RESEARCH ARTICLE

CT-scan Evaluation of Osteointegration and Osteolysis in Different Graft Types and Surgical Techniques for the Treatment of Shoulder Instability

Albizzini Ohin Caterina, MD[1]; Guarrella Vincenzo, MD[1]; Perfetti Carlo, MD[1]; Larghi Marco Mattia, MD[2]; Messina Carmelo, MD, PhD[3]; Sconfienza Luca Maria, MD, PhD[4]; Taverna Ettore, MD, PhD[1]

Research performed at the IRCCS Ospedale Galeazzi - Sant'Ambrogio, Milan, IT

Received: 27 December 2021 *Accepted: 26 August 2022*

Abstract

Background: Bone graft is often needed in treating anterior shoulder instability in glenoid bone loss and graft integration is crucial in achieving good results. This study aimed to evaluate bone graft remodeling in different techniques for shoulder anterior-inferior instability.

Methods: Graft osteointegration and osteolysis were retrospectively evaluated with CT-scan imaging performed 6 to 12 months after surgery to compare the outcome of three procedures: Latarjet, bone block with allograft, and bone block with xenograft. Screw fixation and double endobuttons fixation were also compared.

Results: CT scans of 130 patients were analyzed. Of these, 30 (23%) were performed after the bone block procedure with xenograft and endobuttons fixation, 55 (42%) after the bone block procedure with allograft and endobuttons fixation, 13 (10%) Latarjet with screw fixation and 32 (25%) Latarjet with endobuttons fixation. The prevalence of osteolysis was significantly inferior (P<.01) in the bone block procedure compared to the Latarjet procedure (11.7 % vs. 28.8 %). Bone integration was higher in bone block procedures (90.5%) than in Latarjet (84.4%), but the difference was not statistically significant. Among the Latarjet procedures, endobuttons fixation resulted in a higher integration rate (87.5% vs. 73.6%) and lower osteolysis rate than screw fixation (24.6% vs. 38.5%), despite these differences did not reach a statistical significance. Among the bone block procedures, using a xenograft resulted in a lower osteolysis rate (6.7%) than an allograft (14.5%), but the result was not statistically significant.

Conclusion: This study shows a significantly lower rate of graft osteolysis after bone block procedures compared to Latarjet procedure between 6 and 12 months postoperatively. Moreover, our findings suggest good results in osteolysis and graft integration with xenograft compared to allograft and double endobuttons fixation compared to screw fixation, despite these differences being not-significant. Further studies on this topic are needed to confirm our results at a longer follow-up and thoroughly investigate the clinical relevance of these findings.

Level of evidence: III

Keywords: Bone block, Graft, Osteolysis, Shoulder, Shoulder instability

Introduction

Anterior shoulder instability is often associated with glenoid bone loss.[1] Soft tissue repair alone is insufficient to ensure shoulder stability in case of sizeable glenoid bone defect[2,3] Several surgical treatments have been described to repair the bone deficit using autograft (such as iliac crest bone graft transfer

Corresponding Author: Caterina Albizzini Ohin, Department of Shoulder Surgery, IRCCS Ospedale Galeazzi, Sant'Ambrogio
Via Cristina Belgioioso, 173, 20161, Milan (Mi), Italy
Email: caterinaohin7@gmail.com

