Technical Note

Arthroscopic Superior Capsular Reconstruction Using Hybrid Autologous Fascia Lata and the Long Head of Biceps Tendon Graft: the Central Beam Concept

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Abstract: Superior capsular reconstruction is a joint salvage treatment option for retracted irreparable rotator cuff tears in relatively young patients. Various graft options have been described in the literature, including autologous fascia lata graft, synthetic graft, and dermal patches. Superior capsular reconstruction using long head of biceps tendon autograft alone has also been described by few authors. In this technical note, we describe a modified technique of performing arthroscopic superior capsular reconstruction using both fascia lata graft and the intra articular portion of the long head of biceps tendon. Our technique resembles central beam concept over which the fascia lata graft is anchored, providing good structural support to the graft and enabling graft healing and improved clinical outcomes.

Treatment of massive rotator cuff tears with retraction and fatty infiltration remains a challenge to many shoulder surgeons. The absence of rotator cuff integrity and coordination leads to proximal migration of humeral head with a loss of balanced force couple.[1] With progression, there will be decreased range of motion and stiffness with proximal migration of head leading to functional disability.[2,3]

Superior capsular reconstruction was originally described by Mihata et al. using autologous fascia lata graft. He reported good outcomes in clinical trials, which reversed pseudoparalysis in 96% and 93% of patients with moderate and severe pseudo paralysis.[1,2] However, significant rates of graft failures were reported by other authors. In a recent study, Smith et al. reported 69.8% of graft failures occurred on the humeral side, 16.9% on the interstitial side, and 13.2% on the glenoid attachment.[3]

Despite encouraging results after superior capsular reconstruction with autologous fascia lata graft, debate still exists regarding graft options and fixation techniques.[4-7] The core principle of superior capsular reconstruction is to restore the force couples and prevent proximal migration of the center of rotation of the humerus head by recreating the superior capsule.[8] Superior capsular reconstruction using the long head of the biceps tendon was described since the long head of the biceps acts as a sling and prevents proximal migration and helps in depressing the proximal humerus head through various range of motion.[9-11]

In this technical note, we have described a modification of superior capsular reconstruction using both the fascia lata graft and the long head of the biceps tendon. Incorporating the long head of the biceps tendon, along with the fascia lata graft, provides additional structural support to the fascia lata graft, enabling good healing rates of the graft with improved clinical and radiological outcomes. Advantages of our technique are that it retains the long head of the biceps origin on the glenoid and provides good vascular supply and better integration of the biceps and fascia lata graft. Also, we use the primary humeral depressor effect of the native long head of the biceps tendon.

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Surgical Technique (Video 1)

Indications and Contraindications of Our Technique

The indications of superior capsular reconstruction using our technique are irreparable posterosuperior rotator cuff tears (Fig 1) with normal or repairable subscapularis tendon with normal attachment of the long head of the biceps tendon (LHBT) to the superior labrum, good tone and power of the deltoid muscle, evidence of minimal or absent glenohumeral arthritis, and preoperative good passive range of motion of the shoulder.

Preoperative magnetic resonance imaging (MRI) can help in ensuring the integrity of the LHBT origin at the superior labrum. The contraindications are 1) irreparable subscapularis tendon, 2) bad-quality LHBT or absent LHBT, 3) moderate to severe rotator cuff arthropathy, and 4) axillary nerve dysfunction, deltoid atony, and infection.

Patient Positioning and Diagnostic Arthroscopy

The patient is positioned in lateral position with shoulder in 60° anterior elevation, 10° shoulder abduction, and neutral rotation under general anesthesia combined with interscalene nerve block. A 5-kg traction weight is used. The diagnostic arthroscopy of the glenohumeral joint is done through posterior soft sport portal, made 2 cm medial and 2 cm inferior to the posterolateral corner of the acromion. A standard 4-mm arthroscope (Arthrex, Naples, FL) is used and the quality of the LHBT tendon is examined. If the quality of the LHBT is not satisfactory, we proceed with superior capsular reconstruction with fascia lata graft alone. The supraspinatus, infraspinatus, and the subscapularis tendon are also examined. In case of subscapularis tear, the repair of the tendon is done prior to proceeding with superior capsular reconstruction. Any other glenohumeral pathologies, if present, are addressed. The arthroscope is moved to the subacromial space through the posterior viewing portal, and a lateral portal is created 4 cm below the midpoint of the acromion. Thorough bursectomy is performed from the lateral portal using shaver (Arthrex, Naples, FL) and a radiofrequency ablator (Arthrocare; Smith & Nephew, Andover, MA). Acromioplasty is performed using Burr (Arthrex).

