

Chapter 11

Superior Capsule Reconstruction for Irreparable Rotator Cuff Tears

Teruhisa Mihata

Abstract In 2007 we developed a superior capsule reconstruction for treating irreparable rotator cuff tears. This technique can restore shoulder function with pain relief and low complication rates (re-tear 7/180, 4 %; infection 2/180, 1.1 %; severe synovitis 3/180, 1.7 %; severe stiffness 3/180, 1.7 %). The presence of indications for this surgery is determined by preoperative MRI. Goutallier grades 3 and 4 (fatty infiltration equal to, or more than, muscle volume) are absolute indications. If the torn tendon is severely atrophied, degenerated, and thin in Goutallier grade 2, we recommend superior capsule reconstruction. During arthroscopy, the torn tendon is examined quality and mobility. If it cannot be made to reach the original footprint (i.e., it is an irreducible tear), a preoperative decision is made for superior capsule reconstruction. If the tendon can reach the original footprint after mobilization (i.e., it is a reducible tear), superior capsule reconstruction followed by rotator cuff repair over the reconstructed superior capsule is chosen. Factors prognostic of clinical outcome are the degree of graft healing and the level of deltoid function. Re-tear of the graft of the repaired infraspinatus tendon causes shoulder pain or decreased active elevation. In some patients, concomitant cervical spinal palsy worsens after surgery, resulting in poor shoulder function despite graft healing.

Keywords Irreparable • Reconstruction • Rotator cuff • Shoulder • Superior capsule

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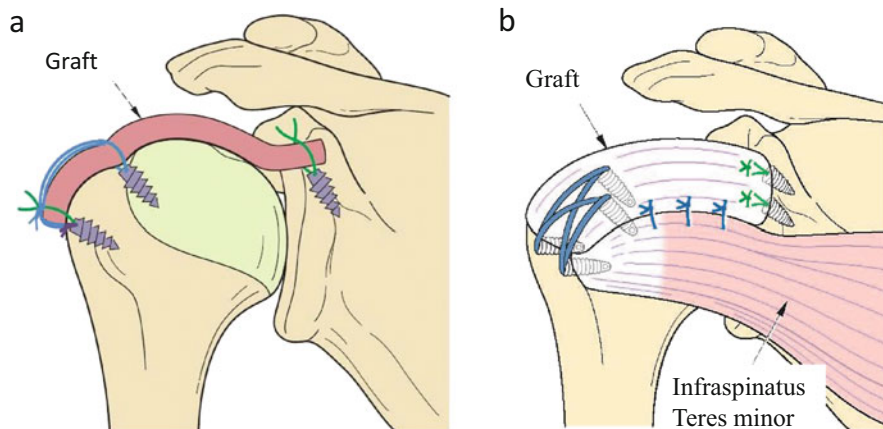


Fig. 11.1 Superior capsule reconstruction. We have developed a method of superior capsule reconstruction as a surgical treatment for irreparable rotator cuff tears. The graft is attached medially to the superior glenoid and laterally to the greater tuberosity. This is followed by side-to-side suturing between the graft and the infraspinatus or teres minor tendon. **(a)** Compression double-row repair technique. **(b)** SpeedBridge repair technique (Arthrex). **(a)** from Mihata [7]; **b** from Mihata [8]

11.1 History, Outcomes, and Biomechanics

In 2007 we developed superior capsule reconstruction for the treatment of irreparable rotator cuff tears [1] (Fig. 11.1). The number of these procedures increased in our hospitals between 2007 and 2014, because superior capsule reconstruction can restore shoulder function with pain relief and a low rate of complications (re-tear 7/180, 4%; infection 2/180, 1.1%; severe synovitis 3/180, 1.7%; severe stiffness 3/180, 1.7%).

