Technical Note

Suture Button Congruent Arc Latarjet Procedure in the Treatment of Recurrent Anterior Shoulder Instability With Glenoid Bone Loss Greater Than 25%

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Abstract: It is generally believed that glenoid bone loss (GBL) greater than 25% can be defined as a massive GBL. For this type of recurrent anterior shoulder instability, the traditional Latarjet technique is usually inadequate to restore the GBL. Although the congruent arc Latarjet technique is able to reconstruct a wider glenoid defect with good clinical outcomes, this technique had not been widely applied due to the limited bone width of the coracoid graft and high rate of coracoid osteotomy and screw fixation–related complications. The emerging suture button flexible fixation technique has been proven to achieve good clinical outcomes and is technically friendly. It can significantly reduce the requirements for large coracoid graft bone mass, and the Latarjet procedure's application scope is expanded. We introduce the suture button congruent arc Latarjet technique for treatment of massive GBL in this Technical Note.

The Latarjet procedure has been the gold standard for the treatment of recurrent anterior shoulder instability (RASI) for 70 years.[1] However, due to the considerable morphologic difference between the reverse banana-shaped structure of the coracoid process (CP) and the edge glenoid defect in the traditional Latarjet procedure, both sides of the coracoid graft (CG) need to be decorticated to match the glenoid defect. Even if the entire CP is harvested, it may not be sufficient to restore the defect, especially for those with an inverted pear shape with over 25% glenoid bone loss (GBL), which is defined as massive GBL (MGBL). In 2010, the congruent arc Latarjet technique was first proposed by de Beer et al.[2] The open congruent arc Latarjet procedure has been proven to achieve good clinical outcomes and less arthritis, even in MGBL cases.[2] However, the biggest disadvantage of the traditional screw fixation congruent arc Latarjet technique is the high risk of cortical bone broken during bone tunnel drilling due to the limited bone width of the CP.[3] The suture button fixation Latarjet procedure by Boileau et al.[4] not only yields good clinical and radiologic outcomes but also requires only a 2.0-mm coracoid bone tunnel for fixation, and therefore, it may completely avoid complications of bone splitting caused by screw fixation in the congruent arc Latarjet procedure. In this Technical Note, we introduce the suture button congruent arc Latarjet technique in the treatment of RASI with MGBL (≥25% GBL) combined with our modified suture button fixation technique (LUtarjet procedure) (Fig 1), which not only restored the integrity of the glenoid but also remodeled it into the perfect-fitting circle (PFC) mirroring the healthy side.[4,5]

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Surgical Technique

Step 1: Preoperative Design

Three-dimensional computed tomography is performed to outline the CP of the bilateral shoulder joints preoperatively (Video 1). According to the PICO technique,[4] the PFC of the affected side can be determined from the en face view mirrored to the healthy side. The proportion of the GBL and the size and shape of the glenoid defect arc (GDA) can be measured based on the glenoid of the healthy side (Fig 2). According to our previous publication, the CP's length, width, and

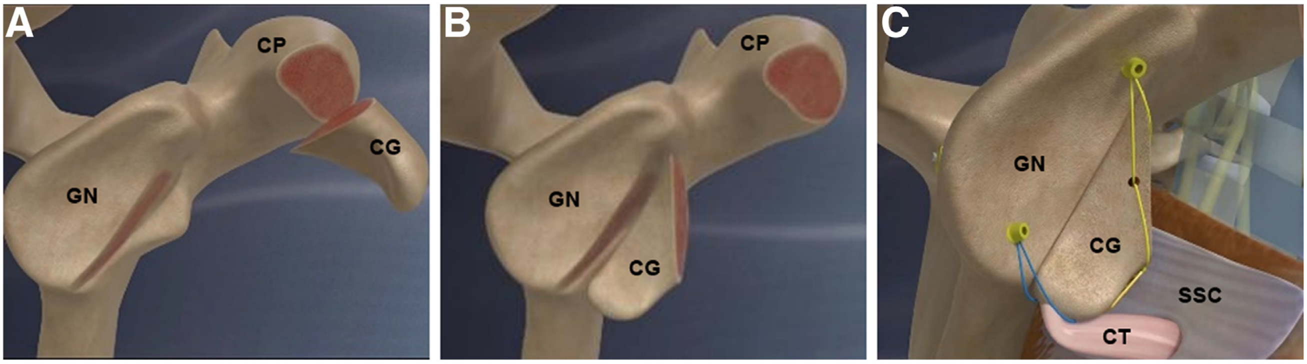


Fig 1. Schematic of suture button congruent arc Latarjet procedure in a three-dimensional model of the glenoid (right side). (A) The CG is harvested and the defect glenoid is refreshed to adapt to the CG's long axis. (B) The CG is flipped upside down and transferred to the glenoid defected surface. (C) The CG is fixed with a suture button. (CG, coracoid graft; CP, coracoid process; GN, glenoid; SSC, subscapularis.)