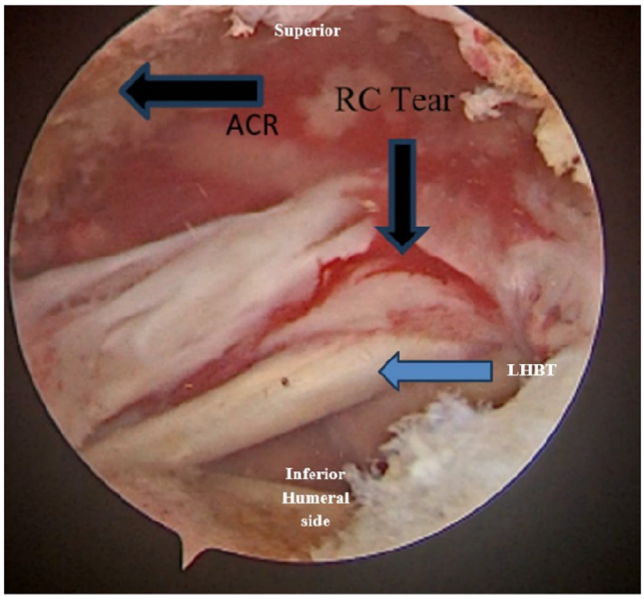

Fig 1. Viewing from the posterior soft spot portal with 4-mm 30° arthroscope in the right shoulder with patient in lateral position, the type 3 Patte's full-thickness rotator cuff tear with retraction up to the level of the glenoid is visualized in the subacromial region. ACR, acromion; RC tear, rotator cuff tear.

Soft Tissue Release and Mobilization of the Posterosuperior Cuff

Using port of Wilmington as the viewing portal, the surgeon performs soft tissue release and mobilization of the posterosuperior cuff working from the lateral portal. Adequate mobilization of the cuff is mandatory from bursal and articular side, as we incorporate the remaining cuff tissue with the fascia lata graft, while performing the superior capsular reconstruction (Fig 2).

Preparation and Anchor Placement on the Glenoid Bed and the Greater Tuberosity

Viewing from the port of Wilmington and working from the lateral portal, the glenoid bed is prepared using arthroscopic RF ablator from 10 o'clock to 2 o'clock position. The greater tuberosity is also prepared from anterior to posterior direction working from the lateral portal. Both glenoid and the greater tuberosity bed are denuded from the soft tissue, and the bleeding bed is prepared for graft fixation (Fig 3). Two double-loaded, all-suture anchors (Stryker, India) are placed from the Neviaser portal, one at 10 o'clock and other at 2 o'clock position on the glenoid (Fig 4). Two double-loaded 2.3-mm self-punching all suture anchors (Stryker, India) are used on the greater tuberosity for lateral side fixation of the SCR graft (Fig 5). The anchors are placed from a near anterior acromial portal, just lateral to the articular margin on the greater tuberosity.

Long Head of the Biceps Tendon Fixation and Tenotomy

The long head of biceps tendon is traced down in the bicipital groove, visualizing from the port of Wilmington and working from the lateral portal and released from the groove aiding in the tendon mobilization. Once the required length of the tendon is made available, the tenotomy is done at the level of the groove. The proximal portion of the biceps tendon is fixed to the greater tuberosity using the one limb of the suture

