

# Association Between Preoperative Glenoid Bone Loss and Postoperative Outcomes After Coracoid Transfer Combined With Open Bankart Repair

## Comparison of the Bristow and Latarjet Techniques

Takehito Hirose,\* MD, PhD, Makoto Tanaka,\*†‡ MD, PhD, Hidekazu Nakai,\* MD, Hiroto Hanai,§ MD, PhD, Yuki Kotani,§ MD, Kosuke Kuratani,|| MD, and Kenji Hayashida,¶ MD, PhD  
Investigation performed at Daini Osaka Police Hospital, Osaka, Japan

**Background:** Whether the extent of glenoid bone loss (GBL) affects clinical outcome after coracoid process transfer (CPT) is still unclear.

**Purpose:** To evaluate postoperative outcomes after CPT combined with open Bankart repair in young rugby players in terms of the extent of GBL and between the Bristow and Latarjet techniques.

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

**Methods:** The authors investigated 101 shoulders in 91 competitive rugby players who underwent CPT combined with open Bankart repair by the Bristow (group B; 66 shoulders) or Latarjet (group L; 35 shoulders) procedure between 2007 and 2017. The extent of GBL was calculated from the en face view of the glenoid on preoperative 3-dimensional computed tomography scans and was used to categorize shoulders into 4 grades (grade 0, 0%; grade 1, >0% and ≤10%; grade 2, >10% and ≤20%; grade 3, >20%). At the minimum 2-year follow-up, the authors analyzed the relationship between GBL or GBL grade and postoperative outcome scores (American Shoulder and Elbow Surgeons score, Rowe score, Western Ontario Shoulder Instability Index, and patient satisfaction), return-to-play (RTP) times, graft failure (insufficient union or translocation), and recurrence.

**Results:** The mean GBL in all shoulders was 10.9% ± 9.2% and was not significantly different between the 2 groups. There were no significant correlations between GBL and any outcome measure in either group. The mean RTP time was significantly shorter in group L versus group B (4.8 ± 1.1 vs 5.8 ± 1.8 months, respectively;  $P = .002$ ), but it was not associated with GBL. In group B, the rate of graft failure was not significantly higher in shoulders with grade 0 or 1 GBL versus grade 2 or 3 GBL (8 [25.0%] vs 4 [11.8%], respectively;  $P = .21$ ). In group B, graft failure was confirmed in 12 shoulders (18.2%), compared with 1 shoulder (2.9%) in group L. Postoperative recurrence occurred in significantly fewer shoulders in group B than in group L (2 [3.0%] vs 5 [14.3%], respectively;  $P = .047$ ).

**Conclusion:** The extent of GBL did not affect outcome scores after CPT, regardless of operative procedure.

**Keywords:** shoulder; instability; glenoid bone loss; Bristow; Latarjet; clinical outcome; rugby

Arthroscopic Bankart repair (ABR) is the gold standard in the surgical treatment of traumatic anterior shoulder instability. However, bone loss,<sup>5,8,24,40</sup> younger age,<sup>24,36,40</sup> and playing a collision or contact sport<sup>12,24,36</sup> are recognized as risk factors for recurrence after ABR. Glenoid bone loss (GBL) is considered to be the most critical element in recurrence after ABR, and significant reduction of anterior

stability is known to occur when GBL is 20% or more.<sup>14,38</sup> In addition, a GBL of 13.5% has been suggested to be a threshold value for the occurrence of shoulder dysfunction after ABR alone and is considered by some to represent subcritical bone loss.<sup>30</sup>

GBL is the one of the factors that can be addressed by orthopaedic surgeons through the choice of surgical technique, and reconstruction of the bone defect by coracoid process transfer (CPT), autologous bone grafting (iliac bone,<sup>1,35</sup> distal clavicle,<sup>3,34</sup> or scapular spine<sup>22</sup>), or artificial bone grafting<sup>13</sup> is recommended in shoulders with a large

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degree of GBL. However, because younger age and playing a contact or collision sport are considered to be strong risk factors for recurrence after ABR alone, performing only capsulolabral complex repair is often not sufficient in these patients regardless of the extent of GBL.<sup>17,19</sup>

In competitive rugby players, the recurrence rates after ABR are known to be much higher than in players of other collision sports because of the particular characteristics of rugby<sup>24</sup>; thus, at our hospital we perform CPT combined with Bankart repair for traumatic anterior shoulder instability in young rugby athletes regardless of preoperative GBL. Tanaka et al<sup>32</sup> previously demonstrated high return-to-play (RTP) rates and good clinical results after this combined procedure. They also found earlier and higher bone union in the Latarjet procedure but higher bone resorption and more frequent subluxations and need for injection for pain after the Latarjet procedure compared with the Bristow procedure.

