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Revision guided suture-button bone block stabilization of the shoulder in the presence of significant retained glenoid metalwork

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Aim: Positioning and fixation of the bone block during revision anterior stabilization of the shoulder, in the presence of significant retained glenoid metalwork, can be challenging. We present the results of a series of patients who underwent a revision bone block procedure secured with double suture buttons using a drill guide system, the position of which was calculated from a preoperative computed tomography (CT) scan.

Materials and methods: We undertook a revision bone block stabilization of the shoulder, using a guided double suture-button fixation, in 10 patients with significant retained glenoid metalwork from previous procedures. A preoperative CT scan was used to determine a position for the guide to allow a safe drill trajectory that would avoid any retained metalwork. A coracoid transfer was undertaken in 4 patients and an Eden-Hybinette in 6. Patients were assessed preoperatively and at final follow-up clinically and using the Oxford Shoulder Instability Score and the Subjective Shoulder Value score. Bone block position and healing was assessed by a CT scan at 6 months. The median follow-up was 36 months (range, 24-47 months).

Results: There were 3 female and 7 male patients with a median age of 24.5 years (17-49 years). At final follow-up, the mean Oxford Shoulder Instability Score had decreased from 25.9 (range, 21-35) to 5.8 (range, 3-14) ($P < .005$). The mean Subjective Shoulder Value score had risen from 87.1 (range, 10-60) to 80 (range, 60-90) ($P < .05$). All of the patients considered their shoulder to be stable apart from 1 patient. There had been no redislocations. The bone block positioned in the glenoid lower quadrant had healed for all of the patients on CT at 6 months.

Conclusion: Guided suture-button fixation of the bone block during revision anterior stabilization of the shoulder, in the presence of significant retained glenoid metalwork, provides a satisfactory outcome in terms of shoulder stability, graft position, and healing.

The management of the unstable shoulder after a failed anterior stabilization procedure is challenging. Although, in certain circumstances, a revision soft-tissue stabilization may be successful, a revision bone block procedure, in the form of either an Eden-Hybinette-type procedure or a coracoid transfer, is the preferred treatment option. When surgery is considered, the choice of the most appropriate procedure for a particular patient should be based on an understanding of the reasons for failure, the resultant surgical anatomy, and the issues that result from these.

When considering a revision bone block procedure, the residual glenoid bone stock may be a particular concern. The presence of retained metalwork, in the form of either metal suture anchors or broken screw shafts, or large bone voids, left as the result of biocomposite implants, may be significant. These may potentially lead to a compromise in the position or bony fixation of screws at the time of revision surgery.

Recently, suture-button fixation techniques for both Eden-Hybinette and coracoid transfer procedures have been described.[3,25] The potential advantage of a suture-button fixation is that the glenoid drill holes required are of smaller diameter and are made using a posterior drill guide jig. The intraoperative position for the drill guide can be predetermined, based on a preoperative computed tomography (CT) scan, to obtain the best trajectory, avoiding any retained metalwork. In addition, fixation is achieved by compression between the anterior cortex of the bone block and

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the posterior cortex of the glenoid and so is not compromised by the presence of bone voids.

We report the results of a consecutive series of patients on whom we undertook a revision bone block procedure, in the presence of significant retained glenoid metalwork, secured with double suture buttons using a drill guide system, the position of which was calculated from a preoperative CT scan. We hypothesized that the instability would be successfully treated and that the use of the suture button would allow accurate placement and healing of the bone graft.

Materials and methods

We searched the senior author's surgical database for patients who had undergone a revision guided suture-button bone block anterior stabilization procedure, and had significant retained glenoid metalwork, between August 2015 and February 2018. For the purpose of this study, we considered the presence of 3 or more metal anchors or 1 or more broken screw shafts in the inferior half of the glenoid as significant. Exclusion criteria included any associated posterior instability, neurologic injury, or infection. Informed consent was obtained from all of the patients.

Although all of the study patients had had at least 2 documented redislocations of their shoulder after previous stabilization surgery, there was a significant variation between patients with regard to the type of index procedures and whether they had had a subsequent revision operation. In the patients who had had a failed bone block procedure (Eden-Hybinette or coracoid transfer), at least one of the screw shafts had broken at the anterior glenoid edge and they had all been revision procedures for previous failed soft-tissue stabilizations. In the patients who had had a failed soft-tissue stabilization, there were at least 3 metal suture anchors situated in the anterior inferior quadrant of the glenoid with associated biocomposite anchor bone voids, they all had a previous failed soft-tissue stabilization, and they all had anterior inferior glenoid bone loss. However, the common denominators were that we considered a bone block procedure to be the most appropriate revision option and that all of the patients had retained metalwork in the inferior glenoid that may compromise the position of fixation of a bone block.

Surgical technique

The senior author's preferred approach for a revision bone block procedure is arthroscopic but, for certain cases where, for technical reasons, there might be difficulty in extracting residual metalwork or where an additional procedure, such as a humeral head allograft is required, an open approach may be required. One of the potential advantages of an arthroscopic revision Eden-Hybinette procedure using suture-button fixation is that the whole procedure can be undertaken intra-articularly through the rotator interval.[25] This avoids any surgical dissection around subscapularis and the previous surgical site. All of the procedures were undertaken by the senior author using a preplanned position for the drill guide, based on a preoperative CT scan.

Although all of the patients had some form of metalwork that was embedded within the glenoid, which was not easily removable, some also had either intact screws that could be removed or broken screw heads that were within the soft tissues. For these cases, this metalwork had to be extracted at the beginning of the procedure.

Management of existing metalwork

It is possible to remove intact screws from the anterior glenoid arthroscopically through a cannula inserted through an anterior portal passing through the rotator interval. This is undertaken at the beginning of the arthroscopic procedure so, if it is not possible to remove the metalwork arthroscopically, the procedure can be converted to open before there is too much soft tissue swelling. Having cleared away any soft tissue from around the head of the screw an appropriate screwdriver can be passed through the cannula and engaged into the screw head. This can be aided by retraction of the scapula, which rotates the glenoid and the screw heads into a more coronal plain.[20]

Broken screw heads, from a previous coracoid transfer, are usually situated within the subscapularis muscle and maybe associated with a fragment of the original bone block or the conjoint tendon. The anterior surface of the subscapularis lies within the anterior compartment. This can be accessed arthroscopically by clearing the rotator interval tissue with a radiofrequency probe inserted through a combination of an anterior portal and a far lateral portal, while viewing with the arthroscope from the posterior portal. The broken screw heads can then be identified and removed using a grasper inserted though the anterior portal.

Management of retained metalwork

Any retained metalwork within the glenoid, in the form of previous metal anchors or snapped off screw shafts, may compromise implant positioning and screw hold at the time of revision surgery. The advantage of the jigged posterior drill guide system, that is used for the suture-button technique, is that it is possible to preplan, off of a CT scan, a drill trajectory that can avoid any retained metalwork within the glenoid.

