

Effect of Modified Arthroscopic Latarjet on Acromiohumeral Distance at 5-Year Follow-up

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Background: It is unclear whether coracoacromial ligament release during the Latarjet procedure will increase superior translation of the shoulder joint.

Purpose: To evaluate whether a modified suture button Latarjet procedure can decrease the acromiohumeral distance (AHD).

Study Design: Case series; Level of evidence, 4.

Methods: A retrospective analysis was conducted among 155 patients who underwent a modified suture button Latarjet procedure between 2013 and 2015. AHD was measured on bilateral computed tomography scans taken preoperatively and on scans of the affected shoulder taken on postoperative day 1 and postoperative month (POM) 6, POM 36, and POM 60. At each time point, we recorded pain on a visual analog scale (VAS) and objective shoulder function using the American Shoulder and Elbow Surgeons, Rowe, and Walch-Duplay scores. Preoperative and final follow-up VAS and functional scores were compared using the paired *t* test. Pairwise comparison of AHD values at each follow-up time point were compared with the preoperative intact side using the paired *t* test. Intra- and interobserver reproducibility of the AHD measurements was evaluated using the intraclass correlation coefficient.

Results: A total of 104 patients who met the criteria completed the final follow-up, which occurred at 62.6 ± 2.4 months (mean \pm SD). When compared with presurgery, the VAS and all functional scores improved significantly at the last follow-up ($P < .001$ for all). Intra- and interobserver intraclass correlation coefficients indicated good reliability for the ADH measurements. Preoperatively, there were no differences in AHD values between the intact and affected shoulders (7.8 ± 0.8 mm for both; $P = .851$). The AHD values at postoperative day 1 and POM 6, POM 36, and POM 60 were 9.6 ± 0.7 mm, 8.6 ± 0.9 mm, 8.0 ± 0.8 mm, and 7.9 ± 0.8 mm, respectively, all of which were larger than those of the preoperative intact side ($P < .001$ for all).

Conclusion: The modified suture button Latarjet procedure not only offered satisfactory therapeutic effects but also did not decrease the AHD at 5-year follow-up.

Keywords: shoulder dislocation; Latarjet procedure; acromiohumeral distance; CT

Recurrent anterior shoulder dislocation with obvious glenoid defect has always been a clinical concern for shoulder surgeons. Anterior subluxation and dislocation account for 52.1% of all shoulder instability injuries, approximately 30% of which require surgical treatment.¹⁸ The arthroscopic Latarjet procedure has gradually become popular for the treatment of shoulder dislocation with evident glenoid defect, and many reports have confirmed that the Latarjet procedure has excellent clinical results.^{1,7,9}

Although the arthroscopic Latarjet procedure is effective, it involves transferring the coracoid and conjoint tendon, which changes the anatomic relationship and subsequent results.

The coracoacromial ligament (CAL) needs to be resected during surgery, but previous studies^{10,19} have confirmed the role of the CAL in maintaining superior stability of the shoulder joint. This procedure arouses some surgeons' concern of possible subsequent superior translation, which may result in secondary acromial impingement, rotator cuff tear, and even anterosuperior dislocation of the humeral head.^{2,5,14}

Previous studies^{6,17} have clarified the important role of the coracoacromial arch, especially the CAL, in maintaining anterosuperior stability of the glenohumeral joint. In a cadaveric study,⁵ upward movement of the humeral head was more pronounced when upward axial stress was applied to shoulder joint specimens after the CAL was cut off. This finding clarified that the CAL restricts upward movement of the humeral head.⁷ Several scholars believe that in patients with massive rotator cuff tear, the CAL

