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ORIGINAL PAPER

Analysis of failures after the Bristow-Latarjet procedure for recurrent shoulder instability

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Abstract

Purpose Despite good clinical results and low recurrence rates, post-operative complications of coracoid process transfer procedures are not well understood. This study aims to evaluate the underlying failure mechanism in cases requiring major open revision surgery after prior Bristow or Latarjet stabilization.

Methods Between January 2006 and January 2017, 26 patients underwent major open revision after primary Bristow or Latarjet procedure. Clinical notes and radiographic images were retrospectively reviewed for all cases to determine underlying pathology. Choice of treatment and clinical and radiographic outcome were similarly reported for all cases.

Results The underlying failure mechanism was associated with non-union in 42.3%, resorption in 23.1%, graft malpositioning in 15.4%, and trauma or graft fracture in 19.2% of cases. Although none of the patients reported any dislocations, mean subjective shoulder score was 60.2% and WOSI scores averaged 709.3 points at final follow-up. Radiographic signs of deteriorating degenerative arthritis were seen in 34.6%.

Conclusion Graft non-union resulting in recurrent instability was the main indication for open revision surgery after Bristow or Latarjet procedure, followed by resorption, malpositioning, and graft fracture in this retrospective case series. Revision surgery consisted of a structural iliac crest bone graft in the majority of cases. Clinical and radiographic outcomes are predictably variable in this population of multioperated patients.

Keywords Glenohumeral instability · Bristow-Latarjet · Coracoid transfer · Complications · Revision

Introduction

Outstanding clinical results have been reported after coracoid process transfers, such as the Bristow [1] and Latarjet [2, 3] procedures (Fig. 1.). They are believed to stabilize the shoulder through the sling effect of the transplanted conjoint tendon, the glenoid surface augmentation of the bone graft, and the capsular reinforcement of the coracoacromial ligament stump [1–4]. Recurrence rates as low as 6% [5–7] are customary after coracoid transfer procedures. However, some have raised concerns about the number of peri-operative complications. Most often cited are neurovascular injury, infection, loss of motion, coracoid non-union or fracture, hardware migration, and early post-operative osteo-arthritis [8, 9]. Although many of these events are rare, they have the potential of severe consequences in a young and active patient population. According to Griesser et al., up to 7% of patients undergoing anterior bone grafting procedures eventually require revision surgery [8]. Despite the widespread popularity of the Bristow-Latarjet procedure, only a few studies have evaluated failure mechanisms and treatment modalities in this population [10, 11]. The aim of this study is to perform a retrospective analysis of revised failed Bristow and Latarjet procedures.

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Materials and methods

A retrospective analysis was performed of all patients who required open revision surgery after either a Bristow or a Latarjet procedure for recurrent anterior shoulder instability. The patients were drawn from the institutions' databases

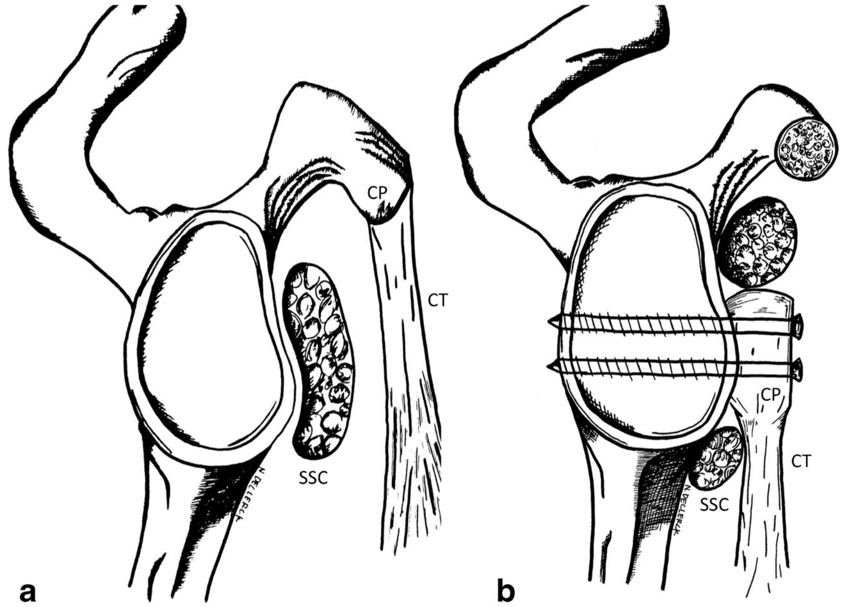

Fig. 1 Latarjet procedure. **a** Lateral view of a right scapula before surgery. **b** Lateral view of a right scapula after coracoid transfer procedure. The subscapularis muscle has been split to affix the coracoid process on the glenoid neck with two parallel screws. SSC subscapularis muscle, CT conjoint tendon, CP coracoid process

