Arthroscopic Anatomic Glenoid Reconstruction Without Subscapularis Split


Abstract: The role of bone loss from the anterior glenoid in recurrent shoulder instability has been well established. We present a completely arthroscopic technique for reconstructing the anterior glenoid with distal tibial allograft and without a subscapularis split. We perform the arthroscopy in the lateral position. We measure and size an allograft distal tibial graft and place it arthroscopically. We use an inside-out medial portal to introduce the graft into the shoulder, passing it through the rotator interval and above the subscapularis. A double-cannula system is used to pass the graft, which is temporarily fixed with K-wires and held in place with cannulated screws. We then perform a Bankart-like repair of the soft tissues to balance the shoulder and augment our repair. Our technique is not only anatomic in the re-creation of the glenoid surface but also anatomic in the preservation of the coracoid and subscapularis tendon and repair of the capsulolabral complex.

The work of Kirkley et al.1 has show that recurrent instability in young contact athletes has a recurrence rate of 50%. These individuals typically have an anterior labral injury—a Bankart lesion. First-time dislocators and, even to a greater extent, recurrent dislocators often have a degree of bone loss on the anterior glenoid (inverted pear) and/or the humeral head (Hill-Sachs lesion). The work by Burkhart and De Beer2 has shown the important role that bone loss on the glenoid side and bone loss on the humeral side both play and how they lead to postoperative failures. In primarily a rugby population, they reported a 6.5% recurrence rate in patients with no significant bone loss and a 89% recurrence rate in those with significant bone defects. When bone loss exceeds 25% to 27%, bone augmentation of the glenoid is recommended to increase the success of any stabilization procedure.2 The Latarjet procedure involves osteotomy of the coracoid at the base and transporting it through a split in the subscapularis. The Latarjet procedure acts to provide increased joint stability by augmenting the total surface area of the glenoid, as well as acting as a soft-tissue stabilizer through a sling effect.3 An arthroscopic technique for Latarjet transfer of the coracoid has been described and shown to be technically possible and successful particularly when bone loss is present.4-6

A number of articles on the use of allograft tissue to address glenoid or humeral head lesions have previously been published using humeral head resurfacing and glenoid reconstruction with distal tibial or glenoid allografts by different techniques and fixation methods.7-12 On the basis of this literature and our previous arthroscopic Latarjet experience, we developed our current technique. We present a technique to perform a distal tibial allograft arthroscopic method for anatomic glenoid reconstruction (Tables 1 and 2).

Technique

Preoperative Assessment

The patient is assessed in the clinic, and a standard history is elicited. Episodes of previous dislocation and provoking factors, as well as previous surgical interventions, are documented. A standard physical examination of the shoulder is then performed. Instability
is assessed using the anterior apprehension, Jobe relocation, sulcus, and load-and-shift tests. Rotator cuff integrity is assessed using empty-can, drop-arm, lift-off, and resisted internal/external rotation testing. Hypermobility of the shoulder and other joints is assessed. Imaging consists of anteroposterior, axillary, and transscapular Y views of the shoulder. A computed tomography (CT) scan with 3-dimensional reconstruction can be used to assess the glenoid bone stock and Hill-Sachs volume.

Positioning and Preparation
The patient is positioned on a standard articulating operating table (Skytron, Grand Rapids, MI). A beanbag positioner is placed under the patient. The patient is rolled into a semi-lateral position at 30° from vertical to make the glenoid parallel to the floor (Fig 1). This assists with glenoid screw placement later in the procedure. The patient’s skin is cleaned with a chlorhexidine solution and draped with 2 split shoulder drapes (Tiburon; Cardinal Health, Dublin, OH). The patient’s arm is then placed in a pneumatic arm holder (Spider 2; Smith & Nephew, Memphis, TN) and abducted 60° in balanced suspension. The DePuy Mitek Bristow-Latarjet Instability Shoulder System (DePuy Mitek, Raynham, MA) is used to place and secure the graft.

