

Comparison Between Modified Latarjet Performed as a Primary or Revision Procedure in Competitive Athletes

A Comparative Study of 100 Patients With a Minimum 2-Year Follow-up

Luciano A. Rossi,^{*†} MD, Agustin Bertona,[†] MD, Ignacio Tanoira,[†] MD, Gastón D. Maignon,[†] MD, Santiago L. Bongiovanni,[†] MD, and Maximiliano Ranalletta,[†] MD

Investigation performed at the Hospital Italiano de Buenos Aires, Buenos Aires, Argentina

Background: The literature lacks evidence comparing outcomes between the Latarjet procedure performed as a primary procedure versus a revision procedure in competitive athletes.

Purpose: To compare return to sport, functional outcomes, and complications of the modified Latarjet performed as a primary or revision procedure in competitive athletes.

Study Design: Cohort study; Level of evidence, 3.

Methods: Between June 2008 and June 2015, a total of 100 competitive athletes with recurrent anterior shoulder instability underwent surgery with the congruent arc Latarjet procedure without capsulolabral repair. There were 46 patients with primary repairs and 54 with revisions. Return to sport, range of motion (ROM), the Rowe score, a visual analog scale (VAS) for pain in sport activity, and the Athletic Shoulder Outcome Scoring System (ASOSS) were used to assess functional outcomes. Recurrences were also evaluated. The postoperative bone block position and consolidation were assessed by computed tomography.

Results: The mean follow-up period was 58 months (range, 24-108 months). A total of 96 patients (96%) returned to competitive sports; 91% returned to their preinjury level of play. No significant difference in shoulder ROM was found between preoperative and postoperative results. The Rowe, VAS, and ASOSS scores showed statistically significant improvements after surgery ($P < .001$). The Rowe score increased from a preoperative mean of 43.8 to a postoperative mean of 96.1 ($P < .01$). Subjective pain during sports improved from a preoperative VAS score of 3.3 to a postoperative score of 1.2 ($P < .01$). The ASOSS score improved significantly from a preoperative mean of 46.3 to a postoperative mean of 88.1 ($P < .001$). No significant differences in shoulder ROM and functional scores were found between patients who underwent a primary versus a revision procedure. No recurrence of shoulder dislocation or subluxation was noted. The bone block healed in 91 patients (91%).

Conclusion: In competitive athletes with recurrent anterior glenohumeral instability, the modified Latarjet procedure produced excellent functional outcomes, with most athletes returning to sport at the same level they had before surgery and without recurrence, regardless of whether the surgery was performed as a primary or a revision procedure.

Keywords: recurrent glenohumeral instability; modified Latarjet; competitive athletes; primary and revision procedures

Following an initial shoulder dislocation, an osseous defect is present in up to 22% of patients and up to 89% of patients with recurrent instability.^{9,34} Glenoid bone loss is a recognized cause of recurrent shoulder dislocation or poorer functional outcomes after an arthroscopic or open soft tissue repair for glenohumeral instability.^{9,21,24,34} Consequently,

the high recurrence rates seen in the presence of significant glenoid bone loss have led many surgeons to choose bony reconstructions to manage these injuries.^{7,30,31}

The Latarjet procedure has proved to be reliable in managing recurrent anterior shoulder instability with significant glenoid bone loss, both as a primary and a revision procedure in the general population.^{2,6,30} However, little information is found in the literature regarding the functional results and complications of this procedure in competitive athletes.^{3,4,10,22,23} Patients who are competitive

The Orthopaedic Journal of Sports Medicine, 6(12), 2325967118817233

DOI: 10.1177/2325967118817233

© The Author(s) 2018

This open-access article is published and distributed under the Creative Commons Attribution - NonCommercial - No Derivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits the noncommercial use, distribution, and reproduction of the article in any medium, provided the original author and source are credited. You may not alter, transform, or build upon this article without the permission of the Author(s). For article reuse guidelines, please visit SAGE's website at <http://www.sagepub.com/journals-permissions>.

athletes present a special challenge for the shoulder surgeon. One of the main expectations of most athletes, whatever their age or level of play, is to return to sports as soon as possible and at the same level as before the injury. For this reason, the surgical procedure chosen to manage these high-demand patients should achieve a stable shoulder and result in a reliable and timely return to play. In patients with multiple recurrences and previous surgeries, the antero-inferior labrum and capsule are often very deficient or almost destroyed. Furthermore, the presence of previous anchors and scar tissue may result in a higher complication rate and could jeopardize results.