The clinical outcomes of the first 24 shoulders in 23 consecutive patients with irreparable rotator cuff tears (11 large tears, 13 massive tears) that underwent arthroscopic superior capsule reconstruction (ASCR) were first reported in 2013 [1]. Mean active elevation increased significantly from 84 to 148° ($P < 0.001$) and external rotation increased from 26 to 40° ($P < 0.01$). Acromiohumeral distance increased from 4.6 mm preoperatively to 8.7 mm postoperatively ($P < 0.0001$). Twenty patients (83.3%) had no graft tear or no tendon re-tear during follow-up (24–51 months) (Fig. 11.2). The mean American Shoulder and Elbow Surgeons score improved from 23.5 to 92.9 points ($P < 0.0001$).

The biomechanical role of superior capsule reconstruction has been confirmed by a cadaveric study [2]. In that study, superior translation and subacromial contact pressure were significantly greater in simulated irreparable rotator cuff tears than in the intact condition (normal rotator cuff). After superior capsule reconstruction using a fascia lata allograft, superior translation and subacromial contact pressure were completely normalized to the intact level. Side-to-side sutures between the graft and residual rotator cuff tendons may improve force coupling in the shoulder

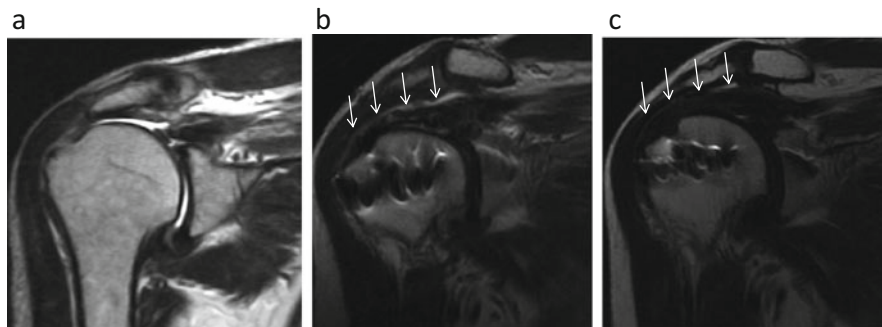


Fig. 11.2 MRI findings before and after superior capsule reconstruction. (a) Before surgery. The torn supraspinatus tendon was severely retracted, and the supraspinatus muscle was severely atrophied and infiltrated with fat. (b) One year after surgery. (c) Four years after surgery. The reconstructed superior capsule has become thicker (*white arrows*)

joint. Restoration of shoulder stability after superior capsule reconstruction improves deltoid function, resulting in increased active shoulder range of motion (especially elevation).

11.2 Indications and Prognostic Factors

Patient suitability for superior capsule reconstruction is determined by preoperative MRI. Goutallier grades 3 and 4 (fatty infiltration equal to, or more than, muscle volume) are absolute indications [3]. If the torn tendon is severely retracted, degenerated, and thin in Goutallier grade 2, we recommend superior capsule reconstruction.

The stage of osteoarthritis before surgery is classified by using the Hamada grade [4]. In this system, grade 1 is associated with minimal radiographic changes; grade 2 is characterized by narrowing of the subacromial space to less than 6 mm; grade 3 is defined as erosion and so-called acetabulization of the acromion caused by superior migration of the humeral head; grade 4 is associated with glenohumeral arthritis; and grade 5 is characterized by the presence of humeral head osteonecrosis. Irreparable rotator cuff tears with Hamada grades 1–3 are an absolute indication for ASCR. Whereas young patients with Hamada grade 4 are recommended for ASCR, elderly patients with Hamada grade 4 and all patients with Hamada grade 5 should have total shoulder arthroplasty with open surgical superior capsule reconstruction.

During arthroscopy, the torn tendon is examined for quality and mobility. If the torn tendon cannot be made to reach the original footprint (i.e., the tear is irreducible), a preoperative decision is made to perform superior capsule reconstruction alone. If the torn tendon can reach the original footprint after mobilization (i.e., the

tear is reducible), superior capsule reconstruction followed by rotator cuff repair over the reconstructed superior capsule is chosen.