between January 2006 and January 2017. After the exclusion of open procedures involving drainage due to haematoma or infection, a total of 29 cases from two treatment centers were eligible for further retrospective study. Three patients had incomplete files or were lost to follow-up. The remaining cohort consisted of 20 males and six females. The mean age at the time of the index procedure was 29.4 years (± 6.6).

Clinical and operative charts were reviewed to assess primary indication, graft and hardware specifications, their activity level at time of revision according to the Walch-Duplay score [12], and type and timing of the revision procedure. Preoperative radiographic images, classic radiographs and computed tomography (CT), were examined in all cases to assess graft and hardware position, graft non-union, graft migration or loosening, graft fracture or resorption, and glenohumeral arthritic changes according to the Samilson-Prieto classification.

Radiographic changes were recorded as described previously [13–15]. Combining the clinical and radiographic data, the most likely failure mechanism was determined in each case.

A post-operative visit or follow-up telephone interview was conducted to assess Subjective Shoulder Score (SSS), Western Ontario Shoulder Instability index (WOSI), type and number of recurrences if any, and return to sports. Radiographic follow-up was present until one year after the revision procedure in all patients. Radiographs were scored according to the Samilson-Prieto classification. Statistical subgroup comparison was done with the help of the SPSS statistical software package (IBM SPSS Statistics, IBM, Armonk, NY, USA). Ethical Review Board approval was granted to conduct this retrospective study (EC/2014/0060).

Results

The initial anterior bone grafting procedure was a Bristow type procedure in five patients, and a Latarjet type procedure in 21. The activity level was competitive in 30.7%, leisure in 38.4%, and not practicing in 23.1%. The type of activity was high risk in three cases, with contact in seven and no risk in eight. The mean time between the primary and revision procedure was 3.11 years (± 2.8).

Four types of failures were seen (Fig. 2). A summary of each case is given in Table 1.

Graft non-union was diagnosed as the cause of failure in 11 cases (42.3%). Mean time between primary and revision procedure was 2.2 years (± 1.4). Evidence of graft non-union culminating in renewed instability in the absence of significant trauma was present in all 11 cases. In seven patients, construct failure with hardware breakage and graft displacement occurred before revision. In the remaining four patients, revision surgery was performed before hardware failure. CT evaluation showing screw loosening and glenoid cyst formation was observed in 6 of the 11 patients revised for non-union. Unicortical screw fixation of the graft was noticed in nearly half of the non-union cases (5/11) (Fig. 3.) Two cases were associated with uncontrolled epilepsy.

Graft resorption was the main failure mechanism in six patients (23.1%) (Fig. 4). The mean time between primary and revision procedure was 5.3 years (± 2.3). Resorption was undiagnosed in all cases until recurrent instability prompted further imaging.

Malposition of the graft or hardware was the deemed to be the cause of failure in four cases (15.4%). Mean time between primary and revision procedure was 2.3 years (± 2.7). In three cases, the graft was placed too laterally on the glenoid neck,