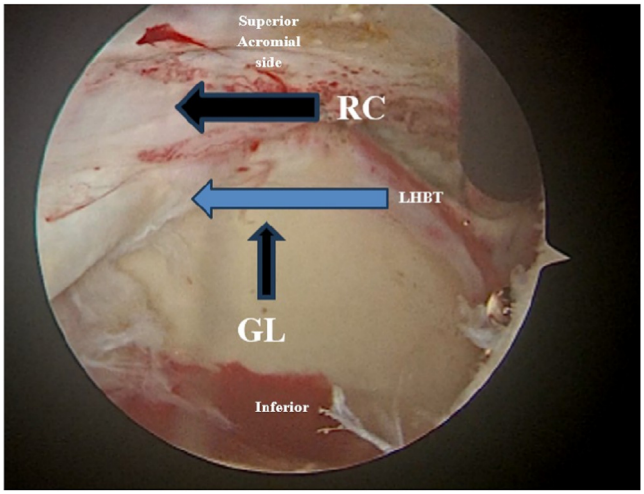

Fig 2. Viewing from the port of Wilmington with 4-mm 30° arthroscope in the right shoulder with patient in lateral position, the retracted cuff tissue is mobilized freeing the adhesions from the bursal and articular sides working from the lateral portal in the subacromial region. GL, Glenoid; RC, rotator cuff.

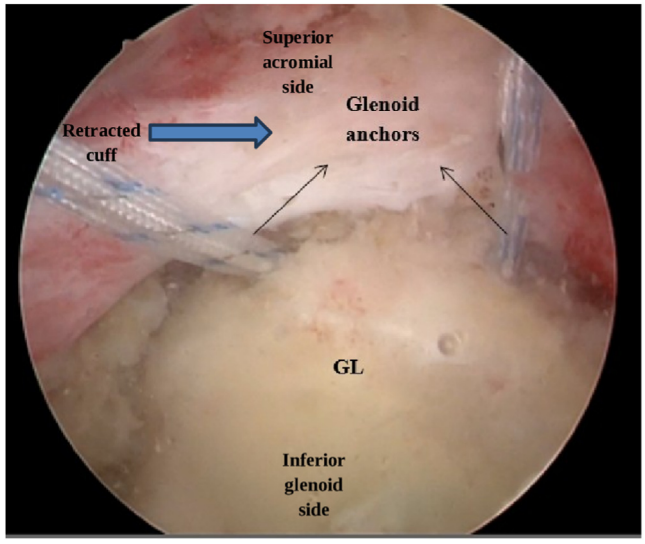

Fig 4. Viewing from the port of the Wilmington and working from the port of Neviaser with 4-mm 30° arthroscope in the right shoulder with patient in lateral position, two double-loaded, all-suture anchors (Stryker, India) are placed at the 10 o' clock and 2 o' clock position on the glenoid. GL, glenoid.

tape from the medial row anchor on the greater tuberosity. The suture bite is taken with the help of the antegrade scorpion suture passer (Arthrex, Naples, FL) in a cinch fashion and secured to the greater tuberosity footprint with half hitching knots working from the lateral portal (Fig 6).

Graft Dimension Measurement and Fascia Lata Graft Harvest

The distance between the glenoid anchors and the medial row anchors on the greater tuberosity is measured to estimate the width of the graft, and 5 mm is added each on the both sides of the estimated

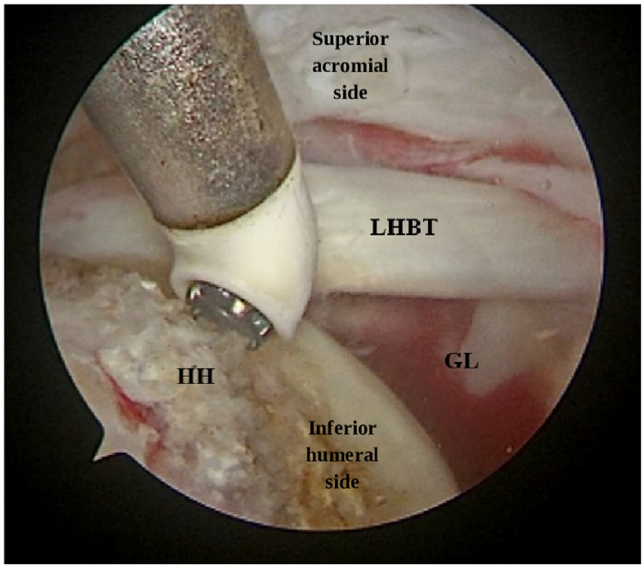

Fig 3. Viewing from the port of the Wilmington and working from the lateral portal with 4-mm 30° arthroscope in the right shoulder with patient in lateral position, humeral footprint is prepared on the greater tuberosity. HH, humeral head; GL, glenoid; LHBT, long head of the biceps.

