Clinical and Radiographic Outcomes After Arthroscopic Inlay Bristow Surgery With Screw Versus Suture Button Fixation

A Comparative Study of 117 Patients With 3.3-Year Follow-up

Qingfa Song,* MD, Shuhan Zhang,* MD, Xu Cheng,* MD, Jian Xiao,* MD, Lin Lin,* MD, Qiang Liu,*† MD, PhD, Zhenxing Shao,*† MD, PhD, and Guoqing Cui,*† MD

Investigation performed at the Department of Sports Medicine, Peking University Third Hospital, Institute of Sports Medicine of Peking University, Beijing Key Laboratory of Sports Injuries, Beijing, China

Background: Some studies have advocated the use of suture button fixation during Bristow-Latarjet surgery to reduce complications associated with screw fixation. However, data comparing these fixation methods are relatively incomplete.

Purpose: To investigate the efficacy of modified arthroscopic Bristow-Latarjet surgery and compare the clinical and radiographic outcomes using screw versus suture button fixation.

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

Methods: We evaluated 136 patients with traumatic anterior shoulder instability who underwent the modified arthroscopic Bristow-Latarjet surgery between June 2015 and February 2018. Of these patients, 117 who met the inclusion criteria were enrolled at a mean follow-up of 3.3 ± 0.7 years. Shoulders were separated into 2 groups based on fixation technique: screw fixation (group A; n = 63) or suture button fixation (group B; n = 54). Computed tomography imaging findings and clinical results were assessed preoperatively; immediately after operation; and postoperatively at 3 months, 6 months, 1 year, and final follow-up.

Results: There were no significant differences between the groups in terms of postoperative clinical scores, the level of return to sports, range of motion, graft position, or reoperation rates. Bone healing was observed in 97.4% of the cases overall (114/117), with 98.4% bone union in group A and 96.3% in group B at final follow-up. Bone absorption was more common in group A (n = 30; 47.6%) compared with group B (n = 10; 18.5%) (*P* = .003). There were no hardware-related complications in group B, compared with 7.9% of patients in group A (*P* = .034). One patient in group B had a recurrent dislocation due to an unexpected event, and there were no recurrent dislocations in group A.

Conclusion: After the modified arthroscopic Bristow-Latarjet procedure, both suture button and screw fixation methods demonstrated high bony healing rates and low risk of recurrence. Less coracoid graft resorption and no hardware-related complications were seen with suture button fixation.

Keywords: Bristow; Cuistow; fixation; instability; Latarjet; shoulder; suture button

The arthroscopic Bristow-Latarjet procedure has become increasingly popular among surgeons for the treatment of recurrent anterior shoulder dislocation.[2,26,30] Compared with isolated soft tissue repairs, the Bristow-Latarjet procedure has a low redislocation rate, especially when associated with a bony defect of the anterior glenoid rim.[2,16,33]

In the Bristow-Latarjet procedure, several types of fixation have been proposed to secure the coracoid process to the glenoid, such as metallic screw, bioabsorbable screw, and, more recently, suture button.[3,7,31] However, no consensus has been reached concerning the optimal fixation of the transferred coracoid bone graft. Screw fixation is a traditional and widely used fixation method, and its effectiveness has been proven clinically and biomechanically.[7,18] However, a significant proportion of complications after Bristow-Latarjet surgery have been related to the screw fixation (ranging from 6.5% to 46%).[9,21] Hardware complications have included hardware failure (screw migration, loosening, breakage) and hardware irritation (joint penetration, soft tissue irritation/impingement).[9] Some of these

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complications may be serious and symptomatic enough to warrant reoperation. For example, according to a systematic review, of the 5% reoperation rate after Bristow-Latarjet surgery, 53% was related to hardware issues.[2]

To make the arthroscopic Bristow-Latarjet procedure safer and reduce complications associated with the traditional screw fixation, Boileau et al[5] introduced suture button fixation in 2016. Clinical studies have reported that suture button fixation has similar outcomes to screw fixation, although the studies were not randomized or controlled.[6,17,23,31] Some biomechanical studies have found that suture button fixation in the Bristow-Latarjet procedure was biomechanically comparable with screw fixation and presented a lower risk of graft fracture.[1,19,24]

The current study aimed to evaluate the efficacy of a modified arthroscopic Inlay Bristow procedure and compare the imaging findings and clinical results of this new technique using screw fixation versus suture button fixation. It was hypothesized that suture button fixation would be a reliable alternative to screw fixation.

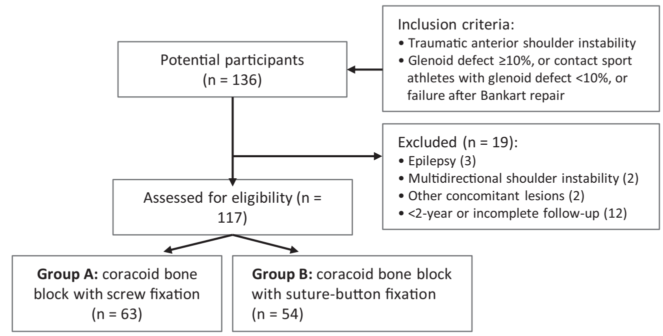

Figure 1. Flowchart of patient selection for this study.

METHODS

Study Design

The protocol for this study received ethics committee approval, and all patients provided informed consent. A retrospective comparative case analysis was performed for all patients with traumatic anterior shoulder instability who underwent the arthroscopic Bristow procedure (termed "inlay Bristow procedure") between June 2015 and February 2018.