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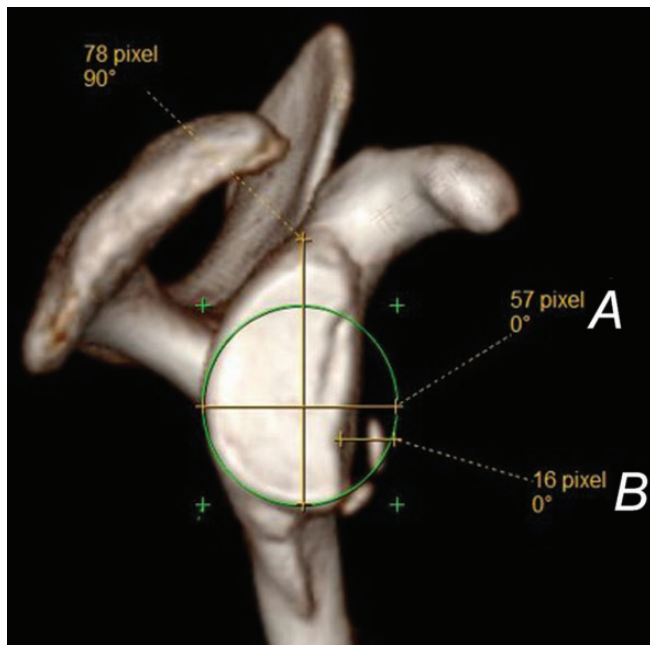


Figure 1. Defect size = $B/A \times 100\%$, where A = diameter of best-fit circle and B = glenoid bone defect width.

should be preserved to avoid subsequent anterosuperior translation postoperatively.¹⁸

Our previous works^{22,23} have demonstrated excellent outcomes with few complications and no degenerative changes during the follow-up of patients who underwent a modified suture button arthroscopic Latarjet procedure. In the present study, we measured the acromiohumeral distance (AHD) in patients who underwent a modified Latarjet procedure to evaluate for increased postoperative superior translation of the shoulder joint. Our hypothesis was that the modified suture button Latarjet procedure would not decrease the AHD.

METHODS

Study Patients

Enrolled in this study were patients who underwent a modified arthroscopic Latarjet procedure with suture button

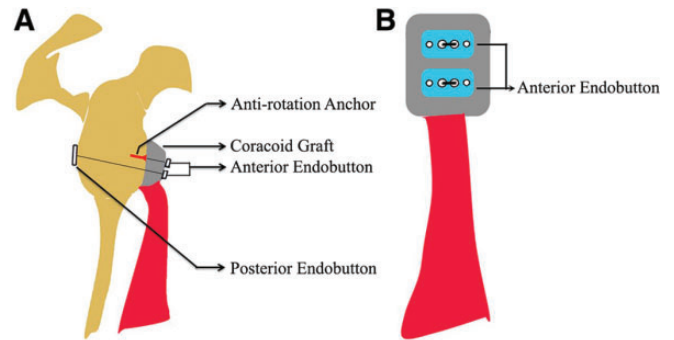


Figure 2. Schematic diagram of the modified Latarjet procedure. (A) Diagram in the sagittal view. (B) Frontal view of the graft.

fixation in our department between October 2013 and October 2015 and met the following inclusion criteria: (1) glenoid defect size $>20\%$ of the glenoid surface area, (2) defect size $>15\%$ combined with an Instability Severity Index Score >6 , (3) defect size of 10% to 15% in contact sport athletes, (4) previous Bankart repair failure, (5) no multi-directional laxity, (6) no evident rotator cuff tear signs and imaging findings before surgery, and (7) 5 years of follow-up. The exclusion criteria were (1) epilepsy, (2) inability to complete follow-up or incomplete follow-up data, and (3) previous shoulder surgery except Bankart repair.

Generalized laxity was measured via the Beighton score. Glenoid bone defect was measured via the surface area method, using a best-fit circle to determine the percentage of missing glenoid relative to its surface area on an en face 3-dimensionally reconstructed axial computed tomography (CT) scan (Figure 1).⁴ This measurement was conducted 3 times by a single experienced radiologist, and the mean value was recorded.

Operative Technique

All surgical procedures were performed by a senior chief physician (W.L.). The detailed modified Latarjet surgical technique was introduced in our previous publications.^{3,22,23} A schematic diagram of the technique is shown in Figure 2.²² Briefly, the coracoid bone graft and conjoint tendon were prepared using a 2.5-cm mini-open incision, starting from 1 cm below the coracoid process in the

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direction of the axilla. The CAL and part of the pectoralis minor muscle were cut 1 cm away from the border of the coracoid. The osteotomy of the coracoid process was then performed at its bend using an oscillating saw to ensure a 2-cm long graft. Two bone tunnels with a distance of 6 mm were drilled in the bone graft along its axis. One high-strength suture (Ultrabraid No. 2 White Suture and Needle Assembly; Smith & Nephew) was pulled into the proximal tunnel for traction. Three high-strength sutures were pulled into the central hole of a suture button (EndoButton; Smith & Nephew) and through the distal bone tunnel. Then the anterior, standard anterolateral, and posterior portals were prepared.

