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# Evaluation of throwing ability after coracoid transfer in non-overhead athletes

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**Background:** Coracoid transfer is the most common procedure for the treatment of traumatic anterior shoulder dislocations with large glenoid bone defects; however, it is rarely used for the treatment of throwing shoulders because of possible postoperative limited range of motion. This study aimed to evaluate throwing function after coracoid transfer for shoulder instability.

**Methods:** The study included non-overhead athletes (n = 11; Bristow-Latarjet [BL] group) who suffered shoulder dislocation and underwent coracoid transfer on the dominant side of the shoulder and healthy volunteers (n = 20; C group) from the same population (overall age distribution: 18–22 years). All participants were evaluated for shoulder function including ball-throwing abilities (e.g., ball velocity and long-throw distance). In the primary analyses, we compared the maximum ball velocity and long-throw distance between the groups using the repeated 2-way analysis of variance. In secondary analyses, all other measurements were compared between the groups using the Mann–Whitney U test.

**Results:** In the primary analysis, mean maximum ball velocity and long-throw distance in the BL and C groups were 83.5 and 87.9 km/h versus 44.8 and 54.7 m, respectively, demonstrating no significant differences between the groups. In the secondary analysis, only the range of external rotation with the shoulder at the side was significantly lower in the BL group ($P = .046$).

**Conclusion:** The throwing ability after coracoid transfer in non-overhead athletes is acceptable compared to that in the matched population. Therefore, this procedure may be an option for treating traumatic anterior shoulder dislocations with large bone defects in athletes such as goalkeepers, handball, and basketball players at the recreational level.



Surgical treatment of traumatic anterior shoulder instability in overhead athletes is challenging, especially in cases involving large glenoid bone defects. To achieve joint stability in this case, arthroscopic Bankart repair alone is not sufficient, as more than 25% of the bone defects in cadaveric biomechanical studies and 13.5% in clinical outcome studies, both relative to the glenoid width, were reported to lead to poor outcomes.[4,5,18,20]

Coracoid transfer, also known as the Bristow–Latarjet procedure, is the most common procedure for this type of shoulder dislocation.[10,16] However, it tends to be avoided in the throwing shoulder of overhead athletes because of its nonanatomic aspect of coracoid tendon transfer, which is the main factor in the stabilization mechanism and often results in complications of joint contracture.[17,22] In recent years, however, there have been clinical reports of a small number of overhead athletes with shoulder dislocation who underwent the Bristow–Latarjet procedure.[1-3,7,8,11] The question arises as to whether the Bristow–Latarjet procedure is contraindicated in overhead athletes. In such cases, the details of the extent to which the throwing ability is impaired remain unclear.

The purpose of this study was to evaluate the throwing ability after coracoid transfer for shoulder dislocation. We hypothesized that after the Bristow–Latarjet procedure in dislocated shoulders, throwing ability would reasonably preserve.

This study was approved by the authors' hospital's institutional review board; Juntendo University Faculty of Medicine (number 24-0065).

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**Table I**
Demographics of participants.

| Variables | Bristow–Latarjet group (n = 11) | Healthy control group (n = 20) | *P* |
|---|---|---|---|
| **Age (y),** *median, 25–75 percentiles* | 21 (19-21) | 20 (20-21) | .39 |
| **Height (cm),** *median, 25–75 percentiles* | 177.5 (176.0-179.0) | 178.0 (177.0-182.0) | .63 |
| **Weight (kg),** *median, 25–75 percentiles* | 91.5 (83.5-103.0) | 89.0 (83.0-97.0) | .50 |
| **BMI (kg/m$^2$),** *median, 25–75 percentiles* | 28.7 (26.9-30.1) | 27.8 (26.7-29.8) | .39 |
| **Dominant side of the shoulder (right:left)** | 11:0 | 19:1 | .65 |
| **Experience of overhead sports (number)** | 3 | 8 | .38 |
| **Duration between the surgery and examinations,** *median, 25–75 percentiles* | 31.9 (18.2-46.7) | - | - |

*BMI*, body mass index.