THE ONLINE VERSION OF THIS ARTICLE
ABJS.MUMS.AC.IR

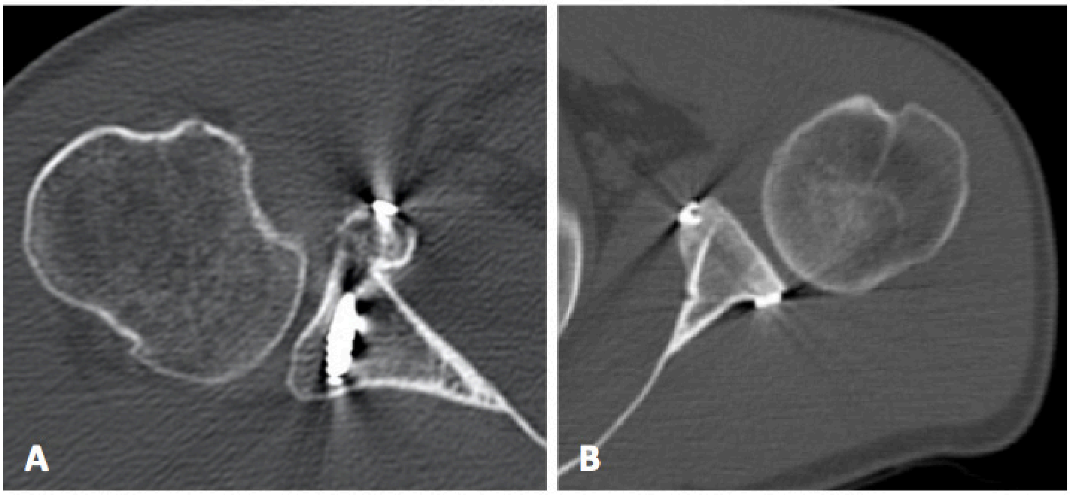

Figure 1. Two examples of successful osteointegration. On the left (image A), a Latarjet procedure shows the coracoid properly fixed to the anterior glenoid. On the right (image B), the bone defect is treated with a bone graft fixed with endobuttons. In both cases, no signs of resorption or osteolysis are present.

or coracoid process transfer), allograft, or xenograft procedure, all with reported good clinical outcomes [Figure 1].[4-7] Moreover, the positive biomechanical effect of grafting procedures has been confirmed in patient-specific finite element models.[8]

While a remodeling process may occur in the graft, preservation of mechanical integrity is crucial to preserve its biomechanical function and avoid complications [Figure 2]. A recent systematic review has shown an overall rate of 2.2% non-union and 0.4% osteolysis in patients treated with allograft.[9] Nonetheless, despite osteolysis and non-union being relatively rare complications, they could lead to postoperative stiffness, pain, and persistence of shoulder instability.[10] In severe cases, the remodeling process could lead to exposure of the fixation hardware (i.e., screws, fixation buttons), with a potential risk of chondral damage.[11,12] Compression of the interface between the graft and the glenoid 13 and poorer blood support in the upper zone,[11] which is more frequently involved, have been reported as possible biomechanical causes of failure [Figure 2]. The role of the fixation method in these processes has not been thoroughly investigated, with standard fixation screws and buttons being both effective in terms of bone union and osteolysis, and some reports of higher resorption rate using bioabsorbable screws.[14,15]