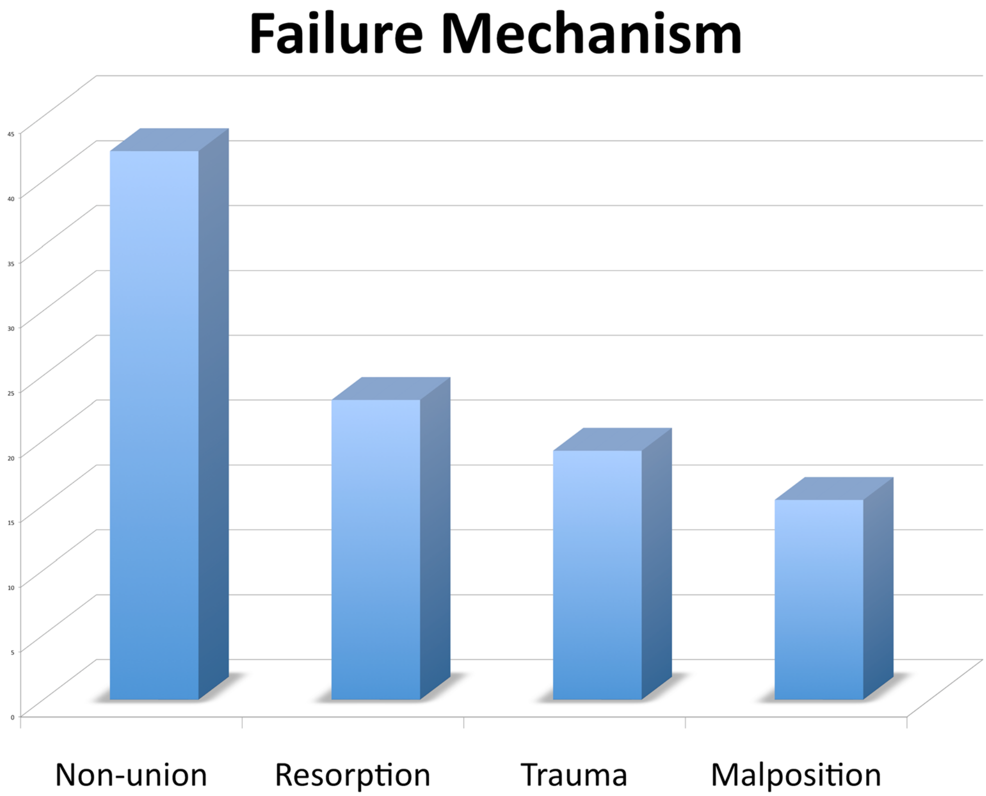

Fig. 2 Failure mechanism. Distribution of cases according to failure mechanism

causing anterior impingement and hardware irritation (Fig. 5). One patient presented with recurrent dislocation due to an excessively inferior graft position (Fig. 6). The patient complained of anterosuperior instability with occasional full dislocation requiring reduction in the emergency room. Grafts positioned too medially or superiorly were not observed in this cohort.

Finally, graft fracture and graft migration were observed in five cases (19.2%).

The mean time between primary and revision procedure was on average 2.9 years (± 4.5). Failure following major trauma to the operated shoulder without indication of impending hardware loosening or fracture was observed in two cases. In two other cases, graft fracture was believed to originate from peri-operative graft handling. One incident was related to an uncontrolled epileptic insult.

The time between index procedure and revision was significantly greater in the resorption group compared to the non-union ($p < 0.001$), malpositioning ($p = 0.04$), and fracture group ($p = 0.04$). The revision procedure consisted of a structural iliac crest bone graft procedure (Eden-Hybinette) in 76.9% (20 cases), re-implantation of the original coracoid graft with an iliac crest bone graft or autologous cancellous bone grafts in 11.5% (3 cases), and repositioning of the original graft in 11.5% (3 cases).

Mean follow-up time was 43.7 months (± 27.7 months). Mean Subjective Shoulder Score was 60.2% (± 19.6). WOSI scores averaged 709.3 points (± 412.5). Three patients reported a persistent feeling of instability or subluxations but none of the patients reported any recurrences. Nine patients (46.1%) returned to their pre-revision level of sport.

Fourteen (53.8%) patients demonstrated evidence of degenerative arthritis on follow-up radiograph, seven patients were scored as mild (grade 1), four as moderate (grade 2), and three as severe (grade 3) glenohumeral arthritic changes. Nine patients demonstrated evolutive radiographic changes (34.6%). This constituted an increase of 1 grade point for six patients, 2 grade points for one patient, and 3 grade points for two patients compared to the pre-revision imaging. The remaining 17 patients did not show any evolving degenerative changes on radiography.

Discussion

The Bristow and Latarjet coracoid transfer procedures have a proven record of success in the treatment of recurrent shoulder instability [13–15]. However, in tandem with the recent gain in popularity, a rise in complications has been observed. Much remains unclear about the management of a failed Bristow or Latarjet procedure. In previous studies, Castagna et al. [16] have investigated the role of arthroscopy, while Lunn et al. [10] discussed open revision using an iliac crest grafting procedure [17, 18]. In contrast, more recent studies have scrutinized Bristow-Latarjet procedures in order to better understand the underlying failure mechanism [11, 19]. In a similar manner, we have attempted to map these processes by reconstructing the clinical and radiographic evidence

