Modified Arthroscopic Latarjet Procedure: Suture-button Fixation will not Cause Obvious Increasement of Superior Instability at 5-Year Follow-up

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Trial registration

Retrospectively registered.

Background: Whether coracoacromial ligament (CAL) release during Latarjet procedure will increase superior instability of shoulder joint postoperatively remains controversial. This study aims to observe changes in the acromiaohumeral distance (AHD) of patients who underwent modified double-button Latarjet procedure and provide evidence to address the issue.

Methods: A retrospective analysis was conducted among 155 patients who underwent modified double-button Latarjet procedure in our department from 2013 to 2015. Preoperative CT scan of bilateral shoulders were used for glenoid defect evaluation. CT scans were performed immediately after operation (PO 0) and during the follow-up at 6, 36, and 60 months postoperatively (POM) to observe the healing and remodeling of the graft, and AHD was measured. The intact sides were set as control group. VAS and objective shoulder scores, including ASES, ROWE, and Walch-Duplay scores, were recorded at each time point.

Results: A total of 104 cases who met the criteria completed follow up. The average follow-up time was 62.6 ± 2.4 months. Compared with preoperative conditions, the function scores of the shoulders were significantly improved at the last follow-up. There were no statistical differences of the AHD values between bilateral shoulders preoperatively. The AHD values at PO 0 and POM 6 were significantly higher than those of intact side ($p < 0.05$). The AHD values at POM 36 and 60 were slightly higher than those of intact side and the differences were statistically significant ($p < 0.05$).

Conclusions: The modified double-button Latarjet procedure not only offers satisfactory therapeutic effect but also will not cause obvious superior instability at the 5-year follow-up.

Key words: Shoulder dislocation; Latarjet procedure; Acromiaohumeral distance; CT

1. Background

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, and approximately 30% of which requires surgical treatment[1]. At present, the arthroscopic Latarjet procedure has gradually become popular for the treatment of shoulder dislocation with evident glenoid defect, and many reports have confirmed that Latarjet procedure has excellent clinical results[2,3,4].

Although arthroscopic Latarjet procedure is effective, it has to transfer the coracoid and conjoint tendon, which changes the anatomic relationship and subsequent results. Coracoacromial ligament (CAL) needs to be cut-off during the surgery, while previous studies have confirmed CAL's function on maintaining superior stability of shoulder joint[5,6]. This procedure arouses surgeons' concern of subsequent superior instability, which may result in secondary acromial impingement, rotator cuff tear, and even anterosuperior dislocation of the humeral head, leading to osteoarthritis and function limitation.

Previous studies clarified the important role of the coracoacromial arch, especially the CAL, in maintaining the anterosuperior stability of the glenohumeral joint[7]. CAL can physiologically provide superior stability. Denard et al found that in patients with rotator cuff tear associated with acromial impingement, the humeral head shifted up to varying degrees after acromioplasty and CAL was released[8]. In another cadaveric study, the upward movement of the humeral head was more pronounced when upward axial stress was applied to the shoulder joint specimens after cutting off the CAL. This finding also clarifies that the CAL restricts the upward movement of the humeral head[3]. Several scholars believe that in patients with massive rotator

74 cuff tear, the CAL should be preserved to avoid subsequent anterosuperior instability
75 postoperatively[7].
76 Our previous works demonstrated excellent outcome with few complications and
77 no degenerative changes during the follow-up of patients who underwent modified
78 suture-button arthroscopic Latarjet procedure[9,10]. In the present study, pre- and
79 postoperative acromiaohumeral distances (AHDs) were measured in patients who
80 underwent Latarjet procedure in our department with 5 years of follow-up to evaluate
81 the effects of the modified procedure on increasing superior instability of shoulder
82 joint postoperatively.