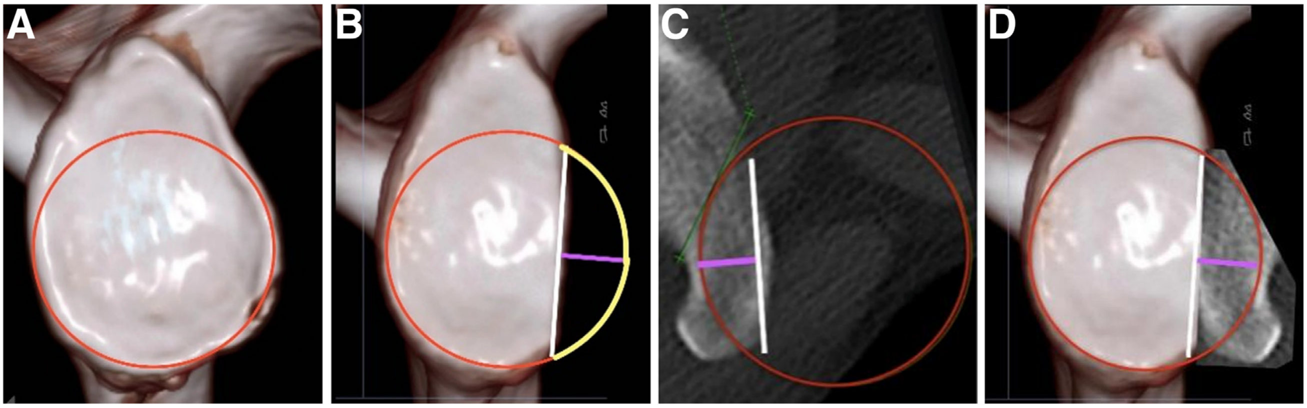
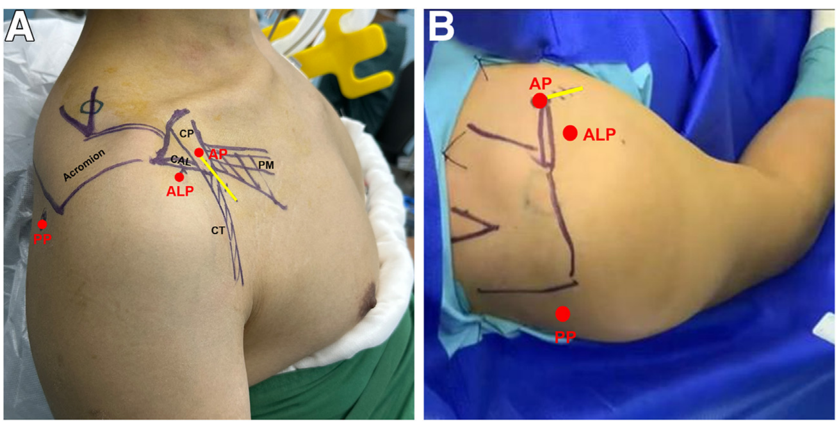


Fig 2. Preoperative GBL and PFC measurement of the glenoid (PICO technique) and coracoid osteotomy level design. (A) Preoperative mirror image of the normal side glenoid (en face view). The red circle indicates the PFC. (B) GDA measurement. The white line indicates the needed length of the graft, the purple line indicates width of the GBL, and area in the yellow arc and the white line indicate the GDA. (C) The largest GBL that the CG could cover. Green lines indicate the coracoid osteotomy level. (D) Simulation of glenoid reconstruction: the harvested area is reversed and fitted to restore the GDA.

Fig 3. (A) The patient is placed in the beach-chair position, and (B) surgical approach is marked on a right shoulder. The yellow line indicates the coracoid osteotomy skin incision. (ALP, anterolateral portal; AP, anterior portal; CAL, coracoacromial ligament; CP, coracoid process; CT, conjoint tendon; PM, pectoralis minor; PP, posterior portal.)



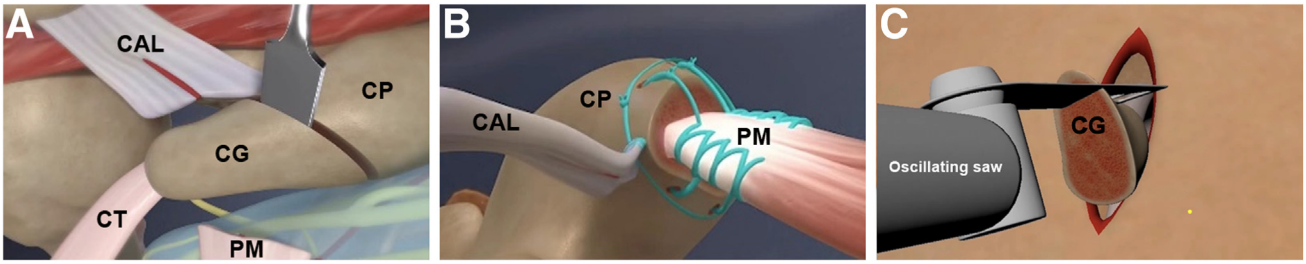


Fig 4. Schematic diagram of a coracoid osteotomy. (A) After exposure, the CP, CAL, and PM are detached, and then the CG is harvested. (B) The CAL and the PM are sutured to the remaining CP. (C) The CG is decorticated. (CAL, coracoacromial ligament; CG, coracoid graft; CP, coracoid process; CT, conjoint tendon; PM, pectoralis minor.)

