Technical Note

Arthroscopic Remnant Coracoid Autograft for Revision of the Failed Latarjet Procedure With Persistent Glenoid Bone Loss

Pascal Boileau, M.D., Ph.D., Prithee Jettoo, M.D., F.R.C.S. (Ortho), and Juan-David Lacouture, M.D.

Abstract: Recurrence of anterior instability after a Latarjet procedure with persistent glenoid bone loss can be related to coracoid bone block resorption, migration, or malposition. Multiple options are available to address anterior glenoid bone loss, including autograft bone transfers (such as iliac crest graft, distal clavicle autograft) or allografts (distal tibia allograft). Here, we present the use of the remnant coracoid process as an option for consideration in the treatment of glenoid bone loss after failed Latarjet procedure with persistent glenoid bone loss. The remnant coracoid autograft is harvested and transferred inside the glenohumeral joint, through the rotator interval, and fixed using cortical buttons. This arthroscopic procedure includes using 1) glenoid and coracoid drilling guides to optimize graft positioning and making the procedure more reproducible and safer and 2) a suture tensioning device to provide intraoperative graft compression and ensure bone graft healing.

Introduction

Recurrence of anterior instability after a Latarjet procedure is rare and can be related to persistent glenoid bone loss because of coracoid bone block resorption, migration, or malposition.[1–5] Multiple options are available to address anterior glenoid bone loss, including auto or allografts[6,7] (Fig 1). Our surgical experience with the arthroscopic iliac crest bone graft (Eden-Hybinette procedure) with use of a suture-button device for graft fixation has been positive.[8,9] However, the need for a second site incision surgery to harvest iliac crest bone graft (ICBG) is cumbersome, lengthening the surgical time and increasing the risk of infection.[10–16] Provencher et al.[16] described using allograft (distal tibia allograft, DTA), while Tokish et al.[17] described a technique of employing a distal clavicle autograft (DCA) as a fresh, osteochondral autograft in the treatment of glenoid bone loss. We developed a modification of this last technique using the undersurface of the distal clavicle autograft (DCA) for restoring glenoid anatomy.[18]

In the present study, we describe an arthroscopic procedure using the remnant coracoid process as a free autograft to reconstruct the glenoid after failed Latarjet procedure with persistent glenoid bone loss. The remnant coracoid autograft (RCA) procedure is performed under arthroscopy and includes 1) using glenoid and coracoid drilling guides to optimize graft positioning and making the procedure technically more reproducible/safer[19,20] 2) using suture buttons to enhance its intra-articular passage of the graft through the rotator interval with the benefits of avoiding hardware problems,[19–21] and 3) using a suture-tensioning device to rigidify the suture, provides intraoperative graft compression, and provides constant bone graft healing.[22,23]

Ethical Approval

The study was performed according to the medical ethical guidelines of our institution, and written,

From ICR — Institut de Chirurgie Réparatrice Locomoteur & Sport, Groupe Kantys, Nice, France

The authors report the following potential conflicts of interest or sources of funding: P.B. reports personal fees from Smith & Nephew and royalties from Stryker Medical, outside the submitted work; he also has a patent issued by Smith & Nephew. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received September 23, 2022; accepted February 12, 2023.

Address correspondence to Pascal Boileau, M.D., Ph.D., ICR - Institut de Chirurgie Réparatrice Locomoteur & Sport, Groupe Kantys, Nice, France. E-mail: pr.boileau@icr-nice.com

2212-6287/221273

https://doi.org/10.1016/j.eats.2023.02.028

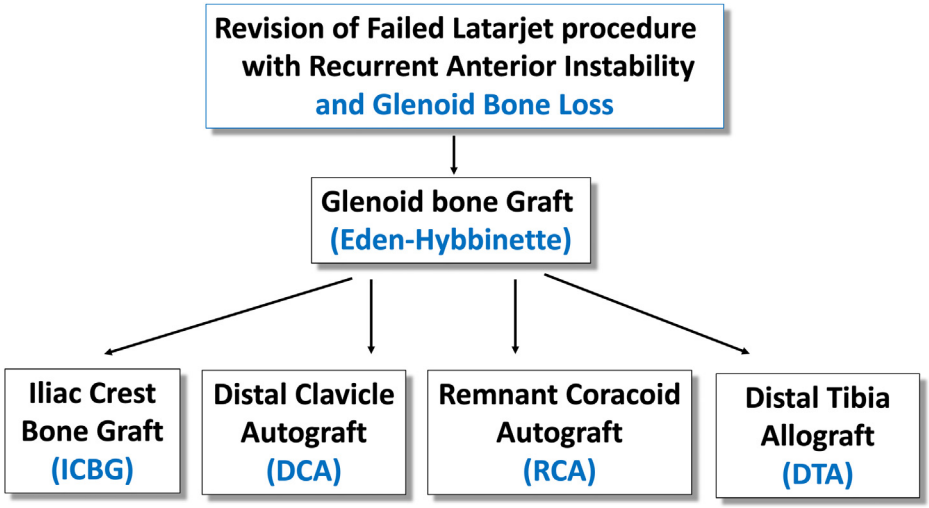

Fig 1. Decision-making process in the presence of glenoid bone loss after a failed Latarjet procedure.

informed consent was obtained for all patients (approval ref: IRB ICR-2021-SA-01-2).

