Risk Factors for Coracoid Graft Osteolysis after the Open Latarjet Procedure

Fatores de risco para osteólise do enxerto do coracoide após o procedimento de Latarjet aberto

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Abstract

Objective Coracoid osteolysis has been described as a possible complication after the Latarjet procedure. The aim of the present study was to investigate the incidence and risk factors associated to coracoid graft osteolysis and to correlate them with clinical results.

Methods A retrospective review of 38 Latarjet procedures was conducted. Computed tomography (CT) scans were obtained from all of the patients before and at least 1 year after the surgery. Coracoid osteolysis was evaluated and correlated to preoperative factors, namely: age, smoking status, and preoperative glenoid bone loss. The patients were divided into 2 groups: A (no or minor bone resorption) and B (major or total bone resorption). The functional outcome was determined by the Rowe score.

Results Coracoid graft osteolysis occurred in 22 cases (57.8%). The mean preoperative glenoid defect was 22.8% in group A, and 13.4% in group B ($p = 0.0075$). The mean ages of the subjects in both groups were not significantly different. Smoking did not seem to affect the main outcome either, and no correlation was found between graft osteolysis and postoperative range of motion, pain, or Rowe score. There were no cases of recurrent dislocations in our sample, although four patients presented with a positive anterior apprehension sign.

Conclusion Bone resorption of the coracoid graft is present in at least 50% of the patients submitted to the Latarjet procedure, and the absence of significant preoperative glenoid bone loss showed to be the only risk factor associated with severe graft osteolysis, even though this did not influence significantly the clinical outcome.

Keywords

- joint instability
- shoulder dislocation
- shoulder joint
- bone resorption
- osteolysis

Resumo

Objetivo Osteólise do processo coracoide é descrita como uma possível complicação da cirurgia de Latarjet. O objetivo do presente estudo foi avaliar a incidência e fatores de risco associados à osteólise do enxerto do coracoide e correlacioná-los com resultados clínicos.

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Métodos Foi realizada uma revisão retrospectiva incluindo 38 casos submetidos ao procedimento de Latarjet. Em todos os casos, foi realizada uma tomografia computadorizada antes e pelo menos 1 ano após a cirurgia. A presença de osteólise do coracoide foi avaliada e correlacionada com os seguintes fatores de risco: idade, tabagismo, e perda óssea pré-operatória da glenóide. Os pacientes foram divididos em dois grupos: A (ausência ou menor reabsorção óssea) e B (maior reabsorção óssea ou total). A avaliação funcional foi determinada através do escore de Rowe.

Resultado Osteólise do processo coracoide ocorreu em 22 casos (57,8%). O defeito ósseo médio pré-operatório da glenóide foi de 22,8% no grupo A e de 13,4% no grupo B ($p = 0.0075$). A média de idade dos casos em ambos os grupos não apresentou diferença estatística. Tabagismo também não esteve relacionado com diferenças no resultado. Não houve correlação entre a presença de osteólise e o arco de movimento, dor ou ao escore de Rowe. Não houve casos de reluxação; entretanto, quatro pacientes apresentaram apreensão anterior no exame físico.

Conclusão A reabsorção do processo coracoide ocorreu em pelo menos 50% dos pacientes submetidos à cirurgia de Latarjet, e a ausência pré-operatória de perda óssea significativa da glenóide foi o único fator de risco associado a osteólise mais severa do enxerto, porém sem influência no resultado clínico.

Palavras-chave
- instabilidade articular
- luxação do ombro
- articulação do ombro
- reabsorção óssea
- osteólise

