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SHOULDER

Arthroscopic double bone block augmentation is a salvage procedure for anterior and posterior shoulder instability secondary to glenoid bone loss

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Abstract

Purpose The aim of this study was to describe a one-step arthroscopic anterior and posterior bone block augmentation technique for bidirectional shoulder instability and to present preliminary results.

Methods Seven consecutive patients who underwent a concomitant anterior and posterior bone block procedure between 2007 and 2015 were retrospectively reviewed. Clinical scores, return to sport rate, and complications were assessed. Radiological outcome, with CT scan at 6 months and plain radiographs at final follow-up were reviewed. Patient reported functional outcomes were also assessed via phone or email interview.

Results Seven consecutive patients were included in the study with a median age at surgery of 27 years. Median clinical and radiological follow-up was 7 months (4–72 months). Walch-Duplay score and Rowe scores were improved. Four patients were able to return to sport. One patient experienced recurrent dislocation, and one subjective instability/subluxation without confirmed recurrence. CT scan showed union in all cases, with one case of anterior bone block osteolysis and one case of partial posterior bone block osteolysis. Radiographs showed no detectable progression of osteoarthritis using the Samilson and Prieto classification. At final follow-up the median WOSI score was 187 (100–1140).

Conclusions An all-arthroscopic technique for the treatment of combined anterior and posterior glenoid bone loss as a cause of shoulder instability can provide fair to good clinical outcomes, with a low incidence of intra-operative complications. The rate of failure in our series remains higher than that seen in primary stabilization procedures. As such we consider this largely as a salvage procedure for cases in which alternative treatments have failed or are unlikely to succeed.

Level of evidence IV.

Introduction

Bone loss in shoulder instability is a challenging condition to treat. Most commonly surgeons face issues relating to anterior glenoid defects, due to the higher incidence of anterior shoulder instability, and in such cases bone block augmentations such as the Latarjet procedure are widely used and have been proven effective by numerous studies in stabilizing the joint and restoring shoulder function [4, 8, 11, 12, 18, 20, 21, 25].

When compared to anterior shoulder instability, the incidence of posterior and multidirectional shoulder instability (MDI) is generally reported to be low [3, 14, 23, 24].

In the presence of significant glenoid bone loss in posterior shoulder instability, such as posterior bony Bankart, posterior glenoid erosion or glenoid dysplasia, open and arthroscopic bone block procedures may be used to address the bony insufficiency [5, 28, 29, 31].

Glenoid bone loss in multidirectional shoulder instability, with both significant anterior and posterior bony defects of the glenoid, however, represent a significant rarity in the published literature. To our knowledge only a single case report has been published on simultaneous anterior and

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Table 1 Demographic characteristics pre-operatively

	Sex		Side		Main problem 1 = painful unstable shoulder 2 = subluxation 3 = (recurrent) dislocation			No of dislocations prior to surgery			No of previous surgical procedures			No of previous bony procedures	
	M	F	R	L	1	2	3	50 or more	=10	3 to 5	0	1 or 2	3 to 5	1 or 2	0
N patients	4	3	3	4	1	0	6	2	2	3	2	2	3	5	2

posterior glenoid augmentation for shoulder instability [7]. The authors in that paper performed a one-step arthroscopic assisted Latarjet procedure and open posterior bone block procedure for a patient with recurrent posterior shoulder instability and an anterior glenoid fracture. At 1 year follow-up the patient demonstrated a stable shoulder joint, a full range of motion, had resumed his occupation and was fully satisfied with the outcome.

In the current case series we report the outcomes of our patients, treated with a one-step arthroscopic anterior and posterior glenoid bone block augmentation for recurrent anterior and posterior shoulder instability due to both anterior and posterior glenoid bone loss and engaging Hill Sachs or reverse Hill Sachs lesions.

To our knowledge, a full arthroscopic double bone procedure has never been described in the literature. The aim of this study was to describe the one-step arthroscopic anterior and posterior bone block augmentation technique and to present preliminary outcomes. The hypothesis is that this technique can be applied as salvage procedure with good results in the rare case of concomitant anterior and posterior glenoid bone loss.