The optimal position for the drill guide tip on the anterior glenoid can be preplanned using the most anterior coronal cut of a CT scan that is tangential to the axis of the articular surface of the glenoid (Fig. 1, *B*). The offset of the drill guide tip, when positioned flush to the glenoid, is 5 mm medial to the anterior edge of the articular surface of the glenoid. Using standard software measuring annotation features, a vertical line is drawn on the coronal cut CT scan image, 5 mm from the articular edge of the lower quadrant. This represents the position that that the drill guide will direct the 2.8-mm-diameter drill holes for the suture buttons. The preset distance between the drill holes on the jig is 10 mm. Using this, a position can then be selected along the vertical line, in the lower quadrant, where two 2.8-mm-diameter circles, 10 mm apart, can be placed avoiding any of the pre-existing metalwork. The midpoint between the 2 circles, 5 mm, will be the position for the drill guide tip (Fig. 1, *C*).

The distance from this point down the vertical line to the inferior edge of the glenoid can then be measured. This can then be used as a reference point, measured up from the inferior edge of the anterior glenoid, at the time of surgery to position the drill guide.

In the case of broken screw shafts, the angle of horizontal inclination of the screws as they pass through the glenoid from anterior to posterior also needs to be taken into consideration. The inclination of the screw shafts can be assessed by using the sagittal cut of a CT scan that is parallel to the axis, and closest to 5 mm medial, to the articular surface of the glenoid (Fig. 1, *D*). Knowing the distance from the inferior edge of the glenoid to the desired position for the drill guide tip, as calculated earlier, the provisional positions for the inferior and superior drill holes can be placed on a vertical line parallel to the anterior edge of the glenoid. Drawing lines from anterior to posterior for each of the drill holes, perpendicular to the vertical line, will give an indication as to a “safe” angle of inclination to the horizontal for the drill guide to be positioned (Fig. 1, *D*).

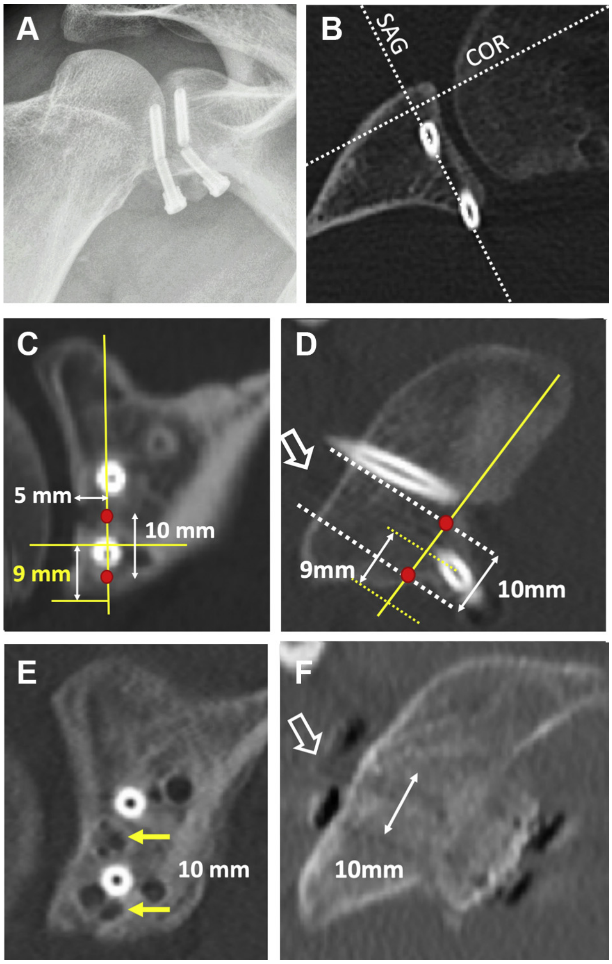

Figure 1 (**A**) Preoperative radiograph, (**B-D**) planning computed tomography (CT) scan, and (**E**, **F**) postoperative CT scan of a patient with a failed coracoid transfer with 2 broken screw shafts retained within the glenoid. (**A**) Plain x-ray demonstrating fracture of the coracoid bone graft and snapping of the screw shafts. A large Hill-Sachs lesion is also present. (**B**) Axial scout CT scan showing the position of the tangential coronal cut (COR) closest to the anterior edge of the glenoid and the position of the tangential sagittal cut (SAG) closest to 5 mm medial to the face of the glenoid. (**C**) The chosen coronal image. The *yellow vertical line* is positioned 4 mm medial to the edge of the glenoid articular surface. A position has been selected on the line, in the lower quadrant, where two 2.8-mm drill holes (*red circles*), 10 mm apart, can be made avoiding any metalwork. The midpoint between the drill holes corresponds to the position for the tip of the drill guide (transection of the upper *horizontal yellow line* with the *vertical yellow line*). The distance from this point to the inferior edge of the glenoid (lower *horizontal yellow line*) can be calculated at 9 mm. (**D**) The chosen sagittal image. The *yellow vertical line* represents the *yellow vertical line* from image (**C**). The 2 drill holes (*red circles*) have been positioned on the *yellow vertical line*, 10 mm apart, with the midpoint being 9 mm from the inferior edge of the glenoid. The proposed drill trajectories (*hashed white lines*) run perpendicular to the *yellow line* and avoid any metalwork. The open *white arrow* points to the “ghost” of the retained inferior screw shaft. (**E**) Six-month postoperative coronal image. The drill holes for the suture buttons (*yellow arrows*) can be seen, 10 mm apart, as determined on the preoperative scan. (**F**) Six-month postoperative sagittal image. The bone block has united. The drill trajectory between the anterior and posterior suture buttons can be seen (*hashed white lines*), as determined on the preoperative scan. The *open white arrow* points to the “ghost” of the retained inferior screw shaft.

Surgical procedure

For all of the procedures prior informed consent was obtained from the patients. The patients were anesthetized using a general anesthetic and interscalene nerve block. Prophylactic intravenous antibiotics were administered before commencement of surgery.

The patients were positioned in the beach chair at 45° with the posterior section of the bed removed to allow access to the posterior shoulder. For the patients undergoing a revision Eden-Hybinette procedure, the shoulder and ipsilateral iliac crest were prepared and draped in the standard fashion. For patients undergoing a revision coracoid transfer, only the shoulder was prepared and draped.

Iliac crest bone graft harvesting and preparation

For the Eden-Hybinette procedure, iliac graft harvesting and preparation is undertaken at the beginning of the procedure to optimize efficiency and avoid having to alternate between surgical sites. Using a standard technique, a tricortical bone graft is harvested using osteotomes. The bone graft is then fashioned into a 20 × 10 × 10 mm block and positioned into a custom clamp (Smith & Nephew, Andover, MA, USA). The drill guide arm on the clamp is then rotated around and positioned appropriately over the bone block. Two 2.8-mm drill holes are then made 10 mm apart in the center of the block.[25,27]

Two suture-button devices (Smith & Nephew) are then loaded into the drill. For the arthroscopic procedure, the tails of the suture buttons are passed through the 15-mm cannula, which will be used for arthroscopic insertion, and the bone block is pulled through to check for easy passage. If there is any difficulty, the bone block can then be trimmed to size (Fig. 2).