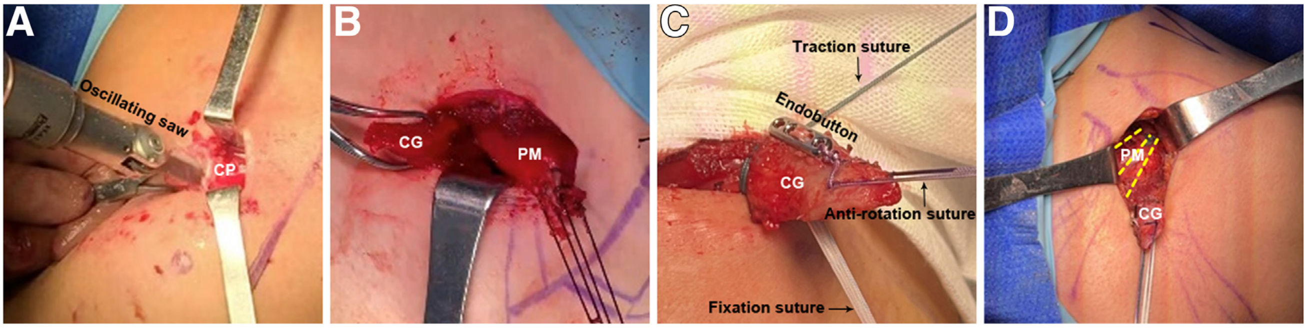


Fig 5. Coracoid osteotomy and CG suture button configuration. (A) Coracoid osteotomy is performed using an oscillating saw. (B) The detached PM is sutured for later reconstruction. (C) CG suture button configuration. (D) The PM is sutured to the remaining CP. The yellow dotted line indicates the reconstructed PM. (CG, coracoid graft; CP, coracoid process; PM, pectoralis minor.)

thickness are measured on 2-dimensional computed tomography images, and a preoperative design of the partial coracoid osteotomy level is made in each case.[5] Reference data for CG size include length = glenoid defect side length, width = the length between the vertex of the PFC and glenoid defect side, and thickness of at least 6 mm (usually 2 mm larger than the real glenoid defect width, given possible bone resorption).

Step 2: Patient Position and Surgical Portals

The patient is placed in the beach-chair position, and general anesthesia is given combined with interscalene block. The upper limb is placed in the neutral position. The bony markers of the shoulder joint and the surgical approaches are marked. The CG graft harvest skin incision via the anterior portal (A portal) and 2 other portals (namely, the anterior lateral portal [AL portal] and posterior portal [P portal]) is needed to complete the whole procedure (Fig 3).

Step 3: Coracoid Osteotomy

A 25-mm incision is made on the surface of the CP. The coracoacromial ligament (CAL) and pectoralis minor (PM) are identified. The PM fibers are separated from the medial side of the CP by radiofrequency (RF). The length, width, and thickness of the CP are measured under direct vision, and the coracoid osteotomy line is marked on the surface of the CP according to the preoperative design. An oscillating saw is used to cut the CP downward along the designated coracoid osteotomy level (Fig 4A and Fig 5A). The remaining proximal length of the CP can be used for PM suturing (Fig 4B and Fig 5 B and C). The CG is usually a triangular arc block facing the lower face, and then the medial side of the CG is decorticated using an oscillating saw (Fig 4C).

Step 4: CG Suture Button Configuration

The CG is grasped outside the incision. A traction suture is placed at the junction of the conjoint tendon (CT) and the CP. The CT is separated downward using the index finger until the CT pedicle is 5 to 6 cm long. A 2.0-mm central tunnel (C tunnel) is made perpendicularly in the center of the osteotomy plane of the CP. An Endobutton (Smith & Nephew) is placed on the other side (Fig 6A). Three high-strength sutures (Smith & Nephew) are put through the Endobutton and graft bone tunnels for later fixation (fixation sutures). A 1.5-mm side tunnel (A tunnel), perpendicular to the C tunnel, is drilled 3 mm away from the distal end of the graft, which is used for passage of an antirotation suture (Fig 6B). A high-strength suture is pulled through the side hole of the Endobutton, and the 2 ends of the suture are crossed through the holes on either side of the A tunnel, respectively (Fig 5D and Fig 6C).