83 **2. Materials and methods**

84 **2.1 Subjects**

85 This retrospective study was approved by the hospital ethics committee of the First
86 Affiliated Hospital of Shenzhen University, Shenzhen Second People's Hospital
87 (reference no. 20190223), and all patients gave informed consent preoperatively.
88 From October 2013 to October 2015, 155 patients underwent modified arthroscopic
89 Latarjet procedure with double-button fixation in our department and 104 of them met
90 the following inclusion criteria: (1) over 20% of glenoid defect, (2) over 15% of
91 glenoid defect combined with an Instability Severity Index Score of higher than 6, (3)
92 10% to 15% of glenoid defect in contact sport athletes, (4) previous Bankart repair
93 failure, (5) no multi-direction laxity, (6) no evident rotator cuff tear signs and imaging
94 findings before surgery, and (7) over 5 years of follow-up. The exclusion criteria are
95 as follows: (1) epilepsy, (2) cannot complete follow-up or incomplete follow up data,
96 and (3) previous shoulder surgery history except Bankart repair.

97 **2.2 Operative Techniques**

All surgeries were performed by a senior chief physician (WL). The modified Latarjet surgical technique was mentioned in our previous publications[9,10,11]. Briefly, this modified procedure included three basic steps, as follows. (1) The coracoid bone graft and conjoint tendon were prepared through a 2.5 cm mini-open incision, starting from 1 cm below the coracoid process in the 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 graft of 20 mm length. Two bone tunnels were drilled with a distance of 6 mm in the bone graft along its axis. High-strength sutures (Ultrabraid #2 white suture assembly; Smith & Nephew) were pulled into the distal tunnel. Three high-strength sutures were pulled into the central hole of a suture button (Endobutton; Smith & Nephew) and then through the proximal bone tunnel. (2) The anterior (including a part of the incision used for graft acquirement), standard anterolateral, and posterior portals were prepared. The glenoid was marked at the 4 o'clock position, and then 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 1.5 cm diameter window for bone graft transfer. (3) The glenoid tunnel was drilled where the suture linked to the graft was passed, and the graft was pulled into the glenohumeral joint via the sutures. Then, another endobutton with sutures of the first endobutton going through was prepared and Tennessee knot was set for fixation. A knotless suture anchor for antirotation (PushLock, Arthrex) was fixed to the glenoid.

2.3 Rehabilitation Protocol

Standardized rehabilitation protocols were applied. All the patients' arms were immobilized in adduction and internal rotation position in a sling for 6 weeks.

Physiotherapy 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 with weights or pulleys were prohibited. Active exercises with weight, active forward flexion, and passive external rotation would be allowed at 6 weeks postoperatively. Active movement in all directions was initialized at 3 months postoperatively (POM). 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.

2.4 Follow-up

CT scan of bilateral shoulders were performed preoperatively to evaluate glenoid defect. At immediate postoperatively (PO 0), POM 6, POM 36, and POM 60, the CT scan of the surgical side shoulder was conducted to observe graft position, absorption, remodeling, and graft-glenoid interface healing. Preoperative and postoperative clinical results were assessed using a visual analog scale (VAS) for pain evaluation. American Shoulder and Elbow Surgeons (ASES), ROWE, and Walch-Duplay scores were recorded at each time point for clinical function assessment. Complications that occurred intraoperatively and postoperatively were recorded.

2.5 Radiological Assessment

CT scan images were used to measure AHD changes before surgery and during the follow-up. This method had been reported before with high accuracy and reliability[12]. The patient should keep the affected limb relaxed and place it at 0° abduction and neutral rotation. The images of the oblique coronal view (parallel to the plane of the scapula) on CT was used to measure AHD. To ensure that all cases in the same anatomical position, we performed measurement by choosing the middle slice of all images, in which the glenoid was observed. When the number of images was

148 even, an image with a larger glenoid was chosen for measurement. A horizontal line
149 A was made through the lowest point of the acromion, which was parallel to the lower
150 surface of the acromion, and a horizontal line B parallel to the horizontal line A was
151 created through the highest point of the humeral head. The perpendicular distance
152 between A and B was recorded as AHD. (**Fig. 1**)

153 **2.6 Statistical Analysis**

154 The measurement data were expressed as mean ± SD, and the data were analyzed
155 statistically using SPSS 16.0 software (Chicago, IL, U.S.A). Pairwise comparison was
156 performed using paired *t*-test, and $p < 0.05$ was considered statistically significant.