Coracoid graft preparation

For the open coracoid transfer procedure, the coracoid is harvested and the conjoint tendon mobilized in the standard fashion. Having decorticated the undersurface of the coracoid, the bone block is loaded into the custom clamp and the 2.8-mm drill holes are made in exactly the same way as for the Eden-Hybinette bone block. However, the suture buttons are not loaded until after the glenoid has been prepared. This is to avoid the suture tangling when the coracoid is pushed inferiorly while exposing the glenoid (Fig. 3).

For the arthroscopic coracoid transfer procedure, the coracoid is skeletonized and the undersurface decorticated at the beginning of the procedure. The two 2.8-mm drill holes are then made and the suture buttons shuttled through and loaded, before undertaking the coracoid osteotomy.

Arthroscopic procedure

Both the arthroscopic suture-button Eden-Hybinette and coracoid transfer procedures have previously been described.[3,5,25] For the coracoid transfer, we used the double bullet drill guide, as opposed to the single bullet guide, in order to secure the coracoid bone block with 2 suture buttons. The modification to the technique for placing the drill guide onto the glenoid at the preplanned position was done in exactly the same way for both procedures.

Drill guide positioning and glenoid drilling

The arthroscope is positioned into the lateral portal and the anterior glenoid, which has already been prepared, is viewed. The distance from the inferior edge of the glenoid to the desired position for the drill guide, which was predetermined on a CT scan, is measured up from the tip of a needle and marked with a marking pen (Fig. 4, *A*). The spinal needle is then inserted vertically, at the anterior edge of the acromion, into the joint so that it runs parallel and anterior to the front of the glenoid (Fig. 4, *B*). The tip of the needle is positioned at the inferior edge of the glenoid, and a radiofrequency probe, introduced through the anterior portal, is used to mark the glenoid articular cartilage at the point of the mark on the needle (Fig. 4, *C*).

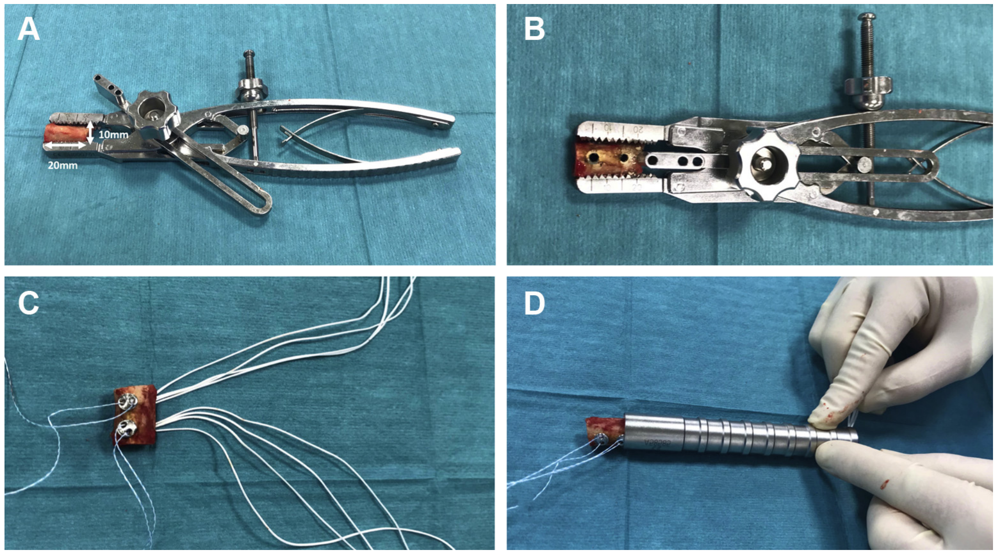

Figure 2 Bone block preparation. (**A**) A tricortical autologous bone graft has been harvested from the iliac crest, trimmed to size (20 mm × 10 mm × 10 mm) and loaded into the custom clamp. (**B**) Using the drill guide from the clamp two 2.8-mm drill holes have been made in the bone graft 10 mm apart. (**C**) Suture buttons have been inserted into each drill hole with the buttons loaded into the cortical bone. (**D**) The tails of the suture buttons have been passed through the 15-mm cannula, and the graft construct is being pulled through to check for easy passage.

A slit cannula is then introduced through the posterior portal into the joint, and the aiming arm for the posterior glenoid jig (Smith & Nephew) is introduced along the axis of the cannula. The cannula is then removed, and the aiming arm rotated and positioned onto the preset mark on the anterior glenoid. The aiming arm is then pulled backward so that the 5-mm offset tip is flush to the anterior glenoid surface.

When the tip of the jig is in position, the 2 drill guide bullets are slotted into the jig and ratchetted down on to the posterior surface of the scapula. Once satisfied that the tip of the jig is in the correct position, the whole jig assembly is locked down into place (Fig. 5, *A*).

While continuing to view anteriorly, a 2.8-mm drill bit, with its outer sleeve, is drilled down each of the drill guide bullets through to the anterior glenoid. The drill bits are then pulled out, leaving the drill sleeves in position. The suture tails from the previously prepared iliac crest bone graft or coracoid graft are then shuttled through from anterior to posterior. The drill sleeves are removed and the suture tails tightened pulling the bone block into position on the anterior glenoid. When a satisfactory position has been obtained, a double eyelet suture button is loaded onto the individual suture tails, tensioned to 100 N and secured with a Nice knot (Fig. 5, *B* and *C*).

For either of the arthroscopic procedures, if there is any functional capsular tissue present, it is then fixed to the anterior glenoid edge using suture anchors.

Open procedure

For both the suture-button Eden-Hybinette and coracoid transfer procedures, a standard subscapularis split is made to expose the anterior glenoid. Any residual capsule, soft tissue, old sutures, and metalwork are then removed from the anterior edge of the glenoid, and, using a burr, the anterior glenoid is decorticated down to a flat, bleeding surface. A slit cannula is inserted through a small posterior incision and passed through to the front of the joint, and the aiming arm for the posterior glenoid jig then introduced. The distance from the inferior edge of the glenoid to the desired position for the drill guide, which was predetermined on a CT scan, is then measured using a sterile surgical ruler. The 5-mm offset tip of the drill guide is then rotated medially and positioned at this point.

As for the arthroscopic procedures, the drill guide bullets are then inserted into the jig and ratchetted down, and the assembly is locked. The superior and inferior drill holes are then made, and the sleeves left in position. For both procedures, having now loaded the suture buttons onto the coracoid graft, the tails of the suture

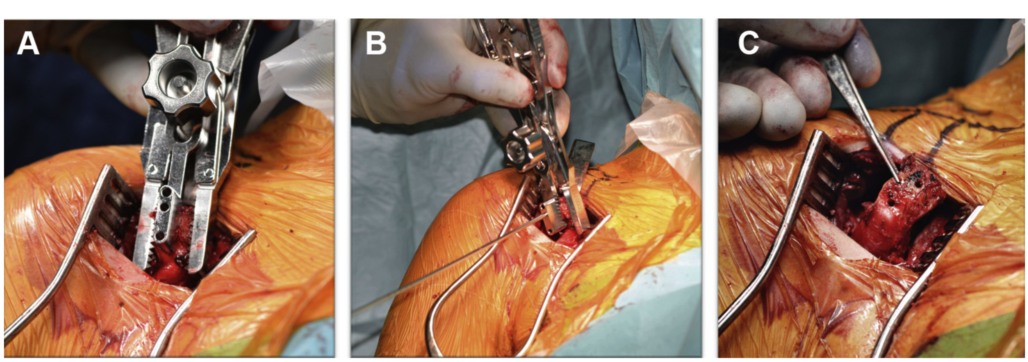

Figure 3 (**A**) The coracoid bone block has been loaded into the custom clamp. (**B**) The superior drill hole is being made using the 2.8-mm drill bit and sleeve. (**C**) The prepared coracoid. The suture buttons will be loaded once the anterior glenoid has been prepared.