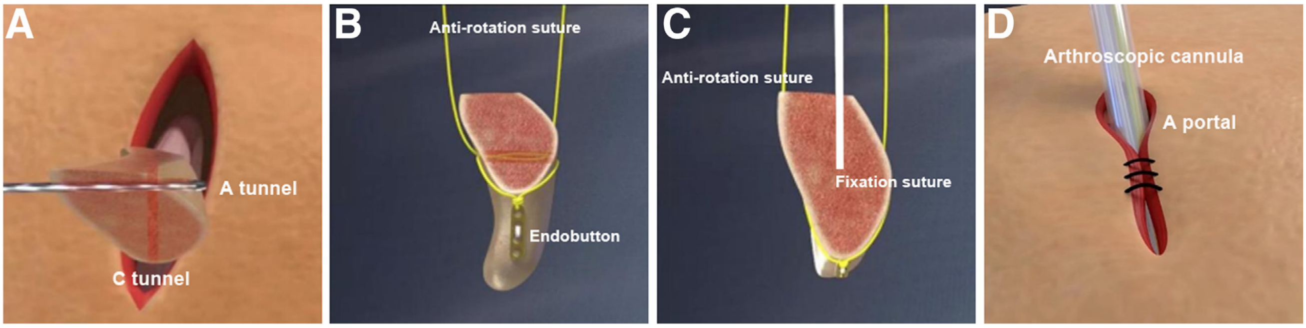


Fig 6. Schematic diagram of CG suture button configuration. (A) Creation of antirotation suture tunnel (A tunnel) and central tunnel (C tunnel) for fixation sutures in the Endobutton. (B) Endobutton position and antirotation suture threading in the CG. (C) The antirotation suture and 2 fixation sutures in the CG. (D) An arthroscopic cannula is inserted, and then the coracoid skin incision is closed, serving as an arthroscopic A portal. (CG, coracoid graft.)

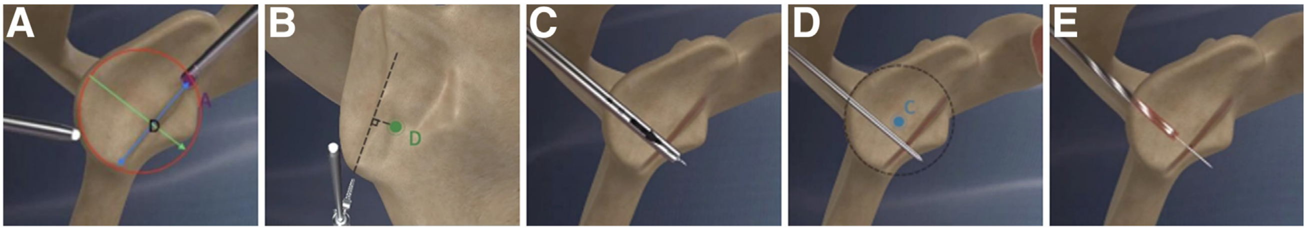


Fig 7. Schematic diagram of glenoid preparation, bone tunnel positioning, and drilling. (A) Measurement of the glenoid defect length, marked at its midpoint as "D." (B) The height of the bone tunnel from the glenoid plane is marked. (C) The self-designed bone tunnel locator is inserted along the switch stick with the arrow pointing to the outlet of the bone tunnel. (D) The bone tunnel is located below the bare area, and a guide pin is drilled. (E) The tunnel is expanded with a 4.5-mm drill.

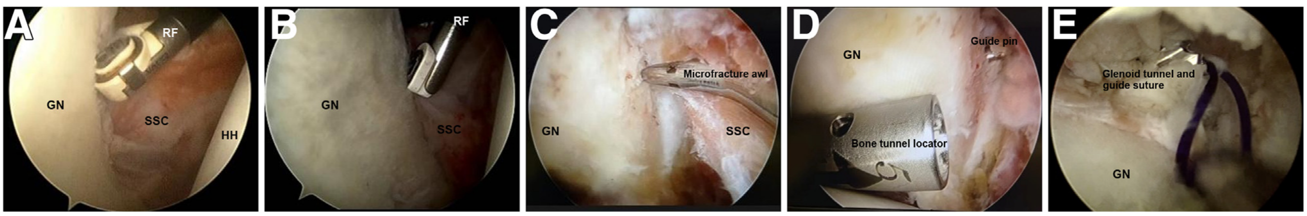


Fig 8. Glenoid bone tunnel positioning and drilling. (A) SSC split plane positioning. (B) Positioning of the bare area and glenoid bone tunnel. (C) A microfracture awl is used to mark the predetermined outlet of the glenoid bone tunnel. (D) Switch stick guide bone tunnel locator placement and guide pin drilling. (E) PDS suture is passed through the glenoid tunnel as a guide suture. (GN, glenoid; PDS, polydioxanone; RF, radiofrequency; SSC, subscapularis.)

After that, all the preset sutures on the CP are put into the cannula (Arthrex). The graft is then placed into the incision and in front of the subscapularis (SSC). The PM can be sutured to the CP remnant with low tension (Fig 5 B and C). The coracoid skin incision is closed to avoid water leakage (Fig 6D).

Step 5: Glenoid Preparation, Bone Tunnel Positioning, and Drilling

Diagnostic arthroscopy is performed from the P portal. The rotator cuff interval tissue is cleaned off from the A portal until the front CG is visualized. The projection point of the upper edge of the SSC on the anterior glenoid is marked as point A using RF, which is where the anterior antirotation anchor is inserted (Fig 7A). The extension point in front of the bare area is the outlet of the glenoid bone tunnel, which is marked as point D, located at the midpoint of the glenoid defect length (Fig 7B). The plane of the SSC split is 5 mm below the extension line in front of the bare area (S plane) (Fig 8A).

