Technical Note

Arthroscopic Xenograft With Cerclage Fixation: A Method for Glenoid Bone Loss Reconstruction With Cerclage Fixation Using a Specific Posterior Guide

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Abstract: Large glenoid bone defects are closely associated with high failure rates after arthroscopic Bankart repair in chronic anterior shoulder instability; therefore nowadays the glenoid bone grafting reconstruction procedure is strictly recommended. On the contrary, the optimal grafting procedure is still controversial because there is considerable concern about the resorption rate of allografts, donor site morbidity of the autografts, and sequelae caused by the use of metal fixation devices in proximity of the shoulder joint. We describe an all-arthroscopic technique for anatomic reconstruction of the glenoid that uses a previously shaped xenograft assembled with a metal-free fixation device using 2 ultra-high-strength sutures (FiberTape Cerclage System; Arthrex, Naples, FL), using a specific posterior guide (Arthrex, Naples, FL) in combination with upper third subscapularis augmentation.

Glenoid bone loss is an important risk factor[1-5] leading to recurrent anterior shoulder dislocation after soft tissue stabilization procedure, so nowadays the threshold being used as a potential cut-off in the decisional process of surgeons to advocate a bony reconstructive procedure is about 13%.[6,7] A number of glenoid bone reconstruction procedures have been proposed such as coracoid transfer and free bone graft, autograft, or allograft, although the optimal grafting procedure is still debated.[8-15]

The Latarjet procedure, despite its wide use, is not an anatomical procedure associated with a high rate of complications.[16-18] Moreover, Zhu et al.[19] report a 90% resorption rate of the coracoid graft, and in 10% of their patients a complete exposure of the screw was found, and removal of the hardware was required. The bone autograft transfers require additional surgery and are associated with donor site morbidity and long surgical time.[8,9] Allografts are associated with low graft quality, low potential healing, and a high resorption rate.[15] Furthermore, most of these techniques require metal implants for fixation, independent of the type of graft used, and bone resorption and residual pain could be related to unstable graft fixation and the presence of metal implants inside or next to the shoulder joint.[12,14,16]

We describe a glenoid reconstruction technique using a preshaped xenograft assembled with metal-free fixation method using 2 high-strength suture tapes.[20-22] The tapes are passed from the posterior to the anterior glenoid rim, throughout the xenograft from the anterior to the posterior part, compressing the posterior face of the graft to the glenoid defect, increasing the stability of the fixation. The glenoid drill holes were performed by a specific posterior guide (Arthrex, Naples, FL). After the glenoid reconstruction procedure, an arthroscopic subscapularis augmentation (ASA)[23-30] was performed (Video 1).

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Surgical Technique

Preoperative Planning

A 3-dimensional computed tomography scan with multiplanar reconstructions of the glenoid neck and a digital subtraction of the humeral head is performed. The Pico surface area method[31] was used to quantify the percentage of inferior glenoid deficiency compared with the contralateral shoulder. The indication is glenoid bone loss > 13%. Arthro-resonance imaging was performed to assess capsule-labral lesion, Hill-Sachs lesion, rotator interval widening, and capsular redundancy.

Patient Positioning

The lateral decubitus arm is kept in abduction and 15° of forward flexion with a balanced suspension of 6 kg (Star Sleeve Traction System; Arthrex, Naples, FL). Arthroscopy is performed with a 30° scope and an arthroscopic pump maintaining pressure at 60 mm Hg. The posterior portal for the scope is created 10 mm lateral to the standard portal. The same portal is used to insert the posterior guide in a correct position on the glenoid, thus avoiding the creation of an accessory posterior portal. Anterosuperior and anterior portals are created in the rotator interval, and 2 cannulas (diameter: 8 mm and 6 mm) are used. Hill-Sachs lesion, capsule-labral and anterior bony lesions were routinely assessed from either posterior and anterior view.