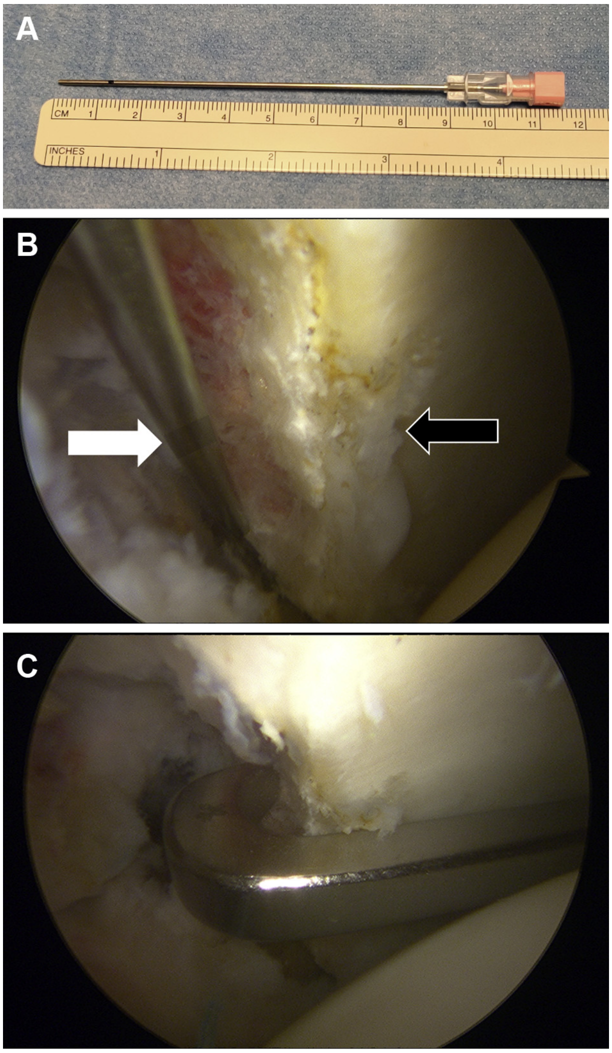

Figure 4 (**A**) A marker pen mark has been made 11 mm from the tip of a standard 18-gauge spinal needle. This corresponds to the precalculated distance from the inferior edge of the glenoid to the desired point for the drill guide. (**B**) Viewing from the lateral portal the spinal needle has been inserted vertically from the anterior edge of the acromion and parallel to the anterior edge of the glenoid. The tip of the needle has been positioned at the inferior edge of the glenoid and a "mark" (*black arrow*) has been made, using the radiofrequency probe, on the articular cartilage corresponding to the mark on the needle (*white arrow*). (**C**) The drill guide has been inserted and positioned at the level of the mark on the glenoid, which corresponds to the preplanned drill position on the computed tomography scan.

buttons are shuttled through the drill sleeves and the grafts secured, in exactly the same way as the arthroscopic techniques, with posterior buttons. Again, if there is any functional capsular tissue present, it is then fixed to the anterior glenoid edge using suture anchors.

Postoperative management

After surgery, the shoulder is immobilized in a neutral rotation sling for 2 weeks. After 2 weeks, the sling is removed and the patient commences pendulum exercises. At 4 weeks, a rehabilitation program is commenced under the supervision of a physiotherapist. At 3 months, the patient can return to heavier lifting and between 4 and 6 months, can recommence sporting activities.

Clinical and radiographic assessment

Patients were followed up and examined at 1, 3, 6, and 12 months and at a final follow-up postoperatively. Any postoperative dislocation or subjective complaint of instability was considered a failure. Outcome scores were assessed using the Oxford Shoulder Instability Score[6] and the Subjective Shoulder Value for activities of daily living.[30] At the final follow-up, we asked the patients to rate their outcome as excellent, good, satisfied, or poor.

Routine plain anterior-posterior, axillary, and lateral x-rays were undertaken at each follow-up visit. A CT scan was obtained for each patient at the 6-month follow-up to assess the graft position and healing. The ideal position for the bone graft was considered to be below the glenoid equator and within the "glenoid circle" in the vertical plane.[22] In the horizontal plane, the graft was considered to be too lateral if there was a visible step beyond the glenoid rim and too medial if it was more than 5 mm medial to the rim.[3] Bony union was confirmed by the presence of bridging bone between the bone block and the anterior glenoid.

Statistical analysis

The statistical analysis was performed using the Wilcoxon signed-rank test between pre- and postoperative functional scores (SPSS Statistics for Windows, version 25.0; IBM, Inc., Armonk, NY, USA). A P value <.05 was considered statistically significant.

Results

Demographics

Ten patients were identified who had undergone a revision guided suture-button bone block anterior stabilization procedure and also had significant retained glenoid metalwork. The demographics of all patients are summarized in Table I. The mean age of the patients at the time of surgery was 27.3 years (range, 17-49 years), and there were 2 female and 8 male patients. The mean time to the final follow-up was 35.2 months (range, 24-47 months; standard deviation [SD], 7.7). All of the patients were available for follow-up.

One patient underwent an open Eden-Hybinette procedure with an additional fresh osteochondral humeral head allograft for a large Hill-Sachs lesion (Fig. 6). Five patients underwent an arthroscopic Eden-Hybinette procedure, all of them having had a previous failed coracoid transfer procedure (Figs. 7 and 8).[16,17,27,28] Two patients underwent an open coracoid transfer procedure, having had a previous failed open Eden-Hybinette procedure (Fig. 9), and 2 patients underwent an arthroscopic coracoid transfer, having both had 2 previous failed arthroscopic Bankart repairs (Fig. 10).

Complications

There were no intraoperative or postoperative complications. There were no hardware failures or migration, and none of the patients required any further surgery. There were no neurologic complications around the shoulder girdle, but 2 of the 6 patients who underwent a revision Eden-Hybinette procedure complained of hypoesthesia over the iliac crest. This had settled at the time of their final follow-up.