## Methods

### *Participants*

This study was approved by the institutional review board of our institute (#24-0065). Non-overhead athletes in a collegiate rugby team aged 18–22 years were recruited during the offseason. Prior to data collection, each participant provided written informed consent and completed a form of agreement. A total of 31 athletes agreed to participate and were enrolled and divided into two groups: non-overhead athletes (n = 11; Bristow-Latarjet [BL] group) who suffered shoulder dislocation at least once and underwent primary shoulder stabilization surgery (open Bristow–Latarjet procedure) on the dominant side of the shoulder, and healthy volunteers in the same population (n = 20; C group). It is noted that not all participants underwent the surgery in our institutes, thus in this study we were not able to quantify preoperative bone loss. Athletes who underwent shoulder surgery less than 1 year ago and those with any history of shoulder or elbow surgery other than the primary coracoid transfer were excluded from the study. The demographics of the participants (e.g., age, height, weight, number of shoulder dislocation episodes, duration between the surgery and examinations in the BL group, and experience of overhead sports) were recorded before the examinations.

### *Functional evaluations*

Functional evaluations were performed for range of motion (ROM) on each side of the shoulder and muscle strength of the shoulder in the external rotation (ER) and internal rotation (IR) with the shoulder at 90° abduction. Measurements of passive ROM of shoulder flexion, abduction, ER, and IR at the side, as well as 90° and horizontal adduction in the supine position, were assessed with one repetition using a goniometer. Muscle strength was measured in the ER and IR at 90° abduction using a handheld dynamometer, MicroFET2 (HOGGAN Scientific LLC, Salt Lake City, UT, USA). We performed three trials of each motion and recorded the peak force (N) for each trial. The median values of each trial were referenced, and the strengths of the ER and IR were represented as ratios by following calculations: ER ratio = median ER strength in the dominant shoulder/median ER strength in the nondominant shoulder; IR ratio = median IR strength in the dominant shoulder/median IR strength in the nondominant shoulder.

The participants then processed ball-throwing tasks to measure ball velocity and long-throw distance on the field. After a normal warm-up, the participants pitched three balls with maximum velocity of their own using a 5-ounce (142 g) standard regulation baseball. For each pitch, the ball velocity was measured using a radar gun (Velocity Speed Gun; Bushnell Corp., Overland Park, KS, USA). Next, they threw the ball three times as far as possible, and the distances were recorded. If the participant experienced shoulder pain during the tasks, a numerical rating scale was used to evaluate the degree of pain.

### *Statistical analysis*

In the primary analyses, we compared the mean maximum ball velocity and long-throw distance between the groups using repeated two-way analysis of variance; these data were normally distributed, as measured by the Shapiro–Wilk test, and were thus represented as mean values and 95% confidence intervals. In the secondary analyses, we compared all other measurements (e.g., demographics, shoulder ROM, and strength parameters) to demonstrate the characteristics between the groups. We used either the Mann–Whitney U tests or Fisher's exact test, depending on the data distribution. We represented these data as median values, 25 and 75 percentiles because most of these data were not normally distributed. Additionally, we addressed correlation coefficients to detect the degree of linear relationship between the variables using Spearman's rank correlation coefficient. An alpha level of .05 was applied to all data as the threshold for statistically significant differences, and all tests other than Fisher's exact test were 2-sided. Data analyses were performed using the SPSS software for Macintosh (version 23.0; IBM Corp., Armonk, NY, USA).

## Results

The demographic characteristics of the participants are presented in Table I. All participants completed the throwing tasks; 3 of 11 participants in the BL group had a pain score of 3 or more/10 on the numerical rating scale during the tasks, whereas no participant in the C group had a pain score of more than 2. In the primary analysis, mean maximum ball velocity (km/h) and long-throw distance (m) in the BL and C groups were 83.5 (95% confidence interval: 75.6–91.3) and 87.9 (82.0–93.7), and 44.8 (36.1–53.5) and 54.7 (48.1–61.3), respectively; the repeated 2-way analysis of variance revealed no significant effect of both the groups and trial orders in ball velocity (*P* = .37, 40, respectively) or long-throw distance (*P* = .07, .14, respectively, Fig. 1). In the secondary analysis for the comparison of ROM and muscle strength between the groups, only the range of ER at the side was significantly lower in the BL group (*P* = .046; Table II). Among the correlations between the studied variables, ball velocity and long-throw distance showed a strong correlation (rho = 0.86) (Figs. 2 and 3). The overall statistical power of the comparison between the groups was 0.14–0.66.