Because CPT is generally performed in patients with a large degree of GBL, few studies have evaluated the association between postoperative healing of the transferred coracoid and smaller degrees of GBL ( $\leq 10\%$ ) or no GBL. In addition, it is unclear whether this association is different between CPT with the Bristow versus Latarjet procedures. As the size of the bone contact surface on the graft side is smaller in the Bristow versus the Latarjet procedure<sup>10</sup> and as the extent of GBL affects the bone shape of the graft recipient site around the anterior glenoid neck, the effect of GBL on graft healing may differ between the 2 techniques.

The aim of the present study was to evaluate postoperative outcomes after CPT combined with open Bankart repair in young rugby players in terms of the extent of GBL and between the Bristow and Latarjet techniques. We hypothesized that the extent of GBL would not affect clinical outcomes after CPT.

## METHODS

### Patients

Between 2007 and 2017, 151 consecutive shoulders in 137 competitive rugby players underwent surgical treatment for traumatic anterior shoulder instability at our hospital. Shoulders were included that were treated by CPT by the Bristow or Latarjet procedure combined with a Bankart repair. Exclusion criteria were as follows: isolated Bankart repair or Bankart repair combined with a procedure other

than CPT, capsular repair, revision surgery, rotator interval closure, and follow-up <2 years. At our hospital, CPT was performed only by the Bristow procedure until December 2014 and by the Latarjet procedure thereafter because the Latarjet procedure was assumed to show a higher graft union rate, which could provide better clinical results.

The study protocol received institutional review board approval from our hospital. At the initial consultation, an opt-out method was applied for patient agreement with the anonymous use of their clinical data, so documented informed consent was not required from all patients.

### Surgical Procedure and Rehabilitation

All operations were performed by the same orthopaedic surgeon (M.T.) in accordance with previously reported methods.<sup>6,32</sup> A standard deltopectoral approach was used to expose the coracoid process and cut the coracoid using an L-shaped bone saw. Subsequently, the lower one-third of the subscapularis muscle was split to reach the anterior capsule and a horizontal capsulotomy was performed to expose the anterior glenoid neck. In the Bristow method, a guide pin was inserted from the tip of the coracoid process to the center of the osteotomy surface and overdrilled with a 3.0-mm cannulated drill. Next, the anterior capsulolabral complex was completely detached until as inferiorly as possible (until the 6-o'clock position of the glenoid). If the patient had a bony Bankart lesion, the lesion was completely removed. A guide pin was then inserted at the 4-o'clock position, 5 to 8 mm medial to the articular surface of the glenoid, and overdrilled with a 3.0-mm cannulated drill. Then, the soft anchors were inserted into the edge of glenoid, and their sutures were passed through the fully detached capsulolabral complex by using the mattress suture technique. At least 3 single-loaded suture anchors were inserted with care taken to avoid the tunnel. Then, the coracoid graft was fixed by placing a 4.0 mm-diameter cannulated screw and washer over the guide pin. Finally, the sutures were tied with sufficient tension so that the capsulolabral complex was reattached at least 1 hour above its detached position in clock positioning under 20° of flexion and neutral rotation.

In the Latarjet procedure, the proximal drill hole was created in the proximal part of the coracoid graft in the graft-lying position, and the position of the proximal drill hole on the glenoid side was set at 3:30 o'clock and drilled through a guide pin 5 to 8 mm medial to the glenoid surface. After preparation for screw fixation, the capsulolabral

†Address correspondence to Makoto Tanaka, MD, PhD, Department of Orthopaedic Surgery, Daini Osaka Police Hospital, 2-6-40 Karasugatsuji Tennoji-ku, Osaka 543-8922, Japan (email: makoto.tanaka@mac.com).

\*Department of Orthopaedic Surgery, Daini Osaka Police Hospital, Osaka, Japan.

†Center for Sports Medicine, Daini Osaka Police Hospital, Osaka, Japan.

§Department of Orthopaedic Surgery, Graduate School of Medicine, Osaka University, Osaka, Japan.

||Department of Orthopaedic Surgery, JCHO Osaka Hospital, Osaka, Japan.

¶Department of Orthopaedic Surgery, Osaka Central Hospital, Osaka, Japan.

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complex was repaired using suture anchors similar to the Bristow technique. Two cannulated screws, 4.0 mm and 3.5 mm in diameter and each with a washer, were used for the proximal and distal parts of the graft fixation, respectively. After graft fixation using the first screw (4.0 mm), another drill hole for the second screw (3.5 mm) was created in the graft and glenoid neck, and the screw was inserted. Then, sutures were tied as in the Bristow procedure.