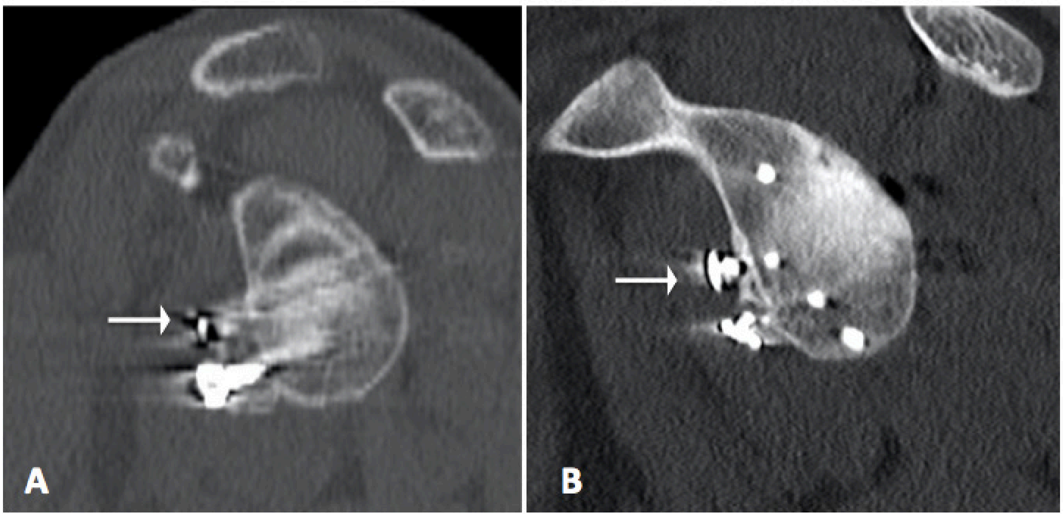

Figure 2. Two examples of lack of osteointegration. On the left (image A) is a Latarjet procedure showing linear osteolysis at the glenoid (white arrow). Similarly, on the right, image B shows the absence of the anterior portion of the graft (white arrow), indicating endobuttons osteolysis.

However, no studies have compared osteolysis and non-union rates using different hardware.

This study aimed to assess osteointegration and osteolysis in glenoid autografts, allografts, and xenografts using CT scan imaging. Among Latarjet procedures, different fixation methods (standard screws and buttons) were also compared.

Materials and Methods

A retrospective, comparative study was conducted on patients suffering from anterior shoulder instability with glenoid bone loss undergoing bone grafting, treated in 3 shoulder surgery departments by the same surgeon. Indication and treatment algorithms for glenoid grafting procedures were the same in all institutions [Tables 1; 2] and have been previously described.[16]

A total of 370 patients were treated for shoulder instability from 2013 to 2019.

For this study, inclusion criteria were as follows:

- Shoulder instability with more than 20% bone loss treated with bone block or arthroscopic assisted Latarjet
- CT-scan imaging at a minimum follow-up of 6 months

Exclusion criteria were:

- Incomplete medical records
- CT-scan follow-up before six months
- Soft tissue repair alone techniques for shoulder instability
- Surgery is performed by other surgeons.

Surgical procedures were classified into two main groups: arthroscopic assisted Latarjet and Bone Block. Arthroscopic assisted Latarjet procedure, as described by LaFosse et al., consists of an autograft-based procedure and may be divided into two subgroups according to fixation type: standard screw and button.[17] Bone block procedure is an arthroscopic method, first described by Taverna et al., which can be divided into two main groups according to graft type: xenograft- and allograft-based procedure.[18]

The following is a brief description of the surgical procedures.

Bone block procedure

In this technique, the bone graft is fixed with four Endobutton™ (Smith & Nephew Inc., Andover, MA, USA).[16,18] The technique combines the Bankart repair with the transfer of the graft, xenograft, or allograft, which is fixed on the glenoid rim. The graft is oriented, so the cancellous surface faces the glenoid's anterior neck. Anterior round Endobuttons are positioned on the cortical surface of the bone graft, and two more buttons are placed on the posterior face of the glenoid. The wires connecting the two superior and an inferior couple of buttons (one on the graft and another on the glenoid neck) are tensioned with a dedicated tool. At last, Bankart repair is performed.

Arthroscopically-assisted Latarjet procedure

The surgery starts with the arthroscopic evaluation of the bone loss and preparation of the anterior glenoid neck, detaching the capsule and the labrum. A dedicated guide (Glenoid GuideTM; Smith and Nephew, London, UK), centered in the middle of the anterior glenoid bone loss, is used to drill the screw holes. After that, a deltopectoral approach is performed for the coracoid harvesting.[19,20] Lastly, the graft is fixed to the glenoid with two screws or two couples of buttons.

Statistical analysis

Comparisons between groups were performed using the Fisher Exact Probability Test. A *P-value <0.05* was considered for statistical significance. Calculations were done using MedCalc Statistical Software version 20.011 (MedCalc Software bv Ostend, Belgium; https://www.medcalc.org; 2021).

Imaging analysis

CT acquisition parameters were similar for the three centers, which included 1 mm thickness slices (with both bone and soft tissue windows) and their coronal and sagittal reformatted images, performed with the patient supine on the CT table. The following scanner was used: 64-slice Somatom Emotion (Siemens Medical Solutions, Erlangen, Germany), 128-slice Ingenuity Core (Philips Medical Systems).