Functional and radiographic outcome

The functional outcome scores for all of the patients are summarized in Table II. At the final follow-up, 9 of the patients considered their shoulders to be stable. One patient complained of

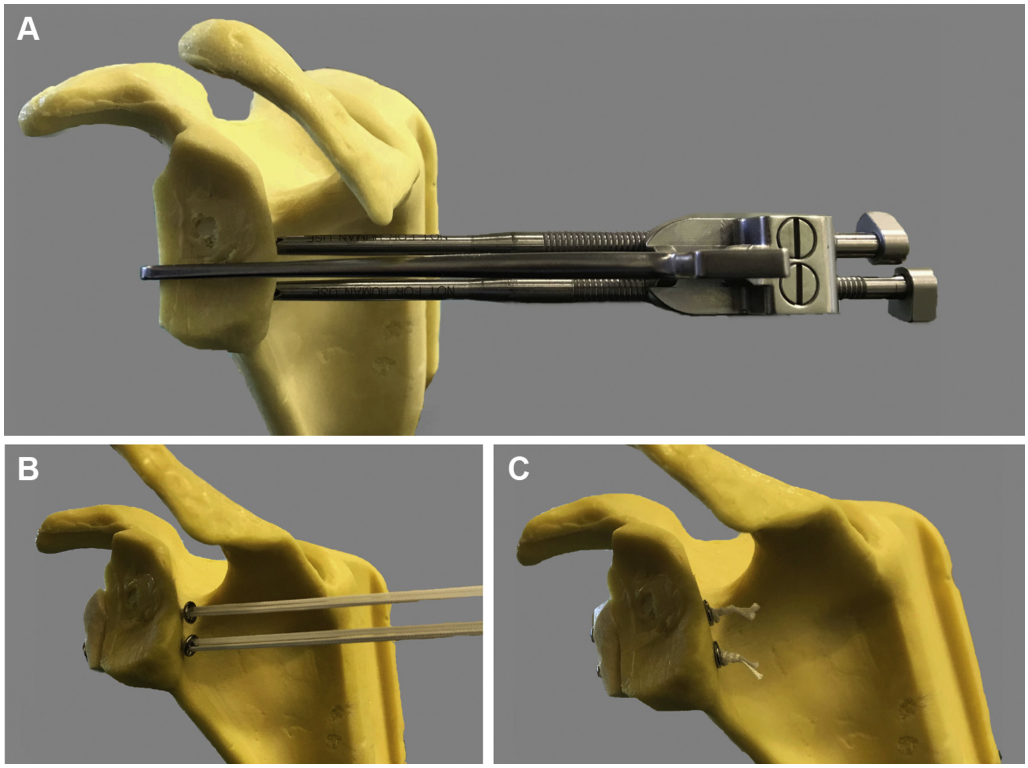

Figure 5 Drill guide jig. (**A**) The drill guide arm and tip have been placed in the desired position on the left anterior glenoid. The 2 drill guide bullets have been inserted and ratcheted down onto the posterior glenoid. (**B**) The posterior buttons have been loaded onto the sutures and passed down onto the posterior glenoid. (**C**) The sutures have been tensioned to 100 N and tied, securing the construct.

a feeling of instability when playing tennis and had given up the sport. However, they considered that their shoulder was stable for all other activities.

At the final follow-up, the average Oxford Shoulder Instability Score had decreased from 25.9 (range, 21-35; SD, 4.6) to 5.8 (range, 3-14; SD, 2.9) ($P < .005$). The average Subjective Shoulder Value score had risen from 87.1 (range, 10-60) to 80 (range, 60-90) ($P < .05$). Nine of the patients considered their outcome to be excellent or good, and 1 patient considered his or her outcome to be satisfactory.

On the postoperative CT scan taken at 6 months, the bone graft was positioned optimally in both the horizontal and vertical plains in all of the patients. There was bridging bone between the bone block and the anterior glenoid in all of the patients.

Table I
Demographics

	Age at revision (yr)	Sex	Side	Previous surgery	Time to most recent failure (mo)	Time to surgery (mo)	Retained glenoid metalwork/ void at surgery	Revision procedure	FU (mo)
1	22	M	R	@ Bankart @ CT	4	9	×2 broken screw shafts Anchor voids	@ EH	47
2	17	M	R	@ Bankart CT	5	7	×2 broken screw shafts	EH + osteochondral humeral head allograft	45
3	26	M	L	@ Bankart ×2 CT Removal m/w	5	29	×4 metal anchors Large anchor void	@ EH	41
4	25	F	R	@ Bankart EH	12	11	×1 broken screw shaft ×3 metal anchors	CT	39
5	19	M	L	@ Bankart CT	7	6	×1 broken screw shaft	@ EH	36
6	49	F	L	@ Bankart ×2	11	132	×3 metal anchors ×3 anchor voids	@ CT	36
7	35	M	R	@ Bankart EH	7	42	×1 broken screw shaft ×3 metal anchors	CT	32
8	19	M	R	CT	18	6	×1 broken screw shaft	@ EH	27
9	37	M	L	@ Bankart ×2	49	7	×4 metal anchors	@ CT	25
10	24	M	R	@ Bankart CT	11	7	×1 broken screw shaft ×3 anchor voids	@ EH	24

@, arthroscopic; *CT*, coracoid transfer; *EH*, Eden-Hybinette; *FU*, follow-up.

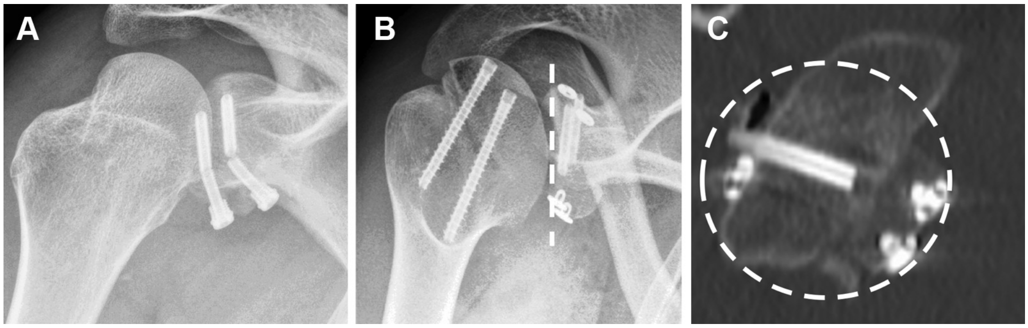

Figure 6 Open Eden-Hybinette procedure. (**A**) Preoperative plain x-ray demonstrating fracture of the coracoid bone graft and snapping of the screw shafts. A large Hill-Sachs lesion is also present. (**B**) Six-month axial postoperative plain x-ray demonstrating a healed bone graft in the lower quadrant of the glenoid with suture buttons in situ. An osteochondral allograft has been used to fill the large Hill-Sachs defect. The *hashed line* demonstrates correct medial-lateral positioning of the bone block. (**C**) Six-month sagittal computed tomography scan demonstrating that the bone block is positioned correctly within the "glenoid circle."

Discussion

Undertaking a revision bone block procedure for failed anterior stabilization surgery, in the presence of significant retained glenoid metalwork, is a rare and challenging surgical problem. The main findings of this study suggest that undertaking a revision bone block procedure secured with double suture buttons using a drill guide system, the position of which was calculated from a preoperative CT scan, provides a satisfactory outcome in terms of graft position, healing, and shoulder stability.

