Glenoid defect associated with anterior shoulder instability: results of open Bankart repair

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Abstract The purpose of the study was to analyse the clinical results of an open Bankart repair for anterior instability in patients with a glenoid defect and those without a glenoid defect, and to identify factors related to the glenoid defect associated with anterior instability. The prospective study involved 20 patients with a glenoid defect (glenoid defect group) and 20 patients without a glenoid defect (control group) who were enrolled after an open Bankart repair. The average age of each group at the time of surgery was 28 and 23 years respectively. The average follow-up periods were 48 and 55 months. There were no significant differences in subjective pain and stability between the two groups. But the final Rowe score decreased significantly as the size of the glenoid defect increased. Redislocation or subluxation was seen in three patients in the glenoid defect group. The open Bankart procedure restored stability and improved shoulder functions in the patients with a glenoid defect associated with anterior instability, even though the glenoid defect group experienced a significant loss in the range of external rotation with the arm at the side, and the final outcome of the surgery depended upon the size of a glenoid defect. This was a therapeutic, level III case-control study.

Résumé Le but de cette étude est d'analyser les résultats cliniques de l'opération de type Bankart pour instabilité

antérieure de l'épaule chez une série de patients présentant soit une instabilité avec défaut glénoïdien soit une instabilité sans défaut glénoïdien. Il s'agit d'une étude prospective. Vingt patients présentant un défaut glénoïdien et 20 patients ne présentant pas de défaut glénoïdien (groupe contrôle) ont été traités par une opération de type Bankart. L'âge moyen au moment de l'intervention a été respectivement de 28 à 23 ans dans chaque groupe et, le suivi moyen de 48 à 55 mois. Il n'y a pas de différence significative sur le plan de la douleur et de la stabilité entre ces deux groupes. Mais, le score de Rowe diminue de façon significative en fonction de la taille du défaut glénoïdien. Une récurrence de sub-luxation est observée chez 3 patients présentant un défaut au niveau glénoïdien. L'opération de type Bankart permet de restaurer une bonne stabilité et améliorer la fonction de l'épaule chez les patients présentant une instabilité antérieure avec défaut glénoïdien, néanmoins dans le groupe présentant un défaut glénoïdien les résultats sont inversement proportionnels à l'importance du défaut.

Introduction

A glenoid defect is the avulsion of the glenohumeral labral complex accompanied by the fracture of the anterior glenoid rim or bony erosion associated with anterior instability. The incidence of a glenoid defect lesion ranges from 5.4 to 32% [15–17]. Lazarus et al. [8], in their cadaveric study, observed that the chondral-labral defect reduced the height of the glenoid by approximately 80% and the stability ratio by approximately 65% for translation in the direction of the defect. They concluded that reconstruction of the antero-inferior aspect of the glenoid using autogenous biceps-tendon graft could achieve near

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normal stability. In addition, Bigliani et al. [1] found in their study on the lesions of glenoid defects that an osseous defect involving over 25% of the glenoid surface required treatments such as a coracoid transfer.

Although many biomechanical studies have proved that a glenoid defect significantly affects the stability of the shoulder joint, operative techniques to treat the defect and resulting clinical reports have varied widely [1–4, 6–8, 11, 13, 14, 16, 18, 20–23]. Many reports have documented that bony procedures such as the Bristow procedure might result in screw breakage, continuous subluxation, severe reduction in external rotation, musculocutaneous nerve damage and arthritic change [6, 20–22]. Thus, a Bankart repair instead of bony reconstruction is often performed in patients with a large defect.

The purpose of the study is to compare the clinical results of an open Bankart repair for anterior instability in patients with a defect involving less than a third of the glenoid surface and those without a glenoid defect, and to identify factors related to the glenoid defect associated with anterior instability.