Observation from the AL portal, the bare area, and other marks of the glenoid is reconfirmed (Fig 8B). The glenoid deficiency bone bed is refreshed. A microfracture awl is used to mark the predetermined outlet of the glenoid bone canal (6 mm medial to the glenoid surface; Fig 8C). A self-designed bone tunnel locator is inserted along the switch stick, and the guiding pin is drilled (Fig 7C and Fig 8D). After expanding the tunnel with a 4.5-mm drill, a polydioxanone (PDS) suture is

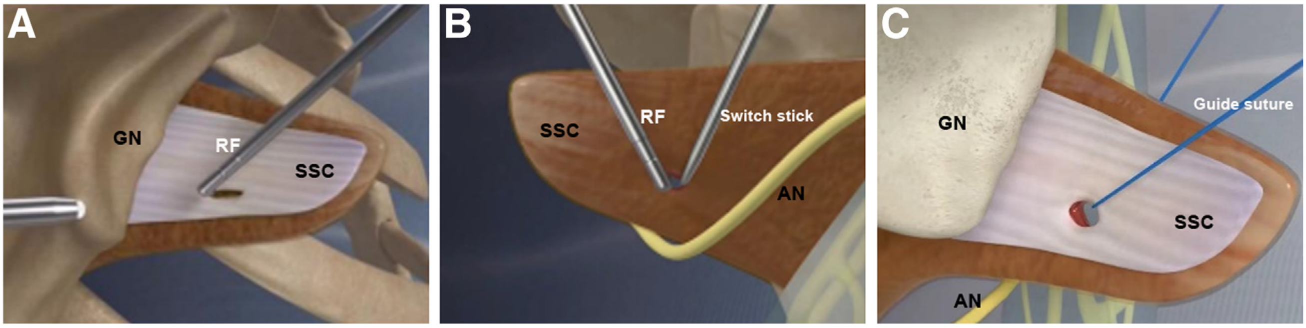


Fig 9. Schematic diagram of splitting of the SSC window. (A) Splitting the SSC using RF and visualizing the myofascia in front of the SSC. (B) A switch stick is inserted into the SSC splitting window from the front to protect the axillary nerve. (C) A guide suture is used to introduce high-strength wire in the coracoid graft through the SSC splitting window into the glenohumeral joint. (AN, axillary nerve; GN, glenoid; RF, radiofrequency; SSC, subscapularis.)

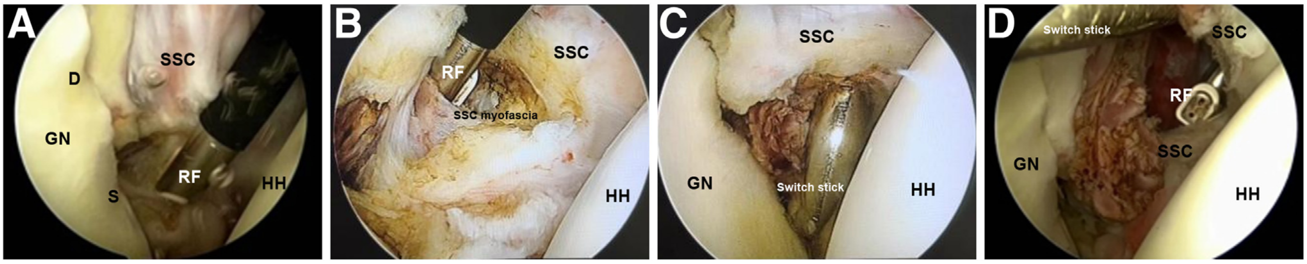


Fig 10. Splitting of the SSC. (A) Splitting the SSC from posterior to anterior using RF. D indicates driving the glenoid bone tunnel outlet. S indicates the SSC split plane. (B) Exposure of the anterior SSC myofascia. (C) A switch stick is inserted into the SSC splitting window from the front to protect the axillary nerve. (D) Splitting the SSC window laterally 8 to 10 mm. (GN, glenoid; HH, humeral head; RF, radiofrequency; SSC, subscapularis.)

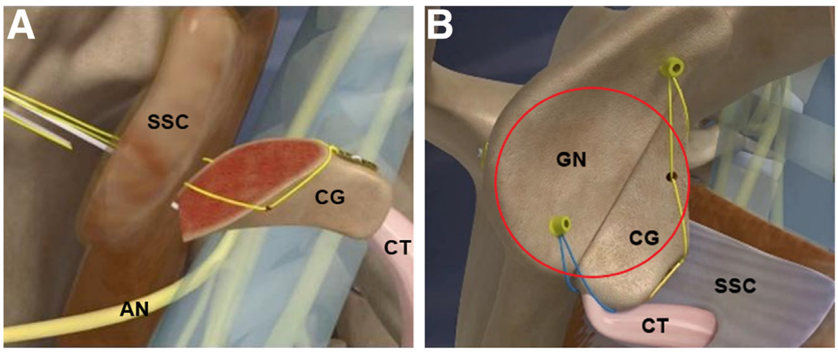


Fig 11. Schematic diagram of CG transfer and fixation. (A) The triangular-sized CG is easy to pass through the SSC split window and goes into the glenohumeral joint. (B) Congruent arc formation after CG fixation. The red circle indicates the perfect-fitting circle. (AN, axillary nerve; CG, coracoid graft; GN, glenoid; SSC, subscapularis.)

passed through the glenoid tunnel as a guide suture (Fig 7E and Fig 8E).