Table 1 Summary overview of case series characteristics

No.	Age (years)	Sex	First	No. of dislocations before revision surgery	Bone loss	Nicotine	Pre-bone block surgery	Type of bone block surgery	Recurrence	Mechanism	Revision
1	28	Male	Fall	20	None	Yes	Open Bankart	Bristow	Fall down stairs	Resorption of bone block	ICBG
2	30	Male	Fall from horse	60	Not significant Hill-Sachs	Yes	Open Bankart	Bristow	Collision with wall	Renewed trauma	ICBG
3	29	Male	Fall	15	Small bony Bankart	No	None	Bristow	Perioperative graft fracture and postoperative trauma	Fractured and migrated graft	ICBG
4	33	Female	Fall on ice	2	Not significant Hill-Sachs	No	Open Bankart	Latarjet	Spontaneous subluxation, full dislocation after fall	Resorption of bone block	ICBG
5	28	Male	Epileptic insult	100	Significant Hill-Sachs	No	None	Latarjet	New epileptic insult	Non-union with cyst formation followed by hardware fail	ICBG
6	26	Male	Kayaking	1	Significant Hill-Sachs	No	None	Latarjet	Spontaneous	Non-union followed by hardware fail	ICBG
7	19	Male	Motocross	3	Not significant Hill-Sachs	Yes	Open Bankart	Latarjet	Motorcross Accident	Non-union with cyst formation followed by hardware fail	Refixation graft plus ICBG
8	35	Male	Motorcross	0	Significant bony Bankart	No	None	Latarjet	Incident during push-ups 3 weeks postop	Non-union with cyst formation followed by hardware fail	Revision pseudarthrosis with cancellous bone grafts
9	35	Male	Surfing	1	Significant Hill-Sachs	Yes	None	Bristow	Subluxation spontaneous	Painful non-union with in-stability	ICBG plus coracoid reinsertion
10	32	Male	Weightlifting	1	Significant bony Bankart	Yes	None	Latarjet	Forced internal rotation during police intervention	Extruded hardware and graft failure	ICBG
11	33	Male	Boxing	10	Small bony Bankart	Yes	None	Latarjet	Early return to sports	Painful non-union with in-stability	ICBG
12	17	Male	Fall	15	Small bony Bankart	Yes	None	Latarjet	Spontaneous	Non-union with cyst formation followed by hardware fail	ICBG
13	22	Male	Squash	12	Small bony Bankart	No	None	Latarjet	Incident during paddling	Non-union with cyst formation followed by hardware fail	ICBG
14	42	Female	Volleyball	5	None	No	None	Bristow	Spontaneous	Inferior graft malposition	ICBG above coracoid graft
15	34	Female	Fall in bathroom	1	Small bony Bankart	No	None	Latarjet	After screw removal	Resorption	ICBG
16	30	Male	Soccer	100	Small bony Bankart and Hill-Sachs	Yes	None	Latarjet	None	Excessive lateral position	Repositioning
17	25	Male	Epileptic Insult	3	Small bony Bankart and significant Hill-Sachs lesion	No	None	Latarjet	New epileptic insult	Graft fracture and hardware failure	ICBG
18	27	Male	Swimming	20	Significant bony Bankart	No	None	Latarjet	Lifting arm	Resorption	ICBG
19	21	Female	Judo	5	Significant Hill-Sachs	No	Capsular plication	Latarjet	Dislocation during contact sports	Resorption	ICBG
20	39	Male	Fall from height	1	Small bony Bankart and Hill-Sachs lesion	No	None	Latarjet	Posterior subluxation	Posterior instability due to lateral graft position	Graft medialization

Table 1 (continued)

No.	Age (years)	Sex	First	No. of dislocations before revision surgery	Bone loss	Nicotine	Pre-bone block surgery	Type of bone block surgery	Recurrence	Mechanism	Revision
21	36	Female	Fall	10	Significant bony Bankart and Hill-Sachs	No	None	Latarjet	Pain and instability	Non-union with cyst formation followed by hardware fail	ICBG
22	18	Male	Fall from stairs	100	Significant Hill-Sachs and ALPSA	No	None	Latarjet	Pain and instability	Graft and screw fracture due to new trauma	ICBG
23	26	Male	Epilepsy	100	Significant Hill-Sachs	Yes	None	Latarjet	Instability after epileptic insult	Non-union followed by hardware fail after seizure	ICBG
24	36	Female	Ehler-Danlos	3	Significant Hill-Sachs	No	None	Latarjet	Spontaneous Pain	Lateral graft position	ICBG
25	24	Male	Soccer accident	10–15	Small Bankart lesion	Yes	None	Latarjet	Pain and instability	Resorption	ICBG
26	25	Male	Fall	3	Small Bankart and Hill-Sachs lesion	No	None	Latarjet	Pain and instability	Graft non-union	ICBG