The glenoid was marked at the 4-o'clock position, and the subscapularis muscle was split from back to front until the anterior fascia became visible. A switch stick was used to protect the axillary nerve from damage. The muscle was split with a window (diameter, 1.5 cm) for bone graft transfer. The glenoid tunnel was drilled using a customized guiding instrument, where the suture linked to the graft was passed and the graft was pulled into the glenohumeral joint via the sutures.²² Another Endobutton was put behind the glenoid and Tennessee knot was set for fixation. A knotless anchor with sutures through the proximal tunnel for anti-rotation (PushLock; Arthrex) was fixed on the glenoid.

Rehabilitation Protocol

Standardized rehabilitation protocols were applied. The affected side was immobilized in adduction and internal rotation with the arm in a sling for 6 weeks. Physical therapy started the day after surgery, with pendulum exercises performed several times per day, followed by a 6-week rehabilitation program. During the period, active exercise and workout using weights or pulleys were prohibited. Active exercises using weight, active forward flexion, and passive external rotation were allowed at 6 weeks postoperatively. Active movement in all directions was initialized at postoperative month (POM) 3. Active biceps tendon contraction training was started and gradually increased at POM 3. Contact sports or motions with "risks" were not allowed until POM 6.

Follow-up

In each patient, CT scans of both shoulders were performed preoperatively to evaluate glenoid defect. At the first postoperative day (PO 0), POM 6, POM 36, and POM 60, CT scan of the affected shoulder was conducted to observe graft position, absorption, remodeling, and graft-glenoid interface healing. Pre- and postoperative clinical results were assessed using a visual analog scale for pain evaluation. American Shoulder and Elbow Surgeons, Rowe, and Walch-Duplay scores were recorded at each time point for clinical function assessment. Complications that occurred intra- and postoperatively were recorded.

Imaging Assessment

The pre- and postoperative CT scans were used to measure AHD changes before surgery and during follow-up

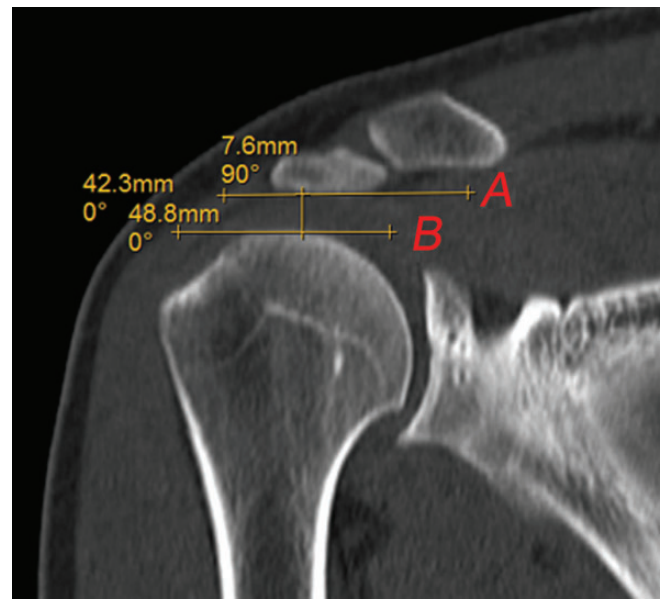


Figure 3. Strategy of acromiohumeral distance measurement of the coronal view on computed tomography scans. Horizontal line A was made through the lowest point of the acromion, which was parallel to the lower surface of the acromion. Horizontal line B, parallel to horizontal line A, was created through the highest point of the humeral head.

according to Werner et al.²¹ This method has been used with a high degree of accuracy and reliability. The affected limb was positioned in 0° of abduction and neutral rotation, and CT scans of the oblique coronal view were recorded (parallel to the plane of the scapula). Measurements were taken on the middle slice of all images where the glenoid was depicted (angled coronal reformations parallel to the scapular body); in case of an even number, the image with the larger amount of glenoid depiction was chosen. It guaranteed that different researchers used the same anatomic references and measured the shortest distance between the undersurface of the acromion and the top of humeral head on similar slices where the humeral head had its maximal superoinferior diameter.