Materials and methods

Patient selection

From January 1997 to August 2002 a series of 20 consecutive shoulders in 20 patients with a glenoid defect underwent an open Bankart repair. This group is referred to as the “glenoid defect group”. They were compared with a consecutive series of 20 patients without a glenoid defect who underwent the same procedure for instability. This group is referred to as the “control group”. The arthroscopic examination and operation were performed by the same surgeon. Patients who demonstrated a SLAP (superior labrum anterior to posterior) lesion, abnormality in the rotator cuff tendon, and a Bankart lesion associated with hyperlaxity at the examination were excluded from our study. A comprehensive approach was taken for the analysis of the patients.

The mean age was 28 (range 17–37) for the glenoid defect group and 23 (range, 18 to 39) for the control group. The mean follow-up period was 48 months (range 26–92) for the glenoid defect group and 55 months (range 32–85 months) for the control group. The majority of patients were males, with 19 males and 1 female in the glenoid defect group and 16 males and 4 females in the control group. The dominant arm was involved in 10 shoulders in the glenoid defect group while 12 shoulders were dominant in the other group. Patients in the defect group experienced an average of 12.8 (range 0.4–100) dislocations a year whereas the average frequency of the control group was 6.4

(range 0.2–50). The mean period from the initial dislocation to the surgery was 7 years (range 1 month to 20 years) for the first group and 5.5 years (range 6 months to 16 years) for the second group (Table 1).

The eventual glenoid defect and the Hill–Sachs lesion were measured arthroscopically in all the cases. The size of the glenoid defect was defined as the distance from the center of the bare area to the corresponding anterior rim and compared with the width of the inferior glenoid (Fig. 1). The size of the Hill–Sachs lesion was measured on its longest diameter. Nine shoulders had a defect involving less than one-sixth of the glenoid length; 7 shoulders, between one-sixth and one-quarter; and 7 shoulders, between one-quarter and one-third. The size of a Hill–Sachs lesion was classified as small for less than 1 cm; moderate, for 1–2.5 cm; and large, for over 2.5 cm (Fig. 2). In the glenoid defect group, 3 shoulders had a small lesion; 5 shoulders, a moderate lesion; and 12 shoulders, a large lesion. In the control group, 8 shoulders had a small lesion; 5 shoulders, a moderate lesion; and 7 shoulders, a large lesion.

Operative technique and rehabilitation

The surgical procedure consisted of a repair of the anterior margin of the glenoid as described by Thomas and Matsen [19]. When anatomical reduction was impossible no attempt was made to fix the malunited bone. The fragment was left outside the capsule and sutured to the remaining anterior glenoid.

For 3 weeks after the day of operation, passive shoulder exercises including 90° flexion and 0° external rotation as well as isometric exercises of the rotator cuff and deltoid muscles were performed so that the normal range of motion could be achieved 6 weeks after the surgery. From 6 weeks postoperatively, active shoulder exercises were carried out. Excessive abduction and external rotation were gradually

Table 1 Patient demographics

Variables	Group	
	Glenoid defect	Control
Number of patients	20	20
Men/women	19/1	16/4
Mean age (range)	28 years (17–37)	23 years (18–39)
Mean follow-up (range)	4 years (26–92 months)	4.6 years (32–85 months)
Dominant/nondominant	10/10	12/8
Dislocation (times/year)	12.8 (0.4–100)	6.4 (0.2–50)
Duration	7 years (1 month–20 years)	5.5 years (6 months–16 years)

Fig. 1 The bare spot is located at the geometric center of the glenoid

introduced according to the results of the patient's apprehension test. The same operative technique and exercises were applied for both the glenoid defect group and the control group.

Clinical evaluation

The results were evaluated and analysed with objective, subjective, and comprehensive methods. For objective evaluation, the range of motion in the shoulder was measured. For subjective evaluation, the patient's pain and

Fig. 2 The arthroscopic view shows a defect involving one-third of the glenoid length and a large Hill-Sachs lesion

stability were recorded on the visual analog scale (VAS) during the follow-up period and the patient's satisfaction was assessed. Finally, the Rowe Scoring System was used to make a comprehensive evaluation. A score over 90 points was rated excellent; 75–89 points, good; 51–74 points, fair; and below 50 points, poor.