We are not aware of any large series in the literature comparing the outcomes of the modified Latarjet performed as a primary versus a revision procedure in competitive athletes. The purpose of this study was to compare return to sport, functional outcomes, and complications of the modified Latarjet performed as a primary or a revision procedure in competitive athletes. We hypothesized that both the primary and the revision procedures would achieve a stable shoulder in competitive athletes who had recurrent shoulder instability, resulting in a reliable and timely return to play with a low rate of recurrence.

METHODS

Between June 2008 and June 2015, a total of 105 competitive athletes with recurrent anterior shoulder instability underwent surgery with the congruent arc Latarjet procedure without capsulolabral repair in our institution. This cohort formed the basis of this retrospective, consecutive case series.

All the included patients were competitive athletes³³ (practice >2 times per week and competition during week-ends) who had a glenoid bone defect greater than 20% shown on the preoperative computed tomography (CT) scan prior to the Latarjet procedure. We excluded patients who had other types of instability (eg, posterior or voluntary), who had glenoid bone loss less than 20% (treated with revision arthroscopic Bankart), or in whom clinical or radiographic evaluations were absent at final follow-up. The ethics committee of our institution approved this study.

Evaluation

Preoperative and postoperative evaluation consisted of a patient-based questionnaire and a physical examination performed by a shoulder fellow (L.A.R.) who did not participate in the surgery. On preoperative examination, all patients had positive results on anterior apprehension and relocation tests. We also evaluated range of motion (ROM)

and strength. Patients were contacted and examined at a minimum 24 months of follow-up.

All patients were studied before surgery with anteroposterior views and axillary glenohumeral views, magnetic resonance imaging (MRI), and CT with 3-dimensional reconstruction (3D-CT). The preoperative glenoid bone loss was measured by use of the glenoid index method according to Chuang et al.¹¹ The distinctive types of shoulder-dependent sport were subdivided in an analog manner according to Allain et al¹: noncollision/nonoverhead shoulder sport (G1), high-impact/collision sport (G2), overhead sport (G3), and martial arts sport (G4). Postoperatively, patients were asked whether they had been able to practice sports again and whether they had been able to perform their sports at the same level they had prior to the injury. We also asked patients who did not return to sports the reasons for cessation.

The Rowe score²⁷ was used as a global outcome measure. A visual analog scale (VAS) was used to assess "pain while performing sport" (ranging from a maximum score of 10 to a minimum of 0). Shoulder-dependent sport ability was measured with the Athletic Shoulder Outcome Scoring System (ASOSS).³³ This score measures subjective sport-specific perceptions of pain, instability, muscular strength and endurance, intensity, and proficiency level, with each point graduated and compared with the time before injury (defined as 100%). The ROM was objectively recorded and compared with that in the untreated shoulder.

The postoperative bone block position and consolidation were assessed with 3D-CT at 3 months postoperatively. In accordance with Burkhart and De Beer⁹ and Kany et al,¹⁸ we considered that accurate positioning of the bone block was reached when values of medialization and lateralization of the bone block were within -5 mm and +3 mm, respectively. Osteoarthritis was graded according to the classification of Samilson and Prieto.²⁸ All surgery-related complications and reoperations were documented.

Surgical Technique

During the surgical procedure, patients received combined anesthesia (regional blockade plus general anesthesia) and were placed in the beach-chair position. The incision was vertical from the tip of the coracoid process and was 5 cm long. The deltopectoral interval was developed; the coracoid was exposed from its tip to the insertion of the coracoclavicular ligaments at the base of the coracoid; and the coracoacromial ligament and the pectoralis minor were cut at the insertion on the coracoid process. The coracoid process underwent osteotomy at the junction between the horizontal part and vertical part. The pectoralis minor was reinserted in the scapula at the level of the osteotomy with a 5-mm suture anchor. The coracoid graft was then rotated

*Address correspondence to Luciano A. Rossi, MD, Peron 4190 (C1199ABB), Buenos Aires, Argentina (email: luciano.rossi@hospitalitaliano.org.ar).

[†]Department of Orthopedics and Traumatology, Prof. Dr. Carlos E. Ottolenghi, Hospital Italiano de Buenos Aires, Buenos Aires, Argentina.

