and Analysis

The primary outcome was the rate of return to sport after the coracoid bone block procedure. Secondary outcomes were the rates of return to sport at the pre-operative level, return to sport at a lower level, return to a different sport, time to return to sport, and other clinical outcome measures. Data

extraction was performed by two independent reviewers (I.M.N. and S.V.). Data extracted included (1) descriptive data on the population (sex, age, sport played, competitive level, dominant shoulder, for example), (2) intervention details (the procedure or procedures performed and the interval between first dislocation and surgical intervention, for example), (3) outcomes (return to sport, time to return, and so on), and (4) any relevant details related to comparative treatments.

We assessed the quality of included clinical studies using the methodological index for nonrandomized studies (MINORS) tool [66].

We used Cohen's κ statistic to evaluate inter-reviewer agreement at all screening stages. Agreement was categorized a priori [52]. We used SPSS software, version 23.0 (IBM, Armonk, NY, USA), to perform all statistical analyses.

Results

Literature Search

Electronic searches initially identified 1619 titles for screening. After elimination of duplicates, 734 titles were screened for the aptness of titles and abstracts. After full-text review of 215 studies, 52 were selected. There was a moderate agreement between reviewers at the title-and-abstract screening stage ($\kappa = 0.820$; 95% confidence interval [CI], 0.775 to 0.865) and the full-text screening stage ($\kappa = 0.775$; 95% CI, 0.679 to 0.871). Figure 1 provides a description of all 52 studies included in the review.

Study Characteristics

Included studies were published between 1975 and 2019, of which 33 (63.5%) were published since 2014 (the last 5 years). All studies had a level of evidence of between II and IV (level II, $n = 5$; level III, $n = 17$; level IV, $n = 30$). The studies involved a total of 2953 shoulders in 2888 patients, out of which 58.8% (1201 of 2044) were dominant shoulders. The mean age of included patients was 26.2 (range, 14 to 69) years. Of the 47 studies reporting sex, 83.5% of subjects (2129 of 2551) were male. Of the 24 studies reporting the surgical history of patients, 22.6% of patients (276 of 1223) had undergone previous shoulder surgery. Additionally, 89.8% of patients (2592 of 2888) were involved in sports. The most commonly reported level of play was competitive ($n = 786$), and the most commonly reported sport was rugby ($n = 283$). The mean time to follow-up assessment was 73.2 months (range, 4 months to 24 years) (Online Resource 1).

We identified many variations of coracoid bone transfer (Table 1). The procedures studied included the Latarjet procedure and its variations (42 studies) and the Bristow procedure and its variations (10 studies).

The mean MINORS score ($\pm$ standard deviation) for noncomparative studies was 9.95 ± 2.87 out of 16, and the

mean MINORS score for comparative studies was 18.7 ± 2.94 out of 24, indicating a fair quality of evidence.

Rate of Return to Sport and Mean Time Until Return to Sport

Of the 2592 subjects involved the studies, 2291 (88.4%) returned to sport after the coracoid bone transfer (Online Resource 1). The mean time to return to sport was 5.38 months (range, 21 days to 36 months).

The overall rate of return to sport after the Latarjet procedure or its variants was 89.4% (1921 of 2149 patients), and after the Bristow procedure or its variants, the rate was 83.5% (370 of 443 patients). Additionally, the rate of return to sport after open Latarjet surgery was 87.8% (1110 of 1264 patients), and after arthroscopic Latarjet surgery, the rate was 96.9% (310 of 320 patients).

Return to Sport at the Pre-operative Level, a Lower Level, or in a Different Sport

The rate of return to sport at the pre-operative level was reported in 38 studies and was 70.3% (1387 of 1974 patients) overall. The rate of return to sport at a lower level of competition was reported in 19 studies; the mean rate was 20.3% (188 of 926 patients). The rate of return to sport but in a different sport was reported in 13 studies; the mean rate was 13.6% (93 of 686 patients). Two studies reported a combined proportion of return to sport at a lower level and return to a different sport [5, 53]; the cumulative proportion of patients who returned to either a lower level of competition or in a different sport was 25.3% (306 of 1211 patients) (Table 1).