Introduction

In the last years, many articles have been published about the results of the bone block procedure described by Latarjet for the treatment of anterior glenohumeral instability.[1–4] Even with some modifications from surgeon to surgeon, the main principle of the surgery remains the coracoid transfer through the subscapularis tendon.[1,5–7] It has become the treatment of choice in the settings of osseous deficiencies > 20% of the glenoid surface area, of revision surgery, and of athletes who practice high-risk contact sports, even in the setting of limited osseous deficiency.[8] For the achievement of the best result and less complications, it is mandatory to position the graft properly with the goal of healing between the coracoid process and the glenoid in a flush position.[9–12] Even after bone union, coracoid bone graft resorption can occur. This phenomenon has been reported, and some authors have considered that it might be associated with shoulder pain and recurrent dislocation.[3,4,11,13] Di Giacomo et al.,[14] were one of the first authors to report the location and amount of coracoid graft osteolysis after the Latarjet procedure using computed tomography (CT) scan analysis. He also published another study, which states that patients with preoperative glenoid bone loss (> 15%) underwent less osteolysis when compared with those with lesser defects.[15] He theorized that in patients without glenoid bone loss, there is lack of mechanical stimuli from the humeral head in certain areas of the graft, which may contribute to the resorption of the coracoid. The purpose of the present study was to evaluate the incidence of bone graft osteolysis after the Latarjet procedure and to correlate it with age, smoking, and the presence of preoperative glenoid bone loss. Our hypothesis was that, as previously described, bone graft osteolysis is more pronounced in cases without glenoid bone loss.

Materials and Methods

Study Population

This is a retrospective observational study of 72 patients submitted to surgery for anterior shoulder instability using the Latarjet procedure, between May 2012 and August 2016. The inclusion criteria were availability of a preoperative and of at least a 1-year postoperative CT scan and physical examination at a minimum of 2 years postoperatively. Cases with a major deviation from the most commonly used technique (such as the congruent arc technique), those that had to be reoperated for hardware removal, or those in which the graft did not heal promptly were excluded. All of the patients gave written consent to participate in the study, and approval from the ethics committee of the institute was granted.

The main outcome studied was osteolysis of the coracoid graft, classified in 4 types according to Zhu et al.[16] (►**Table 1**). According to this classification, we divided the subjects in two groups, A (no or minor resorption) and B (major or total

Table 1 Zhu et al.[16] classification of postoperative coracoid bone resorption (4 grades based on axial computed tomography scan). Bone resorption classified with the highest grade between the two screws

Grade 0 (no resorption): The cone of the screw head is buried in the coracoid bone graft
Grade I (minor resorption): Only the screw head is exposed outside the bone graft.
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, with all of the coracoid bone graft absorbed, and no bone is left on the glenoid neck.

resorption). This was compared with several exposures, namely the amount of glenoid bone loss before surgery, tobacco use, the use of suture anchors, and age. We have also searched for correlation between graft resorption and postoperative clinical results using the Rowe score, visual analogue scale, and range of motion. Variables were obtained from pre- and at least 1-year postoperative CTs. Range of motion was obtained from physical examination, and pain was registered using the visual analogue scale. These results were registered in a Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) spreadsheet and the statistical analysis was performed using the Real Statistics software package (Charles Zaionitz).

Surgical Technique

The surgery was performed under general anesthesia combined with an interscalene block. The patients were placed in the beach chair position. A surgical incision was made starting from the coracoid process and extending $\sim$ 7 cm inferiorly. Through the deltopectoral interval, the coracoid process was osteotomized with a curved osteotome. The subscapularis tendon was divided horizontally along the muscle fiber at the level of the lower one-third of the width of the tendon. A vertical incision was made at the anterior joint capsule. Both the coracoid graft and the glenoid neck were decorticated before fixation with 2 screws (3.5 mm cortical or 4.0 mm cancellous) without any specific guide. According to the preference of the surgeons, the anterior capsule was reattached to the anterior inferior rim of the native glenoid with one bioabsorble Gryphon suture anchor (Depuy Synthes, Warsaw, IN, USA) or sutured to the stump of the coracoacromial ligament, or it was not reattached at all. A sling protected the shoulder for 4 weeks postoperatively. Passive range of motion was started at 2 weeks, and daily activity was allowed at 4 weeks. Strengthening of the shoulder was initiated 3 months after the surgery.