## Discussion

The present study compared non-throwing athletes because the Bristow–Latarjet procedure is not usually applicable to throwing athletes. We first hypothesized that there was no difference in the throwing abilities between the group of non-overhead athletes

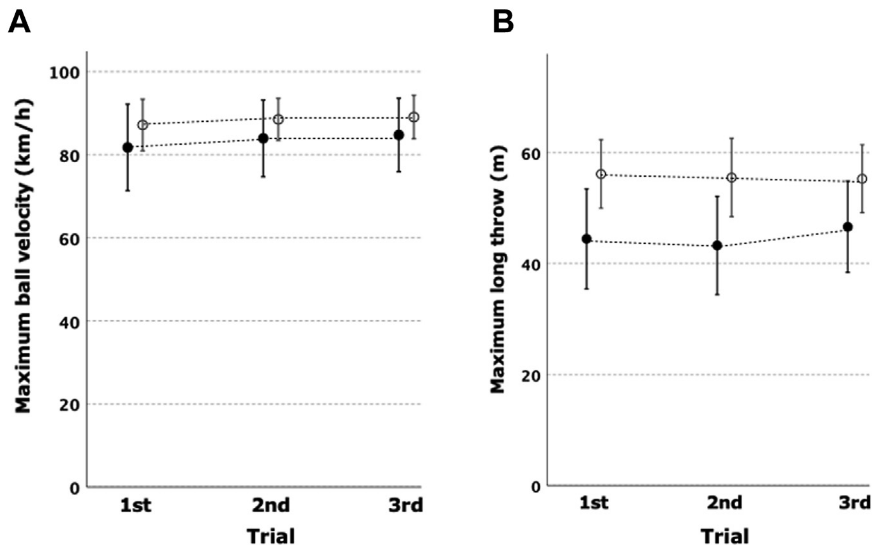


**Figure 1** Mean profile plots of throwing ability. (**A**) Maximum ball velocity and (**B**) Maximum long throw distance in each group. *Black dots* represent the Bristow–Latarjet group; *blank dots* represent the control group. Each bar represents a 95% confidence interval.

**Table II**
Functional evaluation and throwing ability of the participants.

| Variables, median, 25–75 percentiles | Bristow–Latarjet (n = 11) | Healthy control (n = 20) | *P* |
|---|---|---|---|
| ROM of the dominant shoulder (degrees) | | | |
| Flexion | 170.0 (170.0–175.0) | 177.5 (167.5–180.0) | .27 |
| Abduction | 170.0 (165.0–180.0) | 180.0 (170.0–180.0) | .15 |
| Horizontal adduction | 100.0 (90.0–120.0) | 100.0 (95.0–110.0) | .90 |
| External rotation at the side | 50.0 (30.0–60.0) | 60.0 (50.0–60.0) | .046* |
| Internal rotation at the side | 25.0 (23.0–33.0) | 24.5 (22.5–28.5) | .55 |
| ER at 90° of abduction | 85.0 (80.0–95.0) | 95.0 (90.0–95.0) | .18 |
| IR at 90° of abduction | 50.0 (50.0–60.0) | 45.0 (42.5–52.5) | .20 |
| Muscle strength at abduction (ratio) | | | |
| ER ratio | 1.0 (0.7–1.1) | 1.0 (1.0–1.1) | .27 |
| IR ratio | 0.9 (0.8–1.2) | 1.0 (1.0–1.1) | .60 |
| Maximum ball velocity (km/h) | 87.0 (82.0–101.0) | 91.5 (83.5–96.5) | .53 |
| Maximum long throw distance (m) | 53.0 (35.0–59.0) | 55.0 (46.5–66.0) | .21 |

*ROM*, range of motion; *ER*, external rotation; *IR*, internal rotation.
The ER and IR ratios represent the muscle strength of the dominant side of the shoulder relative to that of the nondominant side.
*Significant.

who underwent the Bristow–Latarjet procedure for shoulder dislocation on the throwing side and the normal control group with the same background, and then failed to reject the above null hypothesis. These results suggest that the coracoid transfer may qualify as an acceptable treatment option for shoulder instability in the throwing side in non-overhead athletes. However, our results from athletes who do not have a pitching specialty may not necessarily apply directly to throwing athletes.