The authors declared that there are no conflicts of interest in the authorship and publication of this contribution. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

Ethical approval for this study was obtained from the Hospital Italiano de Buenos Aires.

on its longitudinal axis by 90°, such that the original medial surface was facing the glenoid neck. The medial cortex of the graft was removed with a saw blade. The subscapularis muscle was divided in line with the fibers at the two-thirds superior–one-third inferior junction to expose the anterior capsule, which was divided in the same manner. The anterior glenoid neck was then prepared with a saw blade to be the recipient bed for the coracoid bone graft. The coracoid bone graft was positioned such that the original medial surface of the coracoid was now flat against the glenoid neck and was temporarily stabilized with 2-mm pins. The inferior hole was drilled through the graft and through the glenoid, and the coracoid was fixed with a single screw so that it lay flush with the glenoid joint line. A second screw 1 cm proximal from the inferior one was used to complete graft fixation. In all patients, 2 partially threaded cannulated cortical screws (3.5 mm diameter) were used. We did not attempt to repair the capsulolabral complex. We did not perform remplissage or any other procedure in the presence of a concomitant Hill-Sachs lesion.

Postoperative Rehabilitation

The arm was supported in a sling for 4 weeks. All patients followed a standard postoperative rehabilitation protocol supervised by one of the authors (M.R.). After 1 week, supervised gentle physical therapy consisting of passive pendulum and gradual passive ROM was begun. Active-assisted ROM exercises were started 2 weeks after surgery. When the patient could perform active forward elevation above the shoulder level, strengthening exercises were started. Running was authorized at 8 weeks. Return to sports was allowed when the patient was pain free, full shoulder ROM had been achieved, and shoulder strength was near the preinjury level.

Statistical Method

Preoperative and postoperative outcome scores were compared with the paired *t* test for independent samples. Continuous variables are presented as means \pm SDs; categorical variables are presented as absolute and relative frequencies. Statistical analysis was performed by use of independent Student *t* test with a 95% CI to calculate the differences in ROM and functional scores between the groups. The statistical analysis was performed with STATA version 12 (Stata Corp). A *P* value less than .05 was considered statistically significant.

RESULTS

Five patients were lost to follow-up; thus, the final analysis entailed 100 shoulders in 100 patients (95% follow-up). The 5 patients lost to follow-up had surgery during the study period but did not have a minimum 2 years of follow-up. Despite our best efforts we could not contact them, so they were excluded from the study.

TABLE 1
Patient Demographics

Variable	Primary (46 Shoulders)	Revision (54 Shoulders)
Sex, men/women, n	40/6	52/2
Dominant involvement, n (%)	26 (57)	33 (61)
Age at the time of surgery, y, mean (range)	25.7 (17-46)	27.3 (17-50)
Type of previous surgery, n		
Open Bankart repair		10/68
Arthroscopic Bankart repair		44/68
Revision arthroscopic Bankart repair		14/68
No. of previous operations, mean (range)		1.26 (1-3)
Glenoid bone loss, % (range)	25 (20-36)	26 (20-38)
Type of sport, n		
G1: noncollision/nonoverhead sport	8	8
G2: high-impact/collision sport	27	34
G3: overhead sport	5	8
G4: martial arts sport	6	4

TABLE 2
Summary of Functional Outcomes and Return to Sport^a

Variable	Preoperative	Postoperative	<i>P</i>
Rowe score	43.8 \pm 1	96.1 \pm 5	<.001
Visual analog scale	3.3 \pm 1	1.2 \pm 1	<.001
Athletic Shoulder Outcome Scoring System	46.3 \pm 5	88.1 \pm 3	<.001
Forward flexion, deg	169.3 \pm 3	169.2 \pm 3	NS
External rotation in 90° of abduction, deg	66.4 \pm 2	64.1 \pm 3	NS
Internal rotation in adduction	T5/T6	T5/T6	
Return to sports, n (%)		96/100 (96)	
Return to same level, n (%)		91/100 (91)	

^aValues are expressed as mean \pm SD unless otherwise indicated. NS, not significant.

The mean follow-up period was 58 months (range, 24-108 months). No significant differences were found between groups regarding demographic and injury characteristics (Table 1). Overall, 96 patients (96%) were able to return to sports, and 91 (91%) returned at the same level as before the injury (Table 2). No significant difference regarding return to sports was found between patients who underwent a primary procedure and those who had a revision procedure (Table 3).

Four patients (4%) did not return to sports after the procedure. These 4 patients did not feel psychologically confident and/or they feared they would experience another injury. Five patients (5%) returned to sports at a lower level than before their injury. Although they had good functional