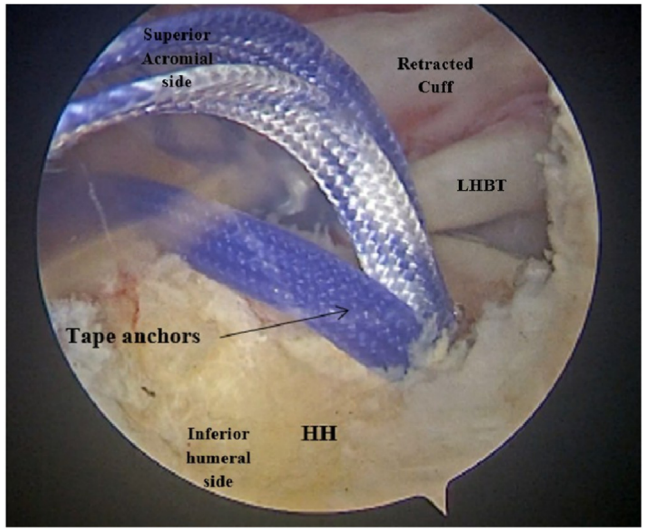

Fig 5. Viewing from the port of the Wilmington and working from the near anterior acromion portal with 4-mm 30° arthroscope in the right shoulder with the patient in the lateral position, two double-loaded self-punching 2.3-mm tape anchors (Stryker, India) are placed in anterior and posterior position over the greater tuberosity as medial row anchors. HH, humeral head.

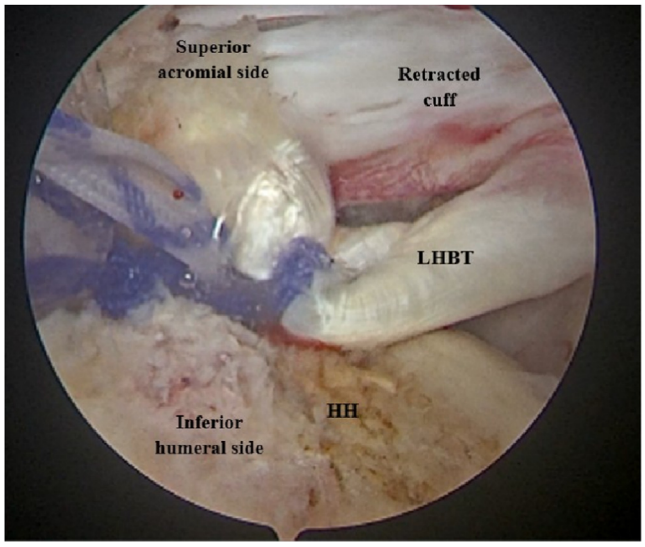

Fig 6. Viewing from the port of the Wilmington and working from the lateral portal with 4-mm 30° arthroscope in the right shoulder with patient in lateral position, the long head of biceps tendon (LHBT) is fixed to the humerus footprint using the suture limb from the medial row anchor on the greater tuberosity. HH, humeral head.

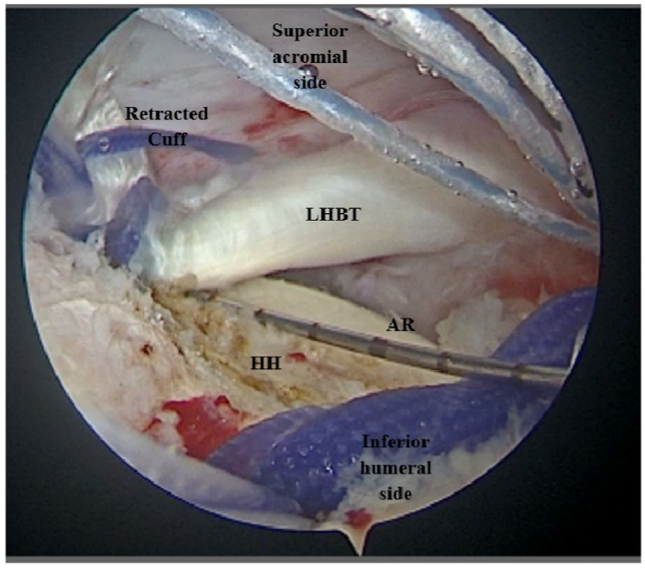

Fig 8. Viewing from the port of the Wilmington and working from the lateral portal with 4-mm 30° arthroscope in the right shoulder with patient in lateral position, graft width is measured with an arthroscopic ruler (AR), between the humeral side anchors. HH, humeral head; LHBT, long head of the biceps tendon.