Materials and methods

All patients that underwent simultaneous arthroscopic anterior and posterior bone block stabilization procedures between 2007 and 2015 at our institution were retrospectively analyzed. Surgery was performed by the senior author in all cases. Seven consecutive patients were included in the study. All patients were available for clinical and radiological follow-up at a median of 7 months (4–72 months) post-operatively. The median age at time of surgery was 27 years (range 22–34 years).

Five patients were available for a final remote follow-up. Email or telephone assessment was performed at a median of 24 months (5–90 months) after surgery.

Surgery was performed on the dominant side in four patients. In five patients the double graft procedure was revision surgery, four of who had a previous bony procedure.

Detailed pre-operative patients demographics including age, sex, side, dislocations/subluxations before surgery, previous surgeries (total number of previous surgeries, number of bony procedures such open or arthroscopic Latarjet and/or Eden-Hybinette procedures) and pre-injury sport participation are provided in Tables 1 and 2.

Clinical outcome measures comprised the Rowe Score [26] and Walch-Duplay Score [33] (classified as excellent (91 and 100 points), good (76 and 90 points), fair (51–75 points) or poor (under 50)) as well as return to sport. Intra-operative and post-operative complications were analyzed (recurrence, infection, revision surgery, screw removal).

Table 2 Pre-injury and post-operative sporting activity

	Pre-injury sporting participation (1) Competition (2) Recreational (3) Occasionally (4) None				Type of sport (1) No risk (2) Contact sport (3) Throwing sport (4) High risk				Apprehension during sport 1 = yes 2 = no		Pain during sport 1 = yes 2 = no		Return to sport post-operatively 1 = yes 2 = no	
	1	2	3	4	1	2	3	4	1	2	1	2	1	2
N patients	3	4	0	0	1	0	2	4	7	0	4	3	4	3

For final remote follow-up the patients complete the following patient reported outcome measure (PROM) questionnaires: Western Ontario Stability Index (WOSI) [13], the abbreviated Disabilities of the Arm, Shoulder, and Hand (QuickDASH) [2], and the 12- Item Short Form Health Survey (SF-12, physical and mental components) [34].

Pre- and post-operative radiographs were analyzed and evaluated for gleno-humeral osteoarthritis according to the Samilson-Prieto classification [27]. Due to the nature of the bifocal bone loss no routine quantitative assessment of anterior and posterior glenoid bone loss was carried out. However, a qualitative analysis of glenoid bone loss was performed in each case, which, together with the clinical findings, informed the indication for a double bone block procedure.

CT scans were performed 6 months post-operatively and analyzed for bony union, as well as graft osteolysis [10] and correct screw positioning.

Surgical technique

This procedure is performed under general anesthesia with a pre-operative interscalene block. The patient is placed in the beach-chair position. No traction is used. In two patients out of seven, a combined arthroscopic Latarjet procedure with coracoid graft and arthroscopic posterior bone block procedure was performed, with the remaining five performed using double autologous iliac crest bone blocks.

1. Diagnostic arthroscopy: A standard posterior "soft spot" portal (A) is used for diagnostic arthroscopy. An anterior portal through the rotator interval (E) is created for instrumentation (Fig. 1). In cases with failure of a previous Latarjet procedure, arthroscopic inspection of the integrity of the "anterior sling" is mandatory.
2. Arthrolysis and Subscapularis Release: Particularly in the case of previous bone block procedures of the anterior glenoid, a thorough arthrolysis and subscapularis release is necessary.

   Using a radiofrequency (RF) ablation device (VAPR®3, DePuy Mitek, Inc., Raynham, MA, USA) and shaver from the E-portal, a thorough release of the extra-articular side of the subscapularis muscle is carried out. The release is continued medially up to the posterior cord of the plexus taking care to locate and protect the subscapular nerves. If necessary, however, a brachial plexus release may be performed at this point [17]. In patients without previous anterior bone block procedures the anterior side of the subscapularis is exposed as previously described [8, 16].