TABLE 3
Comparative Outcomes Between Primary and Revision Procedures^a

Variable	Total Sample		Primary Procedures		Revision Procedures	
	Pre	Post	Pre	Post	Pre	Post
Rowe score	43.8 ± 1	96.1 ± 5	43.7 ± 1	95.3 ± 5	43.9 ± 1	96.8 ± 4
Visual analog scale	3.3 ± 1	1.2 ± 1	3.6 ± 2	1.3 ± 1	3.1 ± 1	1.2 ± 1
Athletic Shoulder Outcome Scoring System	46.3 ± 5	88.1 ± 3	45.8 ± 5	88.1 ± 3.47	46.7 ± 5	88.1 ± 3
Forward flexion, deg	169.3 ± 3	169.2 ± 3	168.7 ± 2	168.7 ± 4	169.8 ± 3	169.3 ± 3
External rotation in 90° of abduction, deg	66.4 ± 2	64.1 ± 3	65.7 ± 2	65.1 ± 2	65.4 ± 2	64.9 ± 2
Internal rotation in adduction	T5/T6	T5/T6	T5/T6	T5/T6	T5/T6	T5/T6
Return to sport, n (%)		96/100 (96)		42/46 (91)		54/54 (100)
Return to same level, n (%)		91/100 (91)		40/46 (87)		51/54 (94)

^aValues are expressed as mean ± SD unless otherwise indicated. Post, postoperative; Pre, preoperative.

TABLE 4
Results of Time to Return to Sport and Functional Scores by Type of Sport and Type of Surgery^a

Surgery	Sport Classification (No. of Athletes)	Return to Sports, mo	Rowe Score ^b	ASOSS ^b
Primary	G1: noncollision/nonoverhead sport (8)	3.7 ± 1	51.4 ± 1	42.5 ± 2
	G2: high-impact/collision sport (27)	5.1 ± 1	50.3 ± 1	41.6 ± 7
	G3: overhead sport (5)	5.4 ± 2	55.0 ± 1	41.8 ± 2
	G4: martial arts sport (6)	5.8 ± 1	54.1 ± 8	45.6 ± 3
Revision	G1: noncollision/nonoverhead sport (8)	3.3 ± 1	55.6 ± 1	41.1 ± 4
	G2: high-impact/collision sport (34)	5.3 ± 1	52.5 ± 1	41.1 ± 7
	G3: overhead sport (8)	5.2 ± 1	48.7 ± 2	43.6 ± 4
	G4: martial arts sport (4)	5.0 ± 2	58.7 ± 6	40.2 ± 3
		<i>P</i> = NS	<i>P</i> = NS	<i>P</i> = NS

^aValues are expressed as mean ± SD. ASOSS, Athletic Shoulder Outcome Scoring System; NS, not significant.

^bExpressed as the average improvement in the score.

scores, these 5 patients reported a decrease in their sports performance.

The mean interval between surgery and return to competition was 4.9 months (range, 3-9 months). No significant differences were found between patients with primary and revision procedures. Regarding type of sports, patients belonging to group G1 (noncollision/nonoverhead sport) returned significantly faster to sports than other patients ($P < .001$). However, the final functional outcomes were not related to the type of sport (Table 4).

No significant difference in shoulder ROM was found between preoperative and postoperative results (Table 2). The Rowe, VAS, and ASOSS scores showed statistically significant improvements after surgery ($P < .01$). Specifically, the Rowe score increased from a preoperative mean of 43.8 points to a postoperative mean of 96.1 ($P < .01$). Subjective pain during sports improved from a preoperative VAS score of 3.3 to a postoperative score of 1.2 ($P < .01$). The ASOSS score improved significantly from a preoperative mean of 46.3 to a postoperative mean of 88.1 ($P < .001$) (Table 2). No significant differences in shoulder ROM and functional scores were found between patients with primary procedures and those with revision procedures (Table 3).

Imaging Results

All patients were evaluated with 3D-CT. The postoperative 3D-CT was performed at a mean of 3.4 months after surgery (range, 3-6 months). The bone block healed in 91 patients (91%). In 8 patients (8%), no evidence of consolidation was observed, and in 1 patient the graft was fragmented. In accordance with Kany et al,¹⁸ in the axial view, 91% (91/100 patients) were within the target range (-5 to +3 mm). In contrast, 5% (5/100 patients) were considered lateralized and 3% (3/100 patients) were considered medialized. At the final follow-up, 11 shoulders (11%) were graded as having mild (stage 1) osteoarthritis and 4 shoulders (4%) with moderate osteoarthritis. No cases of severe arthritis were observed in this study (Table 5). No significant difference in graft consolidation and glenohumeral arthritis was found between patients with primary procedures and those with revision procedures (Table 5).