In previous reports, shoulder dislocation remains a challenging injury for the throwing shoulder, especially for baseball players; full recovery of the throwing shoulder to preinjury levels with arthroscopic Bankart repair was 20% for pitchers and 82% for infielders.[15] Although the present study did not include elite overhead athletes, our findings showed that the best results of postoperative athletes were 100 km/h in ball velocity and 60 m in long-throw, suggesting that coracoid transfer might have a risk of poor outcome for elite pitchers and outfielders. On the other hand, some clinical studies have demonstrated that the results of the Bristow–Latarjet procedure on the throwing shoulder were reasonably acceptable.[1-3,7,8,11] Gowd et al demonstrated that 67.9% of patients (19 of 28) were able to return to throwing sports without difficulty.[7] Bauer et al also reported that 73% (8 of 11) of handball players returned with no pain in the throwing shoulder.[1] Kee et al reported an return-to-sports of 96%, and only 23.2% returned to the same level of sports after an open Latarjet.[11] Arthroscopic Latarjet may also improve the results over traditional open Latarjet.[3] Overall, these reports suggest that the procedure can be a reliable treatment option even in overhead athletes, depending on their sport, position, level, and the extent of the bone defect, and especially for goalkeepers in football and handball as well as basketball players.

Throwing is a complex movement that involves the proper use of the entire body, in which not only the upper limbs centered on the shoulder joint but also the lower limbs, hip joint, and trunk

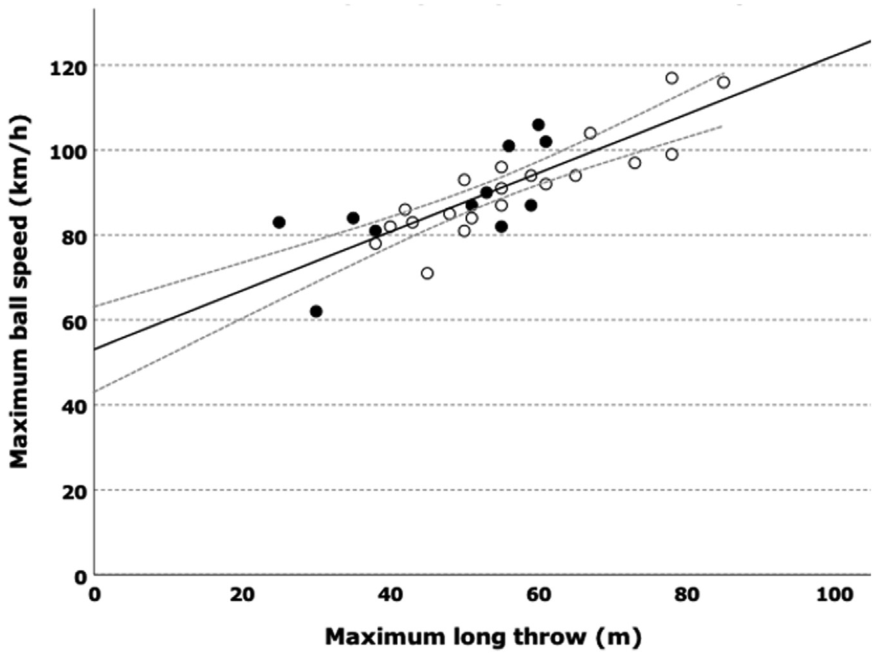


**Figure 2** Scatter plots of throwing ability. Spearman's correlation coefficient (rho) = 0.86. *Black dots* represent the Bristow–Latarjet group; *blank dots* represent the healthy control group.