Post-operative CT-scan between 6 and 12 months were evaluated in consensus by an experienced shoulder orthopedic surgeon and an experienced radiologist. For each scan, both authors evaluated the graft osteointegration (healing) and the presence of bone resorption around the Endobuttons or the screws. We used coronal and sagittal reconstructions for spatial location purposes on the axial

Table 1. Indications for Arthroscopic Bone Block Graft Procedure

Arthroscopic Bone Block Graft Procedure Indication
Anterior glenoid bone loss < 20% with associated Bankart lesion
Anterior glenoid bone loss > 10% but <20% with ISIS score of 3-6 points
First episode of dislocation ≤ 3 years earlier
≤ 5 episodes of dislocation

Indications for Arthroscopic Bone Block Graft Procedure

Table 2.

Arthroscopic Capsuloplasty	Latarjet	Arthroscopic Bone Block
ISIS score < 3 points	ISIS score > 6 points	Young age
No glenoid bone loss	Chronic instability for > 3-5 yr	≤ 5 episodes
Isolated glenoid bone loss < 10%	> 10 episodes	First episode of dislocation ≤ 3 years earlier
≤ 3 episodes	Glenoid bone loss > 25%	Good tissue consistency of capsule and ligaments

Decision Algorithm for Instable Shoulder. ISIS = Instability Severity Index Score.

Table 3.

	Graft resorption classification
Grade 0 (no resorption)	The cone of the screw head is buried in the coracoid bone graft
Grade I (minor resorption)	The screw head is exposed outside the bone graft and the screw shaft is inside the bone
Grade II (major resorption)	Part of the screw shaft is exposed outside the graft
Grade III (total resorption)	The screw head and shaft are both totally exposed, all of bone graft absorbed, no bone is left on the glenoid neck

Graft resorption classification system described by Zhu.

slices. Interobserver agreement was evaluated using Cohen's kappa coefficient. Graft healing was confirmed in cases of bone bridging between the graft and the glenoid. The presence of a complete radiolucent line between the graft and the glenoid represented a non-union. To evaluate coracoid graft resorption, we considered the existence of osteolysis from grade I to III according to Zhu et al.,[21] which is based on the amount of resorption seen in the axial CT scan around each of the screws [Table 3].

Results

After applying inclusion and exclusion criteria, we identified 130 patients among the 370 treated in the study period. The mean age of the patients was 29.9 years (SD: ± 9.67; range:16-51). Of these, 30 (23.1%) underwent Bone Block procedure with xenograft and endobuttons fixation, 55 (42.3%) underwent Bone Block procedure with allograft and Endobuttons fixation, 13 (10%) Latarjet procedure with screw fixation, and 32 (24.6%) Latarjet with Endobuttons fixation.

Concerning Bone block with xenograft, osteointegration was reached in 26/30 (86.7%), and osteolysis was found in 2/30 (6.7%) patients. Among bone blocks with allograft, osteointegration was detected in 51/55 (92.3%) patients and osteolysis in 8/55 (14.5%). In Latarjet using fixation with screws, 10/13 (77%) patients showed osteointegration and 5/13 (38.5%) osteolysis. Regarding Latarjet using endobuttons, osteointegration was found in 28/32 (87.5%) patients and osteolysis in 8/32 (24.6%). A substantial agreement was found between the two examiners, with a κ = 0.791 (95% CI, .756 - .821), *P value <.0005*.

Overall, bone block showed a superior outcome in terms of osseointegration compared to the Latarjet procedure (90.5% vs. 84.4%), but this difference was not statistically significant (*P value >.05*; Fisher Exact Probability Test). Osteolysis was less common in the Bone Block procedure compared with the Latarjet procedure (11.7% vs. 28.8%), and the difference was statistically significant (*P value 0.01*; Fisher Exact Probability Test) [Table 4]. Concerning the location of osteolysis, the superior part of the graft was the most frequently involved (90% of cases). Similarly, most osteolysis was detected around the superior screw (90% of cases) in patients undergoing Latarjet with screws.