Two physicians (X.L. and Q.Q.) with radiologic expertise conducted the AHD measurements, and the mean value was recorded. A horizontal line (A) was made through the lowest point of the acromion, which was parallel to the lower surface of the acromion, and a horizontal line (B) parallel to line A was created through the highest point of the humeral head. The perpendicular distance between A and B was recorded as the AHD (Figure 3).

Degeneration of the shoulder joint was evaluated on anteroposterior radiographs of the glenoid plane and was graded according to Samilson-Prieto classification.¹⁵

Statistical Analysis

The statistical analysis was conducted using SPSS Version 16.0 software (IBM Corp). Pairwise comparison was

TABLE 1
Patient Data

Parameter	Mean \pm SD (Range) or No.
Age, y	29.6 \pm 7.5 (19-45)
Sex, male:female	66:38
Side, left:right	60:44
No. of dislocations	8.4 \pm 4.7
Body mass index	23.2 \pm 4.3
Beighton score	3.4 \pm 1.2
Glenoid defect area, %	23.4 \pm 4.1
Glenoid defect size	
>20%	60
15%-20%	26
10%-14%	12
Bankart failure	6
Hill-Sachs injury	100

performed using a paired *t* test, and $P < .05$ was considered statistically significant. First, the mean AHDs of POM 0 were compared between the first and the second physicians with radiologic expertise for the intraobserver reproducibility using a paired *t* test. Second, the intraclass correlation coefficient (ICC) was computed for exact agreement. Intraobserver and interobserver reproducibility of the AHD measurements were evaluated by ICC, in which <0.4 indicated poor reliability and >0.75 indicated good reliability.

RESULTS

Baseline Characteristics

A total of 155 patients who underwent the modified arthroscopic Latarjet procedure were selected. Seven patients with epilepsy, 15 patients without enough follow-up time, and 29 patients without complete follow-up data were excluded. Ultimately, we enrolled 104 patients aged 29.6 \pm 7.5 years (mean \pm SD; 66 male and 38 female; 60 with the left and 44 with the right shoulder affected). The mean follow-up time was 62.6 \pm 2.4 months. All patients were diagnosed with shoulder dislocation attributed to trauma or sports activity. The mean glenoid defect size was 23.4% \pm 4.1% of the glenoid surface area (range, 17%-30%), and the mean time from initial dislocation to surgery was 24.8 \pm 11.2 months (range, 8-44 months) (Table 1).

Clinical Assessment

At POM 60, all functional outcome scores improved significantly as compared with the preoperative conditions ($P < .001$ for all) (Table 2).

AHD Measurement and Osteoarthritis

The intraobserver ICC was 0.995 (95% CI, 0.991-0.997), and the interobserver ICC was 0.993 (95% CI, 0.990-0.997), indicating good reliability for both. The intact side had an AHD of 7.8 \pm 0.8 mm and was set as the control group. The

TABLE 2
Functional Results Between Presurgery and Final Follow-up^a

Parameter	Presurgery	Final Follow-up ^b
VAS for pain during motion	3.1 \pm 1.3	1.2 \pm 0.7
ASES score	73.2 \pm 14.1	94.4 \pm 4.0
Rowe score	41.7 \pm 8.9	94.5 \pm 2.7
Walch-Duplay score	64.4 \pm 9.8	95.7 \pm 3.5

^aData are reported as mean \pm SD. ASES, American Shoulder and Elbow Surgeons; VAS, visual analog scale.

^bEach comparison between time points: $P < .001$.

TABLE 3
AHD Values at Different Time Points^a

	AHD	<i>P</i> Value ^b
Intact side: preoperative	7.8 \pm 0.8	—
Affected side		
Preoperative	7.8 \pm 0.8	.851
PO 0	9.6 \pm 0.7	<.001
POM 6	8.6 \pm 0.9	<.001
POM 36	8.0 \pm 0.8	<.001
POM 60	7.9 \pm 0.8	<.001

^aValues are presented as mean \pm SD. AHD, acromiohumeral distance; PO 0, the first postoperative day; POM, postoperative month.

