Glenoid Bone Loss – A Retrospective Evaluation of Functional Outcomes after Bone Block Surgery for Anterior Shoulder Instability in High-demand Athletes

Falha óssea na glenoide – Uma avaliação retrospectiva dos desfechos funcionais após cirurgia de bloqueio ósseo para instabilidade anterior do ombro em atletas de alta demanda

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Abstract

Objective This study assesses the relationship between the glenoid bone loss size and range of motion, functional outcomes, and complications in high-performance athletes undergoing bone block surgery for anterior shoulder instability.

Methods This retrospective study evaluated postoperative outcomes in athletes submitted to bone block surgery for anterior shoulder instability. In 5 years, 41 shoulders underwent the procedure; 20 had bone losses up to 15%, and 21 shoulders presented bone losses ranging from 15% and 25%.

Results There was no statistically significant difference regarding postoperative complications, new dislocations, and the rate of return to sports. In addition, the quantitative criteria evaluated, i.e., ranges of motion and functional scores, showed no statistically significant difference between groups.

Conclusion The size of the bone loss per se does not seem to affect functional outcomes and complications from these procedures, which are safe techniques for small and large bone losses.

Keywords
- athletes
- glenoid cavity
- grafting, bone
- joint instability
- shoulder

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Resumo

Objetivo Avaliar a relação do tamanho do defeito ósseo da glenoide no arco de movimento, nos resultados funcionais e nas complicações em pacientes atletas de alta performance submetidos a cirurgia de bloqueio ósseo para instabilidade anterior do ombro.

Método Estudo retrospectivo no qual foram avaliados os resultados pós-operatórios de atletas submetidos a cirurgia de bloqueio ósseo para instabilidade anterior do ombro. Em 5 anos foram 41 ombros operados, sendo 20 deles com até 15% de defeito ósseo e 21 com defeitos entre 15% e 25%.

Resultados Não houve diferença estatisticamente significativa com relação a complicações pós-operatórias, novas luxações, e na taxa de retorno ao esporte. Os critérios quantitativos avaliados – arcos de movimento e escores funcionais – também não apresentaram diferença estatisticamente significativa entre os grupos.

Conclusão O tamanho do defeito ósseo por si só não parece afetar os resultados funcionais e as complicações desses procedimentos, sendo uma técnica segura tanto para defeitos pequenos, quanto para os maiores.

Palavras-chave

- atletas
- cavidade glenoide
- enxerto ósseo
- instabilidade articula
- falha óssea
- ombro

Introduction

Choosing the best treatment for a disease is a constant challenge for the orthopedic surgeon. Another pitfall is the development of effective methods for making such choices. Traumatic anterior shoulder instability is a common condition,[1] especially in young athletes, which leads to the discussion about the several potential techniques for its treatment. These procedures aim to achieve a stable and functional shoulder and prevent the development of osteoarthritis, which is critical when dealing with athletes seeking to return to high-performance activities.

Glenoid bone loss (GBL) is a risk factor for failures in the arthroscopic repair of anterior shoulder instabilities.[2–9] Athletes practicing contact sports have worse recurrence rates and prognosis due to the progression of anterior shoulder instability after a Bankart surgery. This lack of therapeutic success often leads to the need for glenoid bone grafting surgeries, especially when GBL is greater than 20 to 25%.[10,11] However, Dekker et al.[3] showed that bone losses affecting more than 15% of the glenoid surface significantly increase these rates in active patients.

This study evaluated whether high-demand athletes undergoing bone block procedures and presenting GBLs larger than 15% would present worse outcomes concerning the range of motion (ROM), complications, and functional outcomes compared with patients with smaller GBLs.

Methods

This study is a retrospective analysis of computed tomography (CT) scans from participants of a previous prospective study by the same authors. In the first study, participants were randomized into two groups for surgery (Bristow and Latarjet procedures) and followed up for 5 years. Nineteen shoulders underwent a Bristow procedure, and 22 shoulders underwent a Latarjet surgery, totaling 37 patients. At the end of the follow-up period, we retrospectively evaluated the preoperative CT scans of the subjects to calculate GBLs per the contralateral comparison method (►**Fig. 1**).[12] Based on these data, we divided the patients again into two groups according to the values obtained: GBLs lower than 15% and GBLs greater than 15% but equal to or lower than 25%. The first group had 20 shoulders, while the second group included 21 shoulders.