The management of a patient after a failed anterior shoulder stabilization procedure can be difficult. To address this problem, there are a considerable number of revision surgical techniques that have been described. However, it is important to remember

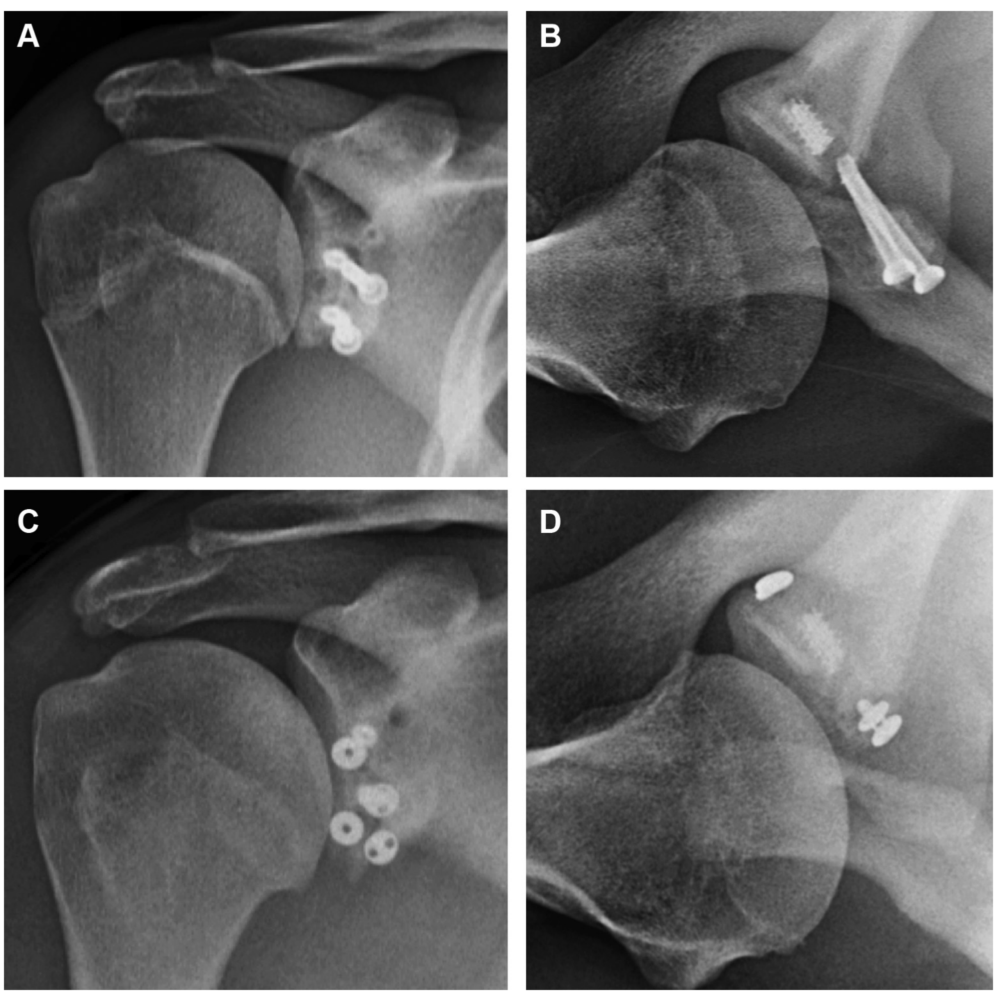

Figure 7 Arthroscopic Eden-Hybinette procedure. (**A**, **B**) Preoperative AP and axial plain x-rays demonstrating nonunion of the coracoid graft with partial pull-out and snapping of the screws. The threaded part of the screw shafts are retained within the glenoid. (**C**, **D**) Six-month postoperative AP and axial plain x-rays demonstrating the bone graft in the lower quadrant of the glenoid with suture buttons in situ. *AP*, XXX.

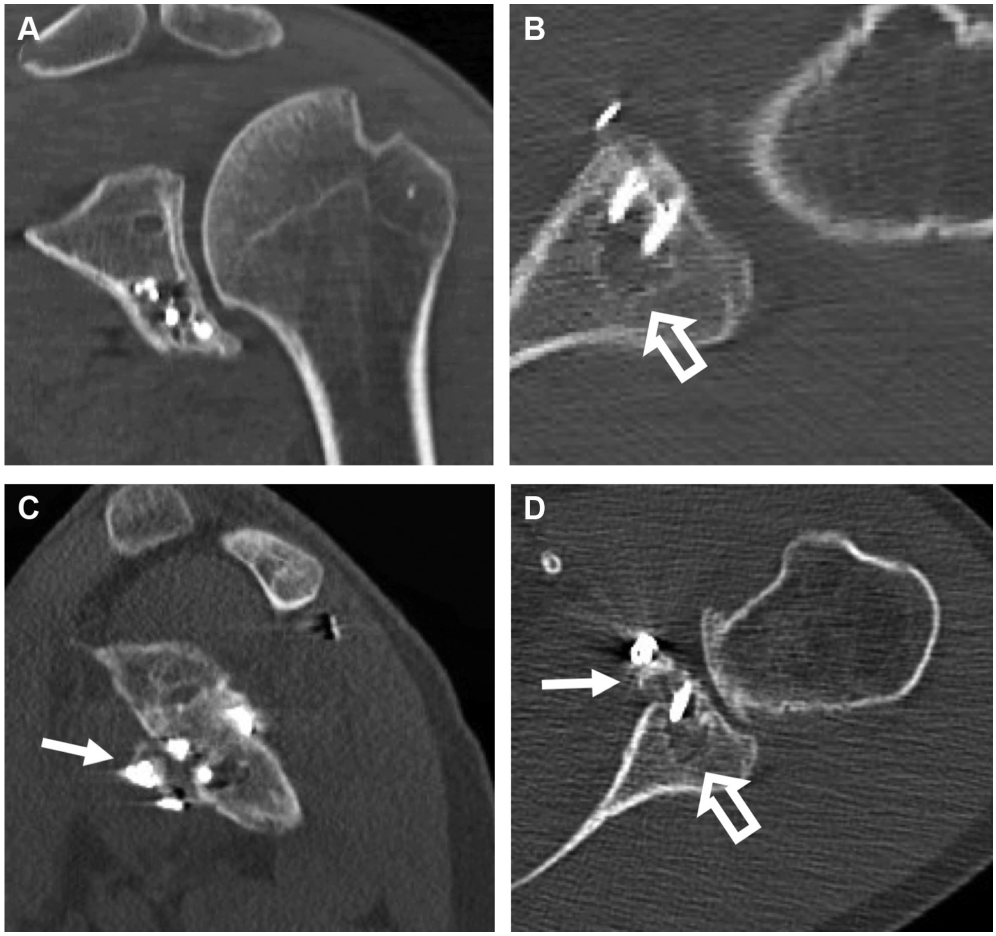

Figure 8 Arthroscopic Eden-Hybinette. (**A**, **B**) Preoperative coronal and axial CT scans demonstrating retained metal suture anchors and a large bone "void" (*open white arrow*) within the glenoid and a loose washer, from a previous coracoid transfer. (**C**, **D**) Six-month postoperative sagittal and axial CT scans demonstrating a healed bone graft in the lower quadrant of the glenoid with suture buttons, providing compression, in situ. *CT*, computed tomography.

that, for certain cases, there is often a cross-over of equal success between techniques. When surgery is considered, the reasons for failure, the resultant surgical anatomy and an individual physician's skill, past experience, and expertise are factors that should be taken into consideration on deciding the most appropriate technique for each individual case.