The inclusion criteria were (1) a glenoid defect $\geq$10%, (2) participation in high-demand (collision and overhead) sports with a glenoid defect <10%, or (3) failure after Bankart repair. The exclusion criteria were (1) epilepsy, (2) multidirectional shoulder instability, (3) other concomitant lesions (eg, rotator cuff tear, symptomatic acromioclavicular joint pathology, or pathological involvement of the long head of the biceps), and (4) incomplete or <2-year follow-up.

The patients were divided into 2 groups depending on the fixation method we used: group A (screw fixation) or group B (suture button fixation). During the study period, 136 patients underwent the arthroscopic inlay Bristow surgery (group A, 74 patients; group B, 62 patients). Based on the inclusion and exclusion criteria, 117 (86.0%) patients were included in the study, comprising 63 patients with screw fixation and 54 patients with suture button fixation (Figure 1).

Surgical Technique

All procedures were performed at a single institution by the lead author (G.C.), who has performed more than 50 arthroscopic Bristow-Latarjet surgery annually. Both fixation methods were performed during the study period. On the premise of fully informing the advantages and disadvantages of the 2 techniques, we opted for screw or button for fixation depending on patient choice. However, we recommend the button if the patient has osteoporosis.

Based on the classic Bristow-Latarjet procedure,[7] we developed the inlay Bristow procedure to improve the coracoid graft union rate onto the glenoid rim. This procedure was inspired by the mortise-and-tenon construction technique (Figure 2). The arthroscopic-guided technique, comprising 6 operative steps, has been described in detail in previous articles and is briefly highlighted below.[22,27]

Step 1: Evaluation of the Shoulder Joint. A thorough evaluation was performed including the glenoid and humeral chondral surfaces, the rotator cuff, glenoid labrum, and glenoid or humeral bony defects.

Step 2: Coracoid Preparation, Drilling, and Osteotomy. The rotator cuff interval was opened, and the conjoint tendon and coracoid process were identified. The hole was drilled with a 2 mm—diameter K-wire with a sleeve 10 mm from the tip of the coracoid process. Then, the K-wire was replaced with a polydioxanone suture to retract the coracoid

†Address correspondence to Guoqing Cui, MD, Institute of Sports Medicine, Beijing Key Laboratory of Sports Injuries, Peking University Third Hospital, 49 North Garden Road, Haidian District, Beijing 100191, People's Republic of China (email: drcuiguoqing1964@126.com); or Zhenxing Shao, MD, PhD, Institute of Sports Medicine, Beijing Key Laboratory of Sports Injuries, Peking University Third Hospital, 49 North Garden Road, Haidian District, Beijing 100191, People's Republic of China (email: shaozhenxing@bjmu.edu.cn); or Qiang Liu, MD, PhD, Institute of Sports Medicine, Beijing Key Laboratory of Sports Injuries, Peking University Third Hospital, 49 North Garden Road, Haidian District, Beijing 100191, People's Republic of China (email: liuqiang_lq1987@163.com).

*Department of Sports Medicine, Peking University Third Hospital, Institute of Sports Medicine of Peking University, Beijing Key Laboratory of Sports Injuries, Beijing, China.

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Ethical approval for this study was obtained from Peking University Third Hospital (study No. M2020078).

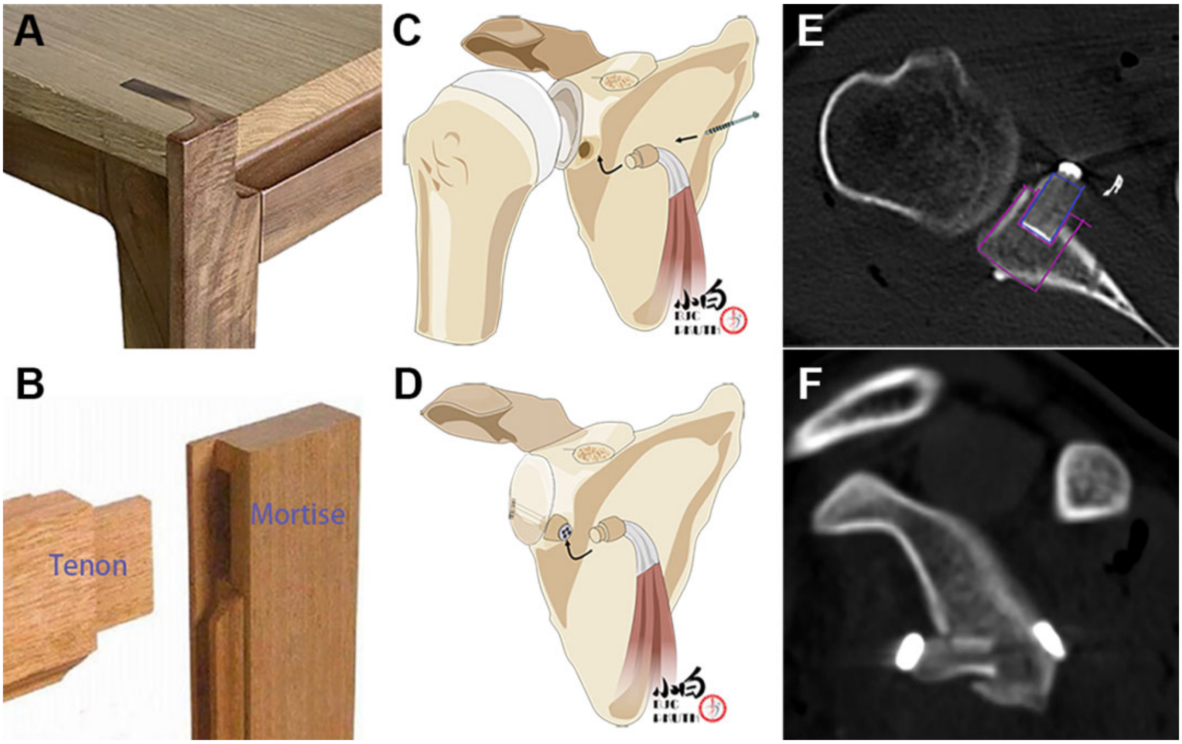

Figure 2. (A, B) Examples of mortise-and-tenon construction. (C, D) A model for mortise-and-tenon structure in inlay Bristow surgery with (C) screw and (D) suture button fixation. (E, F) Computed tomography scans showing the mortise-and-tenon structure in inlay Bristow surgery.

graft, and the coracoid was osteotomized with an osteotome, harvesting about 15 to 20 mm of bone.