We collected the following demographic data: age, gender, weight, and body mass index (BMI). In addition, we compiled qualitative clinical aspects, including shoulder hyperlaxity, athlete category (professional versus amateur), dominant and injured limb side, type of procedure performed, and injury mechanism. If the dislocation resulted from direct trauma to the shoulder, the injury

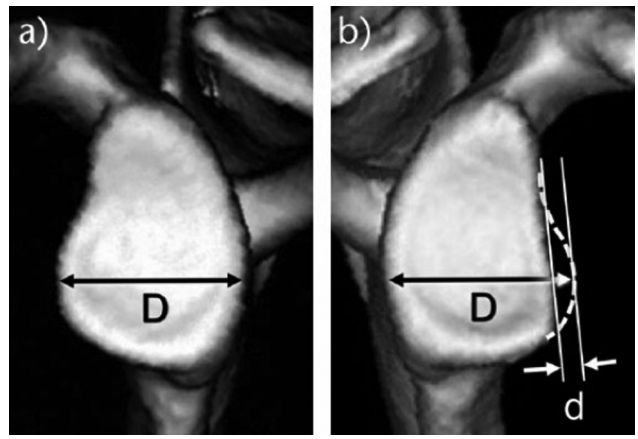

Fig. 1 Linear measurement of the glenoid bone gap using the contralateral comparison method. D represents the width of the intact glenoid (a). The transposition of D to the side with bone loss (b) generates the distance to the edge of the glenoid (d). The expression d/D x 100 (%) represents the bone loss.

had a traumatic mechanism; if not, the mechanism was atraumatic.

Inclusion criteria were anterior shoulder instability with no history of previous shoulder procedures, high sportive demand (stipulated by the researchers as athletes training more than 7 hours per week and participating in competitions, as shown in ►**Table 1**), up to 25% of GBL at a CT scan, and at least 60 months of postoperative follow-up. Exclusion criteria were a previous surgical procedure on the affected shoulder, associated injuries, such as rotator cuff tears or superior labrum anterior and posterior (SLAP) injuries (in these cases, we referred patients for arthroscopy), patients with more than 25% of GBL (subjects referred to Eden-Hybinett surgery with iliac graft), or patients who did not complete the minimum postoperative follow-up period of 5 years. Subjects with a clinical picture suggesting associated injuries, such as rotator cuff and SLAP injuries, underwent magnetic nuclear resonance imaging before inclusion and were excluded from the study in case of confirmation of such lesions.

Table 1 Sports distribution

Sport	Athletes
Soccer	9
Rodeo	9
Handball	4
Jiu Jitsu	4
Muay Thai	2
Other martial arts	2
Rugby	2
Volleyball	2
Boxing	1
Chinese boxing	1
Motocross	1

Before surgery, the affected shoulder from all patients underwent a radiographic evaluation (anteroposterior and lateral views) and a bilateral CT scan. Next, we calculated the GBL using the contralateral method.[12] In our sample, GBL ranged from 10 to 25%. Imaging also allowed the evaluation of the glenoid track, revealing on-track or off-track lesions.[12]

Patients were evaluated before and after surgery according to a previously defined protocol (►**Appendix 1**). Independent physical therapists performed the initial and postoperative follow-up functional and ROM assessments at different times from the routine postoperative evaluations by the surgical team. We analyzed the following items: degree of active and passive lateral rotation, active and passive elevation, visual analog scale (VAS) for pain, the Athletic Shoulder Outcome Rating Scale (ASORS),[13] the Western Ontario Shoulder Instability Index (WOSI),[14] and the American Shoulder and Elbow Surgeons Standardized Shoulder Assessment (ASES).[15] During the follow-up, we also recorded complications (unexpected events during follow-up, including residual instability, except for dislocations), new dislocations, and return to the same sports activity.

ASORS is a questionnaire regarding shoulder stability, ROM, function in daily activities, and pain. A score lower than 50 points indicates poor outcomes; scores from 51 to 74 points are typical outcomes, scores from 75 to 89 are good outcomes, and those from 90 to 100 are excellent outcomes.

WOSI is a questionnaire about the quality of life in patients with anterior shoulder instability. High scores indicate the worse quality of life. The score ranges from 0 (excellent) to 210 (very poor).

ASES is a questionnaire regarding shoulder pain and function. Scores range from 0 to 100, and higher values indicate better outcomes.

For surgery, the patient was in a beach chair position under brachial plexus blockade and sedation in a day hospital. Surgical access was anterior to the coracoid process, extending 5 cm through the deltopectoral interval. After a blunt dissection and coracoid exposure, we performed the osteotomy per the Bristow or Latarjet techniques. The graft fixation used one or two small fragment screws, respectively, complying with the above techniques.

The rehabilitation protocol involved 3 weeks of immobilization with a simple shoulder sling in all cases, followed by physical therapy for a progressive increase of passive and active mobility. Strengthening exercises started at 8 to 12 weeks. Return to sports was allowed 4 to 5 months after surgery when the patient had no pain and instability to perform it as before surgery.

Statistical analysis employed non-parametric methods. The chi-square test compared the distribution of qualitative factors between groups, while the Mann-Whitney test compared quantitative factors. The Kolmogorov-Smirnov test assessed the normality of the distribution, which was not ensured for the main outcome quantitative variables. The significance level adopted was 95%; the statistical significance of comparisons was demonstrated by a p-value ≤ 0.05.