157 **3. Results**

158 **3.1 Baseline Characteristics**

159 A total of 155 patients who underwent modified arthroscopic Latarjet procedure
160 were selected. 7 cases with epilepsy, 15 cases without enough follow up time and 29
161 cases without complete follow up data were excluded. Finally, 104 patients with an
162 average age of 29.6 ± 7.5 years were enrolled. The average follow-up time was 62.6 ±
163 2.4 months. At the last follow-up, all patients could return to daily life activities and
164 90 of them could resume preoperative sports level. No axillary nerves injury and
165 vascular injury occurred in any patient. One 40 years old female patient suffered
166 redislocation because of traffic accident and another 42 years old female patient got
167 shoulder stiffness and recovered after physical therapy. The total complication rate
168 was 1.8%. No one complained about symptoms and signs related to rotator cuff tear
169 and acromial impingement. Among these patients, 66 were male, 38 were female, 60
170 had injury in the left shoulder, and 44 had injury in the right shoulder. All patients
171 were diagnosed of shoulder dislocation due to trauma or sports activity. The average

172 glenoid defect was 23.4% ± 4.1% (17% to 30%), and the average time from initial
173 dislocation to surgery was 24.8 ± 11.2 months (8 – 44 months, Table 1).

174 **3.2 Clinical Assessment**

175 All patients returned to normal daily activities at the last follow-up. At PO 0,
176 significantly decreased VAS score (3.1 ± 1.3 vs 1.2 ± 0.7, $p < 0.05$) and increased
177 ASES (73.2 ± 14.1 vs 94.4 ± 4.0, $p < 0.05$), ROWE score (41.7 ± 8.9 vs 94.5 ± 2.7, p
178 < 0.05) and Walch-Duplay scores (64.4 ± 9.8 vs 95.7 ± 3.5, $p < 0.05$, Table 2)
179 compared with the preoperative conditions, thereby indicating evident pain relief and
180 the improvement of the function of the injury shoulder.

181 **3.3 AHD Measurement**

182 The AHD of intact side was 7.8 ± 0.8 mm and set as control group. The
183 preoperative AHD of affected side was 7.8 ± 0.8 mm and there was no statistical
184 difference compared to intact side ($p > 0.05$). The AHD at PO 0 (9.6 ± 0.7mm)
185 significantly increased compared to control group ($p < 0.05$). During the follow-up,
186 the AHD at POM 6 was 8.6 ± 0.9 mm, which was also higher than control group (p <
187 0.05). The AHD values at POM 36 and 60 were 8.0 ± 0.8 and 8.1 ± 0.8 mm
188 respectively, which were slightly higher than the control group and with statistical
189 significance ($p < 0.05$, Table 3). **Fig. 2** shows AHD measurement at full follow-up in
190 one representative case.

191 **4. Discussion**

192 To the best of our knowledge, this study is the first to observe changes in AHD
193 after Latarjet procedure by evaluating whether the CAL resection of the Latarjet
194 procedure will increase superior instability postoperatively. AHD was significantly
195 improved immediately after Latarjet procedure with a trend of narrow during the

follow-up. Our study found that the modified double-button Latarjet procedure was effective in treating recurrent shoulder dislocation without evident increasement of superior instability of shoulder joint at over 5 years of follow-up. This result may help eliminate concerns about post-operative superior instability, even subsequent acromial impingement, rotator cuff tear and superior dislocation caused by the damage of CAL.