Statistical evaluation

The nonparametric Mann-Whitney *U* test and the Kruskal-Wallis test were used for statistical analysis. All statistics were analysed with the SPSS for Windows software package (SPSS, Chicago, IL, USA) and went through an examination at a 95% confidence level.

Results

Pain

Preoperative pain was assessed by the patient according to the visual analog scale (VAS). The glenoid defect group recorded 0.45 points at rest and 2.75 points during shoulder exercises. The control group scored 0.3 points at rest and 3.05 points during exercises. At the last follow-up, scores during rest and exercises declined to 0 and 1.3 points respectively in the glenoid group and to 0.2 and 1.1 points in the control group.

Range of motion

The range of motion after surgery is summarized in Table 2. The glenoid defect group showed a statistically significant loss in preoperative forward flexion and external rotation compared with the control group ($p=0.001$, 0.001). The glenoid defect group lost 2° in forward flexion and 10° in external rotation with the arm at the side after surgery. The control group lost 4° in forward flexion and 3° in external rotation. The statistical analysis of the results showed that the glenoid defect group had a significant loss of external rotation after surgery compared with the control group ($p=0.009$).

Stability

During the follow-up period, three shoulders of the glenoid defect group developed recurrence of instability. Two cases had defects of one-quarter of the glenoid length and 1 case had a defect of one-third of the glenoid length. No redislocation or subluxation was reported in the control group. The stability of the shoulder joint was assessed according to the VAS at the last follow-up. As a result, the glenoid defect group averaged 1.0 points (range 0–3 points)

and the control group produced a slightly better result with 0.4 points (range 0–3 points), but did not show any statistically significant difference ($p=0.083$).

Patient's satisfaction

At the last follow-up, patients were asked to grade their satisfaction with the surgery from 0 to 5 points. The two groups showed statistically different results, with the glenoid defect group recording 4.25 points and the control group 4.75 points ($p=0.021$) on average.

Comprehensive evaluation

The clinical results of the two groups were compared using the Rowe Rating System. The control group showed better results than the glenoid defect group in stability, range of motion, and function (Table 2). The average total score was 87.1 points (range 30–100) in the glenoid defect group and 95.6 points (range 83–100) in the control group. In the glenoid defect group, 14 cases (70%) were rated excellent; 2 cases (10%), good; 1 case (5%), fair; and 3 cases (15%), poor. In the control group, 18 cases (90%) were rated excellent and two cases (10%), good. The final Rowe scores decreased significantly as the size of a glenoid defect increased ($p=0.029$). However, the size of a Hill–Sachs lesion did not produce a statistically significant difference in the scores at the last follow-up ($p=0.699$; Table 3).

Table 2 Comparison of the glenoid defect and control groups

Variable	Glenoid defect group	Control group	<i>p</i> value**
Number of patients	20	20	
Recurrence	3 (15%)	0 (0%)	
Preoperative range of motion			
Forward flexion	164.3	176.5	0.001
External rotation	54.5	65.8	0.095
Internal rotation	T6.75	T7.35	0.879
Postoperative range of motion			
Forward flexion	162.3	172.5	0.001
External rotation	44.3	62	0.009
Internal rotation	T*7.05	T*7.2	0.738
Mean Rowe score	87.1	95.6	0.018
Stability	44.0	49.0	0.104
Function	28.2	28.6	0.294
Range of motion	14.9	17.6	0.026