dimension. The length of the required graft is measured from the glenoid to greater tuberosity, and 1.5 cm is added to the estimated measurement. The measurements are done with an arthroscopic ruler from the lateral portal, while viewing is done from the Wilmington portal (Figs 7 and 8). The desired length and the width of the graft are harvested from the fascia lata, and the graft is folded and sutured together to achieve a graft thickness of 8 mm.

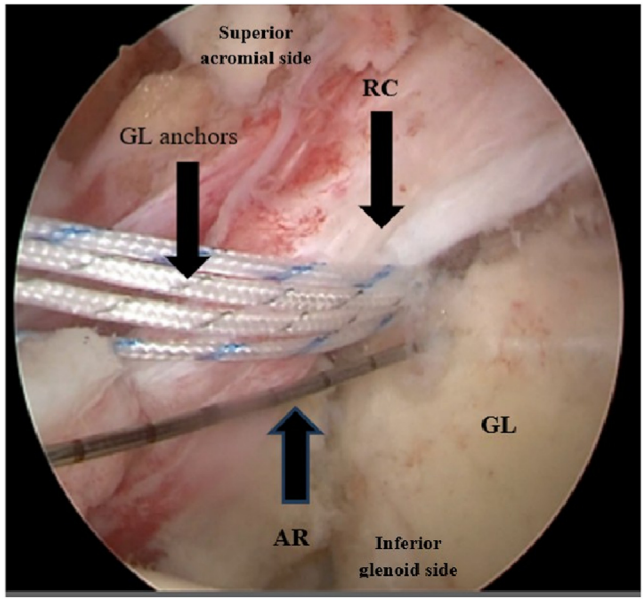

Fig 7. Viewing from the port of the Wilmington and working from the lateral portal with 4-mm 30° arthroscope in the right shoulder with patient in lateral position, the graft length is measured with an arthroscopic ruler (AR), between the glenoid and humeral footprint. Extra 15-mm added to the estimated measurements. GL, glenoid; RC, rotator cuff.

Graft Passage and Suture Management

The suture tape limbs from the medial row anchors on the greater tuberosity are passed through the remnant posterosuperior cuff and parked outside through the near-anterior acromion portal. The suture tapes from each anchor are marked prior to distinguishing them. The 10-cc syringe is introduced through the lateral portal, which aids in the graft passage. The glenoid sutures and the suture tapes from the medial row humeral side anchors are retrieved through the 10-cc syringe. The glenoid sutures are passed through the prepared graft using the scorpion suture passer in the premarked anterior and posterior points on the glenoid side of the graft. The humeral side sutures are also passed in the similar fashion in the premarked points on the humeral side of the graft (Fig 9). The graft is introduced into the subacromial space through the 10-cc syringe using an arthroscopic grasper, and one limb of the anterior glenoid anchor is tied to the one limb of the posterior anchor. The other limbs are pulled to seat the graft on the glenoid bed and secured with half hitching knots.

Double-Row Fixation on the Humeral Side

Once the glenoid side of the graft is secured, working from the lateral portal and viewing from the port of the

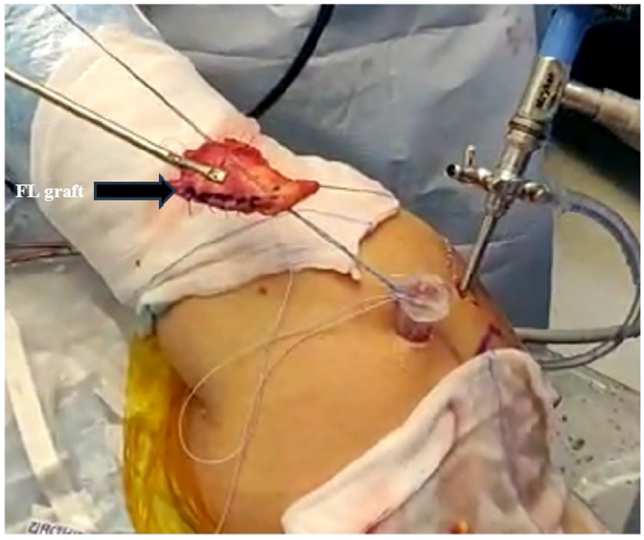

Fig 9. The prepared fascia lata graft is introduced into the joint after passing the glenoid, and the humeral side anchors through the 10-cc syringe placed in the lateral portal. The arthroscopic grasper is used to aid in introducing the graft into the joint with patient in lateral position.