In both procedures, the cortical bone of the anterior glenoid neck was thinly cut, and lattice slits were created with a chisel to facilitate bleeding from the bone marrow. In all cases, the aim was to achieve bicortical screw fixation, and sufficient fixation of both screws was confirmed with postoperative radiography. The operated shoulder was immobilized in the internal rotated position with a brace.

Postoperative rehabilitation consisted of passive forward elevation exercises in the supine position 2 weeks after surgery and active forward elevation and external rotation exercises at 6 weeks after surgery. Muscle strengthening exercises were permitted from 3 months. Patients returned to rugby practice about 4 months after the operation, and full RTP was allowed depending on range of motion, muscle strength, and graft healing evaluated using computed tomography (CT).

## Evaluations

**CT Imaging Analysis.** All patients underwent CT with an Aquilion scanner (Canon Medical Systems Corporation) to analyze glenoid morphology preoperatively and to evaluate the transferred coracoid graft postoperatively. Imaging data were obtained at a slice thickness of 0.5 mm and reconstructed into 3-dimensional models of the glenoid. The preoperative GBL (in percentage) was calculated from the en face view of the glenoid by using the assumed circle method,<sup>23</sup> and the GBL value was used to assign each shoulder to 1 of 4 grades (grade 0, 0%; grade 1, >0% and ≤10%; grade 2, >10% and ≤20%; grade 3, >20%). Postoperative CT was performed on the day after surgery and after 3, 6, and 12 months, depending on patient consent. Coracoid graft conditions were diagnosed according to Tanaka et al<sup>32</sup> as union, insufficient union, or translocation (including graft fracture). In brief, the absence or presence of a radiolucent zone between the coracoid process and glenoid was used to distinguish between union and insufficient union, and translocation was defined as dislocation of the graft from the screw (including bone fragment fracture) or backing out of the screw.

**Postoperative Outcomes and Recurrence.** Clinical outcomes were evaluated by the American Shoulder and Elbow Surgeons (ASES)<sup>28</sup> and Rowe<sup>29</sup> scores at the preoperative examination and final follow-up and also by the Western Ontario Shoulder Instability Index (WOSI)<sup>16</sup> and patient satisfaction rating at the final follow-up. Time to RTP, postoperative recurrence, and complications other than recurrence were also investigated. Recurrence was defined as any report of dislocation or subluxation; the latter was defined as an episode of shoulder instability that did not require manual reduction by a health care provider.<sup>25</sup>

## Statistical Analysis

Comparisons between patients who underwent the Bristow versus Latarjet procedure were performed with the Mann-Whitney *U* test or chi-square test, and the pre- and postoperative data of each operative technique were compared with the paired *t* test. We evaluated the association between preoperative GBL and each outcome measure using correlation analysis. In addition, we evaluated graft condition on final postoperative CT according to both preoperative GBL grade and postoperative outcomes. Statistical analysis was performed with JMP software (Version 16.0.0; SAS Institute Inc). Statistical significance was assumed at  $P < .05$ .

Regarding sample size calculation, it was determined that 26 shoulders would be required for the detection of a 0.5 effect size with 80% power at the 5% level of significance. Thus, the sample sizes of 66 and 35 shoulders in the Bristow (group B) and Latarjet (group L) groups, respectively, were considered acceptable.

## RESULTS

### Patient Characteristics

Of the 151 candidate shoulders, 50 were excluded from evaluation for the following reasons: isolated Bankart repair ( $n = 37$ ), Bankart repair with a remplissage ( $n = 8$ ), isolated capsular repair ( $n = 2$ ), revision after Latarjet ( $n = 1$ ), rotator interval closure ( $n = 1$ ), and loss to follow-up within 2 years ( $n = 1$ ). Thus, 101 shoulders of 91 patients were included in the study. The Bristow procedure was performed in 66 shoulders (group B) and the Latarjet procedure in 35 shoulders (group L). There were no significant differences between the groups in age at surgery, preoperative diagnosis, GBL, or GBL grade (Table 1). The mean overall follow-up time was  $70.0 \pm 22.5$  months (group B,  $73.5 \pm 2.7$  months; group L,  $63.5 \pm 3.7$  months;  $P = .34$ ).