Skin landmarks (scapular spine, acromion, clavicle, acromioclavicular joint, and coracoid) are drawn on the patient. Arthroscopic portals are then located. The standard posterior portal is kept medial to be parallel with the glenoid face. We then identify the anterosuperior and anteroinferior portals. A larger medial portal will also be made, by use of an inside-out technique, to be parallel to the glenoid face but lateral to the conjoined tendon to avoid damage to the neurovascular structures and facilitate passage of the graft.8

Table 1. Advantages and Limitations

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Limitations</th>
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<tr>
<td>- Custom size and shape to accommodate any amount of bone loss</td>
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<td>- Preservation of anatomy</td>
<td>- Graft availability</td>
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<td>- Coracoid</td>
<td>- Graft cost</td>
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<td>- Subscapularis</td>
<td>- Potential graft reabsorption</td>
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<td>- Pectoralis minor</td>
<td>- Learning curve</td>
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<td>- Less abrasive and better contour than coracoid</td>
<td>- Risk of nerve injury</td>
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<td>- Less difficult and faster than performing coracoid osteotomy</td>
<td>- Breast tissue</td>
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<td>- Soft-tissue balancing</td>
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<td>- Easy conversion in technique if larger-than-expected bone loss is found intraoperatively</td>
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Evaluation and Debridement
The posterior portal is made in standard fashion. We attempt to make this portal parallel to the glenoid face. A diagnostic arthroscopy is then performed according to the method described by Snyder.13 The steps of our procedure can be viewed in Video 1. The amount of

Table 2. Steps of Arthroscopic Anterior Glenoid Reconstruction Using Distal Tibial Allograft Without Subscapularis Split

1. Place the patient in the 30° semi-lateral position.
2. Place the arm in a pneumatic arm holder (Fig 1).
3. Perform diagnostic arthroscopy through the posterior portal.
4. Create the anterior portal and anterosuperior portals.
5. Open the rotator interval.
6. Perform viewing from the anterosuperior portal.
7. Measure the glenoid.
8. Shape the tibial allograft using the posterolateral corner. We use the tibia from the same side as the shoulder undergoing surgery (Figs 2 and 3).
9. Find the conjoined tendon, and free up to halfway down the subscapularis muscle.
10. Use an inside-out portal for the creation of the medial portal.
   a. Place a switching stick from the posterior portal parallel to the glenoid surface, superior to the subscapularis, and lateral to the conjoined tendon (Fig 7).
11. Perform blunt dissection to open the medial portal for the graft.
12. Use the switching stick to push down the subscapularis for graft entry.
13. Use half-pipe cannulas to open the soft tissue for the medial portal (Fig 7).
14. Keep in mind that you may need to adduct the arm and flex the elbow to allow placement of the graft.
15. Slide the graft into position. The switching stick can help direct the allograft into position.
16. Pass the guidewires through the cannulated barrels holding the graft.
17. Over-drill the wires and then pass the cannulated screws (Fig 8).
18. Reattach the anterior-inferior labral tissue to the native glenoid using a flexible drill (all suture anchors) to avoid damaging the Latarjet screws (Fig 10).
19. Place postoperative incisions (Fig 11).

Fig 1. Semi-lateral position with pneumatic arm holder.
glenoid bone loss is assessed and compared with the preoperative CT scan. The Hill-Sachs lesion is also visualized. The shoulder is manually reduced (if dislocated). The anterosuperior portal is then created. This is used to probe the quality of the glenoid bone, Hill-Sachs lesion, and anterior capsule, as well as to excise the rotator interval and debride the glenoid neck in preparation for the graft.

We place our anteroinferior portal using an outside-in technique. Using a thermal probe, we perform a release of the rotator interval. The larger the rotator interval release, the easier it is to pass the graft. The anterosuperior portions of the subscapularis, as well as the coracoid, should be fully visualized through this release. Scar tissue, particularly involving the subscapularis in revision surgery, should be removed. The subscapularis should be freely mobile to undergo retraction later in the case. The tip of the coracoid is identified, and the conjoined tendon is identified off the coracoid. The coracoacromial ligament is identified, and a slight release is performed (one-third of the ligament). The arthroscope is then placed in the anterosuperior portal for viewing. A cannula is placed in the posterior portal to serve as outflow to maintain as low an intra-articular portal pressure as possible.

Through our anteroinferior portal, we use a labral elevator to mobilize the remnant labrum, scar tissue, and bone from the injury or from prior repair in revision situations. A large switching stick is placed through...
the posterior portal and used to retract the subscapularis inferiorly. At this point, the anterior glenoid is completely cleared of tissue. The anterior glenoid is rasped and decorticated to provide a bleeding surface for healing. We then measure the dimensions of the glenoid and estimated graft size using a calibrated probe. We measure the dimensions of the glenoid to determine bone loss with the bare spot used as the reference center of the native glenoid.\textsuperscript{14} As described in our previously published technique, a subscapularis split can be performed at this point if one is performing a traditional arthroscopic Latarjet technique.