Rate of Return to Sport in Patients Undergoing Coracoid Bone Block Procedure Relative to the Rates After Comparative Interventions

Among the five retrospective cohort studies that compared Latarjet procedure with arthroscopic Bankart repair, a mean of 87.0% of patients (254 of 292) returned to sport after the Latarjet procedure, and 75.8% patients (424 of 559) returned to sport after arthroscopic Bankart repair (Table 2). Zimmerman et al. found the rate of return to sport to be significantly higher after the open Latarjet procedure ($p = 0.045$); however, Blonna et al. found no significant difference in rates between open Latarjet and arthroscopic Bankart, and Jeon et al. found no significant difference between arthroscopic Latarjet and arthroscopic Bankart ($p > 0.05$) [11, 42, 71]. Bessiere et al. in separate studies in 2013 and 2014 did not conduct statistical analysis [8, 9].

De Carli et al. compared return to sport after open Latarjet with open capsuloplasty and found no significant difference in rates between the two groups ($p > 0.05$) [25].

Kahn et al. compared conservative (non-operative) treatment with the Latarjet procedure and found that return to sport was achieved by 92.3% (24 of 26 patients) in the Latarjet procedure group, as opposed to 60% (12 of 20

Fig. 1. Selection of studies for review using the preferred reporting items for systematic reviews and meta-analyses (PRISMA) checklist.

patients) in a conservative treatment group (no degree of significance was reported) [45].

Clinical Outcome Measures

The 41 studies reporting clinical outcome measures showed significant improvements in scores after coracoid bone block procedure (Online Resource 2). The three most frequently used outcome measures were the Rowe scale score for instability, the subjective shoulder value (SSV), and the Walch–Duplay score. The Rowe standard rating scale was devised to assess outcomes after shoulder surgical repair. The system requires a clinician to assess patients in three domains: stability, range of motion, and function [24]. The totals in each domain are added to produce an overall score of between 0 and 100. The mean Rowe scale score among 804 patients before surgery was 44.7 (range, 5 to 75), indicating poor stability, whereas the mean post-operative Rowe scale score among 1341 patients was 89.0, indicating a good score (range, 10 to 100).

The SSV measures shoulder function as a percentage of a healthy shoulder [34]. The mean pre-operative SSV among 119 patients was 50.4% (range not given), whereas the mean post-operative SSV among 648 patients was 89.1% (range, 5 to 100%).

The Walch–Duplay scale is similar to the Rowe scale, but it measures four items instead of three: daily or sports activity level, stability, pain, and mobility, each item being

worth 25 points. Walch–Duplay scores were reported in nine studies. The mean pre-operative Walch–Duplay score among 136 patients was 45.3 (range, 10 to 70), indicating poor stability. The mean post-operative Walch–Duplay score among 547 patients was 87.5 (range, 15 to 100), indicating good stability.

Post-operative Complications

The overall reported post-operative complication rate after the coracoid bone block transfer procedure was 6.46% (158 of 2446 patients) (Table 3). The most frequently reported post-operative complications were non-union between bone block and glenoid (1.51%, 37 of 2446 patients), infection (1.02%, 25 of 2446 patients), hematoma (0.82%, 20 of 2446 patients), hardware-associated complications (0.61%, 15 of 2446 patients), and neurologic complications (0.53%, 13 of 2446 patients). Jeon et al., Baverel et al., Bohu et al., Aurich et al., Boileau et al., Edouard et al., and Yamashita et al. reported a complication rate of 0% [3, 6, 12, 13, 31, 42, 70].

Discussion

Patients undergoing coracoid bone transfer have a high rate of return to sport (in this review, 88.4%, 2291 of 2592 patients). The variation in proportions of patients returning to sport may be related to differences in the definitions used in the individual studies. Some studies defined return to

Table 1 Reported rates among a total of 2592 subjects of return to sport, return to sport at pre-operative level of competition, return to sport lower level of competition, and return to a change of sport, according to surgical procedure, shown in reverse order of publication date