Results

In total, we evaluated 41 shoulders, including 20 with GBL $\leq$15% and 21 shoulders with GBL >15% and $\leq$25%. There was no statistically significant difference regarding age, gender, height, weight, BMI, shoulder hyperlaxity, athlete category (amateur or professional), dominant limb, injured limb, and injury mechanism. In addition, the distribution of the type of procedure performed in subjects from each group (Bristow or Latarjet) was similar, avoiding a potential bias. However, we noted that patients with a larger GBL had a greater number of previous shoulder dislocations and off-track injuries (►**Tables 2** and **3**). There were no cases of generalized hyperlaxity in this sample.

Follow-up and rehabilitation outcomes showed no statistically significant difference in the number of postoperative complications, new dislocations, and the rate of return to

Table 2 Qualitative characteristics of the samples

		≤15%	>15% and ≤25%	Total	p-value
		N = 20	N = 21		
Category	Amateur	14	11	25	0.248
	Professional	6	10	16	
Shoulder hyperlaxity	No	16	18	34	0.627
	Yes	4	3	7	
Dominant limb	Right	18	21	39	0.137
	Left	2	0	2	
Affected limb	Right	13	11	24	0.412
	Left	7	10	17	
Injury mechanism	Atraumatic	5	3	8	0.387
	Traumatic	15	18	33	
Gender	Female	2	2	4	0.959
	Male	18	19	37	
Performed procedure	Bristow	9	11	20	0.636
	Latarjet	11	10	21	
Glenoid track	Off-track	7	18	25	0.001
	On-track	13	3	16	

sports (►**Table 4**). In addition, there was no statistical difference between groups for ROM, ASORS, ASES, and WOSI. Although preoperative pain was lower in the group with higher GBL, VAS revealed no significant difference in pain at the end of the follow-up period (►**Table 5**).

Discussion

The main finding of this study was to demonstrate that GBL, within the established thresholds, did not change the expected outcomes of bone block surgery for anterior shoulder instability in high-performance athletes. The Bristow and Latarjet bone block surgeries always bring few complications, few cases of recurrent instability, good functional outcomes, and little ROM limitation of the affected shoulder with small and large GBLs up to 25%.

Several authors cite GBLs as a risk factor for instability recurrence. Many studies try to assess a threshold value for GBL size in which this risk would be higher.[3–6,9,16] Jeon et al.[16] report a threshold value ranging from 15 to 20% for bone loss, concluding that the Bankart and Latarjet surgeries result in satisfactory clinical outcomes and pain improvement. However, they also observed that the bone block resulted in a lower rate of recurrence and lower lateral rotation limitation in this population. Burkhart and De Beer[4] showed a 67% rate of instability recurrence in patients with significant glenoid injury (engaged Hill-Sachs or "inverted pear" glenoid), concluding that these subjects have a contraindication for arthroscopic repair. Our study confirms that bone block surgeries may be successful even in small bone defects, without functional impairment for the patient. This fact is relevant in this group of patients (high-demand athletes) who must return to sports at the same pre-injury level and not suffer new dislocations.

Dekker et al.[3] demonstrated that GBLs larger than 15% were a significant risk factor for instability recurrence in patients undergoing Bankart surgery. In addition, these subjects presented worse functional outcomes (WOSI and ASES). In our study, we obtained statistically equal functional

Table 3 Comparison of the quantitative characteristics of the samples

		Mean	Standard deviation	P-value
Age	≤15%	24.8	6.6	0.200
	>15% and ≤25%	28.0	7.4	
Weight	≤15%	79.1	9.5	0.556
	>15% and ≤25%	76.9	6.9	
Height	≤15%	1.78	0.04	0.530
	>15% and ≤25%	1.77	0.06	
Body mass index	≤15%	24.9	2.3	0.584
	>15% and ≤25%	24.5	1.5	
Dislocation episodes	≤15%	5.8	5.9	0.004
	>15% and ≤25%	9.2	5.7	

Table 4 Comparison of outcomes between samples

	≤15%			>15% and ≤25%		Total		P-value
		N	%	N	%	N	%	
Complication	No	16	80%	18	85.7%	34	83%	0.627
	Yes	4	20%	3	14.3%	7	17%	
New dislocations	No	19	95%	20	95.2%	39	95%	0.972
	Yes	1	5%	1	4.8%	2	5%	
Return to sports	No	4	20%	4	19.0%	8	20%	0.939
	Yes	16	80%	17	81.0%	33	80%	

outcomes between groups, more similar to the ones reported with greater GBLs (GBL >15%) by Dekker et al.[3]. However, we observed a lower rate of instability recurrence and new dislocations. Shaha et al.[6] also reported this difference in the WOSI score for patients undergoing the Bankart technique, with a GBL cutoff of 13.5%; these authors obtained significantly better outcomes in lower GBLs. Moreover, they observed a lower rate of instability recurrence in these patients. In comparison with these latter authors, our WOSI scores were statistically equal between groups, consistent with the data obtained by Saha et al.[6] with smaller GBLs (<13.5%). Our recurrence rate was also similar to the cases with the lowest GBLs.[6]