In the Latarjet procedures, Endobutton fixation resulted in a higher integration rate (87.5% vs. 73.6%) and lower osteolysis rate compared with screw fixation (25% vs. 38.4%), but this difference was not statistically significant (*P value > .05*; Fisher Exact Probability Test).

Among the Bone Block procedures, the use of a xenograft

Table 4.

Surgical procedure	Variable	Y	N	Tot	*P value*
Bone Block Latarjet	Osteointegration	77 (90,5%) 38 (84,4%)	8 (9,5%) 7 (15,6%)	85 45	0.22
Latajet Endobuttons Latarjet Screws	Osteointegration	28 (87,5%) 10 (77%)	4 (12,5%) 3 (23%)	32 13	0.65
BoneBlock Xenograft BoneBlock Allograft	Osteointegration	26 (86,7%) 51 (92,3%)	4 (13,3%) 4 (7,7%)	30 55	0.29

Graft osteointegration results.
Y: n. and % of osteointegrated graft. N: n. and % of not osteontegrated graft.
P value <.05 was considered significant.

Table 5.

Surgical procedure	Variable	Y	N	Tot	*P value*
Bone Block Latarjet	Osteolysis	10 (11,7%) 13 (28,8%)	75 (88,3%) 32 (71,2%)	85 45	**0.01**
Latarjet Endobuttons Latajet Screw	Osteolysis	8 (24,6%) 5 (38,5%)	24 (75,4%) 8 (61,5%)	32 13	0.47
Bone Block Xenograft Bone Block Allograft	Osteolysis	2 (6,7%) 8 (14,5%)	28 (93,3%) 47 (85,5%)	30 55	0.29

Graft Osteolysis results.
Y: n. and % of graft osteolysis. N: n. and % of no graft osteolysis.
P value <.05 was considered significant.

resulted in a lower osteolysis rate (6.6%) compared with the use of an allograft (14.5%), but the result was not statistically significant (*P value > .05*; Fisher Exact Probability Test) [Table 5].

Discussion

Glenoid bone grafting may be indicated in case of shoulder instability to address bone loss, especially when the latter exceeds 20-25%. These procedures may be performed using different surgical techniques and grafts and effectively avoid dislocation. Graft integration is crucial to achieving this goal, whereas graft osteolysis might jeopardize the biomechanical function of the graft itself. This study aimed to compare osteointegration and lysis of different types of graft (autograft, allograft, xenograft) performed using Bone Block or arthroscopically assisted Latarjet on CT scan images. Our study shows good results of the techniques in graft osteointegration, which occurred in most cases. Moreover, both the surgical procedures, graft types, and synthesis were effective and showed no statistically significant differences. However, the Latarjet procedure presented a higher prevalence of graft osteolysis between 6 and 12 months postoperatively compared to the bone block procedure.

Some authors reported cases of resorption of the coracoid after the Latarjet procedure using two screws to stabilize the graft.[10,22-24] Zhu et al. conducted a CT-scan evaluation in patients who underwent open Latarjet, using two screws, showing a high incidence of coracoid resorption (90,5%) at a mean follow-up of 15 months (range 11-19 months).[21] Boileau et al. performed a prospective clinical and CT-scan study to evaluate the graft positioning and healing of the arthroscopic Latarjet procedure, using buttons for the graft fixation.[14] They observed integration in 91% and non-union in 9% of cases at six months. Provencher et al. found an overall graft healing rate of 89% with a mean allograft lysis rate of 3% on CT-scan taken at a mean of 1.4 years after reconstruction among 25 patients.[25]