Xenograft

A previously contoured bone block xenograft (Fig 1) of equine origin (Bioteck, Turin, Italy) cleaned by a deantigenation process that allows the complete removal of all immunogenic components without altering the biological and biomechanical properties of the treated graft was used.[32-37] The process consists of the use of extremely selective enzymes that act at low temperature (37°C), thus making it possible to preserve the bone collagen in its native conformation and ensuring that these bone substitutes have unchanged static and dynamic resistance of the graft.[37]

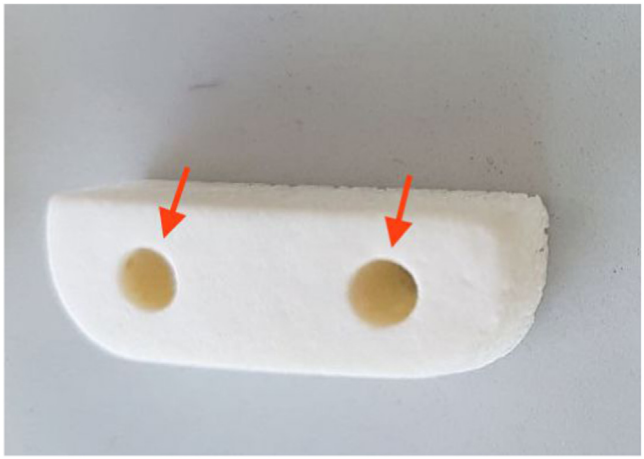

Fig 1. Bone block xenograft: 22 × 10 mm height, 10 mm length and thickness, with two 3 mm holes (red arrows) for the passage of the cerclage tapes fixation device.

Subsequent washing in oxidizing and antimicrobial solutions ensures total removal of cellular components, as well as decontamination of materials. Final electron-beam sterilization, which is considerably less aggressive toward material structure compared to the gamma-ray, ensures that the products obtained are completely sterile and with unaffected mechanical properties.[33]

This process resulted in effective and safe virus clearance and antigen inactivation while preserving the type I collagen structures, which were useful for the activation of endogenous growth factors, which is responsible for osteointegration.[33,37] Furthermore, we chose this kind of material because of the specific dense trabecular structure and high biomechanical resistance of the proximal epiphysis of the equine humerus.

The precision machined graft is composed of a posterior spongy trabecular part that encounters the spongiosa of the glenoid neck. The dimensions of the xenograft are 22 × 10 mm in height and 10 mm in length and thickness, with two 3 mm holes for the passage of the cerclage tapes fixation device, which were previously shaped to match the 2 drill holes made by the specific posterior glenoid guide.

Glenoid Guide

A specific posterior guide (Arthrex, Naples, FL) was used. The original characteristics of this guide are as follow: the hook surface leans on the concavity of the glenoid surface, which is slightly convex, thus improving its stability when fixed on the scapular neck. The sleeve for the drills is composed of 1 single piece to avoid double incision and allows for the possibility of changing the offset of the glenoid tunnels at 5 or 7 mm medial to the glenoid neck (Fig 2). The 5 mm medial position of the guide exit holes has been prepared and designed on the guide to match the height of the two holes of the xenograft.

Glenoid Preparation

Viewing from the anterosuperior portal, the anterior scar tissue and capsule-labral remnants were detached from the anteroinferior glenoid neck by use of a radiofrequency device and a metal spatula for visualizing the glenoid bone defect. The anterior portion of glenoid neck is debrided and abraded with a motorized shaver to improve the bleeding and biological integration of the graft (Fig 3). An arthroscopic measurement probe (Arthrex, Naples, FL) from the interval portal was used to measure the defect from proximal to distal (Fig 4) to verify the correct positioning of the hook guide and the correct position of the hook was marked.

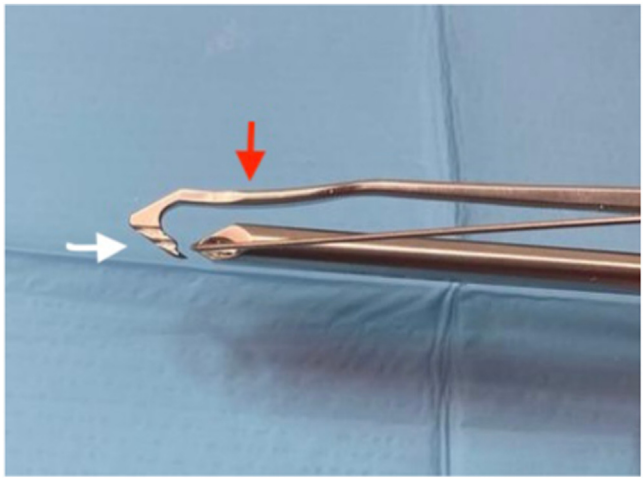

Fig 2. Posterior guide with slightly convex hook surface (red arrow) to lean glenoid concavity. Single-piece sleeve with double offset for glenoid tunnels (white arrow).