Study	Number and percentage of subjects who returned to sport	Number and percentage of subjects who returned to sport at the pre-operative level	Number and percentage of subjects who returned to sport at a lower level	Number and percentage who returned to sport but changed sport
Open Latarjet or Bristow–Latarjet procedure				
De Carli et al. (2018) [25]	36 of 40 (90.0%)	29 of 40 (72.5%)	NA	7 of 40 (17.5%)
Bavarel et al. (2018) [6]	102 of 106 (96.2%)	66 of 106 (62.3%)	25 of 106 (23.6%)	11 of 106 (10.4%)
Privitera et al. (2018) [58]	≥55 of 73 (75.3%)	36 of 73 (49.3%)	10 of 73 (13.7%)	9 of 73 (12.3%)
De l'Escalopier et al. (2018) [26]	20 of 20 (100%)	NA	NA	NA
Kee et al. (2018) [44]	54 of 56 (96.4%)	9 of 56 (16.1%)	27 of 56 (48.2%)	18 of 56 (32.1%)
Elganaïny et al. (2017) [33]	≥7 of 23 (30.4%)	7 of 23 (30.4%)	NA	NA
Vadala et al. (2017) [69]	24 of 24 (100%)	16 of 24 (66.7%)	4 of 24 (16.7%)	4 of 24 (16.7%)
Zimmermann et al. (2016) [71]	~68 of 93 (73.1%)	NA	NA	NA
Blonna et al. (2016) [11]	25 of 30 (83.3%)	NA	NA	NA
Mook et al. (2016) [55]	26 of 38 (68.4%)	21 of 38 (55.3%)	NA	NA
Bohu et al. (2016) [12]	37 of 42 (88.1%)	28 of 42 (66.7%)	4 of 42 (9.52%)	4 of 42 (9.52%)
Beranger et al. (2016) [7]	47 of 47 (100%)	30 of 47 (63.8%)	7 of 47 (14.9%)	10 of 47 (21.3%)
Dauzère et al. (2016) [23]	≥41 of 55 (74.5%)	41 of 55 (74.5%)	NA	NA
da Silva et al. (2015) [22]	32 of 38 (84.2%)	NA	NA	NA
Cho et al. (2015) [20]	31 of 32 (96.9%)	20 of 32 (62.5%)	11 of 32 (34.4%)	NA
Ropars et al. (2016) [63]	66 of 77 (85.7%)	49 of 77 (63.6%)	12 of 77 (15.6%)	5 of 77 (6.49%)
Mizuno et al. (2014) [53]	62 of 68 (91.2%)	57 of 68 (83.8%)	5 of 68 (7.4%)	NA
Bessière et al. (2014) [9]	85 of 88 (96.6%)	67 of 88 (76.1%)	NA	NA
Khan et al. (2014) [45]	24 of 26 (92.3%)	21 of 26 (80.8%)	3 of 26 (11.5%)	NA
Bessière et al. (2013) [8]	≥46 of 50 (92%)	36 of 50 (72%)	NA	NA
Cerciello et al. (2012) [19]	26 of 26 (100%)	18 of 26 (69.2%)	7 of 26 (26.9%)	1 of 26 (3.85%)
Edouard et al. (2012) [31]	19 of 20 (95%)	15 of 20 (75%)	NA	NA
Doursounian et al. (2009) [27]	24 of 27 (88.9%)	16 of 27 (59.3%)	NA	NA
Hovelius et al. (2004) [39]	81 of 86 (94%)	74 of 86 (86%)	7 of 86 (8%)	NA
Allain et al. (1998) [1]	48 of 49 (98.0%)	40 of 49 (81.6%)	5 of 49 (10.2%)	3 of 49 (6.12%)
Matton et al. (1992) [50]	24 of 30 (80%)	14 of 30 (46.7%)	10 of 30 (33.3%)	NA
Arthroscopic Latarjet or Bristow–Latarjet procedure				
Jeon et al. (2018) [42]	30 of 31 (96.8%)	6 of 31 (19.4%)	16 of 31 (51.6%)	8 of 31 (25.8%)
Ranalletta et al. (2018) [59]	65 of 65 (100%)	62 of 65 (95.4%)	NA	3 of 65 (4.6%)
Boileau et al. (2015) [13]	≥71 of 76 (93.4%)	71 of 76 (93.4%)	NA	NA
Dumont et al. (2014) [29]	58 of 62 (93.5%)	NA	NA	NA
Lafosse et al. (2010) [46]	86 of 86 (100%)	NA	NA	NA
Latarjet–Patte procedure				
Cautiero et al. (2017) [18]	15 of 15 (100%)	NA	NA	NA
Bouju et al. (2014) [15]	49 of 59 (83.1%)	36 of 59 (61.0%)	NA	NA
Holzer et al. (2013) [38]	126 of 148 (85.1%)	NA	NA	NA
Neyton et al. (2012) [56]	34 of 34 (64.7%)	19 of 34 (55.9%)	3 of 34 (8.82%)	NA
Modified variation of Latarjet procedure				
Rossi et al. (2018) [64]	96 of 100 (96.0%)	91 of 100 (91.0%)	5 of 100 (5.0%)	NA
du Plessis et al. (2018) [28]	6 of 16 (37.5%)	NA	NA	NA
Aurich et al. (2015) [3]	6 of 6 (100%)	NA	3 of 6 (50%)	NA
Colegate-Stone et al. (2015) [21]	≥50 of 56 (89%)	50 of 56 (89%)	NA	NA
Burkhardt et al. (2007) [17]	53 of 55 (96.4%)	NA	NA	NA
Arthroscopic Bristow–Latarjet procedure combined with Bankart repair				
Taverna et al. (2018) [68]	≥8 of 12 (66.6%)	8 of 12 (66.6%)	NA	NA
Boileau et al. (2014) [14]	≥58 of 64 (90.6%)	58 of 64 (90.6%)	NA	NA