work together and cooperate in propulsion and rotational motion.[13] In such complex motions, the maximum range of ER at 90° abduction on the throwing side of the shoulder is important to compete at a highly competitive level; this affects baseball pitchers' ball velocity as well as the return to sports in overhead athletes.[19] In the present study, contrary to the restriction of ER of the shoulder at the side, the range of ER at 90° abduction was not impaired in the Bristow–Latarjet group, which may explain the preservation of throwing ability. The site of the structure responsible for shoulder contracture depends on the direction of motion; the ER at the side depends on the tightness of the anterosuperior articular capsule and the subscapularis tendon as well as the pectoralis major, while the ER at 90° abduction depends on the tightness of the anterior and inferior articular capsule.[9,14] In the Bristow–Latarjet procedure, the sling effect of the conjoint tendon is potent in stabilizing the shoulder joint. The initial technique of Latarjet consisted in a complete longitudinal section of subscapularis tendon to fix the coracoid process to the anterior surface of the glenoid.[12] This process results in tightness of the anterior component after surgery, subsequently affecting the ER. To minimize the invasion for the subscapularis, Young et al[21] introduced the essential modification with a subscapularis-split transverse incision, which may also contribute to preserve the anatomic running of the superior half of the subscapularis as well as the kinematics of the shoulder. On the other hand, it does not overly invade the anterior inferior glenoid, that is, we assume that no procedure or intervention restricts the ER at 90° abduction. Therefore, the Bristow–Latarjet procedure may not have a fatal effect on the throwing ability.

Another option for the surgical treatment of the throwing shoulder with dislocation involving significant bone loss is free iliac bone grafting. Recently, a systematic review of meta-analyses demonstrated that the overall clinical outcomes, including a return to play, recurrence, complications, and later arthritic change, were not significantly different between the two procedures.[6] Since patients in these reports were not necessarily overhead athletes or had large bone defects, we need to be cautious in the interpretation of these results. The mechanism with which coracoid transfer negatively affects the throwing ability requires a comparison between the two procedures and may be a scope for future study.

Although the present study demonstrated important findings, it had several limitations. This study did not include any data before surgery in the BL group or imaging examinations of the shoulders investigated because a part of the participants underwent surgery at other institutions. It should be noted that preoperative and postoperative imaging evaluations may have influenced the results. Additionally, the overall statistical power was 0.14–0.66, indicating that type II error could be involved in the outcomes. The insufficient sample size and background factors may have affected the results. Further validation of throwing ability in postoperative shoulders with large bone loss is required.

## Conclusion

The present study demonstrated that the throwing ability after coracoid transfer for traumatic anterior shoulder dislocation in a population of non-overhead athletes was acceptable compared to that in the matched population. Although careful assessment is required before stabilization surgery, the Bristow–Latarjet procedure may be an option for the treatment of traumatic anterior shoulder dislocations with large bone defects and possibly in overhead athletes. Further clinical investigations are warranted.