Posterior Glenoid Drilling

An important trick is to enlarge the posterior portal with a radiofrequency device (Fig 5) to avoid resistance from soft tissues to the hook penetration into the joint. The specific posterior glenoid guide was prepared, and the hook component was introduced from the posterior portal (Fig 6). The hook must be placed parallel to the glenoid, just above the previous mark as close as possible to the center of the defect. The 1 single-piece drill guide component was fixed on the posterior glenoid neck. The hook guide with its anterior convexity matches the glenoid vault avoiding possible twisting and tunnel mismatching. Two 3 mm cannulated drills were advanced until they come out of the anterior glenoid defect perfectly parallel and 5 mm medial from the joint rim.

Then the central pins of the cannulated drills were extracted, and 2 nitinol wires with loops (Fig 7) for each

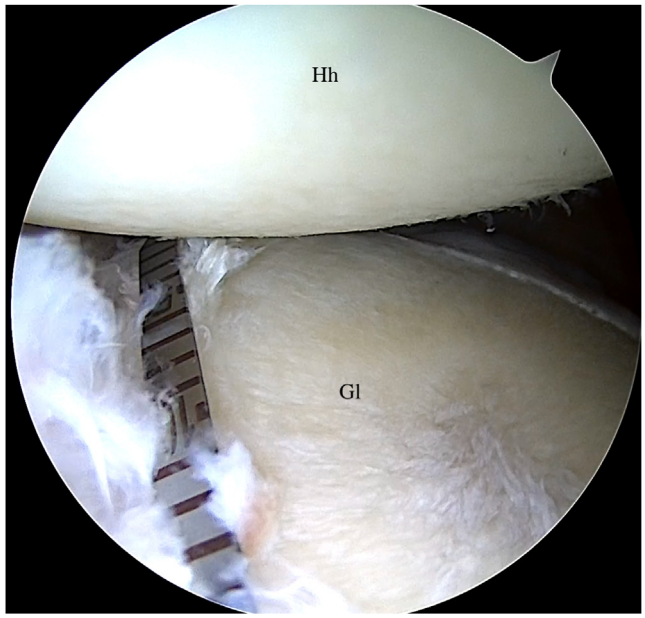

Fig 4. Right shoulder. Lateral decubitus position, anterosuperior view. Glenoid defect measurement from proximal to distal. Gl, glenoid; Hh, humeral head.

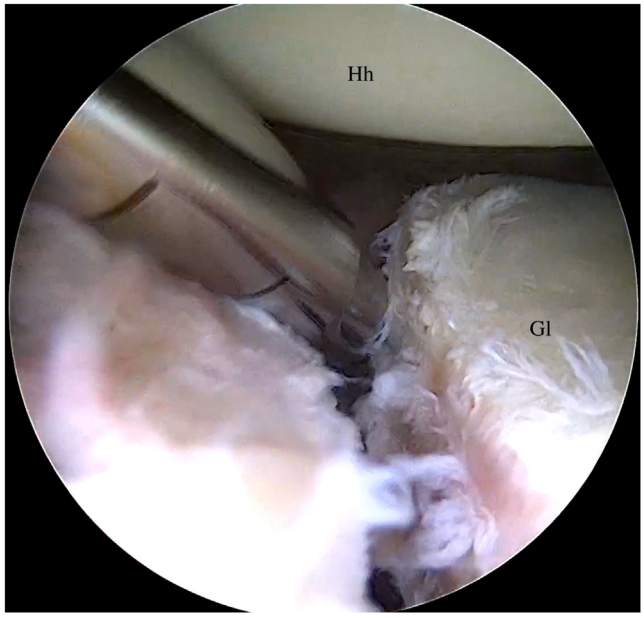

Fig 3. Right shoulder. Lateral decubitus position, anterosuperior view. Glenoid neck preparation with motorized shaver. Gl, glenoid; Hh, humeral head.