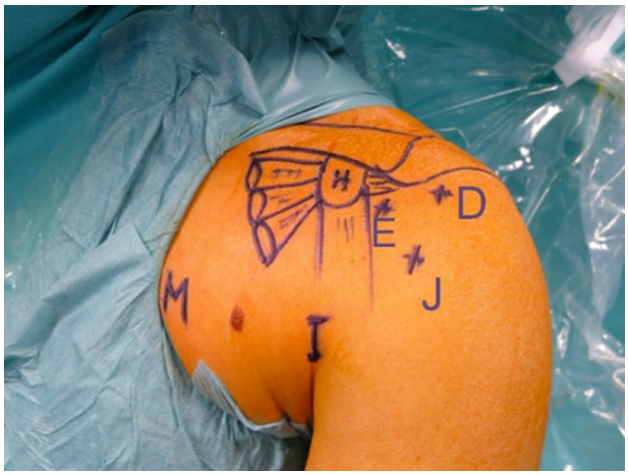

Fig. 1 Arthroscopic portals labeled on a left shoulder

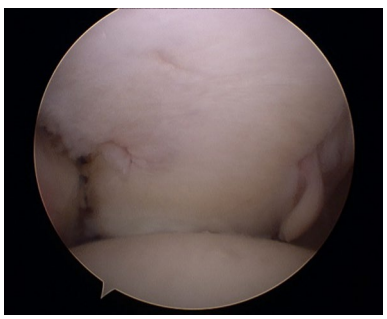

Fig. 2 Left shoulder viewed from antero-lateral portal (D) showing both anterior and posterior bone erosion with an inverted pear shape glenoid

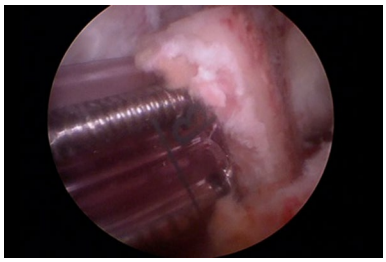

Fig. 3 For anterior bone grafting, an anterolateral inferior view with scope in the J portal is needed. The iliac graft is fixed to the double-barreled cannula and introduced into the joint through the M-portal

3. Anterior Glenoid Preparation: The anterior rim of the glenoid is flattened for iliac crest bone graft placement (Fig. 2). In case of a failed Latarjet procedure, utmost care is taken to prevent damage to the conjoined tendon to preserve the "sling-effect".
4. Subscapularis Split and Hardware Removal (in case of previous Latarjet procedure): The subscapularis is split between the inferior and superior third of the tendon and it is started lateral to the axillary nerve [8, 15, 16].
5. Preparation of posterior glenoid: With the arthroscope in the D-portal, a transinfraspinatus postero-superior B-portal is created and used for posterior glenoid preparation.
6. Iliac Crest Bone Graft harvest: A five to eight cm incision is made just posterior to the anterior superior iliac spine, and a few centimeters inferiorly to avoid scarring directly over the iliac crest. A bicortical graft is harvested, preserving the inner cortex. To ensure appropriate graft dimensions for fixation, prior to graft harvest, the double-barreled cannula (DePuy Mitek, Raynham, MA, USA) is placed laterally on the crest and fixed with two K-wires. Using a cannulated drill, two 3.2 mm holes are created, the drill holes tapped and "Top Hat" washers are inserted into each hole. Two bicortical bone grafts of sufficient length, width and height to match the anterior and posterior glenoid defect are then harvested with an osteotome or oscillating saw. The grafts may be reshaped with an arthroscopic burr [9, 28].
7. Graft passage and fixation: For anterior bone grafting, the iliac graft is fixed to the double-barreled cannula and introduced into the joint through the M-portal (Fig. 3) and fixed as previously described for the arthroscopic Latarjet procedure. A switching stick is introduced through the A-portal and positioned parallel to the glenoid joint surface to define correct graft position flush with the glenoid surface.

Finally the holes are drilled with a cannulated 3.2 mm drill and the graft fixed with two cannulated lag screws (Fig. 4). If the graft is too proud, the graft can be carefully smoothed down to the level of the subchondral bone.

For the posterior bone graft, the procedure is the same as previously described for the posterior bone block augmentation. The surgeon needs to pay particular attention not to damage anterior neurovascular structures during K-wire placement and drilling (Fig. 4). In general the graft should not be proud to the glenoid surface and should be placed along the posterior–inferior glenoid neck to best replace the deficient posterior glenoid bone, although in literature the precise optimal position for the posterior bone graft remains controversial [30].