^bBold *P* values indicate statistical significance vs the intact side ($P < .05$).

preoperative AHD of the affected side was 7.8 \pm 0.8 mm, and there was no statistical difference when compared with the intact side ($P > .05$). The AHD at PO 0 (9.6 \pm 0.7 mm) significantly increased as compared with the control group ($P < .05$). During the follow-up, the AHD at POM 6 was 8.6 \pm 0.9 mm, which was also larger than the that of the control group ($P < .05$). The AHD values at POMs 36 and 60 were 8.0 \pm 0.8 and 8.1 \pm 0.8 mm, respectively, which were slightly larger than those of the control group ($P < .05$) (Table 3). Figure 4 shows AHD measurement at full follow-up in 1 representative case. Using radiography and CT scan, we identified about 28 patients with different degrees of degeneration and osteoarthritis before surgery. At the final follow-up, the cases of preoperative degeneration had not progressed, and the patients without degeneration had not developed new degeneration or osteoarthritis.

Recovery and Complications

Preoperatively, all the patients had participated in a variety of athletic activities, including jogging, association soccer, and basketball with minimal contact. They did not compete at a professional level, and they played amateur sports more for leisure and fitness. At the last follow-up, all patients were able to return to daily life activities, and 90 were able to return to their preoperative sport levels.

The total complication rate was 1.9%, including redislocation and shoulder stiffness. No axillary nerve injury or