Step 6: Mini SSC Split Window

Viewing from the P portal, the SSC is split from posterior to anterior at the plane of the lower one-third level of the SSC via the A portal (Fig 9A and Fig 10A). The joint capsule and fascia behind the SSC are split first, and then the muscle fibers are separated if necessary (Fig 10B). A switch stick is passed through the split window from anterior to posterior from the A portal and placed on the glenoid surface to protect the axillary nerve (Fig 9B and Fig 10C). Then RF is introduced into the AL portal to further expand the SSC split window laterally (about 10 mm) at its front (Fig 10D). A PDS suture is passed through the SSC split window, which guides the fixation suture and antirotation suture on the CG, passing through the split posteriorly, and pulls out from the AL portal for later use (Fig 9C).

Step 7: CG Transfer and Fixation

Observing from the AL portal, the high-strength sutures attached to the CG are extracted through the P portal from the AL portal. By pulling these high-

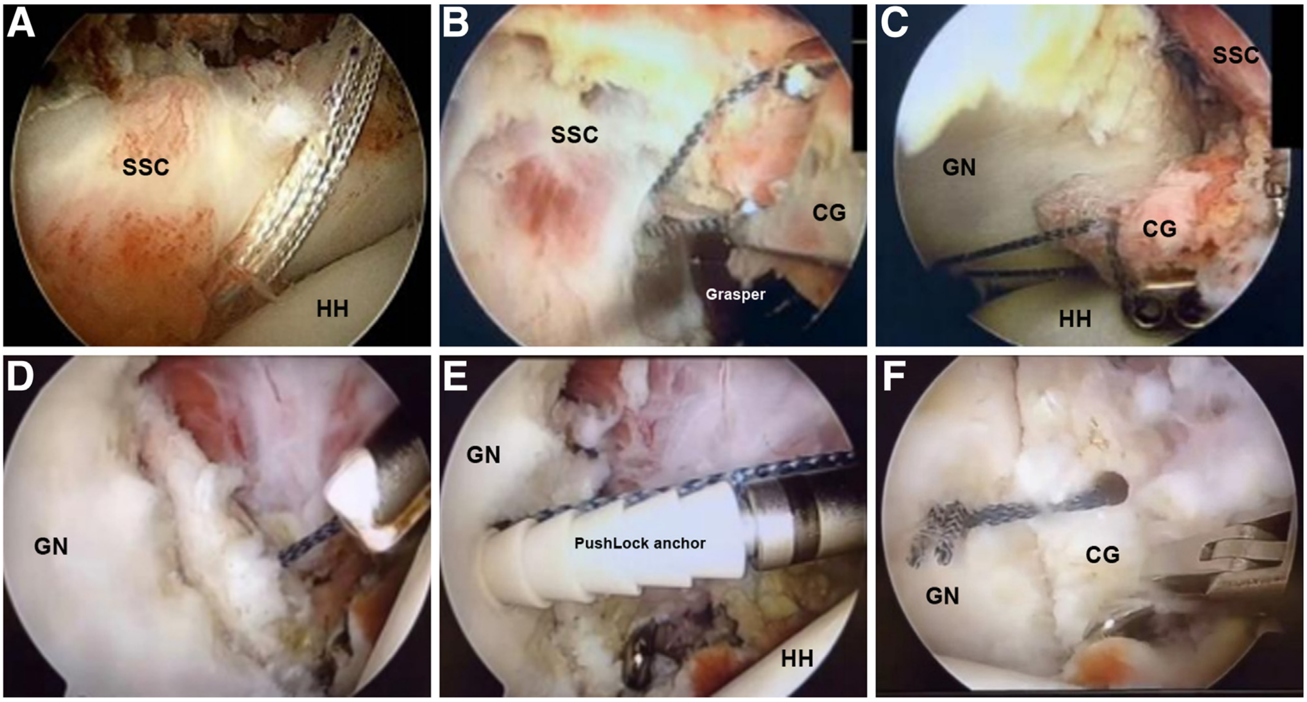


Fig 12. CG transfer and fixation. (A) The fixation and antirotation sutures are pulled into the joint through the SSC split window and pulled out from the AL portal for later use. (B) The top of the triangular-sized CG passes the SSC split window. (C) Pulling the antirotation suture from behind to pull the CG into the joint. (D) The fixation suture and antirotation suture are pulled to adjust the CG position, which is flush to the glenoid surface. (E) A knotless suture anchor is fixed to the glenoid to prevent CG rotation. (F) The CG is fixed to the glenoid. (CG, coracoid graft; GN, glenoid; HH, humeral head; SSC, subscapularis.)

strength sutures posteriorly, the triangular-sized CG can easily pass through the SSC split into the glenohumeral joint (Fig 11A and Fig 12A-C).