An ethical approval form the local IRB was obtained (CERC VS 2016 07 3).

Results

Data were collected prospectively and retrospectively analyzed. The statistical analysis was performed by an orthopedic surgery fellow with training in statistics (K.P.) and using software for statistical analysis. Median Walch-Duplay-Score and Rowe scores improved from 30 (15–55) to 62.5 (15–90) and from 30 (15–50) to 62.5 (30–90), respectively. One patient returned to their pre-injury level of sport, whilst three patients returned to a reduced level of sport and three patients stopped their sporting activity entirely. At final remote follow-up the mean WOSI score was 187 (100 to 1140 and the median Quick DASH score 13.6 (range 0–54.5). The median SF-12 score was 49.3

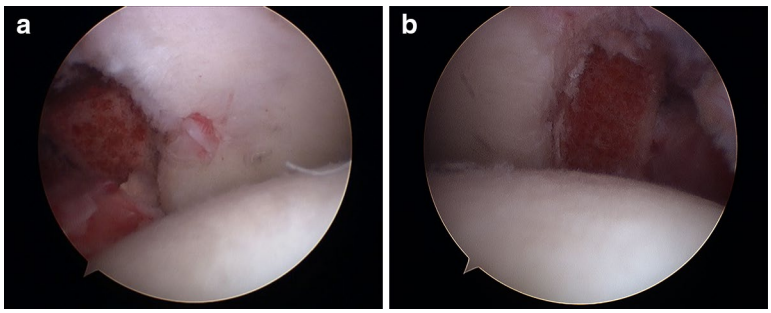

Fig. 4 Left shoulder viewed from an antero-lateral portal D showing the final result with graft fixation on the anterior (**a**) and posterior (**b**) glenoid

Fig. 5 CT scan on the axial plane showing both anterior and posterior graft union and correct screw placement 6 months after surgery

(39–61) and 60.8 (45–66) for the physical and mental component scales, respectively.

No intra-operative complications were reported. Overall, three revision surgeries were performed (N2, N7 and N4): three screw removals and one additional arthroscopic Eden-Hybinette procedure.

At radiological follow-up, 5–72 months post-operatively, one patient with no previous evidence of osteoarthritis showed grade 1 joint degeneration. No patients with pre-operative osteoarthritis showed any osteoarthritis progression at follow-up. On routine CT scans at 6 months post-operatively, bone graft union was demonstrated in all patients with no screw malpositioning seen (Fig. 5).

Discussion

The most important finding of this study is the description, for the first time, of clinical and radiological outcomes following an all-arthroscopic double bone block augmentation for bidirectional shoulder instability, with concomitant glenoid bone loss and Hill Sachs/reverse Hill Sachs lesions. This technique is recommended only as salvage procedure.

Multidirectional shoulder instability (MDI) was initially classified by Neer and Fosters [22] as an instability in two or three directions. Traditionally, MDI is regarded as an atraumatic process, typically resulting from a redundant capsule. However, in our experience it has become increasingly apparent that MDI represents a spectrum of disease from pure capsular laxity to complex structural lesions, of which our patient cohort represent the far end of this spectrum [1, 19]. Historically, posterior and combined anteroposterior glenoid lesions are a rare finding [3, 14, 24]. A recently published epidemiological study in a young and active patient population, however, demonstrated posterior instability in 24.2% and combined instability in 18.6% [30]. Interestingly, MRI findings only correctly characterized the pathology revealed arthroscopically in 68.0% of cases, and in only 37.2% of patient with combined instability. Thus, combined instabilities may well be substantially underestimated in an active patient population and surgeons must be aware that pre-operative MRI may be a poor predictor of intra-operative findings. This rarity, of recognition at least, is reflected by the scarcity of reported cases in the literature, with only a single previous case report of combined anterior and posterior instability due to both anterior and posterior glenoid bone loss found on literature review [30]. Our cohort data support a predominance of this pathology amongst the young and active population. Likewise, these data demonstrate anterior and posterior gleno-humeral instability as an extremely incapacitating pathology, with pre-operative Rowe and Walch-Duplay scores of mean shoulder function in our series rated as "poor".

