The Outcome and Structural Integrity of Arthroscopic Rotator Cuff Repair with Use of the Double-Row Suture Anchor Technique

Surgical Technique

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ABSTRACT FROM THE ORIGINAL ARTICLE

BACKGROUND: The reported rate of failure after arthroscopic rotator cuff repair has varied widely. The influence of the repair technique on the failure rates and functional outcomes after open or arthroscopic rotator cuff repair remains controversial. The purpose of the present study was to evaluate the functional and anatomic results of arthroscopic rotator cuff repairs performed with the double-row suture anchor technique on the basis of computed tomography or magnetic resonance imaging arthrography in order to determine the postoperative integrity of the repairs.

METHODS: A prospective series of 105 consecutive shoulders undergoing arthroscopic double-row rotator cuff repair of the supraspinatus or a combination of the supraspinatus and infraspinatus were evaluated at a minimum of two years after surgery. The evaluation included a routine history and physical examination as well as determination of the preoperative and postoperative strength, pain, range of motion, and Constant scores. All shoulders had a preoperative and postoperative computed tomography arthrogram (103 shoulders) or magnetic resonance imaging arthrogram (two shoulders).

RESULTS: There were thirty-six small rotator cuff tears, forty-seven large isolated supraspinatus or combined supraspinatus and infraspinatus tendon tears, and twenty-two massive rotator cuff tears. The mean Constant score (and standard deviation) was 43.2 ± 15.1 points (range, 8 to 83 points) preoperatively and 80.1 ± 11.1 points (range, 46 to 100 points) postoperatively. Twelve of the 105 repairs failed. Intact rotator cuff repairs were associated with significantly increased strength and active range of motion.

CONCLUSIONS: Arthroscopic repair of a rotator cuff tear with use of the double-row suture anchor technique results in a much lower rate of failure than has previously been reported in association with either open or arthroscopic repair methods. Patients with an intact rotator cuff repair have better pain relief than those with a failed repair. After repair, large and massive rotator cuff tears result in more postoperative weakness than small tears do.

LEVEL OF EVIDENCE: Therapeutic Level IV. See Instructions to Authors for a complete description of levels of evidence.

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INTRODUCTION

The evolution of arthroscopic rotator cuff repair has included a substantial effort to develop methods of fixation that optimize the strength and durability of rotator cuff reconstructions. Numerous fixation techniques have been evaluated both in vivo and in vitro, and widely varying results have been reported[1-10]. Our study focused on the clinical outcomes and structural integrity of arthroscopic double-row suture anchor repair of small, large, and massive rotator cuff tears. In this article, we present a detailed description of the surgical technique and principles.

SURGICAL TECHNIQUE

Perioperative Care of the Patient

Arthroscopic rotator cuff repair is often a very painful procedure if multimodality pain management is not utilized in the perioperative and postoperative period. We believe that the intraoperative use of an interscalene block provides optimal patient management during this procedure. The interscalene block facilitates intraoperative blood-pressure control by the anesthesia team since it blunts the sympathetic response to pain during surgery that would otherwise result in periods of intraoperative hypertension. Hypertension can complicate arthroscopic visualization by increasing bleeding and making hemostasis difficult to achieve. We prefer controlled hypotension for our patients during rotator cuff repair, recognizing that maintenance of good cerebral blood flow is crucial to protect patients from catastrophic cerebral injury. There is a theoretical risk of air embolism