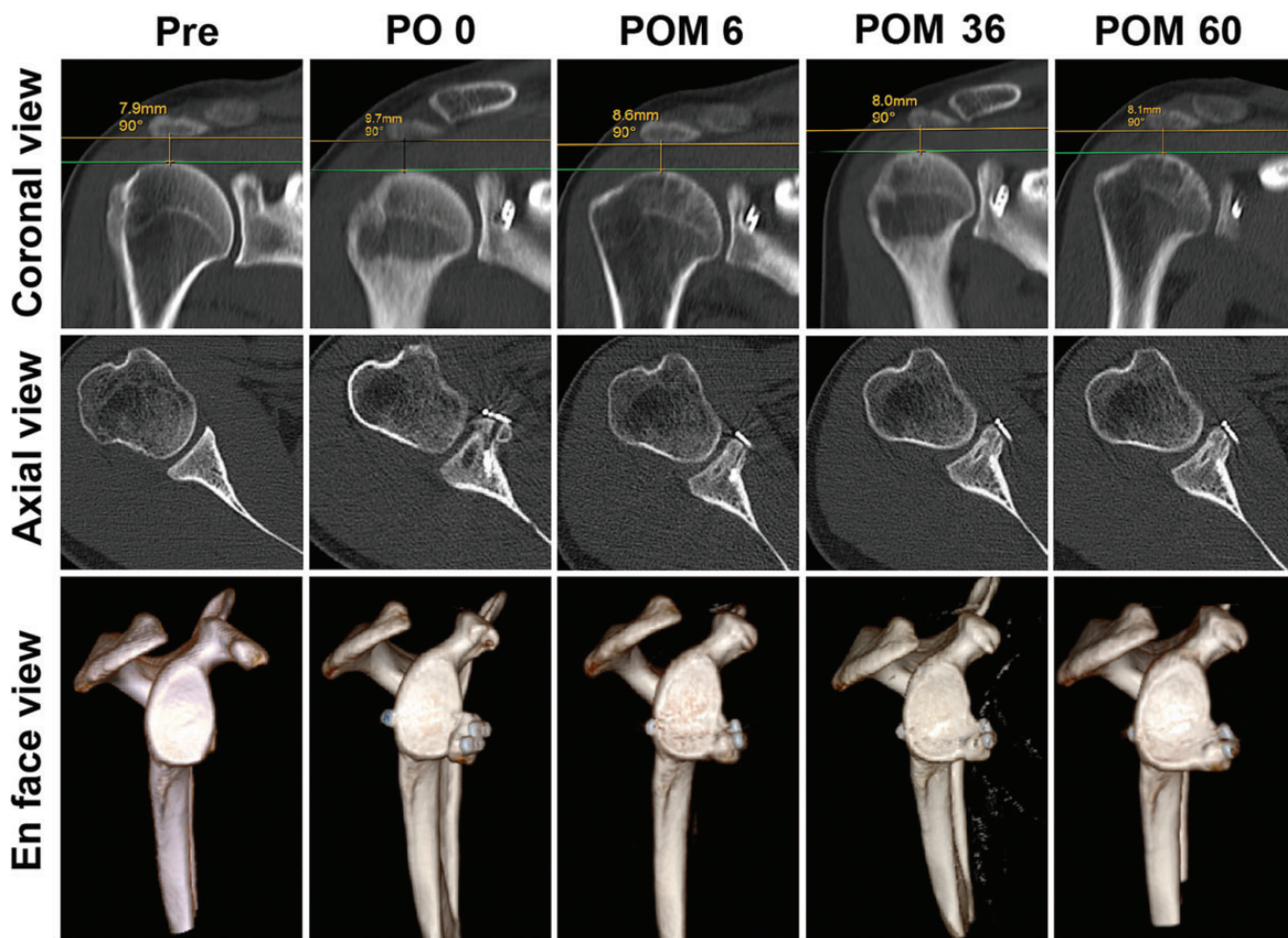


Figure 4. Acromioclavicular distance measurement (coronal view) and observation of graft position, remodeling, and graft-glenoid interface healing (axial and en face views) of 3-dimensionally reconstructed computed tomography scan images at different time points from 1 representative case of the Latarjet procedure. PO 0, immediately after operation; POM, postoperative month; Pre, preoperative.

vascular injury occurred in any patient. One 40-year-old woman experienced redislocation because of traffic accident, and a 42-year-old woman got shoulder stiffness and recovered after physical therapy. No other patients had subluxations or apprehension with activities. No one had symptoms and signs related to rotator cuff tear and acromial impingement (Table 4).

DISCUSSION

To the best of our knowledge, this study is the first to observe changes in AHD after a Latarjet procedure by evaluating whether CAL resection increased superior translation postoperatively. AHD significantly improved from 7.8 ± 0.8 to 9.6 ± 0.7 mm immediately after the Latarjet procedure with a trend of narrowing during follow-up, becoming 7.9 ± 0.8 mm at a mean of 5 years. Our study found that the modified suture button Latarjet procedure was effective in treating recurrent shoulder dislocation without an evident increase in superior translation of the

TABLE 4
Postoperative Complications

Complication	No. of Patients
Redislocation	1
Stiffness	1
Bone nonunion	0
Infection	0
Nerve and vascular injury	0
Others	0

shoulder joint at a mean follow-up of >5 years. This result may help eliminate concerns about postoperative superior translation and even subsequent acromial impingement, rotator cuff tear, and superior dislocation caused by the damage of CAL.

According to clinical and biomechanical studies,^{5,8,10,18} the Latarjet procedure should lead to the possibility of superior translation of the glenohumeral joint when CAL release and coracoid transfer are performed. However, few

studies have focused on the subsequent effects caused by CAL resection during the Latarjet procedure. Several cadaveric studies have observed that the humeral head moves upward to varying degrees after CAL release and coracoid transfer; yet, the frozen specimens could not accurately reflect the physiological situation of the clinical patients.^{10,19} Aurich et al² used a congruent-arc Latarjet procedure to treat patients with recurrent shoulder dislocation. To prevent postoperative superior translation of the shoulder joint, they used a pectoralis minor fascial flap to perform 1-stage reconstruction of the CAL. None of the participants had postoperative complications or secondary superior translation at 1 year of follow-up. Nevertheless, the sample size was small, with 6 cases applied, and the study lacked comparison with the effect of a traditional Latarjet procedure. Therefore, we cannot clarify the specific changes in the humeral head movement of surgically treated patients at different periods after a traditional Latarjet procedure. At present, clinical studies focusing on superior translation after the Latarjet procedure have not been conducted.

We measured the AHD on CT scans to reflect superior translation of the shoulder joint after the Latarjet procedure. CT scans, radiographs, and ultrasound have certain reliability in measuring AHD. CT scans have better reliability and accuracy than radiographs and can be used as a tool in assessing bone graft healing and absorption at the same time.¹³ Regardless of various applications, such as evaluation after reverse shoulder replacement, rotator cuff tear risk assessment, or athletic evaluation, the ultrasound measurement of AHD has high reliability.^{11,12,20} Although ultrasound is simple and repeatable without radiation, it depends on the operator's skill and the patient's cooperation to a large extent. In the present study, AHD measurement was completed under a standard method to avoid subjective deviation.