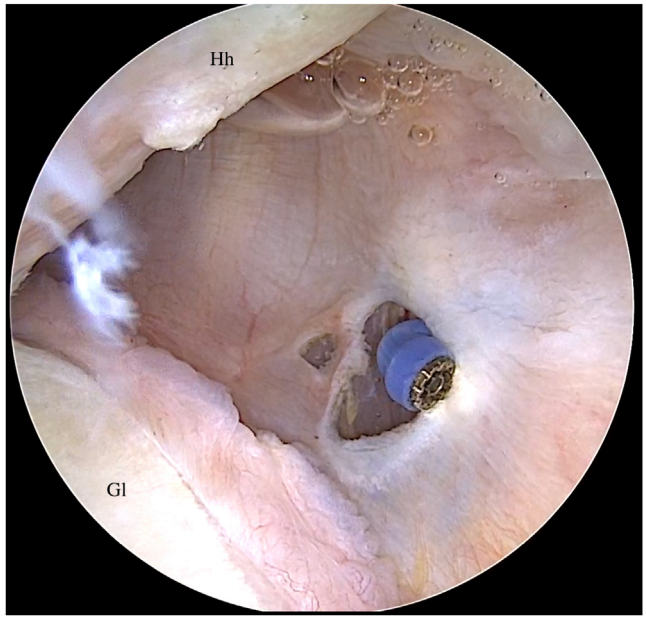

Fig 5. Right shoulder. Lateral decubitus position, anterosuperior view. Enlargement of posterior portal with a radiofrequency device to facilitate hook penetration into the joint. Gl, glenoid; Hh, humeral head.

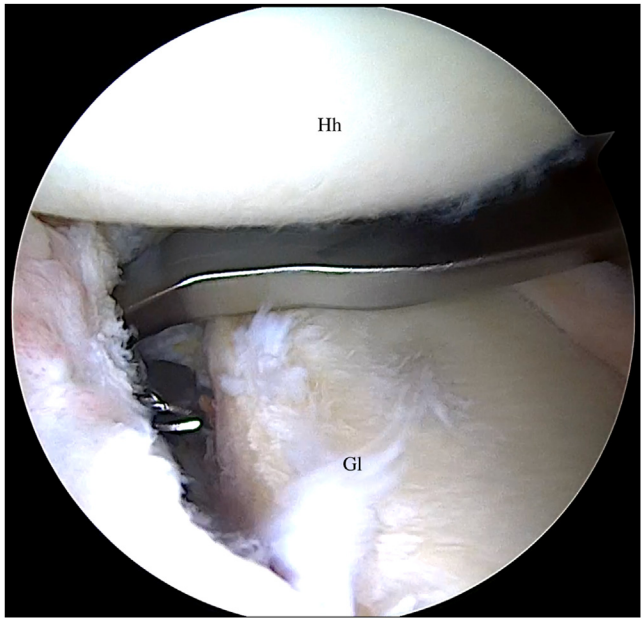

Fig 6. Right shoulder. Lateral decubitus position, anterosuperior view. Positioning of the posterior guide hook. Gl, glenoid; Hh, humeral head.

tunnel are passed and retrieved through the anteroinferior interval portal. The drills, drill guide, and hook were then removed from the shoulder.

Xenograft Housing and Metal-Free Fixation Plus Subscapularis Tendon Augmentation

To facilitate the passage of 2 preconfigured FiberTape and TigerTape Cerclage systems[20-22] (Arthrex, Naples, FL), the nitinol wires were replaced with 2 specific loop sutures (FiberLink/TigerLink sutures; Arthrex, Naples, FL)—one with the anterior loop and the other with the posterior loop. After switching the camera back to the posterior portal, the 2 loop-sutures were passed out the joint through the anterosuperior portal, and the anteroinferior 8 mm cannula was replaced with a 15 mm metal cannula more suitable for passing through the xenograft (Fig 8). At this point the 2 preconfigured FiberTape and TigerTape cerclage tapes entered from the posterior side of the glenoid, passing through one of the tunnels, and were retrieved through the anterior-inferior metal cannula to pass back and forth through the xenograft holes and then returned through the second tunnel. The xenograft was then introduced in the joint sliding it through the inferior metal cannula (Fig 9), pulling the FiberTape cerclage sutures. Once it was properly positioned on the glenoid neck defect (Fig 10), the cerclage tapes from each tunnel were interconnected with each other, and manual traction was applied to slide the loop up to the posterior glenoid neck. Once the stability of the graft is checked, the 2 knots were tensioned one after the other with tensioner (FiberTape Tensioner; Arthrex, Naples, FL) by applying a force of 80 to 100 Newtons to ensure effective fixation strength. Finally, if it is possible, the capsule-labral complex was fixed to the glenoid over the graft.