Recently, when surgically addressing a failed soft-tissue Bankart repair, there has been a general move toward an anatomic reconstruction of the anterior glenoid surface using a bone-block technique rather than a revision soft-tissue repair.[19] The most popular are variations of the open Latarjet procedure,[12,13] Eden-Hybinette procedure[10,29] or J-Graft procedure,[1] and, more recently, arthroscopic versions of the Latarjet[3,7] and Eden-Hybinette procedures.[26] Although all of these reported case series describe differing technical aspects of their particular procedure and, on occasion, peculiarities of individual cases, none of them specifically comment on any issues with pre-existing glenoid metalwork or implant bone voids. However, it maybe that when encountered, the various authors were able to adapt their procedure in a way that they did not consider would compromise graft positioning and outcome.

Failure, requiring a revision stabilization procedure, after a Latarjet procedure is rare.[4,14,31] A number of studies and case reports, specifically dealing with failed Latarjet procedures, have reported successful results undertaking a revision Eden-Hybinette procedure.[2,9,16,17,20,28] In a series, by Lunn et al,[17] of 34 patients who underwent a revision open modified Eden-Hybinette procedure after a failed Latarjet, they mention in their operative description the removal of exposed hardware but do not comment if there was any broken metalwork retained in the glenoid. Boileau et al[2] describe a series of 7 patients who underwent a revision suture-button Eden-Hybinette procedure for a failed Latarjet procedure. Three of the patients had broken screw shafts retained in the glenoid, which were left in situ. For these patients, they did not use a preoperative CT scan to calculate a position for the drill guide, but, instead, chose to use a single button fixation, positioned superiorly, rather than a double button fixation for the bone graft. However, single fixation techniques have been associated with a higher rate of failure.[9]

Although the Eden-Hybinette procedure is an established and proven surgical option for the treatment of anterior shoulder instability with anterior inferior glenoid bone loss, when compared with the Latarjet procedure, there are relatively few studies about it in the literature.[10] Although there are no specific studies about the surgical management of a failed Eden-Hybinette procedure, for the 2 failed cases in our series, which had originally been undertaken for a failed soft-tissue stabilization, we chose to undertake a revision Latarjet procedure.

Malposition of the bone graft on the anterior glenoid has previously been identified as a risk factor for failure, in terms of recurrent instability, and for the development of osteoarthritis. The optimal position for the bone block on the anterior glenoid for a coracoid transfer has previously been investigated. Various studies

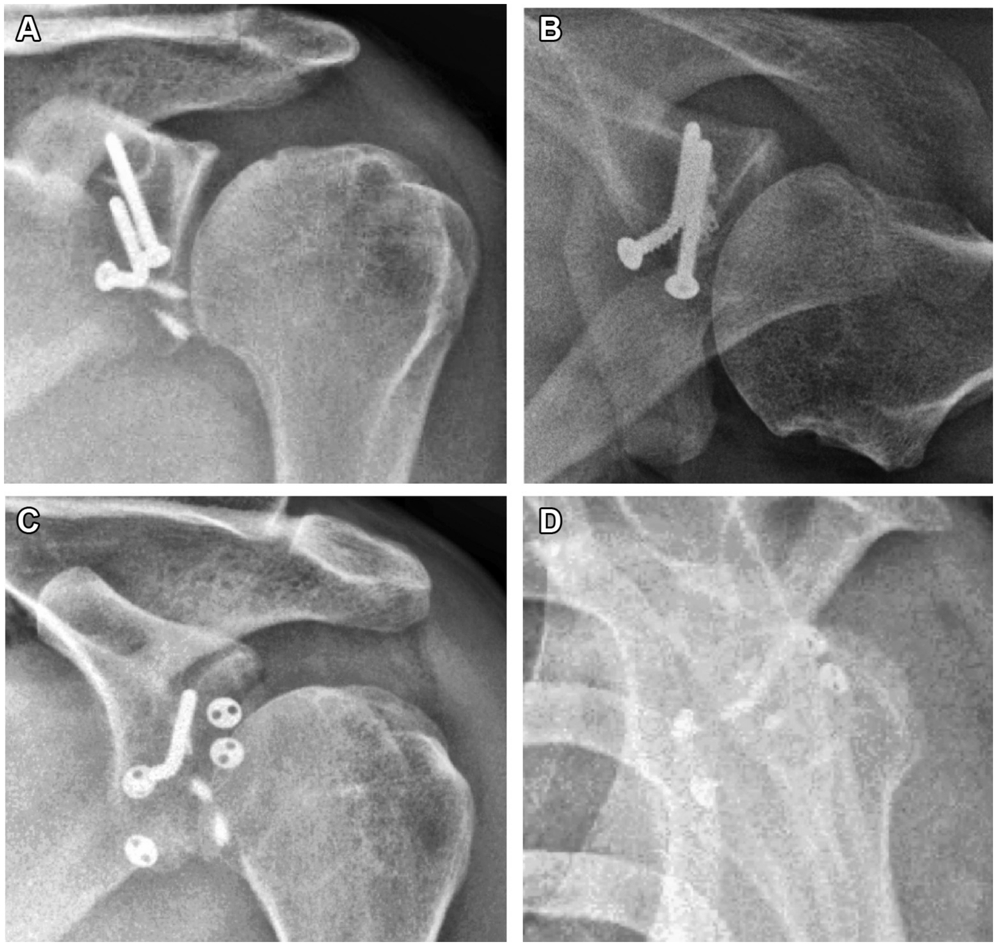

Figure 9 Open coracoid transfer. (**A**, **B**) Preoperative AP and axial plain x-rays demonstrating retained metal suture anchors with an inferior bent and a superior intact screw from a previous Eden-Hybinette procedure. (**C**, **D**) Six-month postoperative anterior oblique and lateral plain x-rays demonstrating the bone graft in the lower quadrant of the glenoid with suture buttons in situ. The bent screw shaft could not be extracted. *AP*, XXX.

have examined this in terms of either the biomechanics of the graft placement or the correlation between clinical outcome and the radiological position of the graft.[3,9,12,15,18,22-24] Although there is no actual defined optimal position, there is a general consensus that the graft should not be placed above the 3 o'clock or below the 5 o'clock position or outside the “glenoid circle,” in terms of the vertical plane.[22] With regard to the horizontal plane, any lateral overhang, which can usually be corrected by burring back the graft at the time of surgery, or medial displacement of more than 5 mm is considered suboptimal.