Surgical Technique

The surgical technique is shown in Video 1. The goal of the procedure is restoration of the glenoid surface by harvesting the remnant of the coracoid process (RCP), which is transferred as a free bone graft inside the glenohumeral joint, through the rotator interval, and fixed with cortical buttons (Fig 2).

Arthroscopic Guided System and Cortical Buttons

The instrumentation and cortical buttons used for RCA are the same ones than those used for the arthroscopic Latarjet and Eden-Hybinette procedures.[8,20,21] The instruments (Latarjet Guiding System, Smith & Nephew, Andover, MA) and implants have been developed by the senior author (P.B.) and are commercially available. The fixation device (Osteoconnect; Smith & Nephew, Andover, MA) consists of 2 purpose-designed titanium cortical buttons with a no. 3-4 ultrahigh-molecular-weight polyethylene suture sling running through them.

Positioning and Portal Establishment

The patient is placed in the "lazy" beach chair position (at 30° of head elevation) to facilitate cerebral perfusion, and the arm is placed in a mobile holder (Spider Limb Positioner, Smith & Nephew, Andover, MA) without traction. The arthroscope is introduced in a standard posterior viewing portal. A complete diagnostic arthroscopy is performed, and the glenoid bone loss is confirmed. Three other portals are usually needed: lateral (North-West, anterolateral (West) and anteromedial (North).

Step 1. Opening of the Rotator Interval and Exposure of the Remnant Coracoid Process

With the scope in the posterior portal, the rotator interval is fully opened with either a motorized shaver (Smith & Nephew, Andover, MD) and/or a radio

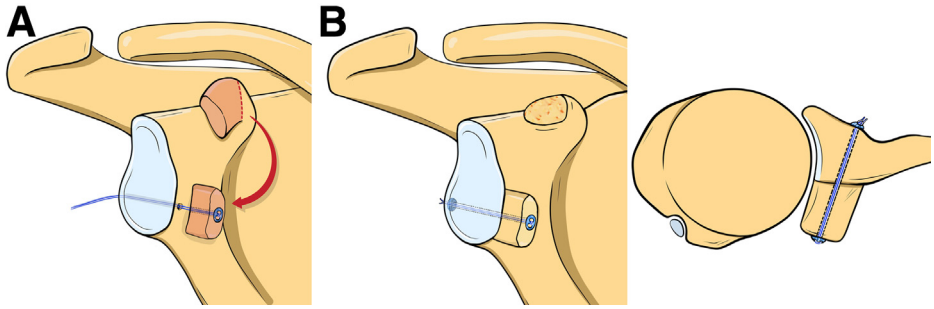

Fig 2. Anterior glenoid bone reconstruction using a remnant coracoid autograft (RCA). (A) After arthroscopic large opening of the rotator interval, the remnant of the coracoid process is dissected, harvested, and transferred (arrow) inside the glenohumeral joint (en face view). (B) The free coracoid bone graft is fixed with 2 cortical-buttons (en face and axial views); a suture tensioner is used to rigidify the suture and provide bone graft compression.