Radiographic Imaging

Images were obtained with a Philips Brilliance 64-slice CT scanner (Philips, Amsterdam, Netherlands) at, 250 mA, 120 Kvp, and slice thickness of 1 mm). Preoperative glenoid bone loss was measured on a three-dimensional (3D) reconstruction en face view of the glenoid with the humeral head subtracted. The percentage of the glenoid bone loss was measured using the surface area method by the Image J software (National Institutes of Health, Bethesda, MA, USA) using the concept of the "best-fit circle."[17–20] The postoperative CT scan was performed after a minimum of 1 year. Healing, position, and resorption of the graft were assessed. Healing was confirmed by bridging with bone between the bone block and the glenoid. The presence of a complete radiolucent line between the graft and the glenoid represented a nonunion, and the case was excluded. If the lateral cortex of the coracoid was $>$ 1 mm medial or lateral to the articular surface of the glenoid, then the position of the coracoid was defined as medial or lateral overhanging position, respectively. Otherwise, if the lateral cortex of the coracoid was within 1 mm of the glenoid surface, the position of the coracoid was defined as flush. The classification system described by Zhu et al.[16] was used to evaluate coracoid graft resorption (►**Table 1**).

Statistical Evaluation

Results were recorded in an Excel spreadsheet, and statistical testing was performed using the Real Statistics tool. Subjects were divided in the two groups, and normality was assessed using the Shapiro-Wilk test. Continuous variables with a normal distribution were compared using the Student t-test (preoperative glenoid defects). Non-normal distribution variables were compared using the Mann-Whitney test (age and Rowe score). Categorical data with small samples were compared using the direct Fischer test (suture anchor use and smoking)

Results

Out of the initial 72 patients included in the study, 13 were excluded for lack of preoperative exams, and 11 for lack of postoperative exams. Three patients were excluded for undergoing implant removal during revision surgery in the 1st year. Two presented with graft nonunion, and in six, the coracoid was placed with the concave inferior surface facing the joint (the congruent arc technique). After exclusions, 38 shoulders in 37 patients remained. Their mean age was 33 years old (21 to 67 years old), 32 were male, and 5 were female. The mean size of the preoperative glenoid defect was 20% (0–34%). A total of 27 cases showed a bony Bankart lesion, and 10 had bone erosion. One case had no defect. In 11 cases, the anterior capsule was reattached to the glenoid with one anchor. In nine cases, no anchor was used, and the capsule was sutured to the stump of the coracoacromial ligament or to the head of the screw (seven and two cases, respectively). In the final 18 cases, no capsule reattachment was performed. The postoperative CT evaluation was performed at a mean follow-up of 27 months (12 to 72 months). The position of the graft was considered optimal in 34 cases. Three were considered medial, and one was considered lateral. According to the classification system by Yi-Ming Zhu et al.,[16] graft resorption occurred in 22 cases (57.8%), with 11 type I, 8 type II, and 3 type III. In all of the cases, more severe resorption occurred in the superior part of the graft around the superior screw (►**Fig. 1**). Hence, the groups were composed of 27 cases in group A (grades 0 and I), and of 11 cases in group B (grades II and III). The mean preoperative glenoid defect observed was 22.8% in group A, and 13.4% in group B ($p = 0.0075$) (►**Table 2**). The mean age of the subjects in both groups were not significantly different: 32 and 35.8 years old in groups A and B, respectively. No correlation was found between graft osteolysis and suture anchor use for capsular repair (6/27 versus 5/11), postoperative range of motion, pain, or Rowe score (88.3 versus 89) ($p = 0.46$) Smoking did not seem to affect the main outcome either, although we had only two smoking subjects in each group. There were no cases of recurring instability in our sample, although four patients presented with a positive anterior apprehension sign, all in group A (►**Table 3**).