ASA Technique

The upper third of the subscapularis tendon, as described in the Maiotti technique,[23-29] was usually fixed at the 2 o'clock (right shoulder) or 10 o'clock (left shoulder) position over the glenoid rim. The upper third of the subscapularis tendon was penetrated at least 5 mm from its superior border with a suture-passing device loaded with tape (LabralTape; Arthrex, Naples, FL) slightly flush to the articular surface in the mediolateral position just over the xenograft. Next, one of the free ends was passed out through the upper cannula with a suture retriever and then passed again into the lower cannula. Then a loop is created, and both free ends of the tape were passed through the anchor's eyelet (2.9-mm, PushLock; Arthrex, Naples, FL); the anchor was then gently pushed along the tape toward the bone hole. Until the anchor was inserted into the bone, the tape sutures were kept in traction in a parallel position, and care was taken to keep the arm in neutral rotation to avoid excessive tension on the tissue repair. It is important to control the insertion of the anchor's eyelet and tape, thereby maintaining the correct direction before impacting. Advancement of the subscapularis tendon over the graft can be assessed by arthroscopic examination from the anterosuperior portal (Fig 11).

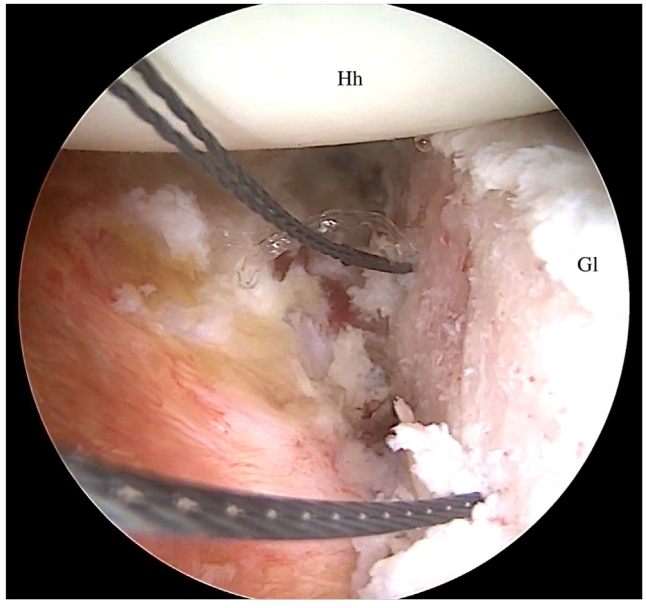

Fig 7. (Right shoulder). Lateral decubitus position, anterosuperior view. Passing of nitinol wires with loops in the glenoid tunnels. Gl, glenoid; Hh, humeral head.

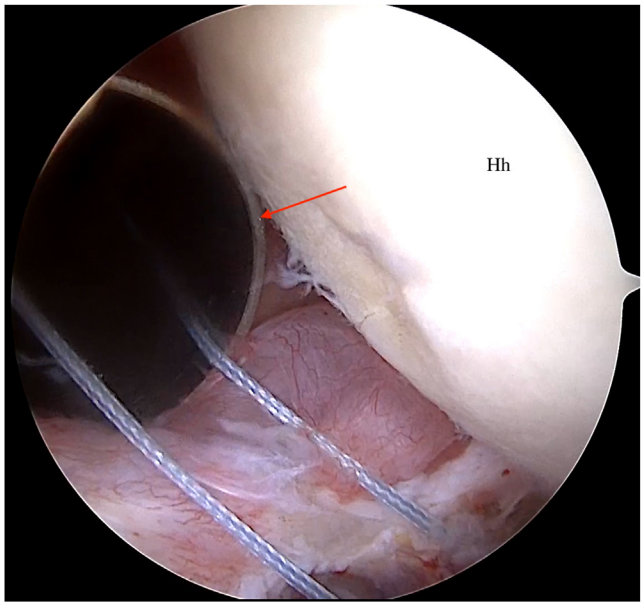

Fig 8. (Right shoulder). Lateral decubitus position, posterior view. Replacement of nitinol wires with two specific loop sutures passing in the metal cannula (red arrow). Hh, humeral head.