The factors prognostic of clinical outcome in superior capsule reconstruction are the degree of graft healing and the level of deltoid function. Re-tear of the graft of the repaired infraspinatus tendon causes shoulder pain or decreased active elevation. Some patients with irreparable rotator cuff tears have concomitant cervical spinal palsy. When patients already have severe deltoid atrophy and weakness from concomitant cervical spinal palsy, we do not recommend superior capsule reconstruction. However, we sometimes do superior capsule reconstructions in patients with slight or moderate deltoid weakness. In some patients the cervical spinal palsy deteriorates after surgery, resulting in poor shoulder function even when the graft is healed.

11.3 Surgical Technique

11.3.1 Measurement of Defect Size

Subacromial bursal tissue around the torn tendons is completely removed before measurement of the defect size. Degenerated (e.g., thin and weak) tendon tissue is also removed, because postoperative tear of the degenerated rotator cuff tendon worsens the postoperative outcome even when the reconstructed superior capsule remains intact. The defect size is then measured in the mediolateral (from the superior glenoid to the lateral edge of the greater tuberosity) and anteroposterior (from the anterior edge to the posterior edge of the torn tendon) directions (Fig. 11.3).

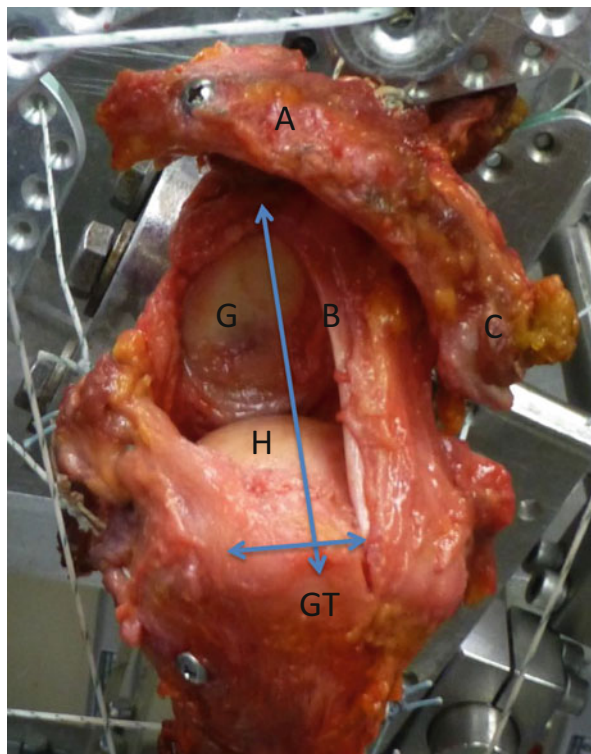
11.3.2 Deciding on Graft Size

Deciding on the correct graft size is the most important step in this surgery. If the graft is torn after surgery because it is too small, the clinical results will be poor.

11.3.2.1 Length in the Anteroposterior Direction

The anteroposterior length of the defect is measured without partial repair of the infraspinatus tendon. In our early cases, we performed a partial repair of the infraspinatus tendon before superior capsule reconstruction. However, we experienced postoperative re-tear of the repaired infraspinatus tendon even when the fascia lata graft had not been torn. The clinical results in such cases of partial re-tear are acceptable (approximately 50–70% of the recovery achieved in cases

Fig. 11.3 Measurement of defect size. The size of the defect is measured in the mediolateral (from the superior glenoid to the lateral edge of the greater tuberosity) and anteroposterior (from the anterior edge to the posterior edge of the torn tendon) directions. *A* acromion, *B* biceps long head tendon, *C* coracoid process, *G* glenoid, *GT* greater tuberosity, *H* humeral head



where there is no re-tear) but not excellent. For this reason, we now omit the partial repair before measurement. Afterward, the graft length in the anteroposterior direction was determined to be exactly the same as the length of the defect without partial repair of the torn infraspinatus tendon.