### Relationship Between Clinical Outcomes and GBL

Preoperative ASES and Rowe scores were significantly worse in group B than group L (ASES score,  $48.0 \pm 14.6$  vs  $60.8 \pm 9.0$ , respectively,  $P < .0001$ ; Rowe score,  $30.6 \pm 14.7$  vs  $38.7 \pm 6.2$ , respectively,  $P = .009$ ); however, significant differences were not seen postoperatively (group B vs group L:  $91.0 \pm 10.2$  vs  $90.2 \pm 13.4$  for ASES [ $P = .82$ ];  $88.5 \pm 13.8$  vs  $86.4 \pm 15.1$  for Rowe score [ $P = .57$ ]). All postoperative scores in both groups were significantly better compared with preoperative scores ( $P < .001$  for all) and exceeded previously reported minimal clinically important differences.<sup>20,26</sup> In addition, the postoperative WOSI and patient satisfaction rate were similar in the 2 groups (group B vs group L:  $402 \pm 326$  vs  $402 \pm 303$  for WOSI [ $P = .87$ ];  $92.0\% \pm 12.5\%$  vs  $94.3\% \pm 10.7\%$  for patient satisfaction [ $P = .27$ ]). Time to RTP was significantly shorter in group L than group B ( $4.8 \pm 1.1$  vs  $5.8 \pm 1.8$  months, respectively;  $P = .002$ ).

TABLE 1  
Patient Characteristics<sup>a</sup>

	Overall (n = 101)	Group B (n = 66)	Group L (n = 35)	P
Age, y	18.1 ± 2.4 [17.7-18.6]	18.4 ± 2.6 [17.7-19.0]	17.7 ± 1.9 [17.1-18.4]	.43
Preoperative diagnosis				.69
Dislocation	46 (45.5)	31 (47.0)	15 (42.9)	
Subluxation	55 (54.5)	35 (53.0)	20 (57.1)	
GBL, %	10.9 ± 9.2 [9.1-12.7]	11.4 ± 9.0 [9.2-13.6]	10.0 ± 9.5 [6.8-13.3]	.39
GBL grade				.65
0 (0%)	25 (24.8)	14 (21.2)	11 (31.4)	
1 (>0% and ≤10%)	23 (22.8)	18 (27.3)	7 (20.0)	
2 (>10% and ≤20%)	33 (32.7)	20 (30.3)	11 (31.4)	
3 (>20%)	20 (19.8)	14 (21.2)	6 (17.1)	

<sup>a</sup>Data are reported as mean ± SD [95% CI] or n (%). GBL, glenoid bone loss.

TABLE 2  
Correlation Between Preoperative Glenoid Bone Loss  
and Postoperative Outcomes<sup>a</sup>

	r	P
ASES score		
Overall	-0.002	.98
Group B	0.129	.30
Group L	-0.189	.28
Rowe score		
Overall	-0.030	.76
Group B	0.032	.80
Group L	-0.148	.40
WOSI		
Overall	-0.002	.99
Group B	-0.010	.94
Group L	0.015	.93
Satisfaction rate		
Overall	0.072	.48
Group B	0.067	.60
Group L	0.104	.55
Time to RTP		
Overall	0.101	.33
Group B	0.055	.67
Group L	0.194	.29

<sup>a</sup>ASES, American Shoulder and Elbow Surgeons; RTP, return to play; WOSI, Western Ontario Shoulder Instability Index.

There were no significant correlations between the extent of GBL and postoperative outcomes (Table 2).

#### Graft Conditions at Final CT Examination

Table 3 shows the coracoid graft conditions at the final CT (mean time until final CT: group B, 10.4 ± 7.4 months; group L, 12.1 ± 4.4 months; *P* = .01). In group B, insufficient union and graft translocation were confirmed in 8 shoulders (12.1%) and 4 shoulders (6.1%), respectively, but in group L, no shoulders had insufficient union and only 1 shoulder (2.9%) had a translocation. In particular, among the cases with grade 0 or 1 GBL (group B, 32 shoulders; group L, 18 shoulders), 5 shoulders (15.6%) showed

TABLE 3  
Final Postoperative Graft Condition by Preoperative  
GBL Grade<sup>a</sup>

	Union	Insufficient Union	Translocation
Group B			
Overall (n = 66)	54 (82)	8 (12)	4 (6)
Grade 0 (n = 14)	10 (71)	1 (7)	3 (21)
Grade 1 (n = 18)	14 (78)	4 (22)	0 (0)
Grade 2 (n = 20)	17 (85)	2 (10)	1 (5)
Grade 3 (n = 14)	13 (93)	1 (7)	0 (0)
Group L			
Overall (n = 35)	34 (97)	0 (0)	1 (3)
Grade 0 (n = 11)	11 (100)	0 (0)	0 (0)
Grade 1 (n = 7)	7 (100)	0 (0)	0 (0)
Grade 2 (n = 11)	10 (91)	0 (0)	1 (9)
Grade 3 (n = 6)	6 (100)	0 (0)	0 (0)

<sup>a</sup>Data are reported as n (%). GBL, glenoid bone loss.

insufficient union and 3 shoulders (9.4%) had translocation in group B, but in group L, no shoulders had insufficient union or translocation. The rate of graft failure (insufficient union or translocation) in group B was not significantly higher among shoulders with grade 0 or 1 GBL than among those with grade 2 or 3 (25.0% vs 11.8%, respectively; *P* = .21). In the subanalysis of the final graft conditions, shoulders with insufficient union or translocation of the graft appeared to have a worse score or delayed RTP compared with those with graft union, although statistical comparisons could not be performed because of the small number of cases with graft failure (Table 4).