The medial portal is then created using an inside-out technique. The arm is first placed in the adducted position with the elbow flexed to 90° to release tension and medialize the conjoined tendon. The humerus is manually reduced onto the glenoid under direct vision. The switching stick in the posterior portal is advanced parallel to the glenoid, superior to the subscapularis, and lateral to the conjoined tendon under direct visualization. This ensures that there is no risk to the neurovascular structures. The switching stick is then advanced through the deltoid, and a skin incision is made over the switching stick. A slotted cannula is placed through this portal, followed by a large channeler, to bluntly dilate this medial portal to allow passage of the graft that is parallel to the face of the glenoid for screw fixation.

We size and mark the distal tibia based on our intraoperative measurements (Fig 2). We use the posterior-lateral corner because it best replicates the contour of the native glenoid and provides 3 cortical surfaces for better strength and screw fixation. We use a microsagittal saw to cut the distal tibia to the appropriate dimensions (Fig 3). Normal saline solution is used to cool the graft during cutting. The dimensions are generally 10 to 15 mm in anteroposterior width and 25 mm in inferior-to-superior height. We generally have a graft thickness of 15 mm. A second graft is made using the remaining distal tibial allograft to use as a template to test the angle of the screw fixation on the graft. An alpha/beta guide is used to pass K-wires at the appropriate angle for graft fixation (Fig 4). The graft is then predrilled and tapped over the guidewire, and top-hat washers are placed. Top-hat washers are placed to prevent hoop stresses from fracturing the graft during screw compression (Fig 5). A clear double-barrel cannula is then attached to the graft using the threaded cannulated screws (Fig 6). During the insertion of the graft, we retract the subscapularis inferiorly using a switching stick from the posterior cannula as opposed to performing a subscapularis split. Two slotted cannulas

Distal Tibial Preparation and Graft Placement

A fresh-frozen (nonradiated) distal tibial allograft (Capital District Health Authority Regional Tissue Bank, Halifax, Nova Scotia, Canada) is used for the reconstruction. The Regional Tissue Bank is accredited with the American Association of Tissue Banks for all aspects of screening, procurement, processing, storage, and distribution for cardiovascular, bone, and skin tissues and the Standards for Tissue Donation and Transplantation of the Canadian Standards Association. We preorder the graft based on the operative side (e.g., right distal tibia for right shoulder).
are used to help prevent soft tissue from being dragged into the shoulder when passing the graft from the outside. By use of the double-barrel cannula, the coracoid graft is introduced through the medial portal, lateral to the conjoined tendon, and superior to the subscapularis and directly onto the anterior glenoid rim. Care is taken to view the positioning of the graft through all the portals to ensure accuracy.

The 2 slotted cannulas are removed. The switching stick in the posterior portal that was used to retract the subscapularis inferiorly can be used to manipulate and position the graft, keeping it level with the glenoid face (Fig 7). Two long guidewires are drilled through the double-barrel cannula and penetrate through the skin posteriorly, parallel to the posterior portal. Penetration of the articular cartilage should be avoided. The graft height (lateral to medial translation) can be fine-tuned by rotating the double-barrel cannula with 1 K-wire used as fixation on the glenoid. Kocher forceps are placed on the guidewires to prevent migration during drilling. The threaded double-barrel guides are then removed. A 2.8-mm calibrated cannulated drill is used to drill and estimate screw length as it perforates the posterior glenoid cortex. The screw length is typically 34 to 40 mm. A titanium 3.5-mm cannulated screw is then passed over the guidewire into position. The screws should be tightened in alternating fashion, and it is during this tightening and compression phase that the top-hat washers absorb the hoop stress (Fig 8). It is important to be collinear to prevent stripping of the screw heads. The subscapularis is then reduced back into the native position in front of the graft using a switching stick from the anteroinferior portal (Fig 9).

The arm is repositioned to a 60° abducted position. We then place an all-knot suture anchor (Y-Knot, 1.3 mm single loaded with No. 2 HiFi suture; Linvatec, Largo, FL) at the 5-o’clock position (on native glenoid between allograft) and perform a standard Bankart repair of the labrum for additional soft-tissue support and to make the graft extra-articular (Fig 10). We use a Spectrum suture-passage device (Linvatec) to shuttle the suture through the labral tissue, fixing it in place with an SMC knot and half-hitches. A second anchor at the 3-o’clock position on the native glenoid can be placed, converting the allograft to an extra-articular bone block. This is an optional step, with the advantage being an additional soft-tissue restraint of the Bankart repair above the new allograft glenoid reconstruction. A final view of the construct is performed through all portals, especially the anterosuperior portal, to confirm that the humerus can no longer be dislocated from an anteriorly directed force on the humerus. Figures 11 and 12 show the postoperative incisions and a CT scan of the graft position after final fixation.