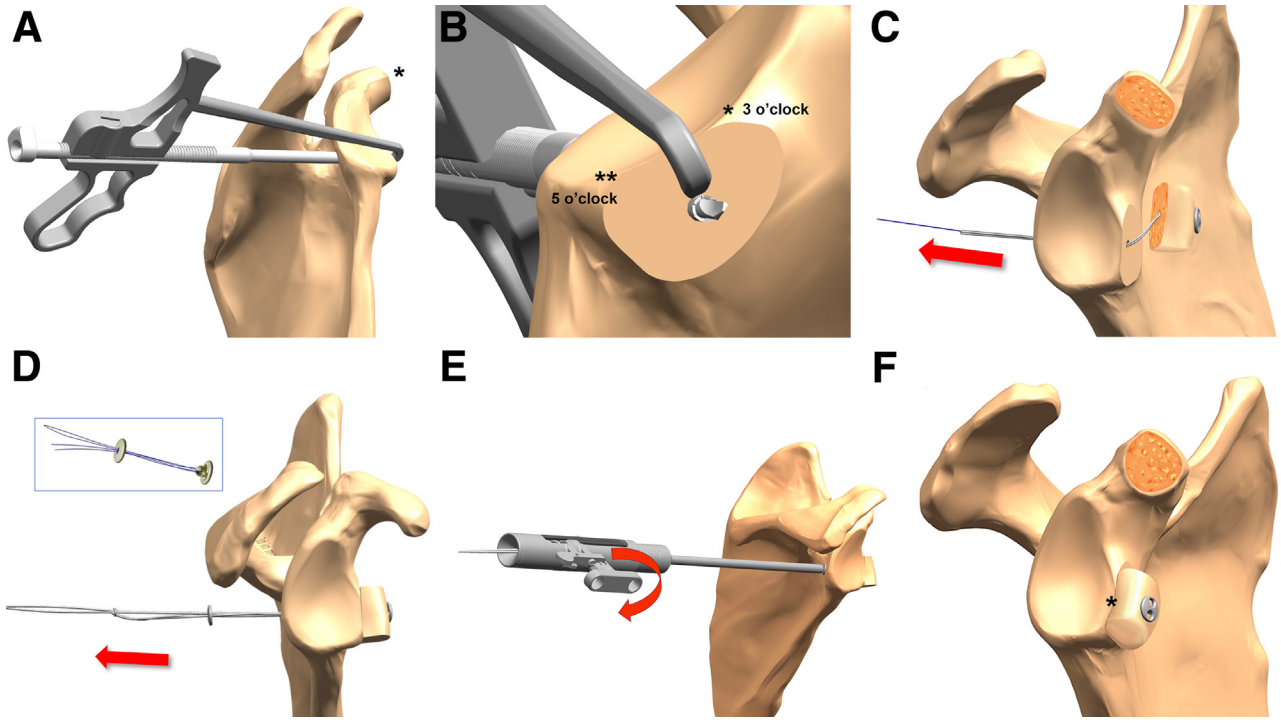

Fig 3. Arthroscopic remnant coracoid autograft (RCA) using a guided technique and suture-button fixation for revision of failed Latarjet procedure. (A) The tip of the coracoid is absent (*), but there is still some remnant of the coracoid process that can be harvested and used as a bone graft; after abrasion of the anterior scapular neck, the glenoid is drilled from posterior to anterior, using a specific drill guide (Smith & Nephew) and K-wire. (B) The drilled hole diameter €s small (2.8 mm) and located 5 mm medial to the glenoid rim at 4 o'clock (between the 2 suture anchors located at 3 (*) and 5 o'clock (**). (C) The RCA is osteotomized and drilled (either inside or outside the shoulder), and the bone graft is shuttled through the rotator interval and brought toward the anterior glenoid neck (arrow). (D) The posterior holed button is slid on the suture, and a sliding-locking knot (Nice knot) is tied. By pulling posteriorly on the suture, the button is shuttled inside the shoulder. € After control of the bone block rotation and position, a suture-tensioning device (Smith & Nephew) is used to rigidify the suture and obtain bone graft compression (100 N × 3 times), clockwise ratcheting of suture tensioner (arrow). (F) Final aspect showing the new bone graft located at 4 o'clock (*) and flush to the articular surface.

frequency ablation (RFA) device (Smith & Nephew). This step is crucial to facilitate the later transfer of the RCA into the glenohumeral joint. Insufficient opening of the rotator interval can make this step difficult or even impossible. Still using the RFA device, a dissection is performed to expose the remnant of the coracoid process (RCP). Attention is then turned onto the glenohumeral joint.

Step 2. Glenoid Preparation and Drilling

The anterior labrum is elevated with the radio frequency device, and the glenoid neck is prepared to a flat cancellous surface using a motorized power rasp (Smith & Nephew, Andover, MA) or a burr (Stone-cutter Smith & Nephew, Andover, MA). Two suture-anchors (FAST-FIX, Smith & Nephew, Andover, MA) are inserted at 3 o'clock and 5 o'clock in preparation of the labral repair at the end of the procedure; they also serve as a landmark for graft positioning. A PDS suture is passed through the labrum at 5 o'clock and used to retract the labrum laterally and to create a pouch; this will facilitate the later introduction of the bone graft on the glenoid neck.

The scope is moved to the anterolateral portal. This anterolateral portal (North-West) portal must be chosen with the help of a spinal needle to ensure a strictly orthogonal position to the base of the remnant coracoid process. Looking with the scope inside the glenohumeral joint, the glenoid guide (Smith & Nephew, Andover, MA) is introduced over a half-pipe through the posterior portal. The glenoid guide must be flush to the glenoid surface and should hook the glenoid rim at the 4 o'clock position (Fig 3). A specific 2.8-mm cannulated drill bit with an outer sleeve (Smith & Nephew) is drilled through the guide across the glenoid and visualized emerging through the front of the glenoid neck. The guide is removed, and the drill K-wire is left in situ.

Step 3: Remnant Coracoid Process Osteotomy and Drilling

The osteotomy of the remnant coracoid process (RCP) is performed using either a 0.5-mm, high-speed