#### Postoperative Recurrence

Postoperative recurrence occurred in significantly fewer shoulders in group B than in group L (2 [3.0%] vs 5 [14.3%], respectively; *P* = .047). One patient with graft failure in group B and 1 patient with a consolidated bone graft in group L required revision surgery. Four of the 5 cases of recurrence in group L were grade 0 GBL, and complete graft union had been achieved in all 5 shoulders. In group

TABLE 4  
Final Postoperative Graft Condition by Outcome Measure<sup>a</sup>

	Union	Insufficient Union	Translocation
<b>Group B</b>			
ASES score	92.3 ± 9.2	83.5 ± 14.5	87.9 ± 8.5
Rowe score	89.4 ± 13.0	85.0 ± 14.6	82.5 ± 23.6
WOSI	390 ± 319	511 ± 397	338 ± 310
Satisfaction rate, %	93.4 ± 11.1	85.0 ± 13.1	87.5 ± 25.0
RTP time, mo	5.8 ± 1.7	6.0 ± 0.5	6.7 ± 4.6
<b>Group L</b>			
ASES score	91.7 ± 12.0	N/A	75
Rowe score	87.7 ± 14.5	N/A	60
WOSI	387 ± 285	N/A	1080
Satisfaction rate, %	94.2 ± 10.9	N/A	90
RTP time, mo	4.6 ± 1.0	N/A	7.0

<sup>a</sup>Data are reported as mean ± SD except for the column of Translocation in Group L, which included only one shoulder. ASES, American Shoulder and Elbow Surgeons; N/A, not available; RTP, return to play; WOSI, Western Ontario Shoulder Instability Index.

L, postoperative recurrence was not significantly different between shoulders with small and large GBL (grade 0 or 1, 22.2% vs grade 2 or 3, 5.9%;  $P = .34$ ), which means GBL had no significant effect on recurrence.

#### Other Complications

Two shoulders in group B had superficial infection, another 2 developed postoperative hematomas, while there was 1 superficial infection in group L. In all cases, preoperative GBL was grade 0 or 1. All patients were treated nonoperatively. No cases of nerve palsy were observed in either group.

#### DISCUSSION

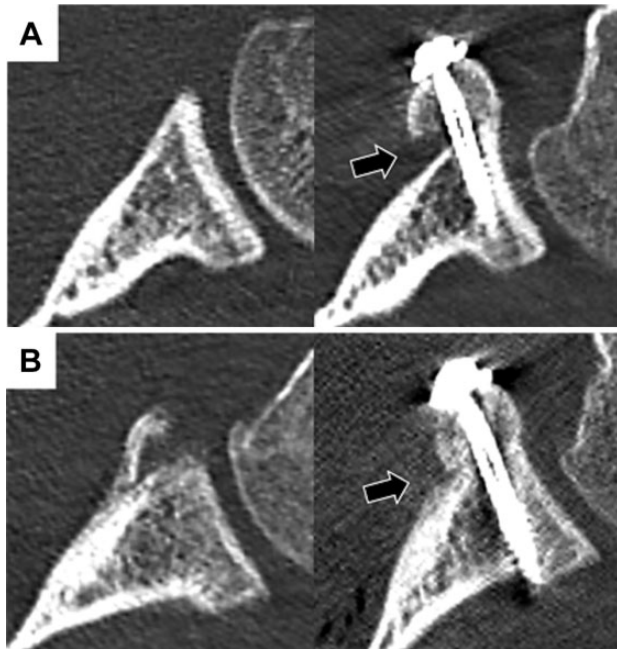
The most important findings of this study were that, in competitive rugby players, CPT combined with a Bankart repair results in a favorable outcome regardless of the extent of preoperative GBL or CPT procedure and that the time to RTP is significantly shorter after the Latarjet procedure than after the Bristow procedure.