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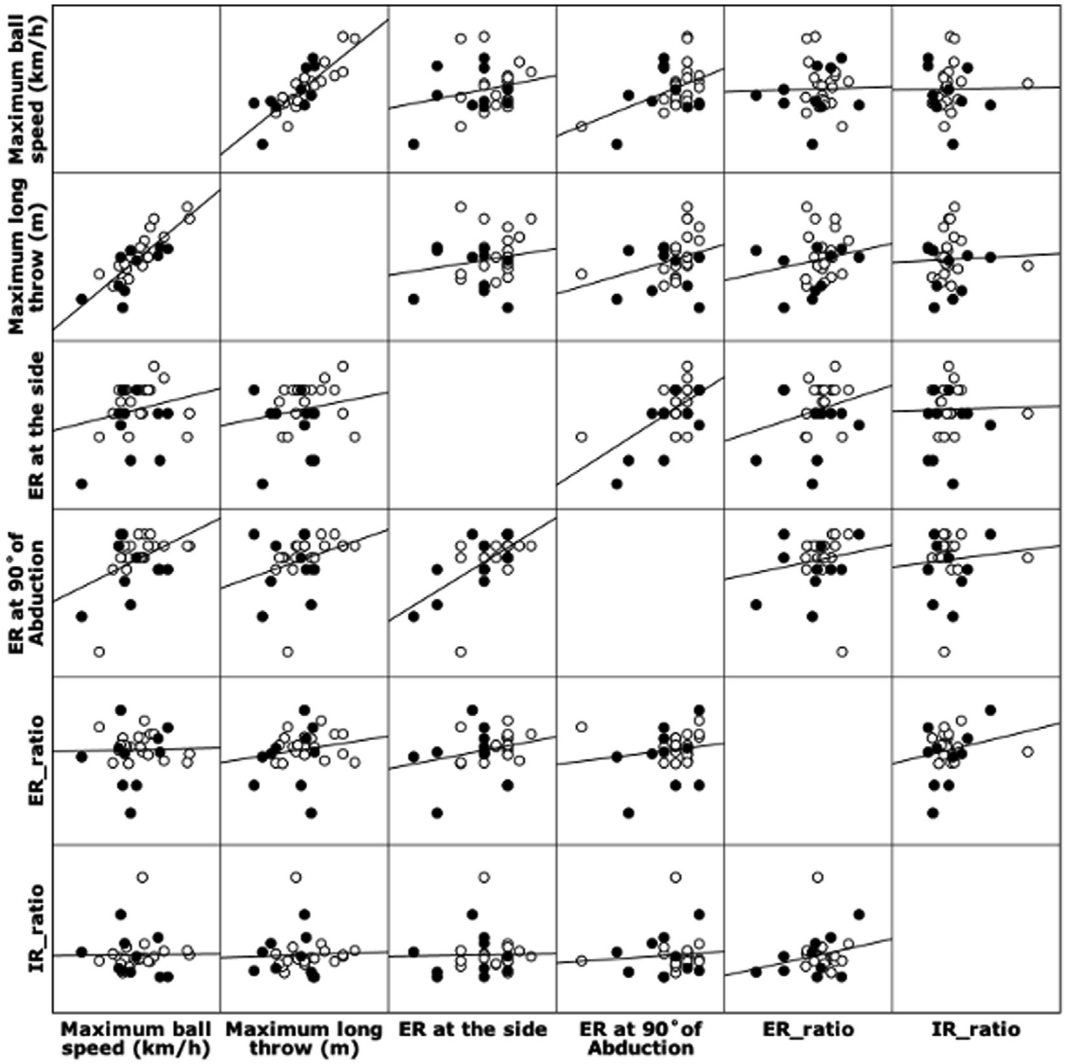


**Figure 3** Correlation matrix for representative variables. *Black dots* represent the Bristow–Latarjet group; *blank dots* represent the healthy control group. *ER*, external rotation; *IR*, internal rotation.

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## References

1. Bauer S, Neyton L, Collin P, Zumstein M. The open Latarjet-Patte procedure for the treatment of anterior shoulder instability in professional handball players at a mean follow-up of 6.6 years. J Shoulder Elbow Surg 2024;33:924-31. https://doi.org/10.1016/j.jse.2023.07.029.
2. Boileau P, Thélu CÉ, Mercier N, Ohl X, Houghton-Clemmey R, Carleset M, et al. Arthroscopic Bristow-Latarjet combined with bankart repair restores shoulder stability in patients with glenoid bone loss. Clin Orthop Relat Res 2014;472: 2413-24. https://doi.org/10.1007/s11999-014-3691-x.
3. Brzoska R, Laprus H, Malik SS, Solecki W, Juszczak B, Blasiak A. Return to preinjury-level sports after arthroscopic Latarjet for recurrent anterior shoulder instability in professional athletes. Orthop J Sports Med 2023;11: 23259671231166371. https://doi.org/10.1177/23259671231166371.
4. Di Giacomo G, Itoi E, Burkhart SS. Evolving concept of bipolar bone loss and the Hill-Sachs lesion: from "engaging/non-engaging" lesion to "on-track/off-track" lesion. Arthroscopy 2014;30:90-8. https://doi.org/10.1016/j.arthro.2013.10.004.
5. Dickens JF, Owens BD, Cameron KL, DeBerardino TM, Masini BD, Peck KY, et al. The effect of subcritical bone loss and exposure on recurrent instability after arthroscopic Bankart repair in intercollegiate American football. Am J Sports Med 2017;45:1769-75. https://doi.org/10.1177/0363546517704184.
6. Gilat R, Haunschild ED, Lavoie-Gagne OZ, Tauro TM, Knapik DM, Fu MC, et al. Outcomes of the Latarjet procedure versus free bone block procedures for anterior shoulder instability: a systematic review and meta-analysis. Am J Sports Med 2021;49:805-16. https://doi.org/10.1177/0363546520925833.
7. Gowd AK, Liu JN, Polce EM, Agarwalla A, Garcia GH, Nicholson GP, et al. Return to sport following Latarjet glenoid reconstruction for anterior shoulder instability. J Shoulder Elbow Surg 2021;30:2549-59. https://doi.org/10.1016/j.jse.2021.04.020.
8. Hurley ET, Montgomery C, Jamal MS, Shimozono Y, Ali Z, Pauzenberger L, et al. Return to play after the Latarjet procedure for anterior shoulder instability: a systematic Review. Am J Sports Med 2019;47:3002-8. https://doi.org/10.1177/0363546519831005.
9. Jost B, Koch PP, Gerber C. Anatomy and functional aspects of the rotator interval. J Shoulder Elbow Surg 2000;9:336-41.
10. Kawasaki T, Hasegawa N, Kaketa T, Shiota Y, Gonda Y, Sobue S, et al. Mid-term clinical results in rugby players treated with the Bristow procedure. Am J Sports Med 2018;46:656-62. https://doi.org/10.1177/0363546517740567.
11. Kee YM, Kim JY, Kim HJ, Lim CT, Rhee YG. Return to sports after the Latarjet procedure: high return level of non-collision athletes. Knee Surg Sports Traumatol Arthrosc 2018;26:919-25. https://doi.org/10.1007/s00167-017-4775-4.