Complications

There were 13 complications (13%) and 3 reoperations (3%). In 8 patients, no evidence of graft consolidation was observed (3 primary and 5 revision procedures), and in 1 patient the graft was fragmented. All of these patients were

TABLE 5
Imaging Results: Comparative Outcomes
Between Primary and Revision Procedures

	Total	Primary	Revision
Graft consolidation, n (%)	91/100 (91)	42/46 (91)	49/54 (91)
Graft position			
Normal, n (%)	91/100 (91)	41/46 (89)	50/54 (93)
Abnormal, n			
Lateral	5	3	2
Medial	3	2	1
Fragmented	1	0	1
Glenohumeral arthritis, n (%) ^a			
Mild	10/100 (10)	4/46 (9)	6/54 (11)
Moderate	4/100 (4)	2/46 (4)	2/54 (4)
Severe	0	0	0

^aAccording to Samilson and Prieto²⁸ classification.

treated conservatively with no evidence of screw loosening at the last follow-up, suggesting a fibrous union between the graft and the glenoid. One athlete reported pain 2 months after surgery during the rehabilitation. The imaging studies showed a loose screw, which was replaced arthroscopically with a longer screw. The graft consolidated 2 months later. One athlete had reoperation at 4 months after surgery because of a symptomatic intra-articular screw. The graft was consolidated, so the screw was removed arthroscopically. Two patients developed postoperative infections. At 3 weeks after surgery, 1 patient developed septic arthritis that was treated successfully with an open lavage and 6 weeks of intravenous antibiotics. The other athlete had a superficial wound infection that responded favorably to 2 weeks of oral antibiotics. All of these patients resumed sports without any limitations.

No recurrence of shoulder dislocation or subluxation was noted in any of the patients. No temporary or permanent nerve injuries were seen.

DISCUSSION

The main findings of this study were that in competitive athletes with recurrent anterior glenohumeral instability, the modified Latarjet procedure resulted in excellent functional outcomes, with most of the patients returning to sport at their preinjury level and with no recurrences at a mean follow-up of 58 months. The results were equally favorable in primary and revision procedures.

In our study, 96% of the patients were able to return to sports, and 91% returned at the same level as before the injury. Interestingly, no significant differences were noted regarding return to sports and the level achieved by the athletes when we compared primary procedures and revision procedures. However, most patients in our revision group had only 1 prior procedure (mean of 1.26 procedures). Privitera et al²³ recently reported the results of the Latarjet procedure for recurrent anterior glenohumeral instability in 73 contact or collision athletes. The investigators found that at a mean follow-up of 52 months, the rate of return to

sport was similar when the Latarjet procedure was performed as a primary stabilization procedure (72%) and when it was performed for patients with only 1 prior stabilization procedure (75%). However, for athletes with more than 2 prior stabilization procedures, the return to sport rate was significantly lower (39%). Although a trend to reduced rate of return to sport and reduced return to preinjury level was noted in the "primary" group, the 4 patients who did not return to sports reported reasons unrelated to the shoulder, such as fear of reinjury.

Beranger et al⁴ evaluated return to sports in 47 athletes after the Bristow-Latarjet procedure at a minimum 2-year follow-up. In that study, 100% of patients returned to sports and 63% returned to the same sport at the same level. However, none of the included patients underwent a revision procedure. An important finding of the Beranger et al⁴ study is that the rate of return to sport was high even in the most risky sports. In our series, 71% of patients participated in collision sport (G2) or martial arts (G4). Previous authors have also reported high rates of return to sport in collision (G2) athletes, ranging between 65% and 97%, with the Latarjet procedure indicated as a primary surgery.^{4,11,21,26,29} However, none of these studies included patients who underwent a revision procedure. Regarding the postoperative level of sport achieved after surgery, only 5% of our patients noticed a decrease in their sports performance. Conversely, other authors have reported that patients who practiced overhead sports were more likely to play at a lower level or to change sport postoperatively.⁴ Nevertheless, overhead sports represented only 13% of the athletes in our series.

The mean delay in return to competition was 4.9 months. As expected, we found that patients belonging to group G1 (noncollision/nonoverhead sports) returned to sports significantly faster than did the other patients ($P < .001$). The G1 category involves sports with a lower demand for the shoulder, and this could explain the faster return to sports in this subgroup of athletes. Finally, all patients in our study were competitive athletes. Previous authors have shown that functional outcomes were not as favorable in recreational athletes. Baverel et al³ retrospectively evaluated 106 competitive and recreational athletes who underwent an open Latarjet procedure for recurrent anterior glenohumeral instability at a minimum 2-year follow-up. The investigators found that 100% of competitive athletes resumed their previous sports practice, compared with only 69% of recreational athletes. Moreover, 79% of competitive athletes returned to their preinjury level or higher, compared with only 43% in the recreational group.