Fig. 3 Non-union with hardware loosening. Axial CT slice of a left shoulder showing graft non-union and loosening around a unicortical screw in the glenoid metaphysis

preceding the failure. Most importantly, our findings suggest a role for graft non-union as a causative factor in the lead-up to hardware failure and recurrence.

Fibrous union

Graft fibrous or non-union is a well-known phenomenon after Bristow-Latarjet type procedures. Two recent review studies found 9.4 and 10.1% non-union rates respectively [8, 9]. The actual rate may be higher but remains undetected in the absence of a dedicated post-operative CT scan protocol. Recent studies have reported significantly higher healing rates after arthroscopic Bristow-Latarjet compared to the traditional open method [20, 21]. Generally, fibrous union is deemed an incidental and innocent finding, rarely requiring attention [8, 22]. However, in this study, we found that the majority of open revisions were related to graft non-union. Hardware failure is

Fig. 4 Resorption. Axial CT slice of a left shoulder showing complete resorption of the graft around the screwhead

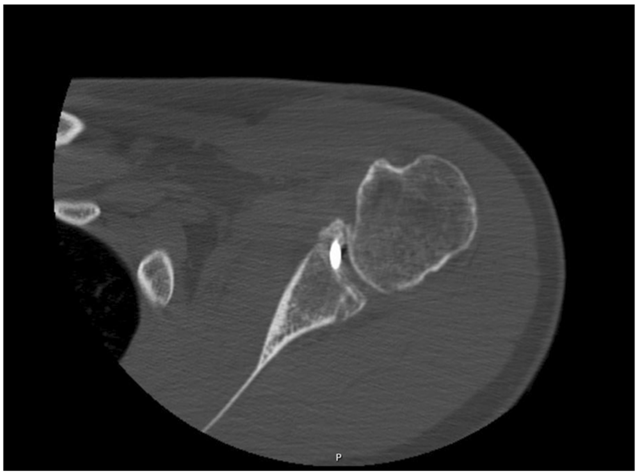

Fig. 5 Lateral malposition. Axial CT slice of a left shoulder showing an excessively lateral coracoid graft with intra-articular screw prominence in conflict with the humeral head

not often linked to graft pseudarthrosis in the available literature [22]. Yet, in this longitudinal case-by-case study, we have found arguments to support that hardware failure may be the result of long-standing non-union. In close to half of the hardware failures, clear signs of loosening around the screws and glenoid cyst formation were observed before final hardware failure and construct collapse. The majority of these cases were not associated with significant new trauma. Therefore, we believe that graft non-union may not be as inconsequential as previously thought. Long-lasting fibrous union may eventually culminate in hardware or graft failure in the active patient due to loosening and material fatigue. Besides patient factors such as age, smoking, and immunological status [23], surgical technical aspects play a role. Similar to Cassagnaud et al. [24], our study found a surprisingly high rate of unicortical screw fixation (41.2%) in the non-union group which may play an etiological role. Thorough

Fig. 6 Inferior malpositioning. Coronal CT slice of a left shoulder showing a small graft placed inferiorly on the glenoid rim

decortication of both the graft and recipient site as well as adequate compression and immobilization of the graft are believed to be crucial although much remains unknown about this topic [11]. Patients in our cohort were treated either by debridement of the original graft site and anterior glenoid rim and substitution with a tricortical iliac crest graft except in two cases where the graft was reimplanted with the aid of cancellous bone grafts.

Resorption

As described by Di Giacomo et al. [25], partial graft resorption is frequently observed after coracoid transplantation. The inverse relationship between pre-operative glenoid bone loss and graft osteolysis supports the role of mechanotransduction in this process of remodeling. Although some argue that the conjoint sling effect and capsular reinforcement provide ample stability in the case of graft resorption [11], our study contained six patients requiring Eden-Hybinette reconstruction due to recurrent instability after complete graft osteolysis. Our analysis also indicated that the time between index procedure and revision, and therefore indirectly the time to failure, was significantly greater in the cases of resorption compared to the other failure mechanisms.