11.3.2.2 Length in the Mediolateral Direction

To make a 10-mm footprint on the superior glenoid and allow for 5 mm of latitude in graft size, in the mediolateral direction the graft should be 15 mm longer than the distance from the superior glenoid to the lateral edge of the greater tuberosity. A graft that is too short, especially in the mediolateral direction, will re-tear, resulting in a poor clinical outcome.

11.3.2.3 Graft Thickness

The appropriate graft thickness for superior capsule reconstruction using the fascia lata is 6–8 mm. The average thickness of one layer of autologous fascia lata is

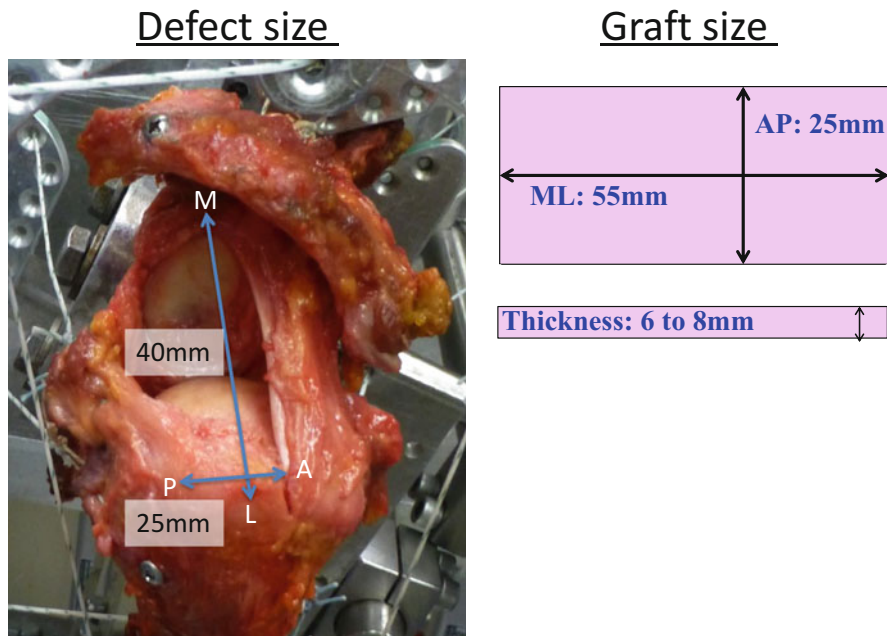


Fig. 11.4 Example. If the defect size is 25 mm anteroposteriorly and 40 mm mediolaterally, the graft should be 25 mm anteroposteriorly, 55 mm (40 + 15 mm) mediolaterally, and 6–8 mm thick

2–4 mm. Therefore, a graft thickness of 6–8 mm is achieved by folding the fascia lata twice or three times. If a fascia lata allograft is used for superior capsule reconstruction, approximately six to eight layers of fascia lata may be needed to give a graft 6–8 mm thick, because the allograft is thinner than an autograft.

11.3.2.4 Example

If the defect is 25 mm anteroposteriorly and 40 mm mediolaterally, the graft should be 25 mm in the anteroposterior direction, 55 mm (40 + 15 mm) in the mediolateral direction, and 6–8 mm thick (Fig. 11.4).

11.3.3 Harvesting the Fascia Lata and Making the Autograft

Fascia lata is harvested around the greater trochanter, taking care to include the posterior, thicker tissue. All fatty tissue should be removed from the graft (Figs. 11.5 and 11.6). The layers of fascia lata are united with nonabsorbable sutures very well to prevent delamination after surgery.