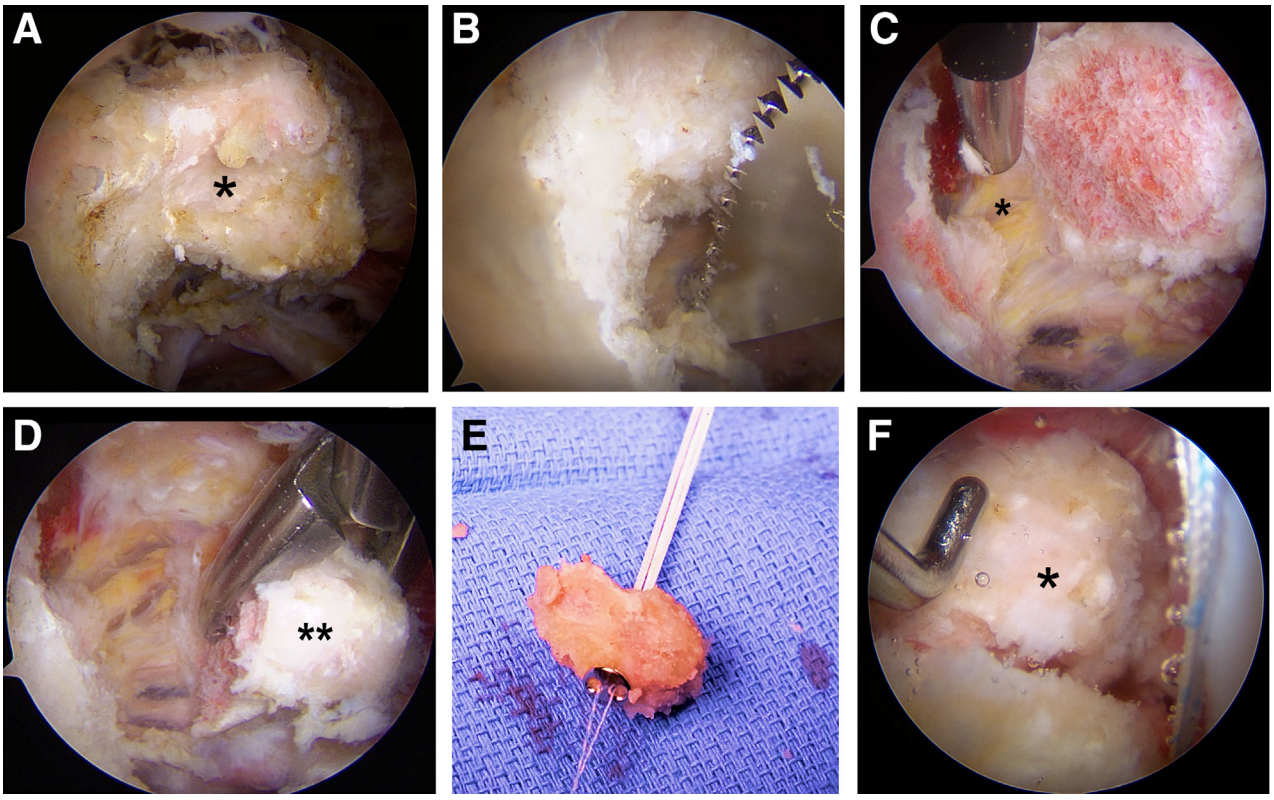

Fig 4. Arthroscopic views showing remnant coracoid autograft (RCA) for reconstruction of the glenoid surface after a failed Latarjet procedure. (A) Arthroscopic dissection and complete exposure of the remnant coracoid process (RCP). (B) A motorized saw blade (or a burr) is used to perform an osteotomy of the RCP. (C and D) After complete detachment of the remaining soft tissues (*) with a radiofrequency device, the RCP (**) is caught with a grasper to be exteriorized. The free graft is drilled, and a suture-button is used to transfer the graft inside the glenohumeral joint and fix it to the glenoid. (F) The free graft (*) is placed flush to the glenoid and under the equator (a suture tensioner is used to put the bone graft under compression and ensure healing).

oscillating saw (Fig 4) or a burr (Stone-cutter, Smith & Nephew). The bone cut is made with a slight obliquity for adaptation later to the obliquity of the anterior scapular neck. The drilling of the RCP graft is performed with the help of a specific three-arm guide (coracoid drill guide; Smith & Nephew) either inside the shoulder or outside after exteriorization of the bone block with a grasper. The coracoid guide is used to clamp the RCP and create a tunnel through the bone block. A second (2.8 mm) cannulated drill bit (Smith & Nephew) is drilled through the guide in the graft and used to pass a PDS suture.

Step 4: RCA Transfer and Fixation

The PDS suture is used to shuttle the suture tail ends of the peg-button implant (Osteo-Connect, Smith & Nephew, Andover, MA) through the free bone graft. The PDS lead suture is then passed through the rotator interval with the help of a grasper, while a suture-retriever, passed through the cannulated sleeve of the glenoid, is used to catch it. The free bone graft is passed through the rotator interval and advanced to congruently match the subequatorial anteroinferior glenoid bone loss. Once the PDS suture is exteriorized posteriorly, the glenoid outer sleeve is removed. The PDS suture is used to shuttle the suture tail ends of the peg-button implant through the glenoid.

The posterior button is then slid along the loop suture exiting posteriorly and a sliding-locking knot (Nice knot)[24] is tied at the back of the shoulder. Gentle traction is placed on the suture, bringing the posterior button on the cortex of the posterior glenoid neck, while a grasper is used to direct and guide the graft through the rotator interval.