Step 3: Subscapularis Splitting and Labral Detachment. The anterior bursa of the subscapularis was removed with a shaver and the anterior-inferior labrum was completely detached to 6 o'clock. A switch stick was used to penetrate through the subscapularis on the level of 5 o'clock. Then, the split was performed at the junction of the inferior one-third and superior two-thirds of the subscapularis muscle, using electrocautery and a shaver, during which step caution for the axillary nerve was taken.

Step 4: Glenoid Preparation and Drilling. The glenoid groove positioning system was to facilitate the positioning of the groove at about 7.5 mm above the bottom of the glenoid and 7.5 mm away from the bone surface of the glenoid. After positioning the trough, a specific drilling bit was used to make a trough with a diameter of 10 mm and a depth of 5 to 10 mm to increase the contact area of the coracoid graft and glenoid.

Step 5: Coracoid Retrieval, Trimming, Transfer, and Fixation. The coracoid graft was trimmed to fit the trough on the glenoid neck with a specially designed razor (WEGO). A 2.5-mm K-wire was used to drill from the tip to the bottom of the coracoid graft to facilitate the fixation. For group A, after making a 3.2-mm bone canal on the coracoid graft and glenoid, the 3.5-mm screw was placed into the coracoid graft, and the graft was pulled through the subscapularis split and into the groove of the glenoid. With the graft in place and being aligned with the groove, the screw was then tightened to compress the graft into the groove. For group B, the coracoid graft was pulled into the groove by a preset traction wire in the bone canal. Then, the suture button (Mini-TightRope; Arthrex) was fixed with at least 5 knots.

Step 6: Bankart Repair. After graft position and stiffness was checked, 2 suture anchors (Pushlock; Arthrex) were used to repair the labrum and anchor the graft. Two sockets were drilled onto the surface close to the anterior edge, usually at the 5- and 3-o'clock positions for the 2.9-mm PushLocks. The conjoint tendon–sutured Orthocord was passed through the labrum and capsule to the joint and then tightened and fixed to the 5 o'clock PushLock to prevent rotation of the graft. Another suture anchor was used to repair the upper labrum at 3 o'clock. These 2 PushLocks provided extra fixation of the coracoid graft by balancing the torque of the conjoint tendon toward the glenoid rim.

Postoperative Rehabilitation

The shoulder was immobilized in internal rotation by a sling for 6 weeks postoperatively. No active biceps tendon contraction or shoulder external rotation was permitted for at least 3 months to reduce the risk of bone absorption. Return to contact sports, throwing, or heavy labor activities were allowed 6 months after surgery when full range of motion was restored and no apprehension was detected.

Clinical Assessment

Clinical data were evaluated by orthopaedic surgeons who were not involved in the surgery (Q.S. and Q.L.). Patient demographics, number of dislocations prior to surgery, and level of sport were recorded preoperatively. The level of sport was categorized as competitive, recreational, or none. Occupation was categorized as professional athlete, military or police, or other.

Patients were seen routinely postoperatively at 6 weeks; at 3, 6, and 12 months; and then annually. Any complications that occurred intraoperatively or postoperatively were recorded. We assessed active shoulder range of motion, including forward flexion, external rotation and internal rotation at the side, and external and internal rotation at 90° of abduction, along with apprehension testing preoperatively and at the last follow-up. Internal rotation was determined as the highest spine level that the patient's thumb could reach behind the back: above T7 (10 points), T7 to T12 (8 points), T12 to L3 (6 points), L3 to sacrum (4 points); sacrum to greater trochanter (2 points); and below the greater trochanter (0 points), as performed for the Constant score.[8]

Preoperative and postoperative clinical results were assessed using the visual analog scale (VAS) for pain and instability, Rowe score, and American Shoulder and Elbow Surgeons (ASES) score. In addition, the Subjective Shoulder Value (SSV) score was used at the final follow-up, expressed as a percentage of a healthy shoulder (100%).[15]

Radiological Assessment

The radiological measurements were evaluated by 2 independent examiners(including S.Z.). The examiners were blinded to the clinical outcomes.