Graft position

Ideal graft position is not completely understood. Saito et al. [26] suggested placing the graft between 2:30 and 4:30 based on the location of the average glenoid fracture on a right scapula. Similarly, Hovelius et al. demonstrated an association between grafts placed above the equator and an increased recurrence in their series [15, 27]. However, none of the patients in our series presented with this type of malpositioning. The study contained one patient with recurrence due to inferior graft placement, allowing anterosuperior instability. A similar case was described by Hovelius et al. [15]. Previous biomechanical research has shown the importance of sagittal plane graft position in restoring glenohumeral stability [28, 29].

Different harvesting strategies can be used depending on whether the procedure is intended as a restoration of the glenoid bone loss or to promote healing of the conjoint tendon transfer or both. Typically, a larger graft is harvested for articular reconstructive purposes [30] and a smaller graft, usually only the coracoid tip, for tendon transfer. However, some have modified the Bristow procedure to include a large on-end graft [31]. Burkhart et al. advocated placing the graft's inferior cortex flush with the articular surface due to concerns over the coracoid's incongruent lateral surface and size [32]. The current literature has not been able to identify superior clinical outcomes of one technique over another. Conversely, recent research has shown that the classic Latarjet orientation can adequately restore the glenoid articular bone stock in cases with more than 20% bone loss [33].

It is generally agreed that the graft should be placed flush or slightly medial to the glenoid cartilage. Excessive medial position is thought to cause recurrence due to insufficient reconstruction of the glenoid articular constraint [27, 34]. In cases without major bone loss, this may not be of equal importance, when the coracoid transfer procedure mainly functions as a dynamic sling, similar to the soft tissue Bristow procedure or conjoint tendon-only transfer [35]. Excessive lateral position occurs in up to 53% percent of cases in some studies [34] and has been correlated with early joint arthritis [6, 15, 34, 36]. Our study included three patients with excessively lateral graft position and acute post-operative symptoms. Revision surgery consisted of medialization of the graft in all cases.

Fracture and traumatic graft migration

Graft fracture and graft migration were observed in 19.2% of cases. Failure following major trauma to the operated shoulder without indication of impending hardware loosening or fracture was observed in three cases (11.5%) (Fig. 6). Graft fracture was believed to originate from peri-operative graft handling in two other cases. One incident was related to uncontrolled epileptic insults. All cases were treated by tricortical iliac crest grafting (Fig. 7).

Fig. 7 Graft fracture. Anteroposterior radiograph of the left shoulder showing graft fracture and displacement with concomitant screw pull-out

Clinical outcome

The Eden-Hybinette-type anterior glenoid bone grafting procedures have been used in the stabilization of shoulder instability for over a hundred years. Although the procedure temporarily fell out of favor after being linked to early-onset shoulder arthritis, it is a valid contemporary solution for both primary and revision cases of recurring anterior shoulder instability [37]. Our study demonstrates that stability could be restored in most patients, yet with significantly lower shoulder scores than those reported in the literature after primary bone block stabilization [10, 38, 39]. Less than half of the athletic patients in our patient cohort were able to regain their pre-injury activity level. Additionally, about half of the patients exhibit mild or worse signs of glenohumeral osteoarthritis on radiography. Three patients demonstrated severe arthritic changes on the final radiography. A slight deterioration of osteoarthritis was noted in the follow-up radiographic exams; however, this study is not suited to answer the question whether the functional and degenerative changes are due to the recurrent trauma, the multiple surgical procedures, or the type of procedures.

Limitations

This study exhibits some of the classical shortcomings of a multicentric retrospective analysis such as patient and procedural heterogeneity, loss to follow-up, and incomplete datasets.

Conclusion

Graft non-union resulting in recurrent instability was the main indication for open revision surgery after Bristow or Latarjet procedure in this retrospective case series. The paper suggests an important role for fibrous union or non-union in the lead-up to hardware breakage and construct failure. Other indications for open revision surgery were graft resorption, malpositioning, and fracture. Revision surgery consisted of a structural iliac crest bone graft in the majority of cases. Clinical outcomes reflect the complexity of treating failed anterior bone graft procedures in shoulder instability. Stability was achieved in most cases, albeit at a functional cost.

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Compliance with ethical standards

Ethical Review Board approval was granted to conduct this retropective study (ED/2014/0060) in compliance with ethical standards.

Conflict of interest The authors declare that they have no conflicts of interest.

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