The RCA is sited on the anterior glenoid neck with its osteotomized cancellous side facing the glenoid neck. Using a probe, the graft is placed flush with the articular glenoid surface (Fig 4). Intraoperative bone graft compression is achieved with the help of a suture tensioner (Smith & Nephew). A force of 100 N is applied 3 times to the Osteo-Connect device Pretension (100 N) allows removal of suture creeping, tension (100 N) provides knot tightening, and overtension (100 N) provides graft compression. The tensioning device is removed, and three additional square knots are tied to lock the construct, and the

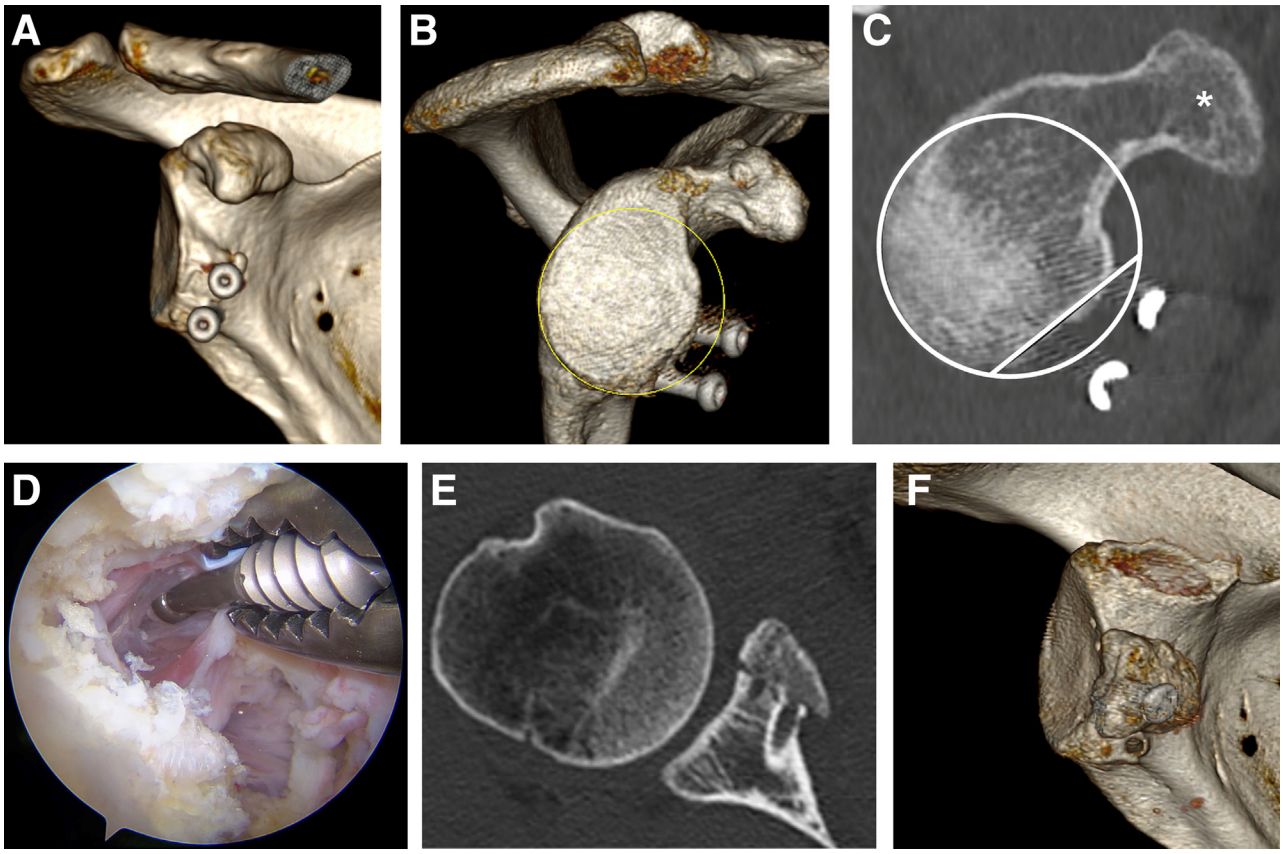

Fig 5. Example of remnant coracoid autograft (RCA) for failed open Latarjet with complete coracoid bone block lysis. (A and B) Three-dimensional CT scans images of a right shoulder showing the complete coracoid bone block lysis with prominent screws. € Two-dimensional CT scan images show severe (>20%) glenoid bone loss and remnant of the coracoid process (*) of sufficient size to be used as a new bone graft. (D) Arthroscopic intra-articular view showing screw removal. € Postoperative axial CT scan view showing glenoid reconstruction with accurate positioning of the new bone graft flush to the glenoid surface. (F) Postoperative 3D CT scan confirms perfect positioning of RCA.

suture-ends are cut short with an arthroscopic suture cutter. At the end of the procedure, the bone graft is securely positioned on the anterior glenoid, flush to the articular cartilage and below the equator.

Step 5: Bankart Repair

Once the graft is firmly fixed in place, the labrum is reinserted to the native glenoid rim with the two suture anchors previously inserted, placing the graft in an extra-articular position.