Applying the principles of addressing the underlying causative pathologies for shoulder instability and restoring anatomy, a combined anterior and posterior bone block glenoid augmentation stands as a logical treatment for such cases. By the same token, the authors do not consider this to be a first-line treatment for bi- or multidirectional instability in the absence of bone loss.

This approach and indication is supported here by the functional outcomes in our series at a mean follow-up of 25.6 months. Likewise, four patients successfully returned to sport post-operatively, although only one to their pre-injury level of participation (Table 2).

At final follow-up, the WOSI score showed a median of 187 (100 to 1140) and the quick DASH a median disability of 13.6. The SF-12 was 49.4 and 58.2 for the physical and mental scores, respectively. Those patients who demonstrated fair to good functional outcomes at their last clinical review also reported consistently good to excellent PROMs scores at final follow-up, with excellent outcomes for the WOSI Score, a low disability for the DASH score, and SF 12 results comparable with those of a normal population [32].

Overall, four out of seven patients in our series may be regarded as having achieved at least good result, one patient a fair result, and two patients may be considered as failures, with poor results.

One patient (N7) had sustained a total of five recurrent dislocation 24 months post-operatively. This patient suffered from a genetic connective tissue disorder (Ehlers-Danlos Syndrome) and CT scans showed massive anterior bone block osteolysis. A revision all-arthroscopic Eden-Hybinette procedure was performed with no subsequent recurrent dislocation reported at last follow-up 24 months

later. This patient, however, was not available for final follow-up and, therefore, it remains unclear whether she remained stable and satisfied at the mid-term point. In the absence of final follow-up, we can only speculate as to the true mechanism of failure and whether anterior bone block revision truly achieved shoulder stability, however, given this episode, we feel it is reasonable to advise extreme caution in selecting this procedure as a first-line intervention in the presence of soft tissue disorders such as Ehlers-Danlos.

A second patient (N2) complained of persisting posterior subluxations and pain. CT scans showed a partial osteolysis of the upper part of the posterior bone block with a prominent superior screw, for which hardware removal was performed. Intra-operative anterior and posterior provocation testing at this time did not demonstrate any persistent instability. Further surgical intervention was not indicated. Despite hardware removal, the patient remained limited at final follow-up, with no clear cause.

Clearly, however, in this limited case series, it is seen to be associated with a higher failure rate than that seen in primary stabilization procedures. As such we regard the described surgery as a salvage procedure, applicable to a very small group of patients in the rare event of significant anterior and posterior glenoid bone loss, usually found after prior failed bony stabilization surgery, where an isolated soft tissue procedure is no long suitable [6]. In our case series two patients were affected primarily, while five patients had undergone previous stabilization surgery; in four cases a Latarjet and/or Eden-Hybinette procedure. Equally, whilst no infection, neurological or vascular complications were seen in our series, this is clearly a highly technical procedure requiring excellent surgical skills and significant arthroscopic experience.

The main limitations of this study relate to the retrospective nature of the data analysis and to the small number of patients in this series, which reflects the low prevalence of this pathology in the patient population. Furthermore, the overall duration of follow-up was very variable. Although the final PROMs scores show promising mid-term results, real long-term clinical and radiological outcomes are pending.

The clinical relevance of this study for the day by day work is related to the description for the first of this rare condition, secondary to concomitant anterior and posterior glenoid bone loss, primarily or after failed bone block procedure. This should be keep in mind while treating patients with recurrent shoulder instability after an arthroscopic or open bone block procedure.

Conclusion

An all-arthroscopic technique for the treatment of combined anterior and posterior glenoid bone loss as a cause of shoulder instability can provide fair to good clinical outcomes, with a low incidence of intra-operative complications. The rate of failure in our series remains higher than that seen in primary stabilization procedures. As such we consider this largely as a salvage procedure for cases in which alternative treatments have failed or are unlikely to succeed.

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Compliance with ethical standards

Ethical approval Ethics approval for this retrospective study was granted following review by the local IRB (CERC VS 2016 07 3).

Conflict of interest Laurent Lafosse is a Consultant for Depuy Mitek. The other authors declare that they have no competing conflict of interest.

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