Radiography, 3-dimensional computed tomography (3D-CT), and magnetic resonance imaging (MRI) were performed preoperatively for evaluation of the bone defects and soft tissue condition. The patients were routinely required to undergo a CT scan immediately after operation and postoperatively at 3 months, 6 months, 1 year, and the final follow-up. A 3D glenoid en face view was acquired without the humeral head using the method described by Sugaya et al.[29]

The evaluation consisted of the following steps: (1) the bone defect of the glenoid and Hill-Sachs lesion was measured using preoperative CT scans according to a validated method described in the literature.[12,25,28,29] (2) Bone block positioning was evaluated using postoperative CT scans obtained immediately after surgery according to a validated method.[10] The bone block was considered too lateral if it went beyond the glenoid rim by more than 5 mm, and it was judged to be too medial if it was medial to the rim by more than 5 mm.[5] The alpha angle was defined as the angle between the axis of the screw (or the bone tunnel) and the glenoid rim. The position was defined as overangulated when the alpha angle was >25°. (3) Graft union with the glenoid was assessed using the method of Hovelius et al.[18] (4) The bone resorption of the transferred coracoid was evaluated on the axial CT scan using a simple classification system consisting of grades 0 (no graft resorption), 1 (resorption occurring only near the screw head or suture button), 2 (most of the graft was absorbed), and 3 (all of the graft was absorbed).[32]

TABLE 1
Preoperative Patient Demographics[a]

Characteristic	Group A (n = 63)	Group B (n = 54)	*P*
Age, y	28.7 ± 9.5	25.9 ± 9.7	**.026**
Male sex	50 (79.4)	41 (75.9)	.656
BMI, kg/m^2	25.0 ± 3.8	25.6 ± 5.2	.974
Dominant side operated	38 (50.7)	25 (59.5)	.357
Number of dislocations	12.4 ± 14.3	8.8 ± 8.0	.179
Time between first dislocation and surgery, y	7.4 ± 6.7	5.7 ± 5.8	.163
Previous Bankart repair	7 (11.1)	2 (3.7)	.250
Occupation			.528
Professional athlete	6 (9.5)	7 (13.0)	
Military or police	6 (9.5)	8 (14.8)	
Other	51 (81.0)	39 (72.2)	
Level of sport: competitive	20 (31.7)	28 (51.9)	.563
Glenoid bone defect, %	16.1 ± 5.8	14.6 ± 7.5	.216
VAS for pain	5.0 ± 3.3	5.5 ± 3.1	.456
VAS for instability	7.5 ± 2.2	7.4 ± 2.4	.874
Rowe score	27.6 ± 12.7	32.8 ± 10.3	**.027**

[a]Data are reported as mean ± SD or n (%). Bolded *P* values indicate statistically significant difference between study groups ($P < .05$). BMI, body mass index; VAS, visual analog scale.

Statistical Analysis

The quantitative data were expressed as the means and standard deviations, and qualitative data were described as sample sizes or percentages. Quantitative variables were compared using *t* test or nonparametric test, depending on if the data were normally distributed. Qualitative variables were compared using the chi-square or Fisher exact test. SPSS statistics software (Version 20.0; IBM) was used for all the statistical analysis, and $P < .05$ was considered statistically significant.

RESULTS

Patient Demographics

The mean final follow-up period for the 117 study patients was 3.3 ± 0.7 years [range, 2.0-4.7 years] and was similar between groups A and B. Patient demographics are summarized in Table 1. The 2 groups were not significantly different, with the exception of age at surgery ($P = .026$) and preoperative Rowe score ($P = .027$).

Clinical Results

Return-to-Sport and Functional Results. At the final follow-up, 97.4% of patients (114/117) had returned to sport, and 80% (94/117) had returned to sport within 1 year

TABLE 2
Clinical Results Preoperatively Versus Final Follow-up[a]

	Preoperative	Final Follow-up	*P*
VAS for pain	5.3 ± 3.2	1.2 ± 1.4	**<.001**
VAS for instability	7.5 ± 2.3	1.4 ± 1.8	**<.001**
Rowe score	30.1 ± 11.9	95.0 ± 7.4	**<.001**
Forward flexion, deg	175.2 ± 11.2	175.9 ± 9.2	.141
External rotation at the side, deg	52.1 ± 14.8	48.5 ± 14.4	**<.001**
Internal rotation at the side, points	9.5 ± 0.9	8.7 ± 1.5	**<.001**
External rotation at 90° of abduction, deg	85.3 ± 13.7	86.4 ± 11.1	.284
Internal rotation at 90° of abduction, deg	71.4 ± 13.0	71.1 ± 11.0	.272

[a]Data are reported as mean ± SD. Bolded *P* values indicate statistically significant difference between preoperative and final follow-up ($P < .05$). VAS, visual analog scale.

TABLE 3
Clinical Results at Final Follow-up[a]

	Group A	Group B	*P*
VAS for pain	1.3 ± 1.4	1.2 ± 1.4	.841
VAS for instability	1.4 ± 1.6	1.4 ± 2.1	.374
Rowe score	95.2 ± 6.0	94.2 ± 8.9	.920
ASES score	90.3 ± 9.4	90.6 ± 9.9	.819
SSV score	87.7 ± 9.1	87.4 ± 9.0	.829
Forward flexion, deg	175.6 ± 9.6	176.2 ± 8.8	.586
External rotation at the side, deg	49.5 ± 16.1	47.1 ± 11.5	.784
Internal rotation at the side, points	8.7 ± 1.2	8.8 ± 1.8	.442
External rotation at 90° of abduction, deg	85.8 ± 12.6	87.3 ± 8.6	.623
Internal rotation at 90° of abduction, deg	71.4 ± 12.2	70.6 ± 9.2	.963

[a]Data are reported as mean ± SD. ASES, American Shoulder and Elbow Surgeons; SSV, Subjective Shoulder Value; VAS, visual analog scale.

of surgery. In terms of the level of sports at final follow-up, 90.6% (106/117) were superior or equal to that of preoperative level. The improvements in clinical scores were statistically significant ($P < .001$ for all) (Table 2). At the final follow-up, no significant difference was detected between the 2 groups (Table 3).