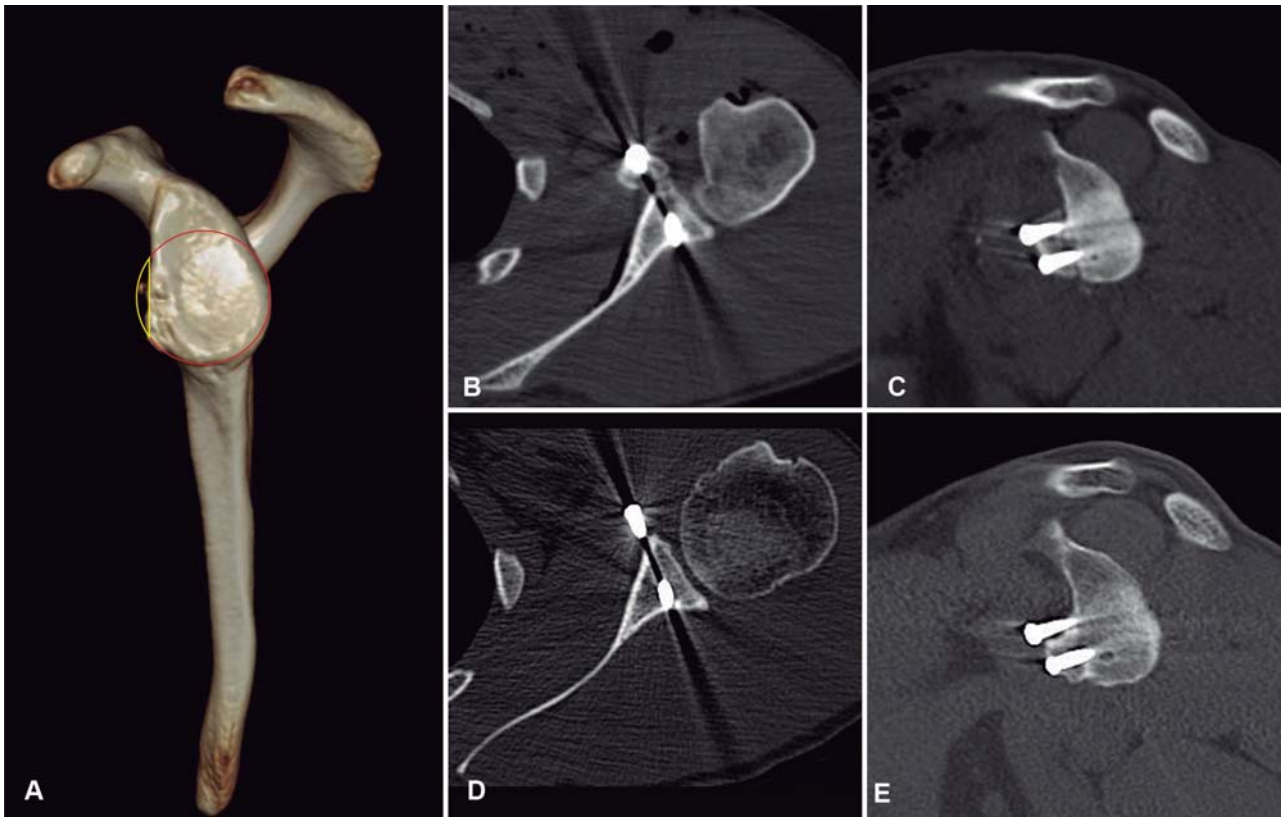

Fig. 1 (A) Preoperative three-dimensional reconstruction computed tomography scan of the glenoid. The anterior glenoid defect border (yellow) and circumference of the perfect circle (red) outlined. Percentage bone loss = (defect surface area/surface area of the perfect glenoid circle) × 100%. (B,C) Immediate postoperative axial and sagittal view computed tomography scan. (D,E) Computed tomography scan 42 months after surgery showing grade III resorption of the superior part of the coracoid graft.

Table 2 Characteristics of groups A and B

	Group A (grade 0/I)	Group B (grade II/III)	*p-value*
Cases	27	11	
Follow-up (months)	27.9 (12- 67)	26.9 (12–72)	
Preoperative glenoid bone loss (area)	22.8% (7–34)	13.4% (0–24)	0.0075
Age (years old)	32	35.8	0.410
Smoking	2	2	0.562
Anchor	6	4	0.424

Table 3 Comparison of the clinical results between groups A and B

	Group A (grade 0/I)	Group B (grade II/III)	*p-value*
Rowe score	88 (45–100)	89 (65–100)	0.46
Forward elevation	160° (130–180)	151° (140–160)	0.175
External rotation	51° (30–80)	48° (25–70)	0.585
Internal rotation	T9 (T6-L1)	T10 (T5-L3)	0.349
Anterior apprehension	4	0	0.309
Recurrence	0	0	

The coracoid graft was well-positioned and without resorption in all four cases with positive anterior apprehension.