This study demonstrated an overall rate of 5% of new dislocations and 17% of procedural complications, with no significant difference between groups with different GBLs; this finding is consistent with bone block studies reported in the literature. Dauzère et al.,[17] or instance, observed a 7.3% rate of clinical complications and a 17% rate of radiological complications, and Butt et al.[18] reported a 6% rate of instability recurrence, a 2.8% rate of new dislocations, and a 3.3% rate of new subluxations. The literature also supports the return to sport rate observed in our study. Dauzère et al.[17] and Bohu et al.[19] reported a 73% rate of return to sports in patients undergoing the Laterjet technique, while we obtained an 80% rate.

A limitation of this study is its retrospective design based on data collected for another purpose; however, all postoperative data collection was prospective, largely reducing any potential bias. Although the sample size may seem small, it is worth mentioning its homogeneity and the specific subgroup addressed here, i.e., high-demand athletes.

Table 5 Pre- and postoperative comparison for range of motion, pain, and functionality

		≤15%		>15% e ≤25%		P-value
		Mean	SD	Mean	SD	
Passive lateral rotation	Preoperative	74.8	1.2	74.5	1.5	0.336
	5 years	66.3	6.0	66.0	6.0	0.788
Active lateral rotation	Preoperative	71	4.2	71.7	4.6	0.503
	5 years	60.5	4.8	60.2	5.6	0.743
Passive elevation	Preoperative	178.0	3.0	176.9	5.1	0.679
	5 years	176.5	2.9	175.7	4.0	0.627
Active elevation	Preoperative	174.1	6.7	173.3	8.9	0.978
	5 years	170.3	7.2	167.1	7.0	0.169
VAS	Preoperative	2.7	1.17	1.76	1.04	0.009
	5 years	1.05	0.89	0.71	0.90	0.195
ASES	Preoperative	53.1	5.2	52.4	5.6	0.917
	5 years	80.2	4.0	80.7	4.5	0.674
ASORS	Preoperative	40.7	20.1	45.4	14.6	0.557
	5 years	78.7	8.5	74.2	7.9	0.107
WOSI	Preoperative	153.8	24.7	148.3	24.6	0.522
	5 years	40.5	7.6	43.2	8.7	0.323

SD, Standard deviation; VAS, visual analog scale; ASES, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment; ASORS, Athletic Shoulder Outcome Rating Scale; WOSI, Western Ontario Shoulder Instability Index.

The main strengths of this study include the follow-up period of 5 years and the homogeneous group consisting of high-demand athletes. In addition, this is one of the first studies to assess whether the size of the GBL would affect functional outcomes in these subjects.

Conclusion

The size of the bone loss per se does not seem to affect functional outcomes and complications from these procedures, which are safe techniques for GBLs $\leq$ 15% or those ranging from 15 to 25%.

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Conflict of Interests
The authors declare no conflict of interests.

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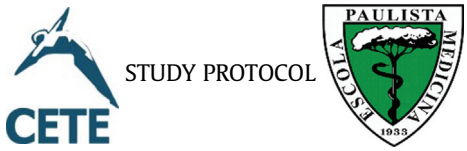
Appendix 1



BONE BLOCK

1) BONE BLOCK SURGERY (BRISTOW-LATARJET)
PREOPERATIVE
- RADIOGRAPH
- BILATERAL COMPUTED TOMOGRAPHY
- RANGE OF MOTION
- QUESTIONNAIRES: Athletic Shoulder Outcome Rating Scale (ASORS), visual analog scale (VAS), American Shoulder and Elbow Surgeons Standardized Shoulder Assessment (ASES), Western Ontario Shoulder Instability Index (WOSI).

3 WEEKS:
- START OF PHYSICAL THERAPY

4 WEEKS:
- RANGE OF MOTION
- VAS QUESTIONNAIRE

8 WEEKS:
- RANGE OF MOTION
- VAS QUESTIONNAIRE
- START OF MUSCLE STRENGTHENING

12 WEEKS:
- RANGE OF MOTION
- VAS QUESTIONNAIRE
- CONSIDER RETURN TO SPORTS

6 MONTHS:
- RANGE OF MOTION

QUESTIONNAIRES: ASORS, VAS, ASES, WOSI

1 YEAR AND YEARLY FOR UP TO 5 YEARS
- RANGE OF MOTION
- QUESTIONNAIRES: ASORS, VAS, ASES, WOSI