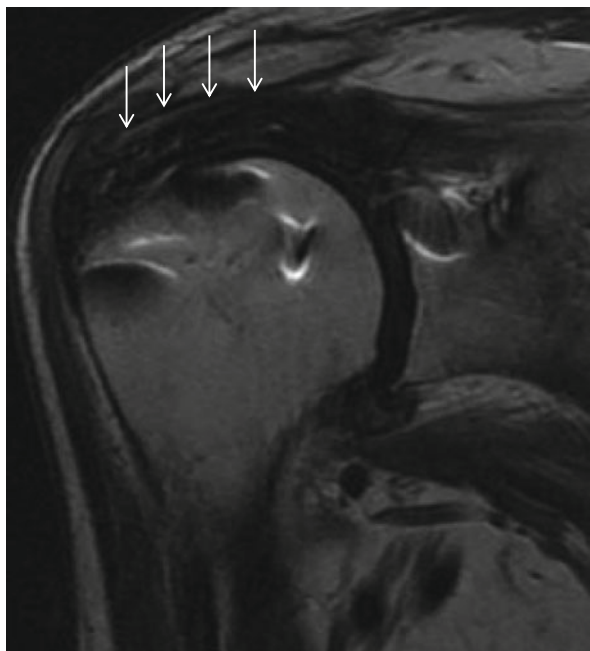


Fig. 11.5 Magnetic resonance imaging (MRI) findings 3 months after superior capsule reconstruction. When all fatty tissue on the graft was removed, T₂-weighted MRI showed that the graft area was of low intensity (*white arrows*)

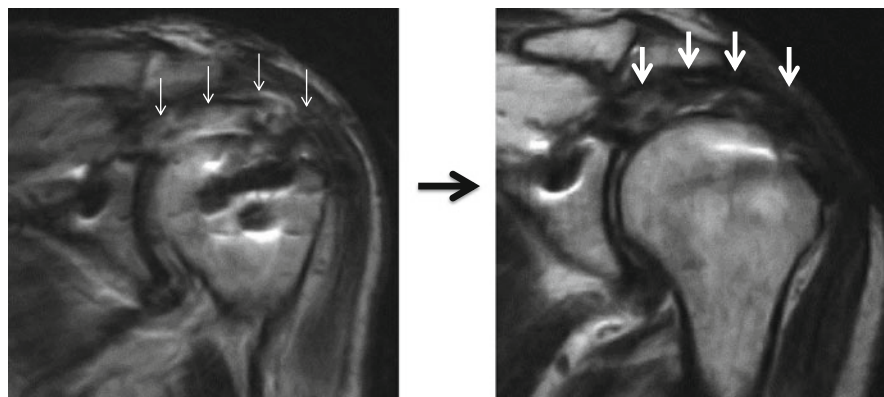


Fig. 11.6 MRI findings after superior capsule reconstruction. *Left*: When some of the fatty tissue was not removed during surgery, T₂-weighted MRI 3 months after surgery showed both low- and high-intensity areas in the graft (*white thin arrows*). *Right*: 1 year after surgery, the graft (*white thick arrows*) was thicker and the low-intensity area had increased on T₂-weighted MRI

11.3.4 Treatment of Associated Lesions

Subscapularis tears should be repaired. Biceps tenodesis or tenotomy is performed for biceps subluxation or dislocation.

11.3.5 Acromioplasty

Acromial spurs on the anterior, lateral, or medial side should be resected. The inferior surface of the acromion (to a thickness of 2 or 3 mm) should be resected to prevent subacromial impingement after surgery.

11.3.6 Anchor Placement on the Superior Glenoid

All soft tissue on the footprint of the superior glenoid should be removed to give a good bone bed before insertion of the suture anchors. Two 4.5-mm Corkscrew FT (Arthrex) anchors are inserted at the 10- or 11-o'clock and 11- or 12-o'clock positions on the glenoid of the right shoulder, and at the 12- or 1-o'clock and 1- or 2-o'clock positions of the left shoulder (Fig. 11.7).