In general, CPT is used to reconstruct bone defects in the glenoid and achieves good postoperative results in cases of anterior shoulder instability with a large GBL.<sup>2,21</sup> Because the conventional indication for CPT is a GBL of 20%<sup>39</sup> or 25% or more,<sup>18</sup> the few previous studies on combining CPT with a Bankart repair included patients, only younger patients who were collision athletes without considering the extent of GBL. Kawasaki et al<sup>15</sup> reported an association between lower postoperative functional scores and the extent of GBL after Bristow procedures combined with a Bankart repair in competitive rugby players. Their colleagues, Shibuya et al,<sup>31</sup> reported on a similar study that included shoulders treated with either the Bristow or the Latarjet procedure and found an association between the

simultaneous presence of a low Rowe score and a high WOSI, which they defined as “functional failure,” and the extent of GBL. On the other hand, Tasaki et al<sup>33</sup> compared postoperative outcomes in 2 groups, one with <10% GBL and the other with >10% GBL, and concluded that GBL does not influence postoperative outcomes. Therefore, the influence of the preoperative extent of GBL on outcome after CPT combined with a Bankart repair was still a controversial topic. Our data indicated that the extent of GBL does not influence postoperative clinical outcomes. In this study, even cases with a GBL >20% showed acceptable postoperative outcomes, indicating that CPT accompanied by a Bankart repair has an excellent stabilizing effect, regardless of the amount of GBL.

A previous review found a graft nonunion rate after CPT of almost 10%,<sup>9</sup> which is consistent with our current study. Di Giacomo et al<sup>11</sup> investigated the graft resorption rate after the Latarjet procedure and concluded that shoulders without GBL had significantly more graft resorption than those with >15% GBL. Although their report did not identify the difference in graft union rate, greater GBL appeared to be more advantageous for the prevention of graft resorption. On the other hand, the current study directly evaluated graft union and demonstrated that the Latarjet procedure is a reliable technique in terms of graft union regardless of the extent of GBL and can lead to an earlier RTP in rugby players. This difference was because of the faster bone union in the Latarjet procedure, as shown in a previous study.<sup>32</sup> However, in contrast, the Bristow procedure showed an inferior graft union rate compared with the Latarjet procedure. Previously, Willemot et al<sup>37</sup> summarized the cases that led to revision surgery after Bristow or Latarjet procedures. Their results implied that graft failures after the Bristow procedure occurred in cases without GBL or with only a small amount of GBL. Although screw length and insertion angle against the glenoid face have been reported as risk factors for graft failure after the Bristow procedure,<sup>4</sup> the present study is the first to evaluate an association between the amount of GBL and graft failure. We could not statistically determine the influence of GBL on graft failure in either group because of the underpowered analysis. However, if the GBL is absent or small, graft placement is likely to be poor in the Bristow procedure, as shown in Figure 1, which may cause graft failure. To avoid poor graft placement in cases with no GBL or a small GBL, the operative procedure may require some modification such as cutting the coracoid graft obliquely to fit the slope of the anterior glenoid neck before grafting.

The results of our subanalysis did not indicate a statistically significant difference in the relationship between graft failure and GBL or its clinical outcome. However, clinical scores in the graft failure group were relatively poor, and there was a tendency for graft failure in shoulders with a GBL ≤10% that underwent the Bristow procedure. This finding might be considered by surgeons in selecting surgical procedures for anterior shoulder instability in young collision athletes and should be proved in future studies with an adequate statistical power. However, the extent of GBL was not correlated with clinical scores in



**Figure 1.** Relationship of the grafted coracoid process to the glenoid before and immediately after the Bristow procedure in 2 representative cases. (A) Image obtained in a 19-year-old male patient without glenoid bone loss (GBL). Arrow indicates a gap between the graft and the glenoid. (B) Image obtained in an 18-year-old male patient with GBL accompanied by a bony Bankart lesion. Arrow indicates no gap.

group B, indicating that this technique is reliable enough to treat patients with large glenoid defects.

### Limitations

This study has several limitations. First, it was not a prospective randomized trial but a retrospective cohort case-control study. The comparison of preoperative clinical status in groups B and L showed worse status in patients who underwent the Bristow procedure. Although postoperative scores were not significantly different between groups, the preoperative differences might have affected these results. In addition, group L had fewer patients than group B, so the effects of the Latarjet procedure might have been underestimated. There was also a significant difference in time to the final CT scan between groups B and L, which may have affected the assessment of graft condition. Second, group L would have benefitted by having a more experienced surgeon perform their surgery, which might have contributed to the different clinical outcome from group B. Third, the study did not evaluate Hill-Sachs lesions (HSLs), although the location of a HSL might affect postoperative outcomes after surgical treatment of anterior shoulder instability. However, because CPT can change the glenoid track and convert an off-track HSL to an on-track one,<sup>7,27</sup> we believe that any potential negative effect of HSLs localization would have been very small or negligible. Fourth, we could not perform statistical comparisons in our

subanalysis because of the quite small numbers of graft failures. The influence of graft failure itself on clinical outcomes should be evaluated in further studies.

### CONCLUSION

The findings of this study indicated that the extent of GBL does not affect clinical scores after CPT, regardless of operative procedure.