Wilmington, the sutures passed through the remnant cuff, and the sutures passed through the graft are fixed on the humeral side using two 5.5-mm SwiveLocks (Arthrex) in the standard double-row fashion (Fig 10). The final arthroscopic evaluation demonstrates the well-secured and -positioned fascia lata graft over the central beam of the LHBT tendon (Fig 11).

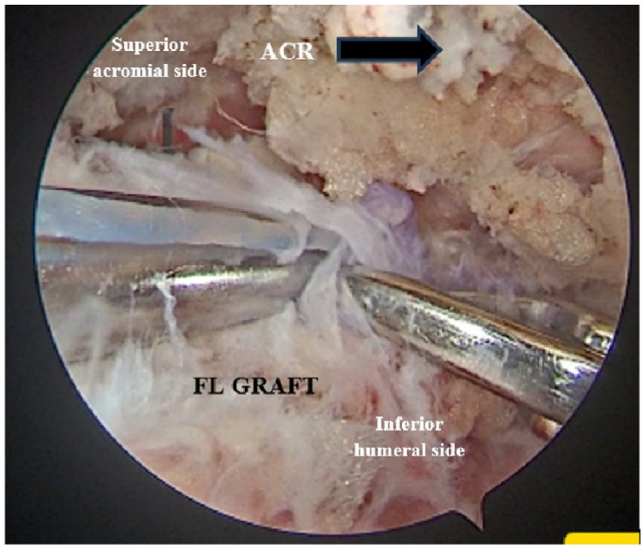

Fig 10. Viewing from the port of the Wilmington and working from the lateral portal with 4-mm 30° arthroscope in the right shoulder with patient in lateral position, the fascia lata (FL) graft is shuttled and is being spread inside the joint. The graft is secured in the glenoid bed using the double-pulley suture configuration. ACR, acromion.

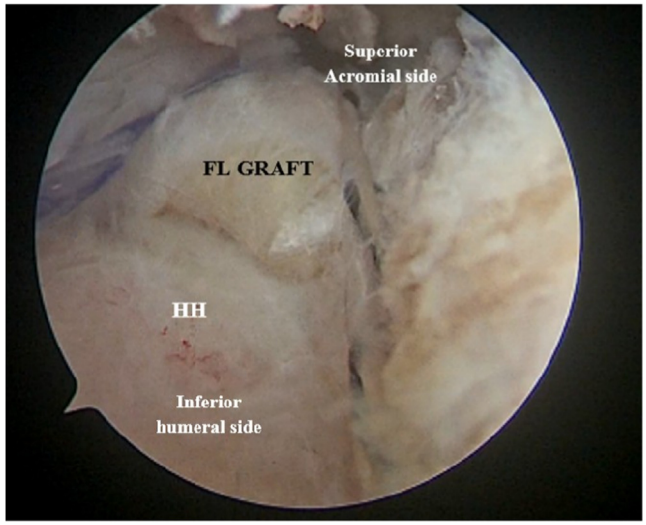

Fig 11. Viewing from the port of the Wilmington and working from the lateral portal with 4-mm 30° arthroscope in the right shoulder with patient in lateral position, final construct showing well-seated fascia lata graft (FL) secured over the greater tuberosity with double-row configuration.