Range-of-Motion and Apprehension Testing. Comparison of mobility preoperatively and at final follow-up in active external rotation and internal rotation at the side was statistically significant (Table 3). However, only 3 (2.6%) patients had significant restriction (loss >20°) in the range of active motion after surgery in terms of forward flexion, external rotation, or internal rotation. No significant difference was detected between the 2 groups in the range of active motion after surgery (Table 3). One patient

TABLE 4
Horizontal and Vertical Position of the Graft on CT Scans From Immediately After Surgery[a]

	Total	Group A	Group B	*P*
Horizontal position on axial view				.137
Flush with the glenoid surface	107 (91.5)	57 (90.5)	50 (92.6)	
Too lateral (>5 mm)	8 (6.8)	6 (9.5)	2 (3.7)	
Too medial (>5 mm)	2 (1.7)	0 (0)	2 (3.7)	
Vertical position on en face view				>.999
3-5 o'clock	115 (98.3)	61 (96.8)	54 (100)	
Superior to 3 o'clock	1 (0.9)	1 (1.6)	0 (0)	
Inferior to 5 o'clock	1 (0.9)	1 (1.6)	0 (0)	
Alpha angle >25°	27 (23.1)	13 (20.6)	14 (25.9)	.498

[a]Data are reported as n (%).

in each group had a positive apprehension test at final follow-up, compared with 97.4% (114/117) with positive apprehension preoperatively.

CT Imaging Results

Graft Position. The total bone graft position was satisfactory, with 91.5% flush with the glenoid surface in the axial view and 98.3% between 3 and 5 o'clock in the en face view. No significant difference was detected between the 2 groups in the graft position (Table 4).

The mean alpha angle was 20.1° ± 9.5°, with 23.1% (27/117) of patients being overangulated (alpha angle >25°) and no difference between the 2 study groups (Table 4). In group A, the screw was bicortical in 63 (100%) patients and no unicortical (too short) was found. In 8 (12.7%) patients, the screw was considered to be slightly longer (>10 mm).

Graft Healing and Absorption. During the 3-month follow-up, the graft had healed in 85.5% (100/117) of the patients (87.3% in group A and 83.3% in Group B). At a mean follow-up of 40 months, the graft had healed in 97.4% (114/117) of cases (98.4% in Group A and 96.3% in group B) (Table 5 and Figure 3).

At a mean of 40 months after surgery, the incidence of coracoid bone resorption was 34.2% (40/117), with 47.6% (30/63) in Group A and 18.5% (10/54) in Group B (Table 5 and Figure 4). We found no statistical difference between postoperative bone resorption and clinical scores.

Graft Remodeling. When comparing the CT scans performed immediately postoperatively with those from final follow-up, we found that almost all the transferred coracoid graft showed bone remodeling. In the axial view, the remodeling process made the graft flush to the glenoid (Figure 5). In the en face view, the graft exhibited growth superiorly, inferiorly, medially, and laterally over time. The glenoid and graft fused with each other, and, finally, the new glenoid tended to form a pear shape (Figure 4).

Complications and Reoperations

After a mean follow-up of 40 months, 1 patient in group B experienced a recurrence of instability caused by an accident and was able to resume her normal daily activities after a revision surgery using the Eden-Hybinette technique. No glenohumeral joint arthropathy and no subluxation of the shoulder joint was observed at final follow-up.

TABLE 5
Healing and Resorption of the Graft on Postoperative CT[a]

	Total	Group A	Group B	*P*
Graft healing at 3-month follow-up				.838
Bone union	100 (85.5)	55 (87.3)	45 (83.3)	
Fibrous union	13 (11.1)	6 (9.5)	7 (13.0)	
Migration	4 (3.4)	2 (3.2)	2 (3.7)	
Graft healing at final follow-up				.595
Bone union	114 (97.4)	62 (98.4)	52 (96.3)	
Fibrous union	0 (0)	0 (0)	0 (0)	
Migrated	3 (2.6)	1 (1.6)	2 (3.7)	
Graft resorption at final follow-up[b]				**.003**
Grade 0	77 (65.8)	33 (52.4)	44 (81.5)	
Grade 1	30 (25.6)	23 (36.5)	7 (13.0)	
Grade 2	10 (8.5)	7 (11.1)	3 (5.6)	
Grade 3	0 (0)	0 (0)	0 (0)	

[a]Values are presented as n (%). Bolded *P* value indicates statistically significant difference between study groups ($P < .05$). CT, computed tomography.

[b]Grades: 0 = no resorption, 1 = resorption near the screw head or suture button, 2 = most of the graft resorbed, 3 = complete resorption.

A total of 5 patients had temporary postoperative complications: 3 had transient musculocutaneous nerve palsy after surgery and all of them recovered within 12 weeks postoperatively; 1 had a postoperative hematoma, which was absorbed spontaneously after 6 weeks; and 1 patient had postoperative infection and recovered by antibiotic treatment alone. None of these patients had any residual sequelae.

In group A, 7.9% (5/63) patients had screw-related complications: 2 had a bone block fracture due to inadequate centering of the screw in the bone block; 2 patients experienced screw breakage at final follow-up; and 1 patient had a screw pullout immediately after surgery and required a return to the operation room for refixation. However, no correlation was found between screw-related complications and the functional results.

Therefore, the overall complication rate was 9.4% (11/117) and the overall reoperation rate was 1.7% (2/117). The overall complication rate and reoperation rate were similar between the 2 groups. However, group B avoided hardware-related complications that accounted for a significant proportion (7.9%) in group A ($P = .034$). These results are detailed in Table 6.

DISCUSSION

Technique Modification

The principal finding of this study is that, with the application of the mortise-and-tenon joint structure in modified Bristow surgery, the bone healing rate appeared to be higher than in traditional Bristow surgery as reported in the literature.