Discussion

The Latarjet procedure has been shown to be a reliable method to prevent recurrent shoulder anterior instability, with many authors reporting successful outcomes.[21–24] At the same time, few studies mention the condition of coracoid bone resorption. The present study shows that some bone resorption of the coracoid graft is present in at least 50% of the patients submitted to the Latarjet surgery, and that patients with less preoperative glenoid bone loss had more chances of having more severe graft osteolysis. One of the theories related to that finding is that there is lack of mechanical stimuli of the graft in patients with less glenoid bone loss, while patients with a more significant defect would be subjected to maintaining forces when the coracoid replaces the large bone defect (Wolff law).[14,15] Accordingly, we found that in all of the patients, the superior part of the graft had a more pronounced resorption. Our impression is that this may be due to the inferior part of the coracoid being subjected to forces of traction from the conjoined tendon, thus protecting it from resorption. We can also speculate that

this part had some contribution of vascularization from the conjoined tendon. Di Giacomo et al.[14] performed a study to determine the location and amount of coracoid graft osteolysis after the Latarjet procedure using CT. He described a classification dividing the coracoid in eight parts and identified more pronounced resorption in the superficial and medial parts. It was the first classification published on this subject, and he believed that the results of resorption were due to mechanical and biological factors.[14] Later, he published a second paper correlating the presence of glenoid bone loss and coracoid graft osteolysis, and identified less osteolysis in patients with significant glenoid bone loss ($> 15\%$).[15]

Zhu et al.[16] described a more simple classification system than Giacomo to evaluate the severity of the bone resorption of the transferred coracoid. His classification is based on the amount of resorption seen in the axial CT scan around each of the screws; the resorption is classified with the highest grade between the two screws. In our study, the highest grade was always in the superior screw. He found an incidence of 90.5% of coracoid bone resorption after 1 year, while in our study, using the same classification, we found an incidence of 57.8%. Zhu et al.[16] did not try to correlate the incidence or severity of the resorption with glenoid bone loss, and all of the patients of his series had a preoperative glenoid bone defect $> 20\%$. Haeni et al.[25] performed a prospective study with 15 patients after the arthroscopic Latarjet procedure and found that the superior half of the coracoid undergoes a significant amount of osteolysis after 6 months. One difference from his study was that the resorption was evaluated through 3D CT scans using volumetric analysis. There was no mention of clinical implications or complications due to the resorption. Recently, Zhu et al.[26] published a prospective comparative study between arthroscopic versus open Latarjet, and found less graft resorption in the arthroscopic group. Both groups had no significant difference for the preoperative glenoid bone loss. They attributed this result to a multifactorial cause of resorption, and believed that a better protection of soft tissue during arthroscopic surgery could lead to better preservation of the blood supply of the coracoid. One of the main concerns about osteolysis of the coracoid process is the possible association with worse clinical results; however, until now, no consensus has been achieved.[4,25] A total of 11 patients (29%) of our series had major resorption (grades II and III), but this was not correlated with any difference in functional outcomes or with the risk of recurrence of instability when compared with patients without or with minor resorption. Lunn et al,[27] in a series of patients with failure after the Latarjet procedure, identified graft lysis as a risk factor for recurrence of instability. This can bring a discussion about the importance of the bone block compared with the sling effect of the conjoined tendon in the stability after the Latarjet procedure.[28,29] Our clinical results demonstrated that the presence of resorption was not related to a higher incidence of recurrence. Giacommo et al.[14,15] suggest that the bone block effect might not be the main effect, because of the huge osteolysis that happened in his patients. We could speculate that the osseous contribution for the stability after the Latarjet procedure is more important in cases with larger glenoid bone defects because those are the patients with less osteolysis, as has been demonstrated previously.

A limited number of patients and short follow-up are some of the limitations of the present study. Although we could not identify a negative effect on the clinical outcome of the patients with more severe graft resorption, concerns about this issue still exist. Therefore, we recommend caution when performing Latarjet procedures in cases without significant glenoid bone loss, taking into consideration that the superior part of the graft has more chances of resorption, and an optimal screw position should be ensured.

Conclusion

The present study shows that some bone resorption of the coracoid graft is present in at least 50% of the patients submitted to the Latarjet surgery, and that the absence of a significant preoperative glenoid defect seems to be the only risk factor associated with more severe graft osteolysis, even though no significant clinical significance was found in these cases.

Note
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Conflicts of Interests
The authors have no conflicts of interests to declare.

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