Then fixation sutures and the antirotation suture are pulled in turn to adjust the graft position so it is flush to or slightly elevated compared with the glenoid surface and completely attached to the glenoid defect side (Fig 12D). The second Endobutton is put into the fixation suture, and a Tennessee knot is tied at the rear to make the anterior CG close to the glenoid. The antirotation suture is fixed at the preset A point with a knotless suture anchor (PushLock; Arthrex) (Fig 12E). The traction suture is fixed by another knotless anchor at the lower glenoid surface, and then the congruent arc is restored (Fig 11B and Fig 12F).

Discussion

The Latarjet procedure in the treatment of RASI with an obvious GBL has been proven to be an effective therapy.[5] For those RASI cases with MGBL (over 25% of GBL), due to the limited shape and size of the CP, it is difficult to completely cover the MGBL for most patients.

The congruent arc Latarjet technique was first proposed by de Beer and Roberts.[6] This technique could make the width of the glenoid reconstruction around 50% larger than that of the traditional Latarjet, which could be applied to cases with a GBL greater than 25%.[7] Previous anatomic and biomechanical studies showed the contact pressures in the glenohumeral joint were reduced, which might subsequently have resulted in better long-term outcomes in the development of traumatic osteoarthritis after the operation.[8,9] However, it is generally believed that due to the limited width of the CP, screw fixation may lead to

Table 1. Advantages and Disadvantages

Advantages
Partial harvest of the CP can restore the GDA of patients with MGBL.
CAL and PM are preserved in most cases.
Accurate design of the CP osteotomy and the triangular shape of the CG make it easy to induce to the joint.
There is small SSC interference and decreased axillary nerve injury risk.
Suture button will avoid complications of screw fixation.
The horizontal and vertical radians of the CG and glenoid after osteotomy are consistent.
Disadvantages
If the MGBL is too large, the whole CP will be used for the graft, and therefore the CAL and PM may still be sacrificed.
The best angle for coracoid osteotomy on the medial side of the CP still needs to be confirmed by biomechanical studies.

CAL, coracoacromial ligament; CG, coracoid graft; CP, coracoid process; GBL, glenoid bone loss; GDA, glenoid defect arc; MGBL, massive glenoid bone loss; PM, pectoralis minor; SSC, subscapularis.

Table 2. Pearls and Pitfalls of Key Surgical Steps

Key Surgical Step	Pearls	Pitfalls
Preoperative design	The morphology of the glenoid and the CP is measured based on the results of 3D-CT scanning preoperatively. The GDA, PFC, the central point of the glenoid bone tunnel, and the glenoid defect inclination angle are determined. The size of the GDA dictates the amount of CG to be harvested. The coracoid osteotomy angle is determined by the glenoid defect inclination angle.	For patients with a small CP, it is essential to design the osteotomy line precisely to prevent postoperative nonunion due to an insufficient healing surface.
Coracoid osteotomy	Preserve the CAL as much as possible. Perform blunt separation of the CT for over 5 cm to facilitate the CG's tension-free passage through the SSC split window. During the freshening of the medial side of the CG, ensure that the coracoid osteotomy angle is greater than the glenoid defect inclination angle.	Avoid preserving the CAL at the expense of harvesting a CG that is too small to restore the PFC. Insufficient blunt separation of the CT will make the CG's passage through the SSC split window difficult, resulting in CG nonunion due to high tension. Small coracoid osteotomy angle will result in collapse of the restored glenoid surface.
CG suture button configuration	The central tunnel for fixation in the CG needs to be eccentrically drilled, based on the glenoid bone tunnel's offset. Both outlets of the CG's bone tunnel should be cortical bone, facilitating traction of the antirotation suture to pass through the SSC.	Creating the fixation suture tunnel in the center of the CG will result in the CG's medial position after fixation to the glenoid. The lateral position of this tunnel is a benefit for future CG remodeling. If the antirotation bone tunnel outlets are in cancellous bone, the tunnel may collapse when large tension is applied during CG traction.
Glenoid preparation	Preoperative measurement of GDA length is important. A completely freshened glenoid defect surface facilitates bone healing. There is no consensus on the capsule suture at present. The authors favored not handling the joint capsule because of its strong regenerative capacity.	Incomplete freshening of the glenoid is one of the main reasons for CG nonunion. If capsule suture is performed, make sure to thoroughly release the joint capsule to avoid postoperative external rotation restriction.
Bone tunnel positioning and drilling	The CG's height can be adjusted appropriately based on the eccentric position of its center fixation suture tunnel. Mark the intended bone tunnel outlet on the anterior glenoid using a microfracture awl before drilling.	The fixation suture tunnel in the coracoid is often eccentric, and therefore the glenoid bone tunnel usually cannot be placed at the PFC center. It should be slightly lower or the CG's position will be too high. The bone tunnel outlet on the anterior side of the glenoid tends to be higher than the intended position due to vision disparity.
Mini SSC split window	The SSC split window should be put at the 4:30- to 5:00-o'clock position of the glenoid. Split the SSC from inside to outside and put a switching stick laterally for protection. If the SSC is thin, simple anterior and posterior fascia debridement is sufficient without the need for splitting.	A too high SSC split window might cause interference to the SSC, and too low might affect the sling effect of the CT. A split from outside to inside might damage the axillary nerve.
CG transfer and fixation	If the glenoid bone tunnel and the coracoid bone tunnel do not match, especially CG is medially positioned, fix the antirotation suture first and then the traction suture on the CT. Insert the antirotation anchor on the glenoid face instead of the glenoid rim. Remplissage procedure is needed in off-track MGBL.	Fixation of the CG first in an unmatched case results in the CG's medial position. Putting the antirotation anchor at the glenoid rim might result in CG nonunion. The PM should not be sutured to the remaining CP if the tension is high.