Discussion
Since the work of Burkhart and De Beer,2 we have had a well-documented understanding that in recurrent instability, the degree of glenoid bone loss plays an important role. Many of our soft-tissue treatments, such as Bankart repair and remplissage techniques, do not fully address the bone loss that can lead to failures. Other techniques such as the Latarjet procedure have...
some advantages such as a large bony block and a soft-tissue sling that help compensate for the bone loss and provide soft-tissue stabilization. Our technique has some distinct advantages over traditional shoulder instability treatments for a number of reasons. We are able to reconstruct any bone loss on the glenoid with tibial allograft. In addition, large Hill-Sachs lesions can be addressed by slightly increasing the size of the distal tibial allograft to minimize the chances of engagement. This is similar to the role of the coracoid in the Latarjet technique; however, we are able to make an anatomic match, with smooth cartilage (less abrasive to the humeral head cartilage and better to align to the native glenoid cartilage) and of any size (independent of the patient’s coracoid size). This procedure can be added to a Bankart repair in the case that bone loss was not detected preoperatively but was found during the operation if equipment and grafts are readily available. We typically perform this technique in the lateral arthroscopic position. By performing it arthroscopically, we can position the graft more accurately and less soft-tissue violation is required. In addition, the medial portal is created to be parallel to the face of the glenoid. Thus the screws will be parallel to the glenoid and allow for the best fixation strength and graft alignment. Regarding the lateral versus beach-chair position, the lateral position is our standard position for shoulder arthroscopy; however, this may be operator dependent. The lateral position is our preferred position, and we believe that it allows better viewing of the structures in the anterior shoulder including the anterior glenoid neck, subscapularis, and coracoid. In addition, we have easy access to the posterior shoulder for the guidewires to exit the shoulder without the risk of hitting the beach-chair apparatus.

Surgeons who regularly perform the Latarjet technique may critique the allograft transplant versus the coracoid technique because of the sling effect provided by the conjoined tendon. For this reason, we have added the Bankart repair augmentation, which on its own is a very successful surgical procedure in patients with no or mild glenoid bone loss. In revision cases, particularly after multiple soft-tissue procedures, the tissues can often be of poor quality. Our technique is not only anatomic in the re-creation of the glenoid surface but also anatomic in the preservation of the coracoid and subscapularis tendon and repair of the capsulolabral complex.
As our technique has evolved, we have tried a number of anchor styles. Currently, we are using the Y-Knot anchor (1.3 mm single loaded with No. 2 HiFi suture) because of the flexible drill and anchor. These anchors are placed after the screws on the native glenoid. We have found that rigid drills tend to hit the titanium screws that are holding the graft in place. These flexible drill bits allow us to curve around the screws and thus have less chance of destabilizing the graft. The strong pullout strength-to-size ratio allows us to better navigate the screws used to fix the graft to the native glenoid. Another advantage of this technique is that it replicates the arthroscopic Bankart technique regarding all portals, visualization, glenoid exposure, and soft-tissue fixation. We believe that this balancing effectively replaces the sling effect lost when using the allograft technique versus the original native-coracoid Latarjet technique. The main difference is the addition of the medial portal, which is accomplished using an inside-out technique under direct visualization at all times to minimize neurovascular damage. Most arthroscopic surgeons are likely to be able to learn this technique versus the arthroscopic Latarjet procedure.

Limitations

A learning curve certainly exists for the described procedure. Arthroscopy proficiency is key to ensure good visualization and manage soft-tissue swelling. Surgeons with arthroscopic Latarjet experience should be able to transition smoothly because the concepts are very similar and the difficulty of performing coracoid osteotomy is eliminated. For those performing open Latarjet surgery, the tools could certainly be used in open cases because the visualization difficulties of the open Latarjet technique may be slightly greater because the coracoid in its native position may obscure the view to a greater degree. Arthroscopically, we have not yet found a coracoid size or position that has prevented us from placing a graft. The issue of graft reabsorption and bony healing has been seen with the Latarjet procedure and exists with our technique. To date, we have had 1 such incidence. The absence of the conjoined tendon placing traction on the graft may actually lead to less reabsorption. Access to allograft tissue may be an issue for some institutions. Institutions without a bone bank will have issues associated with graft access and the cost of acquiring grafts. Distal tibial allograft, as compared with many other grafts, is easy to procure and rarely used for other procedures, thus giving us better access in our institution.

References

7. Provencher MT, Ghodadra N, LeClere L, Solomon DJ, Romeo AA. Anatomic osteochondral glenoid reconstruction for recurrent glenohumeral instability with glenoid...