The most important finding of this study was that we found a statistically significantly higher percentage of osteolysis for the Latarjet procedure than for the Bone Block procedure. Where vast possibilities of surgical treatments are possible, the Bone Block procedure showed good union and lesser osteolysis in patients with bone defects. In fact, the use of dedicated instruments allows for optimal graft positioning and fixation with a double pair of round Endobuttons to avoid rotational instability of the bone graft.[28,29] The appropriate direction of the bony tunnels, parallel to the glenoid face and perpendicular to the graft and glenoid neck, is undoubtedly important for bone integration. The small diameter of the bony tunnels both in the glenoid and in the graft, and the absence of screws, may allow a continuous flow of bone marrow from the glenoid tunnel to the graft, increasing the possibility of bone integration of the graft. This could explain the minor remodeling compared to similar techniques.[30] Another advantage of the use of the round Endobuttons is the reduction of osteolysis rate compared to the use of the screws. According to the available literature, our study confirms that the portion of the coracoid most involved in the osteolysis process is the upper one, mainly where we used the screws.[10,11,13,31] As already observed by Di Giacomo et al., the coracoid resorption area mainly depends on biological and biomechanical factors related to vascularization and to the joint tendon's effect, which act more at the lower edge of the graft, allowing an optimal osteointegration, according with the Wolf Law.[10]

Our study is not without limitations. First, bias was unavoidably introduced due to the retrospective design of our work. In that sense, selection bias likely influenced our findings because patients operated by other surgeons and those without CT-scan were excluded. Second, heterogeneity between groups, in which different surgical techniques and types of grafts were used, probably played a role. Third, the follow-up duration might have been insufficient to identify osteolysis or other complication that might have developed later. Lastly, we did not correlate clinical data with the radiological results, limiting our conclusions.

In this study, arthroscopically assisted Latarjet and Bone block procedures were effective in terms of graft healing. We found a significantly lower rate of graft osteolysis after the Bone Block procedure (xenograft, allograft) compared to the Latarjet procedure (autograft). Our data suggest good results in terms of osteolysis and graft integration with double endobuttons fixation compared with screw fixation. Further studies on this topic are needed to confirm our results at a longer follow-up and thoroughly investigate the clinical relevance of these findings.

Declarations: All procedures performed in this study were in accordance with the ethical standard of the institutional committee and the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

We warrant that the article is the Author's original work and receive the approval of the institutional board.

Disclosure: Ettore Taverna has received consulting fees from Smith & Nephew inc. The other Authors declare that they have no conflict of interests.

Albizzini Ohin Caterina MD[1]
Guarrella Vincenzo MD[1]
Perfetti Carlo MD[1]
Larghi Marco Mattia MD[2]
Messina Carmelo PhD[3]
Sconfienza Luca Maria PhD[4]
Taverna Ettore PhD[1]
1 Department of Shoulder Surgery, IRCCS Ospedale Galeazzi, Sant'Ambrogio Via Cristina Belgioioso, 173, 20161, Milan (Mi), Italy
2 School of Medicine and Residency Program in Orthopaedics, Università degli studi di Milano Via Festa del Perdono 7, 20122 Milano, Italy
3 Unità Operativa di Radiologia Diagnostica ed Interventistica, IRCCS Ospedale Galeazzi, Sant'Ambrogio Via Cristina Belgioioso, 173, 20161, Milan (Mi), Italy
4 Unità Operativa di Radiologia Diagnostica ed Interventistica, IRCCS Ospedale Galeazzi, Sant'Ambrogio Via Cristina Belgioioso, 173, 20161, Milan (Mi), Italy; Dipartimento di Scienze Biomediche per la Salute, Università degli Studi di Milano, Via Pascal 36, 20133 Milano, Italy