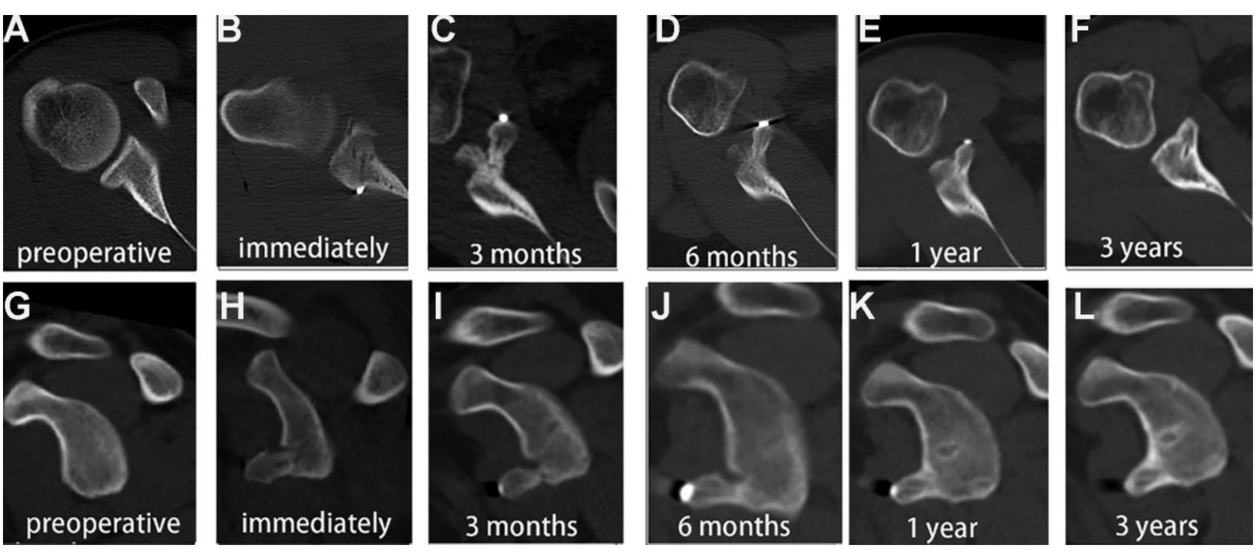

Figure 3. (A-L) CT images from a patient with delayed healing of the coracoid process. (B-F) Bone graft healing process at immediately, 3 months, 6 months, 1 year, and final follow-up postoperatively in axial view, respectively. (H-L) Bone graft healing process in 2D sagittal view. In this case, we found that the bone graft did not heal at 3 months, began to heal at 6 months, and healed completely at 3 years postoperatively. 2D, 2-dimensional; CT, computed tomography.