Bristow procedure				
Regan et al. (1989) [61]	5 of 9 (55.6%)	3 of 9 (33.3%)	2 of 9 (22.2%)	NA
Halley et al. (1975) [36]	21 of 21 (100%)	NA	NA	NA
Bristow procedure with Bankart repair				
Kawasaki et al. (2018) [43]	≥ 142 of 152 (93.4%)	142 of 152 (93.4%)	NA	NA
Tasaki et al. (2016) [67]	38 of 38 (100%)	38 of 38 (100%)	NA	NA
Yamashita et al. (2002) [70]	67 of 72 (93.1%)	40 of 72 (55.6%)	27 of 72 (37.5%)	NA
Modified Bristow repair				
Banas et al. (1993) [5]	62 of 62 (100%)	42 of 62 (67.7%)	20 of 62 (32.3%)	NA
Schauder et al. (1992) [65]	10 of 12 (83.3%)	NA	NA	NA
Brady et al. (1985) [16]	14 of 16 (87.5%)	NA	NA	NA
Nielsen et al. (1982) [57]	11 of 17 (64.7%)	11 of 17 (64.7%)	NA	NA
Lombardo et al. (1976) [48]	≥ 0 of 44 (0%)	0 of 44 (0%)	NA	NA

NA not applicable

Table 2 Studies comparing the rate of return to sport after coracoid bone block procedure with rates after other interventions, shown in reverse order of publication date

Study	Coracoid bone block procedure	Number and percentage of subjects returning to sport after coracoid bone block procedure	Comparator intervention	Number and percentage of subjects returning to sport after comparator intervention	p value (if reported)
De Carli et al. (2018) [25]	Open Latarjet	36/40 (90.0%)	Open capsuloplasty	24/30 (80.0%)	> 0.05
Jeon et al. (2018) [42]	Arthroscopic Latarjet	30/31 (96.8%)	Arthroscopic Bankart	111/118 (94.1%)	> 0.05
Zimmermann et al. (2016) [71]	Open Latarjet	~ 68/93 (73.1%)	Arthroscopic Bankart	~ 166/271 (61.3%)	0.045
Blonna et al. (2016) [11]	Open Latarjet	25/30 (83.3%)	Arthroscopic Bankart	27/30 (90%)	> 0.05
Bessière et al. (2014) [9]	Open Latarjet	85/88 (96.6%)	Arthroscopic Bankart	77/91 (84.6%)	
Khan et al. (2014) [45]	Open Latarjet	24/26 (92.3%)	Conservative treatment	12/20 (60%)	
Bessiere et al. (2013) [8]	Open Latarjet	≥ 46/50 (92%)	Arthroscopic Bankart	≥ 43/49 (87.8%)	
Regan et al. (1989) [61]	Bristow	5/9 (55.6%)	Magnuson–Stack	6/8 (75%)	
			Putti–Platt	4/8 (50%)	