The general assessment of our patients revealed excellent functional outcomes, with a final Rowe score of 96 and a final VAS score of 1.2. These results are similar to those reported by other authors.^{4,5,9,11} Moreover, we evaluated shoulder-dependent sport ability with the ASOSS score, which showed an excellent final performance of the patients' shoulders after their return to sports. No significant difference in shoulder ROM and functional scores was found between patients with primary procedures and those with revision procedures.

The stability achieved with the modified Latarjet procedure was excellent. No recurrence of shoulder dislocation or subluxation was noted in any of the patients. We did not repair the capsulolabral tissue in any patient; some biomechanical and cadaveric studies have shown that the addition of a capsular repair did not result in significantly greater stability and that it could restrict external rotation relative to the Latarjet procedure performed without capsular repair.^{19,35} Although we did not repair the capsule in any patient, the results in our series were similar to those previously reported by other authors who repaired the capsule.^{10,12,22}

An important finding of our study was that the modified Latarjet was equally stable in primary procedures and revision procedures. Schmid et al³⁰ reported no recurrences with the Latarjet procedure for the treatment of anterior instability of the shoulder after a failed operative repair. However, athletes were not included in their series. In our study, all patients were competitive athletes, and a high percentage (71%) participated in high-risk activities such as martial arts and collision sports. Privitera et al²³ reported similar rates of recurrences for primary procedures and revision procedures. In their study, the redislocation rate was 7% for patients who underwent a primary procedure and 9% for those who underwent a revision procedure. A possible explanation for the absence of recurrences in our patients could be the persisting enlargement of the glenoid arc beyond native dimensions that is achieved with the congruent arc technique.⁹ Other authors who performed the same technique reported no recurrences in competitive athletes.^{9,13}

We did not perform any remplissage procedures in the presence of a concomitant Hill-Sachs lesion. Plath et al²⁵ demonstrated that the Latarjet procedure transformed “off-track” Hill-Sachs lesions into “on-track” Hill-Sachs lesions. Those authors showed that at a mean of 23 months postoperatively, a mean persisting enlargement of the glenoid arc of 14% beyond native dimensions remained, avoiding a recurrent off-track lesion in 32% of patients, which would otherwise have occurred with complete remodeling.

An important strength of our study was that the postoperative imaging evaluation of the coracoid graft consolidation and position was performed with 3D-CT. CT scanning is widely accepted as being an accurate method of assessing osseous consolidation and correct graft position.^{18,29} Samim et al²⁹ recently assessed coracoid graft union by CT in 41 consecutive patients treated with the open Latarjet procedure (37% primary, 63% revision) and found similar percentages of osseous union in the primary and revision Latarjet groups. In our study, the bone block was consolidated on CT scans in 91% of the total patient sample. Similar to Samim et al,²⁹ we found no significant difference in graft consolidation between patients who underwent a primary procedure and those who underwent a revision procedure; graft consolidation was 91% in both groups. Furthermore, the coracoid graft was accurately positioned in the axial plane in 91% of the patients, which is similar to the rates reported by previous authors using CT scans.^{8,18}

Regarding postoperative arthritis, long-term outcome studies have reported significant rates of glenohumeral

arthropathy after Latarjet procedures. Hovelius et al¹⁶ and Allain et al¹ examined 15-year results after the Latarjet procedure and reported 14% and 19% of moderate and severe osteoarthritis, respectively. Cadaveric biomechanical studies have shown that excessive lateralization of the coracoid graft with prominence beyond the glenoid margin results in abnormal glenohumeral contact pressures and may contribute to the progression of glenohumeral arthropathy.¹⁴ In our series, only 5% of the grafts were lateralized in the postoperative CT scans, and this could contribute to the low rate of patients with significant osteoarthritis. We had a relatively short minimum follow-up (24 months), and the incidence of degenerative articular findings may be higher with a longer follow-up. However, the development of dislocation arthropathy after the Latarjet procedure appears to be consistent with the natural history of glenohumeral instability¹⁷ and comparable with the results of soft tissue Bankart repair.¹⁶

Although the Latarjet procedure has proved to be reliable to manage recurrent anterior shoulder instability, concerns have arisen regarding a higher surgical complication rate associated with this procedure. The most common complications include infection, frozen shoulder, hematoma formation, symptomatic implants, fracture or non-union of the coracoid graft, neurological complications, arthritis, and recurrence of instability.^{13,15,32} However, a recent large review reported an overall complication rate of 15% for the open Latarjet procedure.²⁰ We found similar rates in our study, with 13 complications (13%) and 3 reoperations (3%). The complication rate was similar in patients with primary procedures and those with revision procedures, and most of the patients resumed sports without any restrictions.