According to clinical and biomechanical studies mentioned above, Latarjet procedure should lead to the possibility of superior instability of the glenohumeral joint when performing CAL release and coracoid transfer[5,6,13,14]. However, extremely few studies have focused on subsequent effects caused by CAL resection during Latarjet procedure. Several cadaveric studies observed that humeral head moves upward to varying degrees after CAL release and coracoid transfer. However, the frozen specimens that could not accurately reflect the physiological situation of the clinical patients. Aurich et al used congruent-arc Latarjet procedure to treat patients with recurrent shoulder dislocation[15]. To prevent postoperative superior instability of shoulder joint, they used pectoralis minor fascial flap to perform a one-stage reconstruction of the CAL. None of the participants had postoperative complications and no secondary superior instability at 1 year of follow-up. However, the sample number was small with six cases applied and lacked comparison with the effect of traditional Latarjet procedure. Therefore, we cannot clarify the specific changes in the humeral head movement of clinical patients at different periods after traditional Latarjet procedure. At present, clinical studies that focused on superior instability after Latarjet procedure have not been conducted yet.

We measured the AHD on CT scan images to reflect superior instability of shoulder joint after Latarjet procedure. CT, ultrasound, X-ray, and ultrasound have certain reliability in measuring AHD. CT have better reliability and accuracy than

221 X-ray and can be used as a tool in assessing bone graft healing and absorption at the
222 same time[16]. Regardless of various applications, such as evaluation post-reverse
223 shoulder replacement, rotator cuff tear risk assessment, or athletic evaluation, the
224 ultrasound measurement of AHD has high reliability[17,18,19]. Although ultrasound
225 is simple and repeatable without radiation, it depends on operating level and patient's
226 cooperation to a large extent. In the present study, the AHD measurement was
227 completed under a standard method to avoid subjective deviation.

228 The release of the CAL will decrease the stability between the humeral head and
229 acromion at the zero time, so that the acromion would move upward. Given the
230 tension and depressive effects of the transferred bone graft and conjoint tendon on the
231 muscle fibers of the lower half of the subscapularis, this effect was transmitted to the
232 humeral head and at last caused AHD increasement (**Fig. 3**). According to our
233 previous studies[9,10], patients received our modified arthroscopic Latarjet procedure
234 would get complete bone healing at about POM 6 and the bone graft kept remodeling
235 up to more than 3 years. Therefore we set the follow up time period as 6 months, 3
236 years and 5 years. During the follow-up, the gradually decreased AHD may be related
237 to the reformation of the ligament-like structure connecting the conjoint tendon and
238 acromion and the readaptation of the glenohumeral joint caused by changes in the
239 patient's own muscle strength[20]. That could be considered as compensatory of CAL
240 function and recovery of superior instability. Nonetheless, no case with narrower
241 AHD after 5 years of follow-up than that before surgery was observed.

242 The limitations of this study should be acknowledged. First, this work adopted a
243 retrospective design without the setup of the control groups treated with other surgical
244 method, such as Bankart, Bristow, et al. Second, the CT images in this study were all
245 scanned on relaxed state, and we did not obtain shoulder images under axial upward

stress. Therefore, the conclusion cannot accurately 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 activity after Latarjet procedure, compare clinical outcomes with other arthroscopic surgeries, and related biomechanical studies will be conducted to enhance our results.

5. Conclusion

The modified double-button Latarjet procedure not only offers satisfactory therapeutic effect but also will not cause obvious superior instability at 5-year follow-up. This result may help eliminate concerns about increased superior instability and subsequent complications after Latarjet procedure.

Ethics approval and consent to participate

This study was approved by the hospital ethics committee of the First Affiliated Hospital of Shenzhen University, Shenzhen Second People's Hospital (reference no. 20190223), and all patients gave informed consent preoperatively.

Consent for publication

Not applicable.

Availability of data and material

The datasets analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Study design: ZD, WL. Drafting manuscript: ZD, LD. Data collection: ZD, DL, HL. Data analysis: ZD, XL, QQ, LL, YH. The author (s) read and approved the final manuscript.

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References

1. 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;36:36-43.

2. 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;36:940-9.

3. Hardy A, Sabatier V, Laboudie P, Schoch B, Nourissat G, Valenti P, et al. Outcomes After Latarjet Procedure: Patients With First-Time Versus Recurrent Dislocations. Am J Sports Med. 2020;48:21-6.

4. 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.

5. 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;10:68-72.

6. 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;24:1258-64.