CAL, coracoacromial ligament; CG, coracoid graft; CP, coracoid process; CT, conjoint tendon; GDA, glenoid defect arc; MGBL, massive glenoid bone loss; PFC, perfect-fitting circle; SSC, subscapularis; 3D-CT, 3-dimensional computed tomography.

CG splitting, and the risk of postoperative bone resorption is high. There are only a few reports on the application of this technique.

Since the application of the suture button technique, its advantages and satisfied outcomes have been continuously reported.[10-12] Based on the previous clinical and basic research results of the congruent arc technique, combined with our own clinical and basic research experience in the suture button Latarjet procedure, we successfully implemented a modified suture button congruent arc Latarjet technique for the treatment of MGBL.

The advantages of this technique can be listed as follows. First, the mini-open CG osteotomy and suture button configuration saves time and has an accurate manipulation. Second, only the 2-mm-diameter bone canal is drilled into the graft, which will not cause bone splitting. Third, the CG is triangular in shape, making it easy to pass through the mini-SSC split window. Due to the precise preoperative design and accurate coracoid osteotomy, the MGBL can be repaired and the PFC can be restored immediately after the operation. Last but not least, in the suture button fixation technique, the bone block can expand and remodel during the healing process with less bone resorption, and the clinical outcome is satisfied.[10,11]

Despite the merits above, there may also be some disadvantages concerning the suture button congruent arc Latarjet procedure. The CAL and PM may still be destructed if the CP is too small. The preoperative design is vital for CAL preservation and PM reconstruction.

The suture button congruent arc Latarjet procedure contains the "triple-blocking" mechanism of the traditional Latarjet procedure; combines the advantages of the suture button fixation and congruent arc technique, which can restore the GDA with few sacrifices of bone and soft tissue; and can be the future direction for the treatment of RASI with MGBL. The advantages and disadvantages/limitations of our technique are shown in Table 1, and pearls/pitfalls are presented in Table 2.

Disclosures

The authors report no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

References

1. Kany J, Codanda B, Croutzet P, Guinand R. Arthroscopic congruent-arc shoulder bone-block for severe glenoid bone defect: Preliminary report. *Orthop Traumatol Surg Res* 2017;103:441-446.
2. Mengers SRP, Knapik DM, Kaufman MW, et al. Clinical outcomes of the traditional Latarjet versus the congruent arc modification for the treatment of recurrent anterior shoulder instability: A meta-analysis. *Orthop J Sports Med* 2021;9:23259671211030204.
3. Dumont GD, Vopat BG, Parada S, et al. Traditional versus congruent arc Latarjet technique: Effect on surface area for union and bone width surrounding screws. *Arthroscopy* 2017;33:946-952.
4. Boileau P, Mercier N, Old J. Arthroscopic Bankart-Bristow-Latarjet (2B3) procedure: How to do it and tricks to make it easier and safe. *Orthop Clin North Am* 2010;41: 381-392.
5. Deng Z, Long Z, Lu W. LUtarjet-limit unique coracoid osteotomy Latarjet (with video). *Burns Trauma* 2022;10: tkac021.
6. de Beer JF, Roberts C. Glenoid bone defects—open Latarjet with congruent arc modification. *Orthop Clin North Am* 2010;41:407-415.
7. Colegate-Stone TJ, van der Watt C, de Beer JF. Evaluation of functional outcomes and complications following modified Latarjet reconstruction in athletes with anterior shoulder instability. *Shoulder Elbow* 2015;7:168-173.
8. Ghodadra N, Gupta A, Romeo AA, et al. Normalization of glenohumeral articular contact pressures after Latarjet or iliac crest bone-grafting. *J Bone Joint Surg Am* 2010;92: 1478-1489.
9. Montgomery SR, Katthagen JC, Mikula JD, et al. Anatomic and biomechanical comparison of the classic and congruent-arc techniques of the Latarjet procedure. *Am J Sports Med* 2017;45:1252-1260.
10. 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.
11. Xu J, Liu H, Lu W, et al. Modified arthroscopic Latarjet procedure: Suture-button fixation achieves excellent remodeling at 3-year follow-up. *Am J Sports Med* 2020;48: 39-47.
12. Gendre P, Thélu CE, d'Ollonne T, Trojani C, Gonzalez JF, Boileau P. Coracoid bone block fixation with cortical buttons: An alternative to screw fixation? *Orthop Traumatol Surg Res* 2016;102:983-987.