Our study has several limitations. First, we did not have a control group and therefore could not compare our results with another surgical technique. Second, our series included a limited number of female athletes and overhead athletes. Third, although we included a large number of patients, we did not perform a sample size calculation and the study could be underpowered to detect a difference in some of the outcomes analyzed. Fourth, we had a relatively short minimum follow-up (24 months).

Despite these factors, we consider our findings particularly relevant given the limited data available in the literature comparing functional outcomes and complications of the modified Latarjet procedure performed as a primary versus a revision procedure in competitive athletes. Furthermore, the data from all treated patients were carefully collected, several validated shoulder scores were used to assess the results, and CT scans were used to assess bone graft consolidation and accurate position.

CONCLUSION

In competitive athletes with recurrent anterior glenohumeral instability, the modified Latarjet procedure produced excellent functional outcomes; most athletes returned to sport at their preinjury level without recurrences, regardless of whether the surgery was performed as a primary or a revision procedure.

REFERENCES

1. Allain J, Goutallier D, Glorion C. Long-term results of the Latarjet procedure for the treatment of anterior instability of the shoulder. *J Bone Joint Surg Am.* 1998;80:841-852.
2. An VV, Sivakumar BS, Phan K, Trantalis J. A systematic review and meta-analysis of clinical and patient-reported outcomes following two procedures for recurrent traumatic anterior instability of the shoulder: Latarjet procedure vs. Bankart repair. *J Shoulder Elbow Surg.* 2016; 25:853-863.
3. Baverel L, Colle PE, Saffarini M, Anthony Odri G, Barth J. Open Latarjet procedures produce better outcomes in competitive athletes compared with recreational athletes: a clinical comparative study of 106 athletes aged under 30 years. *Am J Sports Med.* 2018;46(6): 1408-1415.
4. Beranger JS, Klouche S, Bauer T, Demoures T, Hardy P. Anterior shoulder stabilization by Bristow-Latarjet procedure in athletes: return-to-sport and functional outcomes at minimum 2-year follow-up. *Eur J Orthop Surg Traumatol.* 2016;26:277-282.
5. Bessière C, Trojani C, Carles M, Mehta SS, Boileau P. The open Latarjet procedure is more reliable in terms of shoulder stability than arthroscopic Bankart repair. *Clin Orthop Relat Res.* 2014;472(8): 2345-2351.
6. Bhatia S, Frank RM, Ghodadra NS, et al. The outcomes and surgical techniques of the Latarjet procedure. *Arthroscopy.* 2014;30: 227-235.
7. Blonna D, Bellato E, Caranzano F, Assom M, Rossi R, Castoldi F. Arthroscopic Bankart repair versus open Bristow-Latarjet for shoulder instability: a matched-pair multicenter study focused on return to sport. *Am J Sports Med.* 2016;44(12):3198-3205.
8. Boileau P, Mercier M, Old J. Arthroscopic Bankart-Bristow-Latarjet (2B3) procedure: how to do it and tricks to make it easier and safe. *Orthop Clin North Am.* 2010;41:381-392.
9. Burkhart SS, De Beer JF. Traumatic glenohumeral bone defects and their relationship to failure of arthroscopic Bankart repairs: significance of the inverted-pear glenoid and the humeral engaging Hill-Sachs lesion. *Arthroscopy.* 2000;16:677-694.
10. Burkhart SS, De Beer JF, Barth JR, Cresswell T, Roberts C, Richards DP. Results of modified Latarjet reconstruction in patients with antero-inferior instability and significant bone loss. *Arthroscopy.* 2007;23: 1033-1041.
11. Chuang TY, Adams CR, Burkhart SS. Use of preoperative three-dimensional computed tomography to quantify glenoid bone loss in shoulder instability. *Arthroscopy.* 2008;24:376-382.
12. Colegate-Stone TJ, van der Watt C, de Beer JF. Evaluation of functional outcomes and complications following modified Latarjet reconstruction in athletes with anterior shoulder instability. *Shoulder Elbow.* 2015;7:168-173.
13. Domos P, Lunini E, Walch G. Contraindications and complications of the Latarjet procedure. *Shoulder Elbow.* 2018;10(1):15-24.
14. Ghodadra N, Gupta A, Romeo AA, et al. Normalization of glenohumeral articular contact pressures after Latarjet or iliac crest bone-grafting. *J Bone Joint Surg Am.* 2010;92: 1478-1489.