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### REFERENCES

- Avramidis G, Kokkineli S, Trellopoulos A, et al. Excellent clinical and radiological midterm outcomes for the management of recurrent anterior shoulder instability by all-arthroscopic modified Eden-Hybinette procedure using iliac crest autograft and double-pair button fixation system: 3-year clinical case series with no loss to follow-up. *Arthroscopy*. 2021;37(3):795-803.
- Bessi re 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.
- Boileau P, Baring T, Greco V. Arthroscopic distal clavicular autograft for congruent glenoid reconstruction. *Arthrosc Tech*. 2021;10(11):e2389-e2395.
- Boileau P, Th lu C, Mercier N, et al. Arthroscopic Bristow-Latarjet combined with Bankart repair restores shoulder stability in patients with glenoid bone loss. *Clin Orthop Relat Res*. 2014;472(8):2413-2424.
- Boileau P, Villalba M, H ry JY, et al. Risk factors for recurrence of shoulder instability after arthroscopic Bankart repair. *J Bone Joint Surg Am*. 2006;88(8):1755-1763.
- Bouju Y, Gad a F, Stanovici J, Moubarak H, Favard L. Shoulder stabilization by modified Latarjet-Patte procedure: results at a minimum 10 years' follow-up, and role in the prevention of osteoarthritis. *Orthop Traumatol Surg Res*. 2014;100(4)(suppl):S213-S218.
- Brandariz RN, Gorodischer TD, Pasqualini I, et al. The Latarjet procedure without remplissage is effective to restore stability in athletes with glenoid bone defects greater than 25% and off-track Hill-Sachs lesions. *Arthroscopy*. 2021;37(8):2455-2461.
- 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(7):677-694.
- Butt U, Charalambous CP. Complications associated with open coracoid transfer procedures for shoulder instability. *J Shoulder Elbow Surg*. 2012;21(8):1110-1119.
- Cowling PD, Akhtar MA, Liow RY. What is a Bristow-Latarjet procedure? A review of the described operative techniques and outcomes. *Bone Joint J*. 2016;98-B(9):1208-1214.
- Di Giacomo G, de Gasperis N, Costantini A, et al. Does the presence of glenoid bone loss influence coracoid bone graft osteolysis after the Latarjet procedure? A computed tomography scan study in 2 groups of patients with and without glenoid bone loss. *J Shoulder Elbow Surg*. 2014;23(4):514-518.
- Hayashida K, Yoneda M, Nakagawa S, Okamura K, Fukushima S. Arthroscopic Bankart suture repair for traumatic anterior shoulder instability: analysis of the causes of a recurrence. *Arthroscopy*. 1998;14(3):295-301.