The release of the CAL will decrease the stability between the humeral head and acromion on PO 0 so that the humeral head will move upward. We speculated that, given the tension and depressive effects of the transferred bone graft and conjoint tendon on the muscle fibers of the lower half of the subscapularis, this effect was transmitted to the humeral head and at last caused an increase in AHD (Figure 5). According to our previous studies,^{22,23} patients who underwent our modified arthroscopic Latarjet procedure had complete bone healing at about POM 6, and the bone graft kept remodeling for >3 years. Therefore, we set the follow-up periods as 6 months, 3 years, and 5 years. During the follow-up, the gradually decreased AHD may be related to the reformation of the ligament-like structure connecting the conjoint tendon and acromion and to the readaptation of the glenohumeral joint caused by changes in the patient's muscle strength.¹⁶ That could be considered as compensatory of CAL function and recovery of superior translation. We may postulate that after healing of the bone block, the inferior capsule is scarred (the sling affect) and helps to prevent migration of the humeral head superiorly. Nonetheless, none of the study patients had a narrower AHD after 5 years of follow-up when compared with presurgery.

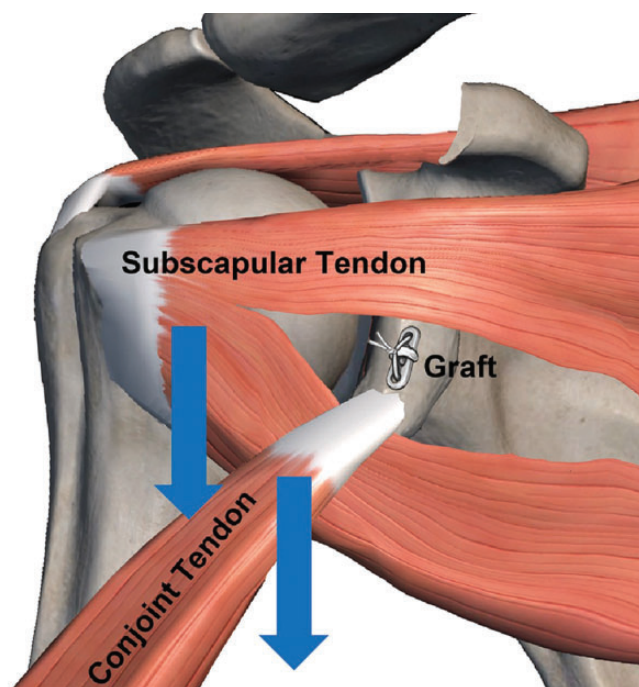


Figure 5. Theoretical depressive effect of the subscapular and conjoint tendons on the humeral head.

The limitations of this study should be acknowledged. First, this work adopted a retrospective design without the setup of control groups treated with other surgical methods (eg, Bankart, Bristow). Second, the CT images were all collected with patients in a relaxed state and supine position, and we did not obtain images with the shoulder under axial upward stress or patients in a standing position. Therefore, the conclusion cannot accurately and completely reflect the various mechanics of the patient after resuming exercise. Future directions require kinematic experiments to observe the specific humeral head movement of patients during different activities after the Latarjet procedure and compare clinical outcomes with those of other arthroscopic surgical procedures. Related biomechanical studies will be conducted to enhance our results.

CONCLUSION

The modified suture button Latarjet procedure not only offered a satisfactory therapeutic effect but also did not decrease AHD, and it thus did not result in superior translation of the humeral head at a mean of >5 years.

REFERENCES

1. Ali J, Altintas B, Pulatkan A, Boykin RE, Aksoy DO, Bilsel K. Open versus arthroscopic Latarjet procedure for the treatment of chronic anterior glenohumeral instability with glenoid bone loss. *Arthroscopy*. 2020;36(4):940-949.
2. Aurich M, Hofmann GO, Gras F. Reconstruction of the coracoacromial ligament during a modified Latarjet procedure: a case series. *BMC Musculoskelet Disord*. 2015;16:238.