12. Latarjet M. Treatment of recurrent dislocation of the shoulder. Lyon Chir 1954;49:994-7.
13. Nobuhara K. The shoulder in sports. In: Nobuhara K, editor. The shoulder: Its function and clinical aspects. Singapore: World Scientific Publishing Co; 2003. Toh Tuck Link.
14. Ovesen J, Nielsen S. Stability of the shoulder joint. Cadaver study of stabilizing structures. Acta Orthop Scand 1985;56:149-51.
15. Park JY, Lee JH, Oh KS, Chung SW, Lim JJ, Noh YM. Return to play after arthroscopic treatment for shoulder instability in elite and professional baseball players. J Shoulder Elbow Surg 2019;28:77-81. https://doi.org/10.1016/j.jse.2018.07.006.
16. Shibuya K, Kawasaki T, Hasegawa Y, Gonda Y, Itoigawa Y, Sobue S, et al. Glenoid bone loss is a risk factor for poor clinical results of coracoid transfer in rugby players with shoulder dislocation. Orthop J Sports Med 2021;9: 2325967121993233. https://doi.org/10.1177/2325967121993233.
17. Singer GC, Kirkland PM, Emery RJ. Coracoid transposition for recurrent anterior instability of the shoulder. A 20-year follow-up study. J Bone Joint Surg Br 1995;77:73-6.
18. Shaha JS, Cook JB, Song DJ, Rowles DJ, Bottoni CR, Shaha SH, et al. Redefining "critical" bone loss in shoulder instability: functional outcomes worsen with "subcritical" bone loss. Am J Sports Med 2015;43:1719-25. https://doi.org/10.1177/0363546515578250.
19. Werner SL, Suri M, Guido Jr JA, Meister K, Jones DG. Relationships between ball velocity and throwing mechanics in collegiate baseball pitchers. J Shoulder Elbow Surg 2008;17:905-8. https://doi.org/10.1016/j.jse.2008.04.002.
20. Yamamoto N, Muraki T, Sperling JW, Steinmann SP, Cofield RH, Itoi E, et al. Stabilizing mechanism in bone-grafting of a large glenoid defect. J Bone Joint Surg Am 2010;92:2059-66. https://doi.org/10.2106/JBJS.I.00261.
21. Young AA, Maia R, Berhouet J, Walch G. Open Latarjet procedure for management of bone loss in anterior instability of the glenohumeral joint. J Shoulder Elbow Surg 2011;20:S61-9. https://doi.org/10.1016/j.jse.2010.07.022.
22. Young DC, Rockwood CA Jr. Complications of a failed Bristow procedure and their management. J Bone Joint Surg Am 1991;73:969-81.