13. Iizawa N, Yoneda M, Yamada S, et al. Benefits of bone graft augmentation to arthroscopic Bankart repair for recurrent anterior shoulder instability with glenoid bone loss. *Knee Surg Sports Traumatol Arthrosc.* 2020;28(7):2325-2333.
14. Itoi E, Lee SB, Berglund LJ, Berge LL, An KN. The effect of a glenoid defect on antero-inferior stability of the shoulder after Bankart repair: a cadaveric study. *J Bone Joint Surg Am.* 2000;82(1):35-46.
15. Kawasaki T, Hasegawa Y, Kaketa T, et al. Midterm clinical results in rugby players treated with the Bristow procedure. *Am J Sports Med.* 2018;46(3):656-662.
16. Kirkley A, Griffin S, McLintock H, Ng L. The development and evaluation of a disease-specific quality of life measurement tool for shoulder instability. *Am J Sports Med.* 1998;26(6):764-772.
17. Lee SH, Lim KH, Kim JW. Risk factors for recurrence of anterior-inferior instability of the shoulder after arthroscopic Bankart repair in patients younger than 30 years. *Arthroscopy.* 2018;34(9):2530-2536.
18. Lynch JR, Clinton JM, Dewing CB, Warne WJ, Matsen FA III. Treatment of osseous defects associated with anterior shoulder instability. *J Shoulder Elbow Surg.* 2009;18(2):317-328.
19. Mazzocca AD, Brown FM Jr, Carreira DS, Hayden J, Romeo AA. Arthroscopic anterior shoulder stabilization of collision and contact athletes. *Am J Sports Med.* 2005;33(1):52-60.
20. Menendez ME, Sudah SY, Cohn MR, et al. Defining minimal clinically important difference and Patient Acceptable Symptom State after the Latarjet procedure. *Am J Sports Med.* 2022;50(10):2761-2766.
21. Moon SC, Cho NS, Rhee YG. Quantitative assessment of the Latarjet procedure for large glenoid defects by computed tomography: a coracoid graft can sufficiently restore the glenoid arc. *Am J Sports Med.* 2015;43(5):1099-1107.
22. Moroder P, Kathi T, Lacheta L, et al. Arthroscopic bone block cerclage technique using a tricortical scapular spine autograft for glenoid reconstruction in patients with anterior shoulder instability. *Arthrosc Tech.* 2022;11(3):e379-e383.
23. Nakagawa S, Hirose T, Uchida R, et al. A glenoid defect of 13.5% or larger is not always critical in male competitive rugby and American football players undergoing arthroscopic bony Bankart repair: contribution of resultant large bone fragment. *Arthroscopy.* 2022;38(3):673-681.
24. Nakagawa S, Mae T, Sato S, Okimura S, Kuroda M. Risk factors for the postoperative recurrence of instability after arthroscopic Bankart repair in athletes. *Orthop J Sports Med.* 2017;5(9):2325967117726494.
25. Nakagawa S, Sahara W, Kinugasa K, Uchida R, Mae T. Bipolar bone defects in shoulders with primary instability: dislocation versus subluxation. *Orthop J Sports Med.* 2021;9(5):23259671211003553.
26. Park I, Lee JH, Hyun HS, Lee TK, Shin SJ. Minimal clinically important differences in Rowe and Western Ontario Shoulder Instability Index scores after arthroscopic repair of anterior shoulder instability. *J Shoulder Elbow Surg.* 2018;27(4):579-584.
27. Plath JE, Henderson DJH, Coquay J, et al. Does the arthroscopic Latarjet procedure effectively correct "off-track" Hill-Sachs lesions? *Am J Sports Med.* 2018;46(1):72-78.
28. Richards RR, An KN, Bigliani LU, et al. A standardized method for the assessment of shoulder function. *J Shoulder Elbow Surg.* 1994;3(6):347-352.
29. Rowe CR, Patel D, Southmayd WW. The Bankart procedure: a long-term end-result study. *J Bone Joint Surg Am.* 1978;60(1):1-16.
30. Shaha JS, Cook JB, Song DJ, et al. Redefining "critical" bone loss in shoulder instability: functional outcomes worsen with "subcritical" bone loss. *Am J Sports Med.* 2015;43(7):1719-1725.
31. Shibuya K, Kawasaki T, Hasegawa Y, et al. Glenoid bone loss is a risk factor for poor clinical results after coracoid transfer in rugby players with shoulder dislocations. *Orthop J Sports Med.* 2021;9(3):2325967121993233.
32. Tanaka M, Hanai H, Kotani Y, et al. Open Bristow versus open Latarjet for anterior shoulder instability in rugby players: radiological and clinical outcomes. *Orthop J Sports Med.* 2022;10(5):23259671221095094.
33. Tasaki A, Morita W, Nozaki T, et al. Arthroscopic Bankart repair and open Bristow procedure in the treatment of anterior shoulder instability with osseous glenoid lesions in collision athletes. *Orthop J Sports Med.* 2021;9(5):23259671211008274.
34. Tokish JM, Fitzpatrick K, Cook JB, Mallon WJ. Arthroscopic distal clavicular autograft for treating shoulder instability with glenoid bone loss. *Arthrosc Tech.* 2014;3(4):e475-e481.
35. Ueda Y, Sugaya H, Takahashi N, et al. Arthroscopic iliac bone grafting for traumatic anterior shoulder instability with significant glenoid bone loss yields low recurrence and good outcome at a minimum of five-year follow-up. *Arthroscopy.* 2021;37(8):2399-2408.
36. Verweij LPE, van Spanning SH, Grillo A, et al. Age, participation in competitive sports, bony lesions, ALPSA lesions, > 1 preoperative dislocations, surgical delay and ISIS score > 3 are risk factors for recurrence following arthroscopic Bankart repair: a systematic review and meta-analysis of 4584 shoulders. *Knee Surg Sports Traumatol Arthrosc.* 2021;29(12):4004-4014.
37. Willemot L, De Boey S, Van Tongel A, et al. Analysis of failures after the Bristow-Latarjet procedure for recurrent shoulder instability. *Int Orthop.* 2019;43(8):1899-1907.
38. Yamamoto N, Itoi E, Abe H, et al. Effect of an anterior glenoid defect on anterior shoulder stability: a cadaveric study. *Am J Sports Med.* 2009;37(5):949-954.
39. Yamamoto N, Muraki T, Sperling JW, et al. Stabilizing mechanism in bone-grafting of a large glenoid defect. *J Bone Joint Surg Am.* 2010;92(11):2059-2066.
40. Yian EH, Weathers M, Knott JR, Sodl JF, Spencer HT. Predicting failure after primary arthroscopic Bankart repair: analysis of a statistical model using anatomic risk factors. *Arthroscopy.* 2020;36(4):964-970.