References

1. Milano G, Grasso A, Russo A, et al. Analysis of risk factors for glenoid bone defect in anterior shoulder instability. Am J Sports Med. 2011;39(9):1870–6. doi: 10.1177/0363546511411699.
2. Piasecki DP, Verma NN, Romeo AA, Levine WN, Bach BR, Provencher MT. Glenoid bone deficiency in recurrent anterior shoulder instability: diagnosis and management. J Am Acad Orthop Surg. 2009;17(8):482–93. doi: 10.5435/00124635-200908000-00002.
3. Bliven KCH, Parr GP. Outcomes of the Latarjet Procedure Compared With Bankart Repair for Recurrent Traumatic Anterior Shoulder Instability. J Athl Train. 2018;53(2):181–3. doi: 10.4085/1062-6050-232-16.
4. Sayegh ET, Mascarenhas R, Chalmers PN, Cole BJ, Verma NN, Romeo AA. Allograft reconstruction for glenoid bone loss in glenohumeral instability: a systematic review. Arthroscopy. 2014;30(12):1642–9. doi: 10.1016/j.arthro.2014.05.007.
5. Gilat R, Lavoie-Gagne O, Haunschild ED, et al. Outcomes of the Latarjet procedure with minimum 5- and 10-year follow-up: A systematic review. Shoulder Elbow. 2020;12(5):315–29. doi: 10.1177/1758573220945318.
6. Gilat R, Wong SE, Lavoie-Gagne O, et al. Outcomes are comparable using free bone block autografts versus allografts for the management of anterior shoulder instability with glenoid bone loss: a systematic review and meta-analysis of «The Non-Latarjet». Knee Surg Sports Traumatol Arthrosc. 2021;29(7):2159–74. doi: 10.1007/s00167-020-06194-z.
7. Russo R, Maiotti M, Taverna E, Rao C. Arthroscopic Bone Graft Procedure Combined With Arthroscopic Subscapularis Augmentation for Recurrent Anterior Instability With Glenoid Bone Defect. Arthrosc Tech. 2018;7(6):e623–32. doi: 10.1016/j.eats.2018.02.009.
8. Sigrist B, Ferguson S, Boehm E, Jung C, Scheibel M, Moroder P. The Biomechanical Effect of Bone Grafting and Bone Graft Remodeling in Patients With Anterior Shoulder Instability. Am J Sports Med. 2020;48(8):1857–64. doi: 10.1177/0363546520919958.
9. Malahias M-A, Chytas D, Raoulis V, Chronopoulos E, Brilakis E, Antonogiannakis E. Iliac Crest Bone Grafting for the Management of Anterior Shoulder Instability in Patients with Glenoid Bone Loss: a Systematic Review of Contemporary Literature. Sports Med Open. 2020; 6(1):12. doi: 10.1186/s40798-020-0240-x.
10. Di Giacomo G, Costantini A, de Gasperis N, et al. Coracoid graft osteolysis after the Latarjet procedure for anteroinferior shoulder instability: a computed tomography scan study of twenty-six patients. J Shoulder Elbow Surg. 2011;20(6):989–95. doi: 10.1016/j.jse.2010.11.016.
11. Kee YM, Kim JY, Kim HJ, Sinha S, Rhee Y-G. Fate of coracoid grafts after the Latarjet procedure: will be analogous to the original glenoid by remodelling. Knee Surg Sports Traumatol Arthrosc. 2018;26(3):926–32. doi: 10.1007/s00167-017-4808-z.
12. Moroder P, Hirzinger C, Lederer S, et al. Restoration of anterior glenoid bone defects in posttraumatic recurrent anterior shoulder instability using the J-bone graft shows anatomic graft remodeling. Am J Sports Med. 2012;40(7):1544–50. doi: 10.1177/0363546512446681.
13. Alp NB, Doğan O, Yılmaz TG, et al. Understanding the causes behind coracoid graft osteolysıs in latarjet