15. Griesser MJ, Harris JD, McCoy BW, et al. Complications and reoperations after Bristow-Latarjet shoulder stabilization: a systematic review. *J Shoulder Elbow Surg.* 2013;22:286-292.
16. Hovelius LK, Sandstrom BC, Rosmark DL, Saebo M, Sundgren KH, Malmqvist BG. Long-term results with the Bankart and Bristow-Latarjet procedures: recurrent shoulder instability and arthropathy. *J Shoulder Elbow Surg.* 2001;10:445-452.
17. Hovelius L, Saeboe M. Neer Award 2008: Arthropathy after primary anterior shoulder dislocation: 223 shoulders prospectively followed up for twenty-five years. *J Shoulder Elbow Surg.* 2009;18:339-347.
18. Kany J, Flamand O, Grimberg J, et al. Arthroscopic Latarjet procedure: is optimal positioning of the bone block and screws possible? A prospective computed tomography scan analysis. *J Shoulder Elbow Surg.* 2016;25:69-77.
19. Kleiner MT, Payne WB, McGarry MH, Tibone JE, Lee TQ. Biomechanical comparison of the Latarjet procedure with and without capsular repair. *Clin Orthop Surg.* 2016;8:84-91.
20. Longo UG, Loppini M, Rizzello G, Ciuffreda M, Maffulli N, Denaro V. Latarjet, Bristow, and Eden-Hybinette procedures for anterior shoulder dislocation: systematic review and quantitative synthesis of the literature. *Arthroscopy.* 2014;30:1184-1211.
21. Mologne TS, Provencher MT, Menzel KA, Vachon TA, Dewing CB. Arthroscopic stabilization in patients with an inverted pear glenoid: results in patients with bone loss of the anterior glenoid. *Am J Sports Med.* 2007;35(8):1276-1283.
22. Neyton L, Young A, Dawidziak B, et al. Surgical treatment of anterior instability in Rugby Union players: clinical and radiographic results of the Latarjet-Patte procedure with minimum 5-year follow-up. *J Shoulder Elbow Surg.* 2012;21:1721-1727.
23. Privitera DM, Sinz NJ, Miller LR, et al. Clinical outcomes following the Latarjet procedure in contact and collision athletes. *J Bone Joint Surg Am.* 2018;100(6):459-465.
24. Piasecki DP, Verma NN, Romeo AA, Levine WN, Bach BR Jr, Provencher MT. Glenoid bone deficiency in recurrent anterior shoulder instability: diagnosis and management. *J Am Acad Orthop Surg.* 2009;17(8):482-493.
25. Plath JE, Henderson DJH, Coquay J, Dück K, Haeni D, Lafosse L. Does the arthroscopic Latarjet procedure effectively correct "off-track" Hill-Sachs lesions? *Am J Sports Med.* 2018;46(1):72-78.
26. Ranalletta M, Rossi LA, Bertona A, et al. Modified Latarjet without capsulolabral repair in rugby players with recurrent anterior glenohumeral instability and significant glenoid bone loss. *Am J Sports Med.* 2018;46(4):795-800.
27. Rowe C, Patel D, Southmayd W. The Bankart procedure: a long-term end-result study. *J Bone Joint Surg Am.* 1978;60:1-16.
28. Samilson RL, Prieto V. Dislocation arthropathy of the shoulder. *J Bone Joint Surg Am.* 1983;65:456-460.
29. Samim M, Small KM, Higgins LD. Coracoid graft union: a quantitative assessment by computed tomography in primary and revision Latarjet procedure. *J Shoulder Elbow Surg.* 2018;27(8):1475-1482.
30. Schmid SL, Farshad M, Catanzaro S, Gerber C. The Latarjet procedure for the treatment of recurrence of anterior instability of the shoulder after operative repair: a retrospective case series of forty-nine consecutive patients. *J Bone Joint Surg Am.* 2012;94:e75.
31. Schrupf MA, Maak TG, Delos D, et al. The management of anterior glenohumeral instability with and without bone loss: AAOS exhibit selection. *J Bone Joint Surg Am.* 2014;96(2):e12.
32. Shah AA, Butler RB, Romanowski J, Goel D, Karadagli D, Warner JJ. Short-term complications of the Latarjet procedure. *J Bone Joint Surg Am.* 2012;94:495-501.
33. Stein T, Linke RD, Buckup J, et al. Shoulder sport-specific impairments after arthroscopic Bankart repair: a prospective longitudinal assessment. *Am J Sports Med.* 2011;39:2404-2414.
34. Sugaya H, Moriishi J, Dohi M, Kon Y, Tsuchiya A. Glenoid rim morphology in recurrent anterior glenohumeral instability. *J Bone Joint Surg Am.* 2003;85:878-884.
35. Yamamoto N, Muraki T, An KN, et al. The stabilizing mechanism of the Latarjet procedure: a cadaveric study. *J Bone Joint Surg Am.* 2013; 95(15):1390-1397.