Postoperative Management

Early passive motion is allowed. Postoperative radiographs and CT scan images are performed to assess new coracoid bone graft positioning and healing (Figs 5 and 6).

Discussion

Recurrence of anterior shoulder instability after a failed Latarjet procedure is often related to persistent glenoid bone loss secondary to coracoid bone graft migration/resorption (Fig 5) or malposition[25,26] (Fig 6). Our surgical experience shows that glenoid reconstruction with remnant coracoid autograft (RCA) is a viable and highly effective revision procedure to treat this challenging group of patients.

Arthroscopy allows successful reconstruction of the anterior glenoid rim and simultaneous treatment of all associated instability lesions (capsular deficiency and humeral bone loss).[27,28] The technique can be performed open and because the RCA is a free graft, it can be used for posterior bone loss as well. Pearls and pitfalls of the surgical technique are summarized in Table 1.

The remnant coracoid autograft (RCA) has some distinct advantages over the other options. First, the graft is a free autograft and readily available. Second, the graft is located inside the shoulder, and there is no donor site morbidity, as seen in other autograft harvests. There is no need for a second site incision like with ICBG.[12,14,15] Third, the graft greatly decreases the cost and logistical hassles with allografts.[16] Fourth, the graft is inserted inside the joint through the rotator interval, which

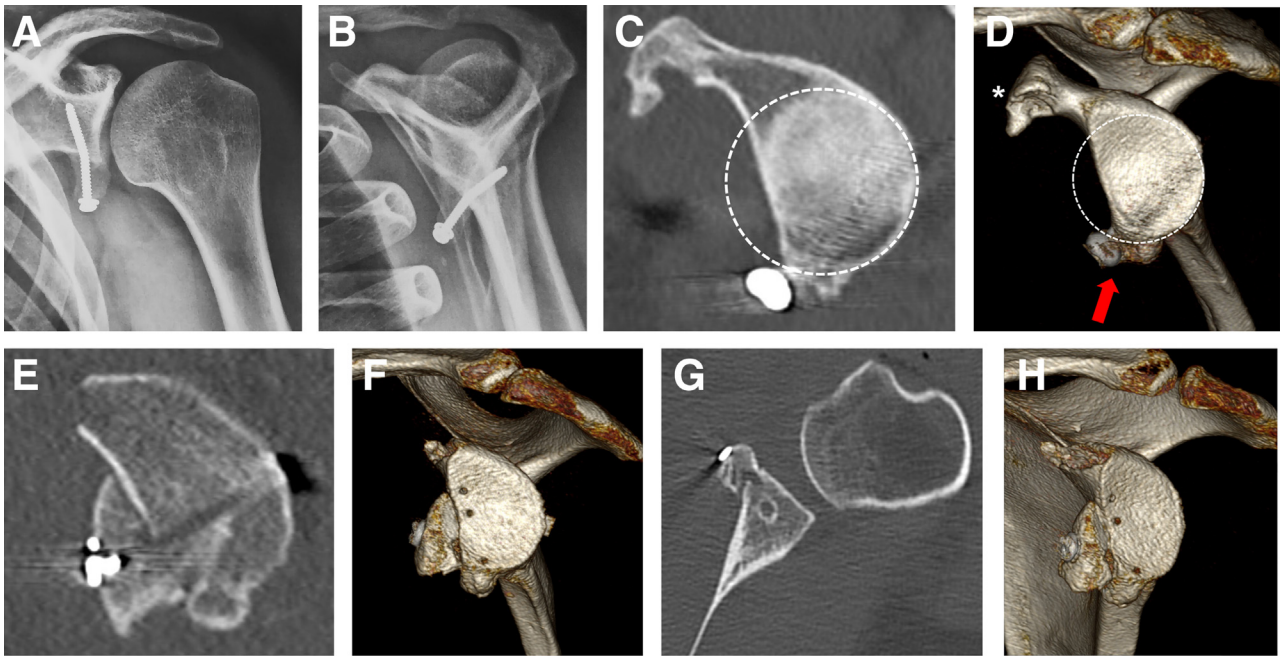

Fig 6. Example of remnant coracoid autograft (RCA) for failed Latarjet with persistent glenoid bone loss related to low coracoid placement. (A and B) Preoperative anterior posterior and lateral radiographs of a left shoulder showing too low coracoid bone block with a bended screw because of recurrent dislocations. (C and D) Preoperative two-dimensional and three-dimensional CT scan images showing low coracoid transfer placement (arrow), severe anterior glenoid bone loss (>20%), and sufficient remnant of coracoid process (*) to be used as a new bone graft. (E and F) Postoperative CT scan images showing anatomic glenoid reconstruction after screw removal and transfer of RCA. (G and H) The new bone block, fixed with cortical buttons, is flush with the glenoid surface and between 3 and 5 o'clock.

obviates the need to split the subscapularis.[21,29] This makes the procedure easier and safer.