The difficulty during a revision stabilization with significant retained glenoid metalwork is that the location of the retained metalwork, particularly if there are 2 snapped screw shafts, is generally in the position required for the drill holes to place the graft in an optimal position. Using standard 3.75- or 4.5-mm screws to secure the revision graft and “navigating” these around the retained metalwork is likely to significantly compromise graft placement and result in suboptimal positioning. In addition, at the time of surgery, the ends of the broken screw shafts or metal anchors are often not visible on the anterior glenoid, leading to “blind” drilling and the potential for drill bit breakage.

To avoid these problems, we used a standard suture-button fixation technique and additionally preplanned the drill guide position, to place and secure the graft. The advantage of this technique is that the drill holes in the bone block are positioned using a clamp and drill guide and are 5 mm from the lateral edge. These correspond to the drill holes made in the glenoid using the posterior drill guide and jig, which are 5 mm medial to the articular surface. As a result, the bone block will always be placed correctly on the glenoid with regard to the horizontal plane. Knowing that the standard technique ensures the correct medial-lateral position for the graft, we used coronal and sagittal CT images to calculate and preplan a position for the glenoid drill guide that would avoid the retained metalwork and also position the bone block correctly with regard to the vertical plane. This was further aided by the fact that the drill holes were only 2.8 mm in diameter.

For one of the cases in our series, as well as having retained metal anchors in the glenoid, there was a large bone void measuring 20 mm × 18 mm (Fig. 8). The patient had previously undergone 2 Bankart repairs, the first using metal anchors and the second using biocomposite anchors, a coracoid transfer, with additional biocomposite anchors, and subsequent removal of the screws. We suspect that the bone void was created by a conglomeration of the multiple biocomposite anchors and that it was possibly enlarged further by the drilling and passage of the coracoid transfer screws. A further advantage of the suture-button technique is that the fixation is obtained by the tension and compression created between the buttons either side of the bone block and the posterior cortex of the glenoid. It does not rely on any cancellous bone hold and avoids any fixation compromise from bone voids.[11]

There have been no prior studies on revision bone block procedures in the presence of significant retained glenoid metalwork.

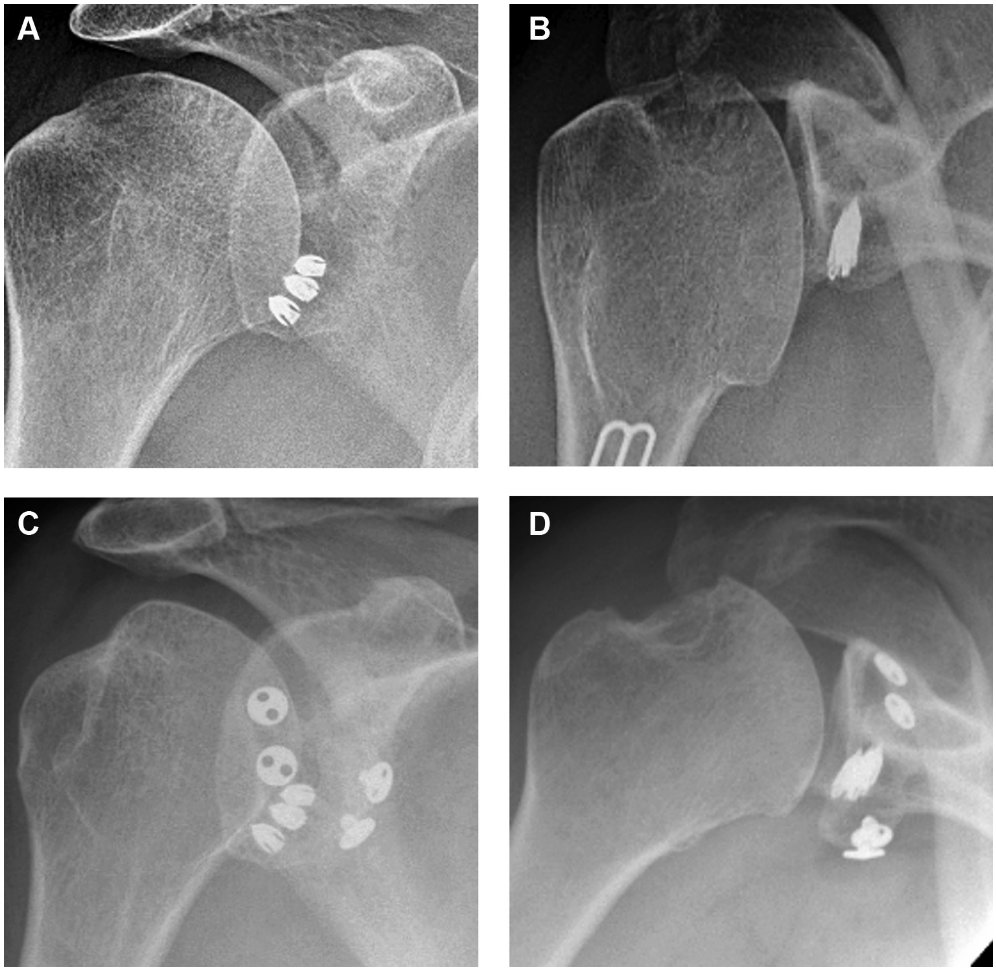

Figure 10 Arthroscopic coracoid transfer. (**A**, **B**) Preoperative AP and axial plain x-rays demonstrating 3 large metal suture anchors clustered closely together in the inferior quadrant of the glenoid. (**C**, **D**) Six-month postoperative AP and axial plain x-rays demonstrating the bone graft in the lower quadrant of the glenoid with suture buttons in situ. *AP*, XXX.

This maybe a reflection that, previously, there has been a relatively high threshold to undertake a bone block procedure for instability and so a rarity of this problem. However, with an increasing trend to undertake bone block procedures as a primary as well as a revision operation, it is likely that there will be an increase in the number of failed stabilizations with significant retained glenoid metalwork.[8,21]

Table II
Functional scores

Patient	OSIS (48-0)		SSV (%)		Stability	Subjective result
	Preop	Postop	Preop	Postop		
1	22	4	60	90	Stable	Excellent
2	29	7	30	75	Stable	Good
3	21	5	50	85	Stable	Good
4	24	3	40	80	Stable	Excellent
5	28	6	31	80	Stable	Good
6	24	5	30	85	Stable	Good
7	32	5	20	80	Stable	Excellent
8	35	14	10	60	Subluxation	Satisfied
9	22	4	30	80	Stable	Good
10	22	5	40	85	Stable	Good
Mean	25.9	5.8	37.1	80		
	$P < .05$		$P < .05$			

OSIS, Oxford Shoulder Instability Score; *SSV*, Subjective Shoulder Value.

The limitations of this study are that it is a retrospective analysis, although we attempted to minimize any recall bias by using prospectively collected data. It is also a single-surgeon series and could, potentially, be susceptible to observer bias as there was no matched cohort group for comparison. In addition, there are only a small number of patients with a minimum follow-up of 24 months. Further studies are required to assess the longer-term results.

Conclusion

Guided suture-button fixation of the bone block during revision anterior stabilization of the shoulder, in the presence of significant retained glenoid metalwork, provides a satisfactory outcome in terms of shoulder stability, graft position, and healing.

Disclaimer

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