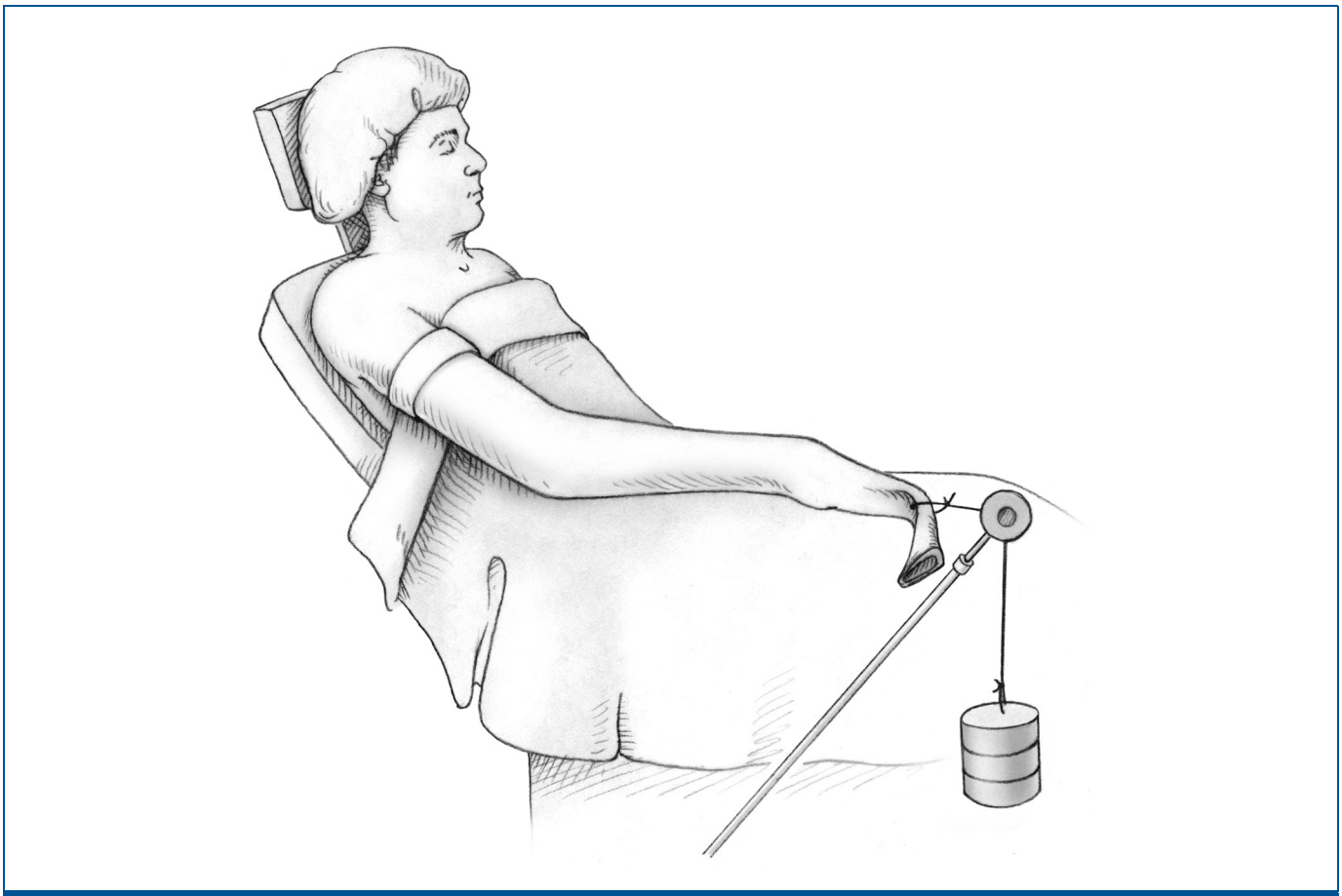

FIG. 1

Beach-chair position with 1.5 to 3 kg of longitudinal skin traction used to perform arthroscopic double-row suture anchor repair.

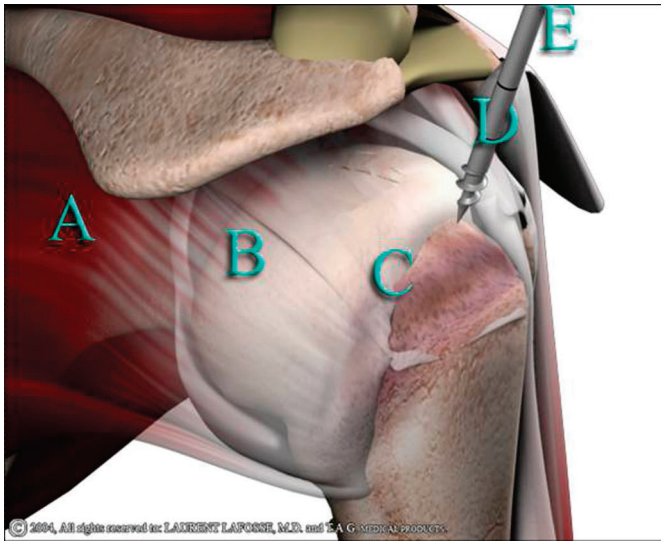

FIG. 2-A FIG. 2-B

A digital drawing (Fig. 2-A) and surgical markings (Fig. 2-B) depicting portals for arthroscopic double-row repair. A = posterior portal, B = accessory posterolateral portal, C = lateral portal, D = accessory anterolateral portal, and E = anterior portal. (Figure 2-A printed with permission of T.A.G. Medical Products, Kibbutz Gaaton, Israel.)

in the beach-chair position; however, we have never observed this complication in our patients, and we are not aware of any reports in the literature of air embolism related to the beach-chair position during arthroscopic surgery.

The patient is placed in the beach-chair position for the procedure with the arm forward flexed with approximately 1.5 to 3 kg of skin traction applied (Fig. 1). Before the extremity is placed in traction, and before it is wrapped, it is important to adequately pad the hand and forearm with gauze or foam in order to avoid injuries to the skin from traction and to avoid excessive nerve compression about the forearm and wrist.