Table 3 Post-operative complications after coracoid bone block transfer procedure

Study	Complication rate	Post-operative complication/number
Rossi et al. (2018) [64]	13/100 (13.0%)	Non-union (no evidence of graft consolidation)/8 Loose screw/1 Symptomatic intra-articular screw/1 Post-operative infection/2 Superficial wound infection/1
De Carli et al. (2018) [25]	8/40 (20.0%)	Positive apprehension test/2 Positive anterior drawer test/6
Jeon et al. (2018) [42]	0/31 (0%)	None
Taverna et al. (2018) [68]	2/26 (7.7%)	Hematoma/2
Baverel et al. (2018) [6]	0/110 (0%)	None
Privitera et al. (2018) [58]	1/73 (1.4%)	Occasional paresthesia/1
Ranalletta et al. (2018) [59]	8/65 (12.3%)	Graft-related complication/5 Pain in abduction-external rotation/1 Septic arthritis/1 Superficial wound infection/1
Kawasaki et al. (2018) [43]	30/176 (17.0%)	Non-union of the transferred coracoid process/19 Surgical-site infections/3 Severe contracture/3 Coracoid detachment/4 Axillary nerve palsy/1
du Plessis et al. (2018) [28]	5/29 (17.2%)	Graft-related complications/2 Neurologic complications/2 Superficial wound infection/1
Elganainy et al. (2017) [33]	1/23 (4.3%)	Superficial infection/1
Vadalà et al. (2017) [69]	4/24 (16.7%)	Superficial infection/4
Zimmermann et al. (2016) [71]	3/93 (3.2%)	Post-operative hematoma/1 Surgical hardware irritation/1 Superior labral anterior to posterior tear/1 Post-operative hematoma/2
Blonna et al. (2016) [11]	2/30 (6.7%)	None
Bohu et al. (2016) [12]	0/46 (0%)	None
Dauzère et al. (2016) [23]	5/68 (7.4%)	Hematoma/4 Nerve injury/1
da Silva et al. (2015) [22]	4/52 (7.7%)	Pseudoarthrosis without instability/3 Early loosening of synthesis material/1
Aurich et al. (2015) [3]	0/6 (0%)	None
Boileau et al. (2015) [13]	0/76 (0%)	None
Cho et al. (2015) [20]	5/35 (14.3%)	Fibrotic unions/2 Impingement of screws with severe osteoarthritic change/1 Transient neurological injury/1 Post-operative stiffness/1 Hematoma/1
Ropars et al. (2016) [63]	1/79 (1.3%)	Hematoma/1
Tasaki et al. (2016) [66]	5/40 (12.5%)	Complete detachment of transplanted bone from glenoid/2 Non-union of grafted bone/3 Musculocutaneous nerve paresis/1 Wound hematoma/1 Infection secondary to <i>Staphylococcus warneri</i> /1 Hardware removal necessary/1
Colegate-Stone et al. (2015) [21]	4/56 (7.1%)	Post-operative hematoma/3 Post-operative hematoma along the axillary fold/1 Transient musculocutaneous nerve palsy/1
Dumont et al. (2014) [29]	3/64 (4.7%)	Complex regional pain syndrome/1
Boileau et al. (2014) [14]	2/70 (2.9%)	Post-operative infection/1 Transient lesion of the musculocutaneous nerve/1 Superficial vein thrombosis/1
Bouju et al. (2014) [15]	1/70 (1.4%)	None
Holzer et al. (2013) [38]	3/148 (2.0%)	Bone block fracture observed 3 months post-operatively/3 Hematoma/2 Transient musculocutaneous nerve palsy/1
Edouard et al. (2012) [31]	0/20 (0%)	Superficial scar infection/1
Neyton et al. (2012) [56]	3/37 (8.1%)	Hematomas/2 Loose hardware/2 Fibrous union of the bone graft/1
Lafosse et al. (2010) [46]	3/100 (3.0%)	Hematoma/1 Suspected transplant in joint/1
Doursounian et al. (2009) [27]	1/34 (2.9%)	None
Burkhart et al. (2007) [17]	5/102 (4.9%)	None
Hovellius et al. (2004) [39]	2/118 (1.7%)	None
Yamashita et al. (2002) [70]	0/126 (0%)	None