Discussion

In full-thickness rotator cuff tear with retraction, there is proximal migration of the humeral head, as the fulcrum is lost due to disruption of forces acting across the glenohumeral joint.[12,13] The superior capsular reconstruction was designed to provide a constraint to the superior migration and to obtain a stable fulcrum to the humeral head.[8] The most commonly used grafts are the fascia lata graft, dermal allograft, and the synthetic grafts. Fascia lata graft has the advantage of readily availability, free of cost, no immune reaction, and thickness of the graft can be adjusted to achieve maximum thickness and spacer effect and less stretching of the graft.[14] However, the failure of graft healing is described as a result of graft creep, the thinning and elongation of the graft leading to failures.[15]

Table 1. Tips and Tricks of our Technique

1. Good Quality of the Long Head of Biceps is a Prerequisite. Preoperative Magnetic Resonance Imaging can Help in Determining the Long Head of the Biceps Tendon Anchor.
2. Long head of biceps tenotomy at appropriate position at the level of the bicipital groove enabling good length of the tendon is obtained for fixation.
3. Adequate mobilization of the remnant rotator cuff is done enabling fixing the cuff tissue over the fascia lata graft.
4. Appropriate passage of the sutures from medial row anchors on the humeral head to the remnant cuff is done prior to the graft introduction.
5. Appropriate marking of the sutures from individual anchors helps to prevent suture mismatch and helps in suture management.
6. Incorporating the LHBT tendon graft can also be tried with dermal grafts and other synthetic grafts.

Table 2. Pitfalls of our Technique

1. Long Head of Biceps Tenotomy may Lead to pain and Popeye Deformity.
2. It is technically demanding to pass fascia lata graft into the joint when the long head of biceps tendon origin is preserved on the glenoid.
3. Proper placement of the long head of the biceps tendon on the humeral head prevents bulging of the fascia lata graft.
4. Fascia lata graft should be of appropriate thickness and must be spread properly to provide sufficient spacer effect.
5. Suture tangling between fascia lata graft and long head of biceps can occur; this can be avoided with proper suture management.

In our technique of superior capsular reconstruction, we combine both the fascia lata and the long head of the biceps tendon graft. The advantages of using the long head of the biceps tendon are its biological availability, and it has been successful in restoring force vector in glenohumeral articulation when used for augmentation in rotator cuff repairs. Second, it is rich in tendon-specific fibroblasts and vascular supply, which makes the long head of biceps a suitable augment in rotator cuff repair.[16,17] Currently, the long head of biceps tendon is being used for superior capsular reconstruction as it is readily available.[18]

Cheng et al. demonstrated that arthroscopic superior capsular reconstruction with in situ proximal LHBT augmentation provided good clinical outcomes in cases of irreparable cuff tears. Our technique involves LHBT tenotomy at the level of the groove and anchoring the proximal LHBT stump at the level of the greater tuberosity.[19]

The advantages of our technique are that the origin of the LHBT from the superior glenoid is preserved, thereby preserving the vascularity of the tendon. This helps in better incorporation of fascia lata graft into the biceps tendon and helps in better overall graft healing.

Table 3. Advantages and Limitations of our Technique

Advantages

1. The long head of the biceps tendon (LHBT), rich in tenocytes, serves as suitable graft option in RCT repair and superior reconstruction.
2. Using the LHBT as part of the superior capsular reconstruction maintains the physiological humeral head depressor effect of the LHBT.
3. Maintaining the LHBT origin at the superior labrum helps in providing the vascularity to the tendon.
4. LHBT tenotomy at the level of the groove helps in reducing the pain associated with inflamed LHBT tendon.
5. Anchoring the LHBT at the greater tuberosity helps in recreating the superior capsule even in cases of partial tear of the fascia lata graft.

Limitations

1. Tenotomy at the level of the groove may lead to Popeye deformity, a mostly cosmetic issue in elderly age group.
2. A longer learning curve is associated with the procedure.
3. Poor-quality biceps tendon, if incorporated in the reconstruction, may lead to undesirable outcomes.