A potential disadvantage of the RCA is the limited graft size, as part of the coracoid has already been harvested. We highlight the importance of preoperative CT scan evaluation to assess the size of the glenoid bone loss and the available size of the remnant of the coracoid process (Figs 5 and 6). It has been shown that a 10-mm bone graft is sufficient to reconstruct up to 30% bone loss.[17] For the larger bone defect, we would consider using a DCA or ICBG in the failed Latarjet cases.[8,18] Another potential disadvantage is that the osteotomy of the coracoid process could potentially damage of the coracoclavicular ligaments. However, so far, we did not observe any AC joint dislocation in the four patients that we operated. A further drawback of

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
Large opening of the rotator interval is important for easy passage of the autograft. Insufficient opening can make further steps difficult or impossible.	The RCP autograft is of limited size, preoperative evaluation of glenoid loss and residual coracoid graft size are important.
A powered rasp is used to improve a uniformly flat anterior glenoid neck, and a powered saw is used to perform the coracoid osteotomy.	Obtain the correct obliquity for cutting the remnant coracoid process autograft to match the glenoid inclination.
Positioning suture anchors at 3 o'clock and 5 o'clock represents landmarks for successive graft positioning; they will used for further Bankart repair.	
Use of the guided technique for glenoid tunnel and coracoid graft preparation allows placement of the graft flush to the glenoid surface.	
Use of the suture tensioner provides bone graft compression and enhances healing.	
A Bankart repair is performed and if a large or deep Hill-Sachs lesion is present, an additional remplissage is performed.	

RCP, remnant of the coracoid process.

Table 2. Advantages and Disadvantages of the RCA Procedure

Advantages	Disadvantages
Convenient local availability of a free autograft	Potential limited graft size
No donor site morbidity (no second site incision needed)	Theoretical risk of damaging coracoclavicular (CC) ligaments
No cost for the bone graft	Lack of articular cartilage
No need to split the subscapularis (no risk of neurologic complications)	
The procedure is all-arthroscopic and uses standard portals. It can be accomplished with the skills already possessed by most arthroscopic surgeons.	
The use of cortical buttons simplifies graft transport and eliminates risk of hardware and neurologic complications.	
The guided technique optimizes bone graft placement and increases safety drilling of the glenoid from posterior to anterior allows, staying inside the glenohumeral joint and eliminating risk of neurovascular complications, avoiding work close to the brachial plexus.	

RCA, arthroscopic remnant coracoid autograft.

the RCA is the lack of articular cartilage. However, we perform a Bankart repair with suture anchors, placing the graft in an extra-articular position and preventing direct contact between the humeral head and graft. Furthermore, some recent studies suggest that a fibrous or pseudo-cartilaginous joint surface may regularly develop on the articular surface of bone autografts.[30] Advantages and disadvantages of the surgical technique are summarized in Table 2.

In summary, RCA is a viable and highly effective revision procedure to treat recurrent anterior shoulder instability after a failed Latarjet procedure with persistent anterior glenoid bone loss due to coracoid graft resorption, migration, or misplacement. RCA is a promising option that avoids donor site morbidity, is cost effective, and allows reconstruction of significant (>20%) glenoid bony defects. If the size of the remnant of coracoid process is big enough, RCA is our first-line option (rather than ICBG, DCA, or DTA) for treating glenoid bone loss after failed Latarjet or Eden-Hybinette procedures. Our arthroscopically guided RCA procedure using suture-buttons for graft fixation potentially simplifies the treatment of a very difficult clinical problem.