Allain et al. (1998) [1]	5/58 (8.6%)	Post-operative infection/3 Frozen shoulder/1 Humeral fracture/1
Banas et al. (1993) [5]	4/79 (5.1%)	Musculocutaneous nerve paresthesias/2 Hematoma/1 Transient rotator cuff tendinitis/1
Matton et al. (1992) [50]	10/30 (33.3%)	Neural damage/1 Infection/3 Stiffness/5 Complication related to implant/1
Braly et al. (1985) [16]	3/20 (15.0%)	Screw avulsion or partial fracture of transplanted coracoid/2 Symptomatic screw/1
Nielsen et al. (1982) [57]	8/17 (47.1%)	Non-union with screw-related complications/4 (screw loosening/2; fractured screw/2)
Lombardo et al. (1976) [48]	3/51 (5.9%)	Bone block fracture intra-operatively/1 Pulmonary embolus/1 Hematoma/1
Halley et al. (1975) [36]	1/24 (4.2%)	Superficial wound infection/1

sport as return to sport at the pre-operative level of competition only, whereas others defined it as return to any sport at any level. Among the 52 studies we reviewed, nine did not report return to general sport but rather return to sport specifically at the pre-operative level [7, 13, 14, 21, 23, 33, 43, 48, 68]. Since the rate of return to general sport was unavailable in these studies, we used the available reported proportions when calculating the cumulative proportion. Had these studies reported return to any sport at any level, the cumulative proportion of return to sport in general might have been higher. Additionally, more than 70% of patients returned to sport in all but seven studies [28, 33, 43, 55, 57, 61, 68]. These differences may also affect the calculated reported proportion. Furthermore, although the general return to sport rate is high, the rate of return to sport at pre-operative level was lower (70.3%, 1387 of 1974 patients). This proportion should also be considered when reporting the return to sport rate after surgery.

Our review shows the rate of return to general sport and to sport at the pre-operative level to be higher after the Latarjet procedure than after the Bristow procedure (return to general sport, 89.4 vs. 83.5%, respectively; return to sport at the pre-operative level, 70.3 vs. 70.1%, respectively). Additionally, we found higher rates of return to sport after arthroscopic Latarjet procedure (96.9%, 310 of 320) than after open Latarjet procedure (87.8%, 1110 of 1264). Because of the lack of comparative studies, formal statistical analysis was not possible, and this comparative assessment should be viewed with caution. A recent meta-analysis performed by Hurley et al. compared arthroscopic and open Latarjet procedures [40]. It was reported that the open Latarjet procedure resulted in a significantly lower rate of persistent apprehension around shoulder movement, as compared with the arthroscopic variation (10.2% vs. 35.7%) [40]. Consequently, the use of the open Latarjet procedure may translate to a higher rate of return to sport, particularly among collision athletes.

Of particular interest is the use of the Latarjet procedure in treating collision athletes. Kee et al. differentiated return to sport in collision athletes from that in noncollision athletes after Latarjet procedure [44]. At final follow-up, 96.4% of all patients (54 of 56 patients) returned to sport, with 16.1% (nine of 56 patients) returning to sport at the pre-operative level. However,

the rate of return to sport among noncollision athletes was significantly higher than among collision athletes. Among collision athletes, 93.1% (27 of 29 patients) returned to sport, with 3.4% (1 of 29 patients) returning to their pre-operative competition level; in the group of noncollision athletes, 100% (27 of 27 patients) returned to sport, with 29.6% (8 of 27 patients) returning to pre-operative level. Nonetheless, the mean visual analog scale, Rowe, and University of California at Los Angeles shoulder scale scores improved significantly in both groups, with no statistically significant differences between them. These findings suggest that noncontact athletes treated with the Latarjet procedure may have a higher likelihood of returning to sport.