7. Su WR, Budoff JE, Luo ZP. The effect of coracoacromial ligament excision and acromioplasty on superior and anterosuperior glenohumeral stability. Arthroscopy. 2009;25:13-8.

8. Denard PJ, Bahney TJ, Kirby SB, Orfaly RM. Contact pressure and glenohumeral translation following subacromial decompression: how much is enough? Orthopedics. 2010;33:805.

9. Xu J, Liu H, Lu W, Deng ZH, Zhu WM, Peng LQ, et al. Modified Arthroscopic Latarjet Procedure: Suture-Button Fixation Achieves Excellent Remodeling at 3-Year Follow-up. Am J Sports Med. 2020;48:39-47.

10. Xu J, Liu H, Lu W, Zhu WM, Peng LQ, Ouyang K, et al. Clinical outcomes and radiologic assessment of a modified suture button arthroscopic Latarjet procedure. BMC Musculoskelet Disord. 2019;20:173.

11. Boileau P, Saliken D, Gendre P, Seeto BL, d'Ollonne T, Gonzalez JF, et al. Arthroscopic Latarjet: Suture-Button Fixation Is a Safe and Reliable Alternative to Screw Fixation. Arthroscopy. 2019;35:1050-61.

12. Werner CM, Conrad SJ, Meyer DC, Keller A, Hodler J, Gerber C. Intermethod agreement and interobserver correlation of radiologic acromiohumeral distance

316 measurements. J Shoulder Elbow Surg. 2008;17:237-40.
317 13. Degen RM, Giles JW, Boons HW, Litchfield RB, Johnson JA, Athwal GS. A
318 biomechanical assessment of superior shoulder translation after reconstruction of
319 anterior glenoid bone defects: The Latarjet procedure versus allograft reconstruction.
320 Int J Shoulder Surg. 2013;7:7-13.
321 14. Hockman DE, Lucas GL, Roth CA. Role of the coracoacromial ligament as
322 restraint after shoulder hemiarthroplasty. Clin Orthop Relat Res. 2004:80-2.
323 15. Aurich M, Hofmann GO, Gras F. Reconstruction of the coracoacromial ligament
324 during a modified Latarjet procedure: a case series. BMC Musculoskelet Disord.
325 2015;16:238.
326 16. McCreesh KM, Crotty JM, Lewis JS. Acromiohumeral distance measurement in
327 rotator cuff tendinopathy: is there a reliable, clinically applicable method? A
328 systematic review. Br J Sports Med. 2015;49:298-305.
329 17. Mackenzie TA, Bdaiwi AH, Herrington L, Cools A. Inter-rater Reliability of
330 Real-Time Ultrasound to Measure Acromiohumeral Distance. PM R. 2016;8:629-34.
331 18. McCreesh KM, Anjum S, Crotty JM, Lewis JS. Ultrasound measures of
332 supraspinatus tendon thickness and acromiohumeral distance in rotator cuff
333 tendinopathy are reliable. J Clin Ultrasound. 2016;44:159-66.
334 19. Werner BS, Jacquot A, Mole D, Walch G. Is radiographic measurement of
335 acromiohumeral distance on anteroposterior view after reverse shoulder arthroplasty
336 reliable? J Shoulder Elbow Surg. 2016;25:e276-80.
337 20. Smolen D, Went P, Tomala D, Sternberg C, Lafosse L, Leuzinger J. Identification
338 of a Remodeled Neo-tendon After Arthroscopic Latarjet Procedure. Arthroscopy.
339 2017;33:534-42.

340

341 **Figure legends**

342 **Figure 1** Strategy of AHD measurement of coronal view on CT scan image.

343 **Figure 2** AHD measurement (coronal view), observation of graft position, remodeling,
344 and graft-glenoid interface healing (axial and en face view) of 3D reconstructed CT
345 scan images at different time points from one representative case that underwent
346 Latarjet procedure. Pre, preoperative; PO 0, immediate after operation; POM: month
347 postoperatively.

348 **Figure 3** Depressive effect that subscapular and conjoint tendons on the humeral
349 head.