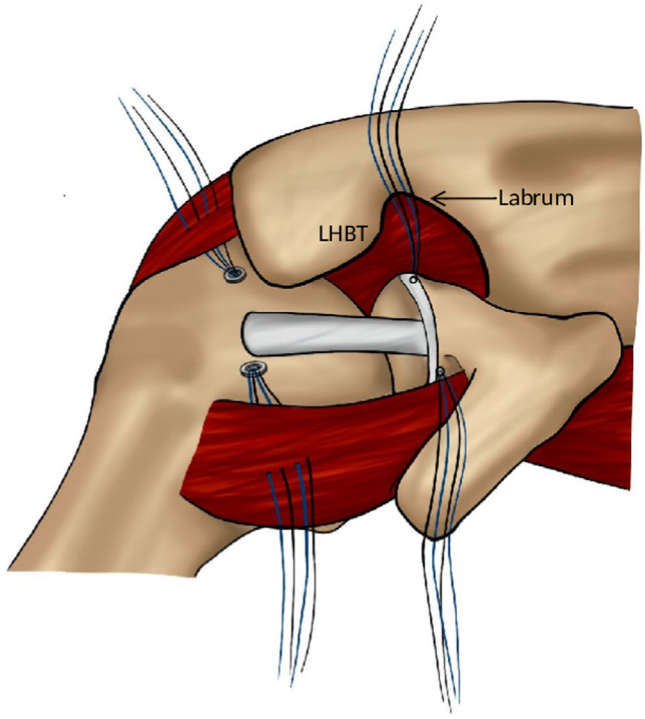

Fig 12. Animated illustration showing anchor placement over the glenoid bed and humeral head respectively, with sutures passed through the remnant rotator cuff.

The LHBT has a depressor effect on the humerus head, which prevents proximal migration and helps restore the forces across the glenohumeral joint. The LHBT tendon provides structural support to the fascia lata graft. The long head of biceps tendon partial tears or degeneration is quite commonly associated with massive rotator cuff tears.[20] The availability of the long head of biceps tendon and its structural integrity must be evaluated with MRI preoperatively before planning for the procedure. Our technique can be used

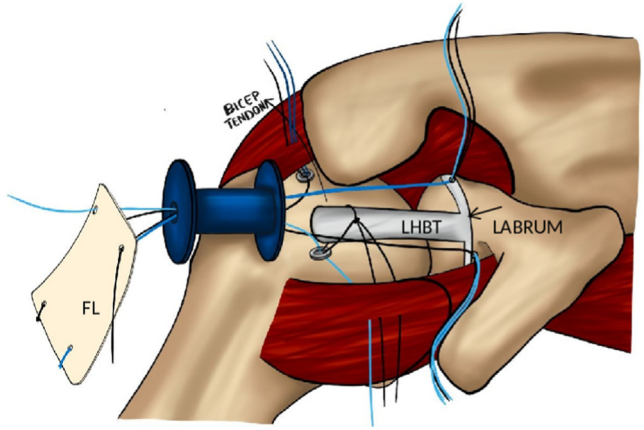

Fig 13. Animated illustration showing the long head of biceps tendon fixed over the greater tuberosity on the humeral head and fascia lata graft (FL) placed outside the lateral portal.

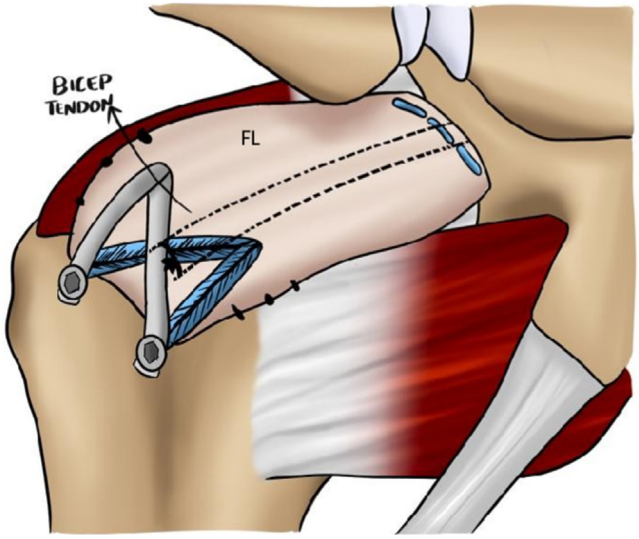

Fig 14. Animated illustration showing fascia lata graft shuttled into the joint and fixed over the top of the long head of biceps tendon using double row fixation on the humeral head.

whenever structurally intact long head of biceps tendon is present (Tables 1-3).

Our technique restores the anterior superior stability and force couple of the glenohumeral joint. We believe that the proposed technique of incorporating the long head of biceps tendon with fascia lata autograft for superior capsular reconstruction can be a viable option for irreparable massive rotator cuff tear (Figs 12, 13, and 14).

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