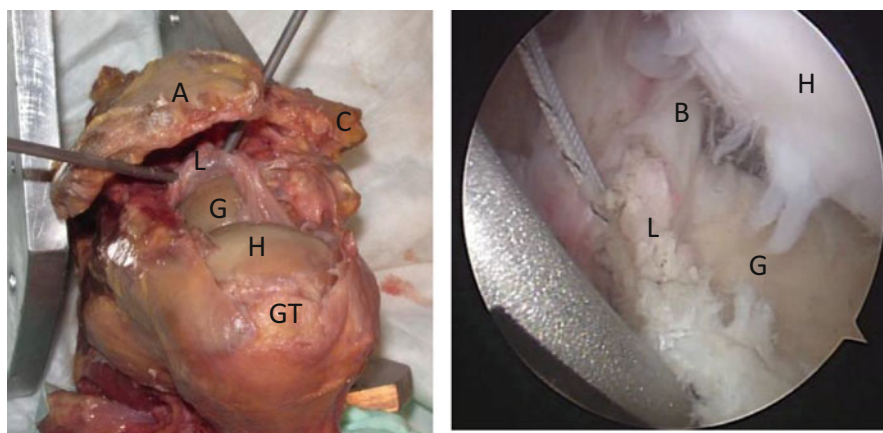


Fig. 11.7 Anchor placement on the superior glenoid. Two 4.5-mm Corkscrew FT (Arthrex) anchors are inserted at the 10 or 11-o'clock and 11 or 12-o'clock positions on the glenoid of the right shoulder. *Left*: cadaveric shoulder; *right*: posterior view of shoulder arthroscopy. *A* acromion, *B* biceps long head tendon, *C* coracoid process, *G* glenoid, *GT* greater tuberosity, *H* humeral head, *L* labrum

11.3.7 Anchor Placement on the Medial Footprint

All soft tissue on the footprint of the greater tuberosity should be removed. Two 4.75-mm SwiveLock (Arthrex) anchors with FiberTape (Arthrex) are inserted on the medial footprint of the greater tuberosity to make a SpeedBridge (Arthrex) (Fig. 11.1). When we fix the graft on the greater tuberosity using compression double-row repair technique, two 4.5-mm Corkscrew FT (Arthrex) anchors are inserted on the medial footprint (Figs. 11.1 and 11.9) [5, 6].

11.3.8 Insertion of Fascia Lata into the Subacromial Space

A 10-ml syringe is used as a cannula. Fiberwires (Arthrex) from the superior glenoid suture anchors are placed through the fascia lata in a mattress fashion when the graft is still outside the body (Fig. 11.8). After all Fiberwires have been placed through the fascia lata, one Fiberwire is tied while the graft is pushed into the subacromial space. The graft can then be inserted in its appropriate place on the glenoid. All sutures are then tied in the subacromial space.

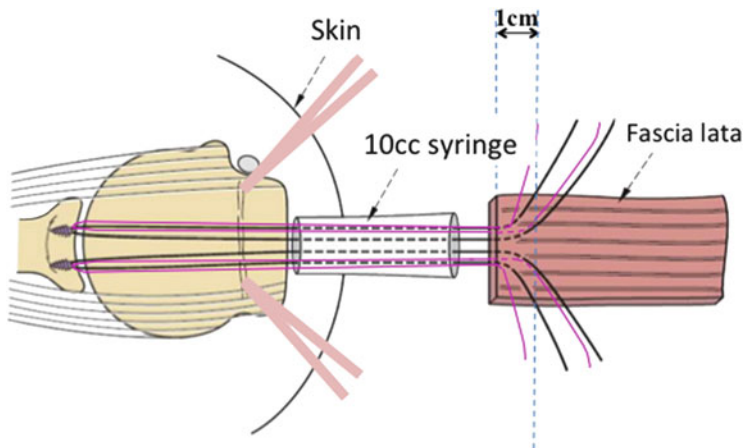


Fig. 11.8 Insertion of fascia lata into the subacromial space. A 10-ml syringe is used as a cannula. Fiberwires (Arthrex) from the superior glenoid suture anchors are placed through the fascia lata in a mattress fashion when the graft is still outside the body. After all Fiberwires have been placed through the fascia lata; one Fiberwire is tied while the graft is pushed into the subacromial space. The graft can then be inserted into its appropriate place on the glenoid. All sutures are tied in the subacromial space. (From Mihata [7])