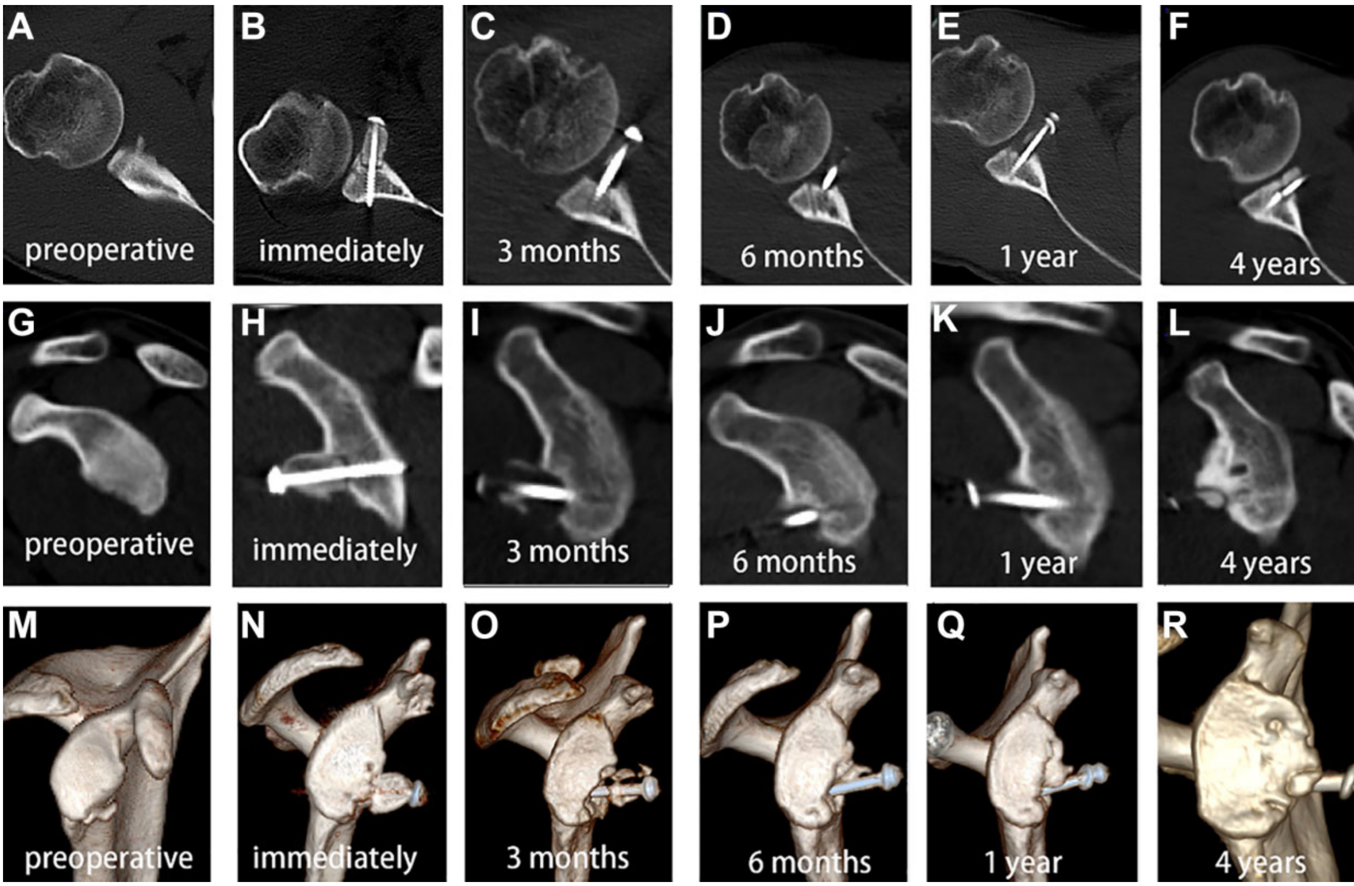

Figure 4. (A-R) CT images of graft absorption and remodeling in a patient with graft-nonunion; (A-F) preoperative 2D axial view and 2D axial view at immediately, 3 months, 6 months, 1 year, and final follow-up postoperatively respectively; (G-L) 2D sagittal view; (M-R) 3D en face view. The coracoid graft stayed nonunion at 3 months postoperatively and was gradually absorbed during follow-up. To our surprise, at the 4-year follow-up, we found that new bone fragments had grown out to fill in the bone defect of the glenoid, forming a pear shape in the 3D en face view. 2D, 2-dimensional; 3D, 3-dimensional; CT, computed tomography.

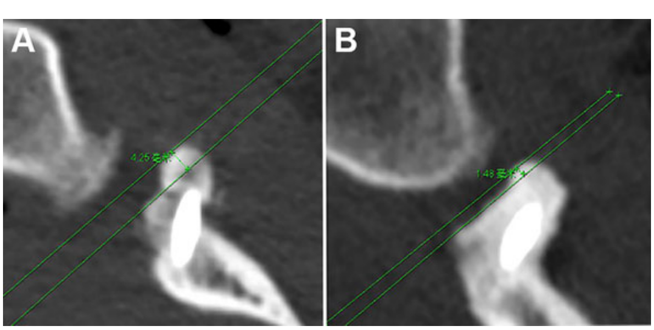

Figure 5. Graft remodeling process on 2-dimensional computed tomography axial view. (A) Immediately postoperatively and (B) at 2-year-follow-up. After surgery, we found that the graft was laterally inclined by 4.25 mm, but after 2 years, the distance was reduced to 1.48 mm. The remodeling process gradually made the graft flush to the glenoid.

TABLE 6
Complications and Reoperations at Final Follow-up[a]

Complications and Reoperations	Total	Group A	Group B	P
Complications	11 (9.4)	6 (9.5)	5 (9.3)	NS
Recurrence	1 (0.9)	0 (0)	1 (1.9)	NS
Postoperative infection	1 (0.9)	0 (0)	1 (1.9)	NS
Temporary hematoma	1 (0.9)	0 (0)	1 (1.9)	NS
Neurologic lesion/palsy	3 (2.6)	1 (1.6)	2 (3.7)	NS
Hardware-related complications	5 (4.3)	5 (7.9)	0 (0)	**.034**
Intraoperative graft fracture	2 (1.7)	2 (3.2)	0 (0)	
Material breakage	2 (1.7)	2 (3.2)	0 (0)	
Screw pullout	1 (0.9)	1 (1.6)	0 (0)	
Reoperations	2 (1.7)	1 (1.6)	1 (1.9)	NS
Screw refixation	1 (0.9)	1 (1.6)	0 (0)	
Screw removal	0 (0)	0 (0)	0 (0)	
Eden-Hybinette	1 (0.9)	0 (0)	1 (1.9)	

[a]Values are presented as n (%). Bolded P value indicates statistically significant difference between study groups ($P < .05$). NS, nonsignificant.

There are 2 different ways to perform the coracoid transfer technique: the Bristow procedure uses 1 screw and the graft in the horizontal position, and the Latarjet procedure uses 2 screws and the graft in the vertical position.[4,13] Both procedures have been used to treat glenohumeral instability, with varying outcomes. A systematic review of Bristow and Latarjet techniques by Garcia et al[13] showed a statistically significant difference in favor of the Bristow procedure, including rates of apprehension, pain, lateral graft, osteoarthritis, and osteolysis. However, the review also showed that the Bristow procedure presented more nonunions. In addition, a retrospective clinical study conducted by Gendre et al[14] also showed that the Latarjet procedure had a higher rate of bone healing than the Bristow procedure (Latarjet surgery 91%; Bristow surgery 74%). The authors attributed this to the fact that the Latarjet surgery had greater bone contact area with the anterior side of the scapular neck. Meanwhile, some studies have demonstrated that coracoid nonunion is the most common cause of recurrence after Latarjet stabilization.[20]

To improve the bone graft union rate of the Bristow surgery, in this study, we developed a new arthroscopic Bristow technique. In our inlay Bristow technique, the most important modification is the application of the mortise-and-tenon joint structure: making a bone groove on the glenoid neck at 4 o'clock and trimming the coracoid graft to fit the groove. There are 2 advantages of this structure: (1) more bone contact area makes the coracoid graft fixation more stable; and (2) complete fresh bone contact area improves bone graft healing. Furthermore, we used the threads left on the tip of the coracoid graft to do the Bankart repair with 2 Pushlock anchors in the final step. This can give extra fixation to the graft, because these 2 anchors can press the graft onto the glenoid neck and prevent rotation of the graft. As the result of the above technical improvements, in the present study, the graft healed in 85.5% (100/117) of cases by 3 months after the surgery. During follow-up at a mean of 40 months, the graft healed in 97.4% (114/117) of cases.