Patient perception and motivation may play critical roles in returning to play. Mancuso et al. reported on expectations in patients undergoing shoulder surgery [49]. The most prevalent expectation of patients is return to sport; psychosocial expectations include physical function and psychological well-being (resuming a normal life). The review found the rate of return to sport to be higher in patients participating in competitive sports before injury. Ranalletta et al. reported that patients did not return to sport at the pre-operative level because they lacked confidence or feared re-injury [59]. These findings may explain why return to sport was highest in studies with athletes, who presumably have greater motivation to return to their previous level of athletic ability.

Although the rate of return to sport was high in our review, many complications were reported. The overall post-operative complication rate was 6.46% (158 of 2446 patients), and the most frequently reported post-operative complications were non-union, hematoma, infection, hardware-associated complications, and neurologic complications. Therefore, although the rate of return to sport may be high, the possibility of post-operative complications must also be taken into consideration.

Limitations

This systematic review is limited by the level of evidence of the included studies because the studies were primarily retrospective observational or case series. The dates of publication also ranged over more than 40 years (1975 to 2019), with earlier studies employing different techniques. The earlier techniques would logically be associated with different rates of return to sport. Additionally, many studies lacked

a comparative group, precluding any formal meta-analysis. Furthermore, significant heterogeneity was present among the included studies, particularly with respect to outcome reporting. Large high-quality randomized trials are necessary to determine the optimal treatment for recurrent shoulder instability. This review also highlights the need for consistent outcome reporting after shoulder stabilization surgery.

Conclusion

Coracoid bone block transfer allows for a high rate of return to sport. However, the rate of return to sport at pre-operative levels is not as high. The rate of return to sport may be higher with the Latarjet procedure than with the Bristow procedure. Additionally, arthroscopic Latarjet surgery may result in a higher rate of return to sport than does open Latarjet surgery. The rate of return to sport following the

Latarjet procedure was higher in comparison with arthroscopic Bankart repair. Additionally, various clinical outcome measures showed improvements following coracoid bone block transfer. Common post-operative complications include non-union between bone block and glenoid, hematoma, and infection.

Compliance with Ethical Standards

Conflict of Interest: Ibrahim M. Nadeem, BHSc, candidate, Seline Vancolen, BHSc, candidate, Nolan S. Horner, MD, Asheesh Bedi, MD, Bashir Alolabi, MD, MSc, FRCSC, and Moin Khan, MD, MSc, FRCSC, declare that they have no conflicts of interest.

Human/Animal Rights: NA

Informed Consent: NA

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

Appendix

Table 4 Databases searched and strategies used to identify studies ($N = 1619$)

MEDLINE: 505 identified	Embase: 587 identified	PubMed: 527 identified
Search strategies: 1. Athletes/ or Athlet*.mp. 2. Sports/ or Sport*.mp. 3. Return to play.mp. 4. Return to sport.mp. or Return to Sport/ 5. Shoulder/ or Shoulder*.mp. 6. Dislocation.mp. or Shoulder Dislocation/ 7. Instability.mp. 8. Stabilization.mp. 9. Latarjet*.mp. 10. Bristow*.mp. 11. Bristow-Latarjet procedure.mp. 12. 6 or 7 or 8 13. 5 and 12 14. 1 or 2 or 3 or 4 or 13 15. 9 or 10 or 11 16. 14 and 15	Search strategies: 1. Athlete/ or Athlet*.mp. 2. Sport/ or Sport*.mp. 3. Return to play.mp. 4. Return to sport.mp. or Return to Sport/ 5. Shoulder/ or Shoulder*.mp. 6. Dislocation.mp. or Shoulder Dislocation/ 7. Instability.mp. 8. Stabilization.mp. 9. Latarjet*.mp. 10. Bristow*.mp. 11. Bristow-Latarjet procedure.mp. 12. 6 or 7 or 8 13. 5 and 12 14. 1 or 2 or 3 or 4 or 13 15. 9 or 10 or 11 16. 14 and 15	Search strategies: (athlete OR sport OR return to play OR return to sport OR (shoulder AND (dislocation OR instability OR stabilization))) AND (Latarjet OR Bristow OR Bristow-Latarjet procedure)

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