T* thoracic level

**The values are given as the mean with the 95% confidence interval.

Discussion

The concavity compression mechanism plays an important role in the stability of the shoulder joint by maintaining the location of the humeral head at the glenoid against translation forces [5, 9]. The glenoid concavity is established by the glenoid shape, the glenoid cartilage, and the glenoid labrum [8]. The glenoid labrum increases the width and depth of the glenoid and achieves stability by spreading the weight inflicted on the shoulder. Thus, a defect in the glenoid inevitably leads to reduction in the depth of the glenoid, causing subluxation and dislocation [9]. In a cadaveric study, Greis et al. [4] reported that with bone loss corresponding to a defect measuring 30% of the diameter in the antero-inferior quadrant, the contact area across the entire glenoid decreased a mean of 53% compared with the intact specimen and increased the average contact pressure up to 300–400%, resulting in severe instability. Novotny et al. [12] noted in their cadaveric study that the anterior stability of the shoulder with the arm in abduction and external rotation did not change according to the length of the capsulo-ligamentous structures after they had been repaired back to the glenoid rim. Itoi and coworkers [7] studied the effect of a glenoid defect on shoulder stability after a Bankart repair and showed that the tension of the anterior capsule is increased during abduction and external rotation of the humerus. Their qualitative assessment revealed that in the mid-range of motion (abduction and neutral rotation) where a ligamentous tension had little effect, instability (dislocation or subluxation) increased with the size of the glenoid defect. In their study, half the shoulders that had a glenoid defect with a width of 9% of the glenoid length became unstable while all the patients with a glenoid defect of 21% became unstable. This result led them to the conclusion that the stability of the shoulder after a Bankart repair depended

Table 3 Comparison of clinical results according to the size of the glenoid defect and Hill–Sachs' lesion in the glenoid defect group

Size	Mean Rowe score
Glenoid defect	
<1/6	92 (9**)
1/6–1/3	83.7 (7**)
<1/3	82 (4**)
<i>p</i> value*	0.029
Hill-Sachs lesion	
Small	90 (3**)
Medium	94 (5**)
Large	87 (12**)
<i>p</i> value*	0.699

*Mean with the 95% confidence interval using the Kruskal–Wallis test.

**Number of patients

on the position of the arm and deteriorated in the presence of an osseous defect with a width of at least 21% of the glenoid length.

Our study also noted statistically significant differences between the glenoid defect group and the control group in subjective stability evaluation on the VAS and the final Rowe scores. The glenoid defect group showed poorer results in the Rowe score for stability. Furthermore, only the defect group reported three cases of recurrence and had lower Rowe scores with the increase in the size of a glenoid defect. However, the size of a Hill-Sachs' lesion did not produce a statistically significant difference in Rowe scores at the last follow-up.

A Bankart repair on a glenoid defect has been believed to reduce the range of motion as the operation creates tension in the capsule by closing the gap between the detached capsule and the glenoid rim. In a clinical report on 20 shoulders, Lusardi et al. [10] reported that anterior capsulorrhaphy might result in severe limitation in external rotation. In addition, Black et al. [2] in a study of six cadaveric specimens, demonstrated that the 2 mm of imbrication of the anterior part of the capsule caused a 40% decrease in external rotation and that 7 mm of imbrication caused a 67% decrease, which meant that a centimeter could reduce the range of external rotation by 25°.

In our study, there was a statistically significant difference in forward flexion and external rotation between the defect group and the control group. Preoperatively, forward flexion and external rotation in the two groups differed by 12° and 10° respectively. This difference was 10° for forward flexion and 12° for external rotation after surgery. In particular, external rotation in the glenoid defect group was significantly reduced by 10° postoperatively. Therefore, authors are required to consider that the presence of a glenoid defect can limit the preoperative and postoperative forward flexion and external rotation.

Our study was effective in the sense that it was a comparative analysis between the glenoid defect and non-defect groups and was performed by a single surgeon at a single institution. However, the subjective measurement of the sizes of a Hill-Sachs lesion and a glenoid defect, as well as the small number of cases, were the limitations of our study.

In summary, the open Bankart repair produced relatively good results in treating anterior instability of the shoulder accompanied by an osseous defect involving less than a third of the glenoid length, even though the results were poorer than those for the group without a glenoid defect. In particular, the glenoid defect group experienced a significant loss in the range of external rotation with the arm at the side and in patients with a glenoid defect, the final outcome of the surgery depended upon the size of the defect.

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