The healing rate of inlay Bristow surgery appears to be higher than that of traditional arthroscopic Bristow surgery and reaches the level of arthroscopic Latarjet surgery in the literature. In previous studies by Boileau et al[7] and Gendre et al,[14] the coracoid union rate for arthroscopic Bristow surgery with suture button fixation was only 74% and with screw fixation it was 73%. On the other hand, for Bristow surgery, a retrospective study conducted by Hovelius et al[18] reported bony healing in 246 of 297 shoulders (83%) with at least 5 years follow-up. In recent studies of Latarjet surgery, Boileau et al[6] reported a 95% coracoid union rate and Xu et al[31] reported a 98% union rate.

The reason for this difference in union rate between Bristow and Latarjet may be a difference in bone-contact area. A recent study also demonstrated that the healing rate of coracoid was related to bone contact area.[11] As the mortise-and-tenon structure that we used in inlay Bristow surgery improved coracoid healing, we believe this technique may be a satisfactory way to resolve the lower bone healing rate of Bristow surgery compared with Latarjet surgery. In addition to the improved healing rate, the inlay Bristow technique showed excellent clinical results, which were confirmed by functional scores and a return to sport in 97.4% of the patients, and accurate positioning of the graft, without decreasing stability and mobility.

Despite the advantages of inlay Bristow surgery, it still has some limitations. First, some instruments used in this surgery are uniquely designed. In the future, we will generalize and standardize the instruments for this surgery. Second, this is still a technically demanding procedure, which requires a certain learning curve.

Screw Fixation Versus Suture Button Fixation

Through comparative study, we found that suture button fixation may be a safe and reliable alternative to screw fixation for the Bristow-Latarjet procedure, which not only obtains satisfactory stability but can also reduce hardware-related complications, and partly reduce the resorption of transferred coracoid graft after surgery.

Stability is the main objective of Bristow-Latarjet surgery, and recurrent instability is our main concern. In this study, we found that both screw fixation and suture button fixation achieved excellent stability, with only 1 patient relapsing due to an unexpected event. Our results are inconsistent with those reported in the literature. Metais et al[23] compared screw and suture button fixation, finding a higher rate of recurrent dislocation with suture button fixation (6.25% vs 3.5%) at a mean follow-up of 23 months. Meanwhile, another multicenter comparative study also found patients undergoing a Latarjet procedure with suture button fixation demonstrated a significantly higher rate of recurrent instability than patients treated with screw fixation [6 (8.3%) vs 6 (2.5%); $P = .02$].[17] Furthermore, the recurrence rate reported in the above literature was much higher than our cohort (0.9%) in similar follow-up time. One explanation for the discrepancy could be that, in our study, the application of the mortise-and-tenon joint structure and the Bankart repair with 2 Pushlocks improved the stability of the operation.

Theoretically, the faster fusion is obtained, the sooner return to sports under safe conditions can occur. Therefore, the time required for bone fusion to allow return to sports under secure conditions is critical after a Latarjet procedure. Bonnevialle et al[8] found the rates of fusion were 41% and 100% for the screw fixation and suture button fixation groups at 3 months postoperatively, respectively. In our study, we found that the rate of bone healing with screw fixation was not significantly different at 3 months postoperatively (87.3% vs 83.3%). However, our rate of early healing with suture button fixation was higher than that reported in the literature. We explain that the use of the mortise-and-tenon joint structure increases the bone contact area and thus the rate of early healing.

In our study, the overall rate of complications and reoperation were not statistically significant between the 2 groups. However, it is worth noting that suture button fixation successfully avoided the complications associated with screws, which accounted for a significant proportion (5/63) following Bristow with screw fixation. Although no correlation was found between screw-related complications and the functional results, we believed that screw-related complications lead to an increased risk of reoperation, such as screw refixation and screw removal.

Another major difference between the 2 groups was found in bone resorption. The study showed that the use of a coracoid bone block fixation system with suture button significantly reduced bone resorption. We found that at an average of 40 months of follow-up, the absorptivity of screw fixation (47.6%) was significantly higher than that of suture button fixation (18.5%). We also found absorption of screw-fixed coracoid bone occurred primarily near the screw. Therefore, we believe that screw stimulation is an important risk factor for bone resorption after the surgery, which is consistent with a biomechanical study.[1] In addition, some studies have shown that too much bone resorption is associated with persistent apprehension after surgery.[7]

In addition to the above differences, both groups showed excellent results in clinical scores, return to sports, mobility, bone healing, and bone position, with no statistical difference between the 2 groups. We found that almost all the transferred coracoid graft showed bone remodeling to make the graft flush to the glenoid in the axial view and to form a pear shape in the en face view at the final follow-up.

Limitations and Strengths

There are several limitations to this study. A randomized controlled study was not used because we were developing a new arthroscopic technique. The groups are not quite comparable, with an age and Rowe score difference. These may lead to a deviation in the final result. On the other hand, our study has several strengths. Preoperative and postoperative standardized CT imaging was performed for all patients to assess the bone graft union and positioning accuracy, and a minimal number of patients was lost at follow-up.

CONCLUSION

The principal finding of this study is that suture button fixation may be a safe and reliable alternative to screw fixation for the Bristow-Latarjet procedure, which not only obtains satisfactory stability but can also reduce hardware-related complications, and reduce the resorption of transferred coracoid graft after surgery to some extent.

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