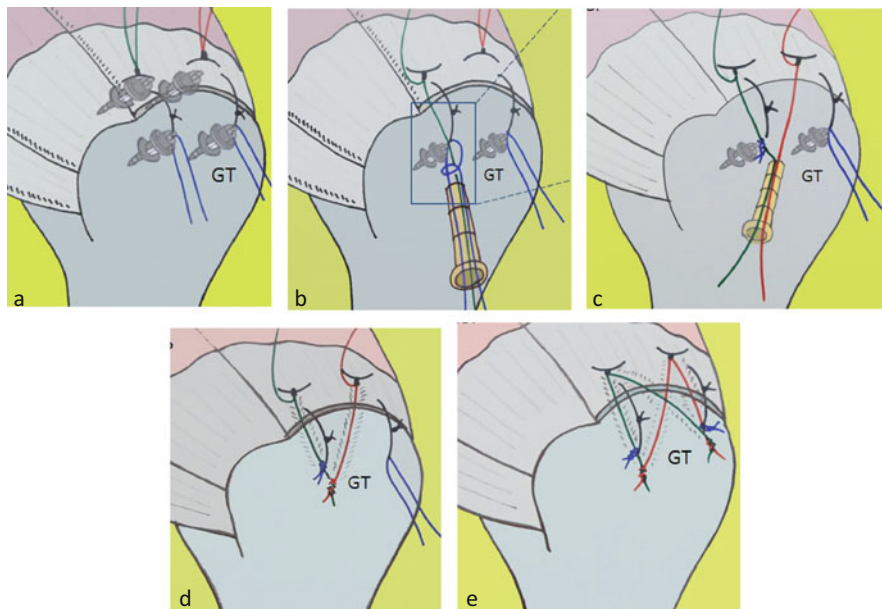


Fig. 11.9 The compression double-row repair technique (combination of the double-row and suture-bridge technique). (a) First, the conventional double-row repair is performed. After the knots were tied for the conventional double-row repair, the medial sutures were not cut because the suture limbs would be used to create suture bridges over the tendon. (b) The lateral suture is tied around the medial limb to create a loop for the suture bridge. (c, d) A suture limb from another medial suture is tied to the first medial suture limb with a nonsliding knot, which is called the “rotator cuff knot,” thereby yielding two suture bridges from two medial suture limbs and the loop from both limbs of a single lateral suture. (e) The remaining medial suture limbs are then tied through loops of the lateral suture in the same procedure used for the first suture bridge. *GT* greater tuberosity. (From Mihata et al. [6])

11.3.9 Attachment to the Greater Tuberosity

Any fixation method, such as a suture bridge, double row, or single row, can be used to attach the graft to the greater tuberosity. My preference is the compression double-row repair [5, 6], which is one of the most secure fixations (Figs. 11.1 and 11.9), or SpeedBridge (Arthrex), which provides easy and secure fixation of the graft (Fig. 11.1).

11.3.10 Side-to-Side Suturing Between the Graft and the Infraspinatus Tendon or Teres Minor

Two or three sutures for posterior side-to-side suturing are placed between the graft and the infraspinatus tendon or teres minor (Fig. 11.1). Side-to-side suturing both

anteriorly and posteriorly may cause postoperative shoulder stiffness, so it is best not to add anterior sutures in superior capsule reconstruction using fascia lata.

11.4 Postoperative Protocol

An abduction brace is used for 4 weeks after superior capsule reconstruction. After the immobilization period, passive and active-assisted exercises are initiated to promote scaption (scapular plane elevation). Eight weeks after surgery, patients begin to perform exercises to strengthen the rotator cuff and the scapular stabilizers. Physical therapists have assisted all our patients.

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