References

1. Butt U, Charalambous CP. Complications associated with open coracoid transfer procedures for shoulder instability. *J Shoulder Elbow Surg* 2012;21:1110-1119.
2. Griesser MJ, Harris JD, McCoy BW, et al. Complications and re-operations after Bristow-Latarjet shoulder stabilization: A systematic review. *J Shoulder Elbow Surg* 2013;22:286-292.
3. Lemmex D, Cárdenas G, Ricks M, Woodmass J, Chelli M, Boileau P. Arthroscopic management of anterior glenoid bone loss. *JBJS Rev* 2020;8:e0049.
4. Mizuno N, Denard PJ, Raiss P, Melis B, Walch G. Long-term results of the Latarjet procedure for anterior instability of the shoulder. *J Shoulder Elbow Surg* 2014;23:1691-1699.
5. Shah AA, Butler RB, Romanowski J, Goel D, Karadagli D, Warner JJP. Short-term complications of the Latarjet procedure. *J Bone Joint Surg Am* 2012;94:495-501.
6. Tytherleigh-Strong GM, Morrissey DI. Failed Latarjet procedure treated with a revision bone block stabilization using a suture-button fixation. *J Shoulder Elbow Surg* 2017;26:e102-e107.
7. Giannakos A, Vezeridis PS, Schwartz DG, Jany R, Lafosse L. All-arthroscopic revision Eden-Hybinette procedure for failed instability surgery: Technique and preliminary results. *Arthroscopy* 2017;33:39-48.
8. Boileau P, Duysens C, Saliken D, Lemmex DB, Bonnevialle N. All-arthroscopic, guided Eden-Hybbinette procedure using suture-button fixation for revision of failed Latarjet. *J Shoulder Elb Surg* 2019;28:e377-e388.
9. Eden R. Zur Operation der habituellen Schulterluxation unter Mitteilung eines neuen verfahrens bei Abrißam inneren Pfannenrande. *Dtsch Zeitschrift für Chir* 2008;144:269-280.
10. Ahlmann E, Patzakis M, Roidis N, Shepherd L, Holtom P. Comparison of anterior and posterior iliac crest bone grafts in terms of harvest-site morbidity and functional outcomes. *J Bone Joint Surg Am* 2002;84:716-720.
11. Kraus N, Amphansap T, Gerhardt C, Scheibel M. Arthroscopic anatomic glenoid reconstruction using an autologous iliac crest bone grafting technique. *J Shoulder Elbow Surg* 2014;23:1700-1708.
12. Dimitriou R, Mataliotakis GI, Angoules AG, Kanakaris NK, Giannoudis PV. Complications following autologous bone graft harvesting from the iliac crest and using the RIA: A systematic review. *Injury* 2011;42:S3-S15 (Suppl 2).
13. Lunn JV, Castellano-Rosa J, Walch G. Recurrent anterior dislocation after the Latarjet procedure: outcome after revision using a modified Eden-Hybinette operation. *J Shoulder Elbow Surg* 2008;17:744-750.
14. Myeroff C, Archdeacon M. Autogenous bone graft: donor sites and techniques. *J Bone Joint Surg Am* 2011;93:2227-2236.
15. Warner JJP, Gill TJ, O'hollerhan JD, Pathare N, Millett PJ. Anatomical glenoid reconstruction for recurrent anterior glenohumeral instability with glenoid deficiency using an autogenous tricortical iliac crest bone graft. *Am J Sports Med* 2006;34:205-212.
16. Provencher MT, Peebles LA, Aman ZS, et al. Management of the failed Latarjet procedure: Outcomes of revision surgery with fresh distal tibial allograft. *Am J Sports Med* 2019;47:2795-2802.
17. Tokish JM, Fitzpatrick K, Cook JB, Mallon WJ. Arthroscopic distal clavicular autograft for treating shoulder instability with glenoid bone loss. *Arthrosc Tech* 2014;3:e475-e481.

18. Boileau P, Baring T, Greco V. Arthroscopic distal clavicular autograft for congruent glenoid reconstruction. *Arthrosc Tech* 2021;10:e2389-e2395.
19. Gendre P, Thélu C-E, d'Ollonne T, Trojani C, Gonzalez J-F, Boileau P. Coracoid bone block fixation with cortical buttons: An alternative to screw fixation? *Orthop Traumatol Surg Res* 2016;102:983-987.
20. Boileau P, Saliken D, Gendre P, et al. Arthroscopic Latarjet: Suture-button fixation is a safe and reliable alternative to screw fixation. *Arthroscopy* 2019;35:1050-1061.
21. Boileau P, Gendre P, Baba M, et al. A guided surgical approach and novel fixation method for arthroscopic Latarjet. *J Shoulder Elbow Surg* 2016;25:78-89.
22. Boileau P, Gendre P, Saliken DJ, Thélu CÉ, Trojani C. Tensioning device increases coracoid bone block healing rates in arthroscopic Latarjet procedure with suture-button fixation. *J Shoulder Elbow Surg* 2022;31:1451-1462.
23. Barret H, Chelli M, Van Der Meijden O, Langlais T, Boileau P. Arthroscopic Latarjet: 2 or 4 Cortical buttons for coracoid fixation? A case-control comparative study. *Am J Sports Med* 2022;50:311-320.
24. Rumian A, Trojani C, Boileau P, Seidl AJ, Schwartz DG, Alami G. The doubled-suture Nice knot. *Orthopedics* 2017;40:e382-e386.
25. Young DC, Rockwood CAJ. Complications of a failed Bristow procedure and their management. *J Bone Joint Surg Am* 1991;73:969-981.
26. Gartsman GM, Waggenspack WNJ, O'Connor DP, Elkousy HA, Edwards TB. Immediate and early complications of the open Latarjet procedure: A retrospective review of a large consecutive case series. *J Shoulder Elbow Surg* 2017;26:68-72.
27. Lavoué V, Gendre P, Saliken D, Brassac A, Boileau P. The role of arthroscopic soft tissue reconstruction for failed Bristow-Latarjet procedure. *Arthroscopy* 2019;35:2581-2588.
28. Athwal GS, Meislin R, Getz C, Weinstein D, Favorito P. Short-term complications of the arthroscopic Latarjet procedure: A North American experience. *Arthroscopy* 2016;32:1965-1970.
29. Hassebrock JD, Starkweather JR, Tokish JM. Arthroscopic technique for bone augmentation with suture button fixation for anterior shoulder instability. *Arthrosc Tech* 2020;9:e97-e102.
30. Auffarth A, Resch H, Matis N, et al. Cartilage morphological and histological findings after reconstruction of the glenoid with an iliac crest bone graft. *Am J Sports Med* 2018;46:1039-1045.