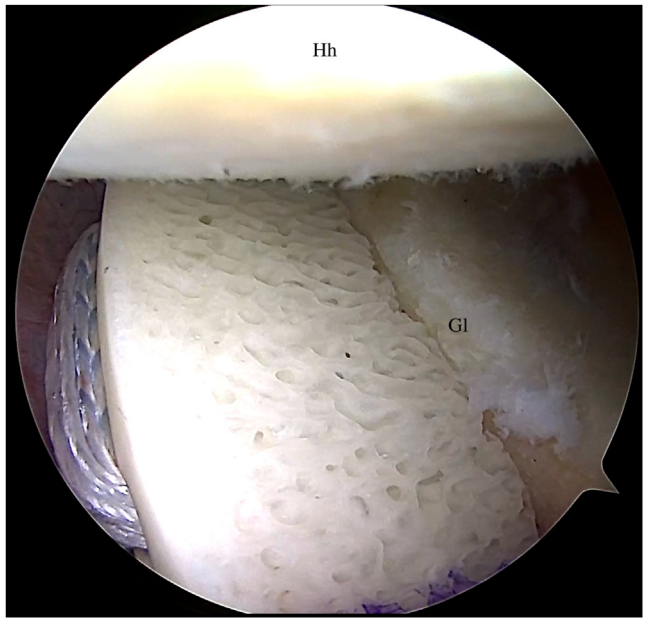

Fig 10. (Right shoulder). Lateral decubitus position, anterosuperior view. Xenograft placement onto glenoid defect. Gl, glenoid; Hh, humeral head.

Discussion

An altered glenoid rim is common in up to 90% of patients with chronic shoulder instability, and large bone glenoid defects[1-5] represent one of the most important causes of failure after soft-tissue stabilization procedures; therefore, in patients with recurrent shoulder dislocations and glenoid bone loss > 13%, bony augmentation techniques such as coracoid transfer, iliac crest autograft, or allografts are strictly recommended.[6,7] The Latarjet procedure, which is not

Fig 9. The Xenograft is introduced in the joint through the inferior metal cannula (red arrow).

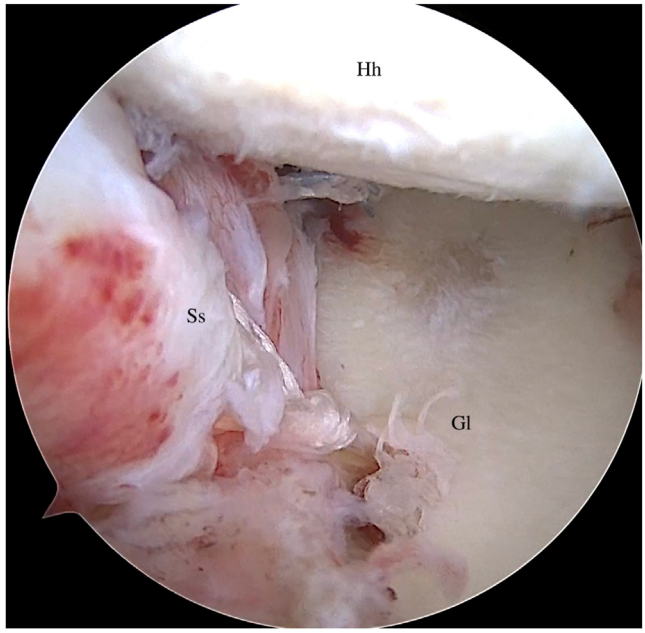

Fig 11. (Right) shoulder. Lateral decubitus position, anterosuperior view. Subscapularis upper third tenodesis. Ss, subscapularis tendon; Gl, glenoid; Hh, humeral head.