3. Boileau P, Saliken D, Gendre P, et al. Arthroscopic Latarjet: suture-button fixation is a safe and reliable alternative to screw fixation. *Arthroscopy*. 2019;35(1):1050-1061.
4. Burkhart SS, De Beer JF, Barth JR, et al. Results of modified Latarjet reconstruction in patients with anteroinferior instability and significant bone loss. *Arthroscopy*. 2007;23(10):1033-1041.
5. Degen RM, Giles JW, Boons HW, Litchfield RB, Johnson JA, Athwal GS. A biomechanical assessment of superior shoulder translation after reconstruction of anterior glenoid bone defects: the Latarjet procedure versus allograft reconstruction. *Int J Shoulder Surg*. 2013;7(1):7-13.
6. Denard PJ, Bahney TJ, Kirby SB, Orfaly RM. Contact pressure and glenohumeral translation following subacromial decompression: how much is enough? *Orthopedics*. 2010;33(11):805.
7. Hardy A, Sabatier V, Laboudie P, et al. Outcomes after Latarjet procedure: patients with first-time versus recurrent dislocations. *Am J Sports Med*. 2020;48(1):21-26.
8. Hockman DE, Lucas GL, Roth CA. Role of the coracoacromial ligament as restraint after shoulder hemiarthroplasty. *Clin Orthop Relat Res*. 2004;419:80-82.
9. Hurley ET, Montgomery C, Jamal MS, et al. Return to play after the Latarjet procedure for anterior shoulder instability: a systematic review. *Am J Sports Med*. 2019;47(12):3002-3008.
10. Lee TQ, Black AD, Tibone JE, McMahon PJ. Release of the coracoacromial ligament can lead to glenohumeral laxity: a biomechanical study. *J Shoulder Elbow Surg*. 2001;10(1):68-72.
11. Mackenzie TA, Bdaiwi AH, Herrington L, Cools A. Inter-rater reliability of real-time ultrasound to measure acromiohumeral distance. *PM R*. 2016;8(7):629-634.
12. McCreesh KM, Anjum S, Crotty JM, Lewis JS. Ultrasound measures of supraspinatus tendon thickness and acromiohumeral distance in rotator cuff tendinopathy are reliable. *J Clin Ultrasound*. 2016;44(3):159-166.
13. McCreesh KM, Crotty JM, Lewis JS. Acromiohumeral distance measurement in rotator cuff tendinopathy: is there a reliable, clinically applicable method? A systematic review. *Br J Sports Med*. 2015;49(5):298-305.
14. Moorman CT, Hussain SS, Warren RF, Deng XH, Wickiewicz TL, Torzilli PA. Anatomy of the coracoacromial veil. *Surg Orthop Adv*. 2008;17(2):69-73.
15. Samilson RL, Prieto V. Dislocation arthropathy of the shoulder. *J Bone Joint Surg Am*. 1983;65:456-460.
16. Smolen D, Went P, Tomala D, Sternberg C, Lafosse L, Leuzinger J. Identification of a remodeled neo-tendon after arthroscopic Latarjet procedure. *Arthroscopy*. 2017;33(3):534-542.
17. Su WR, Budoff JE, Luo ZP. The effect of coracoacromial ligament excision and acromioplasty on superior and anterosuperior glenohumeral stability. *Arthroscopy*. 2009;25(1):13-18.
18. Trojan JD, Meyer LE, Edgar CM, Brown SM, Mulcahey MK. Epidemiology of shoulder instability injuries in collision collegiate sports from 2009 to 2014. *Arthroscopy*. 2020;36(1):36-43.
19. Wellmann M, Petersen W, Zantop T, Schanz S, Raschke MJ, Hurschler C. Effect of coracoacromial ligament resection on glenohumeral stability under active muscle loading in an in vitro model. *Arthroscopy*. 2008;24(11):1258-1264.
20. Werner BS, Jacquot A, Mole D, Walch G. Is radiographic measurement of acromiohumeral distance on anteroposterior view after reverse shoulder arthroplasty reliable? *J Shoulder Elbow Surg*. 2016;25(9):e276-e280.
21. Werner CM, Conrad SJ, Meyer DC, Keller A, Hodler J, Gerber C. Interobserver agreement and interobserver correlation of radiologic acromiohumeral distance measurements. *J Shoulder Elbow Surg*. 2008;17(2):237-240.
22. Xu J, Liu H, Lu W, et al. Clinical outcomes and radiologic assessment of a modified suture button arthroscopic Latarjet procedure. *BMC Musculoskelet Disord*. 2019;20(1):173.
23. Xu J, Liu H, Lu W, et al. Modified arthroscopic Latarjet procedure: suture-button fixation achieves excellent remodeling at 3-year follow-up. *Am J Sports Med*. 2020;48(1):39-47.