procedure (finite element analysis and comparison of three fixation methods). Orthop Traumatol Surg Res. 2020;106(1):53–9. doi: 10.1016/j.otsr.2019.11.007.
14. Boileau P, Gendre P, Baba M, et al. A guided surgical approach and novel fixation method for arthroscopic Latarjet. J Shoulder Elbow Surg. 2016;25(1):78–89. doi: 10.1016/j.jse.2015.06.001.
15. Balestro J-C, Young A, Maccioni C, Walch G. Graft osteolysis and recurrent instability after the Latarjet procedure performed with bioabsorbable screw fixation. J Shoulder Elbow Surg. 2015;24(5):711–8. doi: 10.1016/j.jse.2014.07.014.
16. Taverna E, D'Ambrosi R, Perfetti C, Garavaglia G. Arthroscopic bone graft procedure for anterior inferior glenohumeral instability. Arthrosc Tech. 2014;3(6):e653-660. doi: 10.1016/j.eats.2014.08.002.
17. Lafosse L, Lejeune E, Bouchard A, Kakuda C, Gobezie R, Kochhar T. The arthroscopic Latarjet procedure for the treatment of anterior shoulder instability. Arthroscopy. 2007;23(11):1242.e1-5. doi: 10.1016/j.arthro.2007.06.008.
18. Taverna E, Golanò P, Pascale V, Battistella F. An arthroscopic bone graft procedure for treating anterior-inferior glenohumeral instability. Knee Surg Sports Traumatol Arthrosc. 2008;16(9):872–5. doi: 10.1007/s00167-008-0541-y.
19. Taverna E, Ufenast H, Broffoni L, Garavaglia G. Arthroscopically assisted Latarjet procedure: A new surgical approach for accurate coracoid graft placement and compression. Int J Shoulder Surg. 2013;7(3):120–3. doi: 10.4103/0973-6042.118912.
20. 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(2):S61–9. doi: 10.1016/j.jse.2010.07.022.
21. Zhu Y-M, Jiang C-Y, Lu Y, Li F-L, Wu G. Coracoid bone graft resorption after Latarjet procedure is underestimated: a new classification system and a clinical review with computed tomography evaluation. J Shoulder Elbow Surg. 2015;24(11):1782–8. doi: 10.1016/j.jse.2015.05.039.
22. Lafosse L, Boyle S. Arthroscopic Latarjet procedure. J Shoulder Elbow Surg. 2010;19(2 Suppl):2–12. doi: 10.1016/j.jse.2009.12.010.
23. Cassagnaud X, Maynou C, Mestdagh H. Clinical and computed tomography results of 106 Latarjet-Patte procedures at mean 7.5 year follow-up. Revue de Chirurgie Orthopedique et Reparatrice de L'appareil Moteur. 2003; 89(8):683-92.
24. Allain J, Goutallier D, Glorion C. Long-term results of the Latarjet procedure for the treatment of anterior instability of the shoulder. J Bone Joint Surg Am.1998;80(6):841–52. doi: 10.2106/00004623-199806000-00008.
25. Provencher MT, Ghodadra N, LeClere L, Solomon DJ, Romeo AA. Anatomic osteochondral glenoid reconstruction for recurrent glenohumeral instability with glenoid deficiency using a distal tibia allograft. Arthroscopy. 2009;25(4):446–52. doi: 10.1016/j.arthro.2008.10.017.
26. Mochizuki Y, Hachisuka H, Kashiwagi K, Oomae H, Yokoya S, Ochi M. Arthroscopic autologous bone graft with arthroscopic Bankart repair for a large bony defect lesion caused by recurrent shoulder dislocation. Arthroscopy. 2007;23(6):677.e1-4. doi: 10.1016/j.arthro.2006.01.024.
27. Levine WN, Richmond JC, Donaldson WR. Use of the suture anchor in open Bankart reconstruction. A follow-up report. Am J Sports Med. 1994;22(5):723–6. doi: 10.1177/036354659402200525.
28. Zhao J, Huangfu X, Yang X, Xie G, Xu C. Arthroscopic glenoid bone grafting with nonrigid fixation for anterior shoulder instability: 52 patients with 2- to 5-year follow-up. Am J Sports Med. 2014;42(4):831–9. doi: 10.1177/0363546513519227.
29. Moroder P, Schulz E, Wierer G, et al. Neer Award 2019: Latarjet procedure vs. iliac crest bone graft transfer for treatment of anterior shoulder instability with glenoid bone loss: a prospective randomized trial. J Shoulder Elbow Surg. 2019;28(7):1298–307. doi: 10.1016/j.jse.2019.03.035.
30. Guity MR, Roques B, Mansat P, Bellumore Y, Mansat M. Painful or unstable shoulder after coracoid transfer: result of surgical treatment. Rev Chir Orthop Reparatrice Appar Mot. 2002;88(4):349–58.
31. Di Giacomo G, de Gasperis N, Costantini A, De Vita A, Beccaglia MAR, Pouliart N. 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):514–8. doi: 10.1016/j.jse.2013.10.005.