Table 1. Advantages and Disadvantages

Advantages
No metal implants
No donor site additional surgery
Limited postoperative patient pain
No hand-made graft holes
Less surgical time
Easy to revise
Magnetic resonance imaging investigations allowed
Disadvantages
Difficult to switch to open surgery/patient in lateral position
Long learning curve

an anatomical technique, is associated with a high rate of complications,[16-18] and sometimes the coracoid can be reabsorbed, with complete exposure of the screws on the humeral head.[19] Autograft transfers are generally not well accepted by patients because of the required additional surgery, postoperative pain and donor-site morbidity,[8,9] whereas allografts have several drawbacks including poor graft quality, huge costs and higher risk of osteolysis.[15] Nowadays, the xenografts represent a further option to address glenoid bone loss in patients with chronic shoulder instability. Although xenogeneic bone grafts have only recently been introduced in the orthopaedic field, they have been already used with satisfactory outcomes for a long time in some branches of surgery including maxillary and spine surgery.[32-36] In the present study, for the first time the use of a heterologous bone block/cerclage fixation has been described for glenoid reconstruction, as well as the use of a posterior guide whose 5 mm drilling offset has been previously adapted to the xenograft's machine precontoured holes.

In particular augmentation with the upper third of the subscapularis tendon produces an additional triple effect: addressing the stretched portion of the subscapularis tendon, always present in chronic shoulder instability; amending capsular insufficiency; and restoring the physiological coracohumeral ligament tension without causing external rotation restriction.[26-30] Furthermore, by augmentation of the subscapularis on the glenoid neck, it is possible to get better covering of the xenograft. Moreover, the previously countered graft reduces the surgical time and avoids the possible mismatching of the handmade holes with the glenoid tunnels. The advantages and disadvantages, as well as pearls and pitfalls of the technique, are summarized in Tables 1 and 2. In addition, the specific posterior guide presents a curved hooked probe that matches the glenoid concavity and provides a more stable drilling positioning. The 2 different drilling off-sets allow the surgeon to optimize the xenograft positioning, reducing the risk of tunnel malalignment and graft malpositioning. Furthermore, metal-free fixation allows us to perform postoperative magnetic resonance imaging, which makes it possible to analyze the soft tissue position and covering of the graft (Fig 12) and to avoid complications caused by the presence of metal fixation next to the shoulder joint. Last, the use of a precontoured machined graft decreases surgical time and avoids possible rocking of the graft on the glenoid surface after compression caused by mismatching of the handmade graft holes.

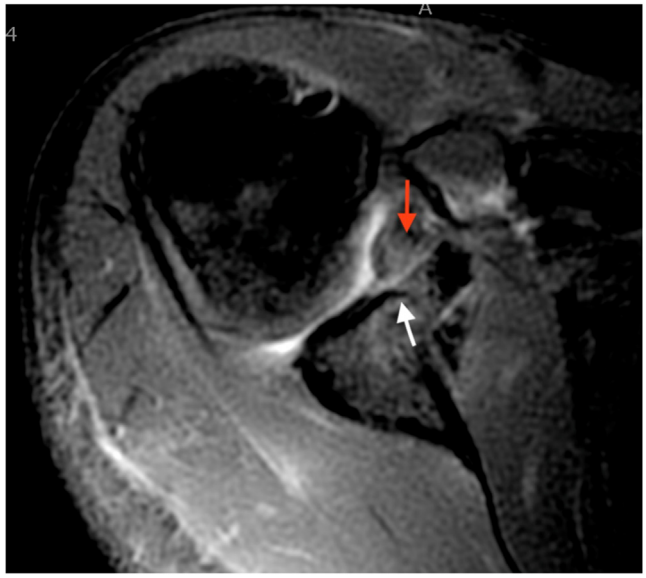

Fig 12. Magnetic resonance imaging scan (axial view). The graft is perfectly flush with the glenoid surface (white arrow). The coverage of the graft by soft tissue (capsule and subscapularis tendon) is clearly visible (red arrow).

Table 2. Pearls and Pitfalls

Pearls
Horizontal posterior approach for better placement of the drill guide.
Blunt metal cannula 15 mm for easier xenograft passage through the rotator interval
Enlarge posterior portal with radiofrequency for easier guide entrance
Pitfalls
Malpositioning of drill guide leads to xenograft malposition
Difficult fixation in case of xenograft twisting during articular passage

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