Arthroscopic Double-Row Suture Anchor Repair

Next, a modified posterior portal ("A" in Figs. 2-A and 2-B) is used for entry into the glenohumeral joint. We typically use a spinal needle in order to localize the glenohumeral joint. It is important, when a rotator cuff repair is being done, to move the traditional location of the posterior portal slightly superior to the location that is used in procedures focusing on intra-articular pathology. As most of the work for rotator cuff repairs is performed in the subacromial space, our preferred location for the posterior portal is approximately 10 mm inferior to the scapular spine, in line with the sagittal plane of the glenohumeral joint. A number-11 blade is used to make a small incision in the skin, and a trocar is introduced into the glenohumeral

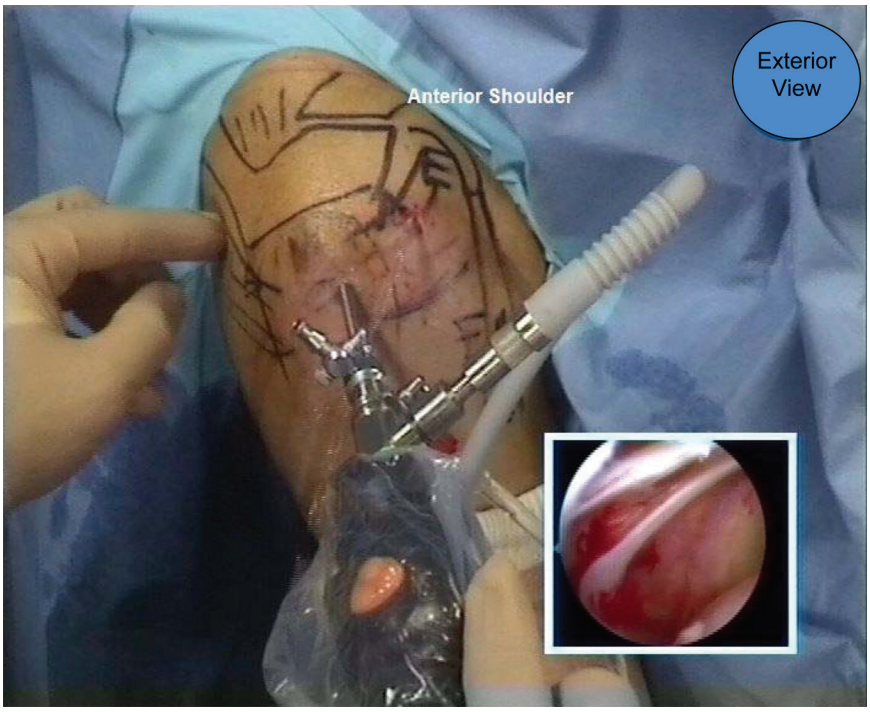

FIG. 3

The lateral portal ("C" in Figs. 2-A and 2-B) is the optimal position for visualization during rotator cuff repair with use of the double-row suture anchor technique. (Printed with permission of Alps Surgery Institute.)

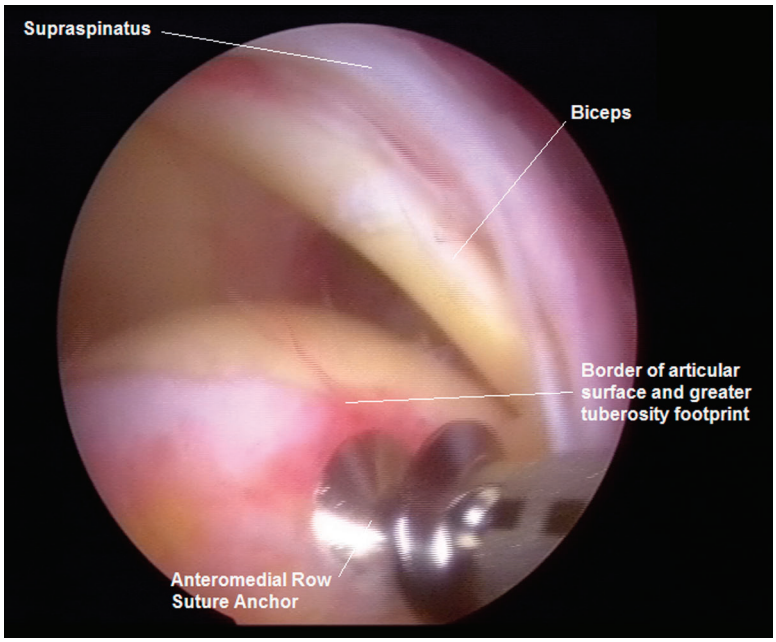

FIG. 4-A

The medial-row anchor is placed at the junction of the supraspinatus or infraspinatus footprint and the articular surface at a 45° angle of insertion. (Printed with permission of Alps Surgery Institute.)

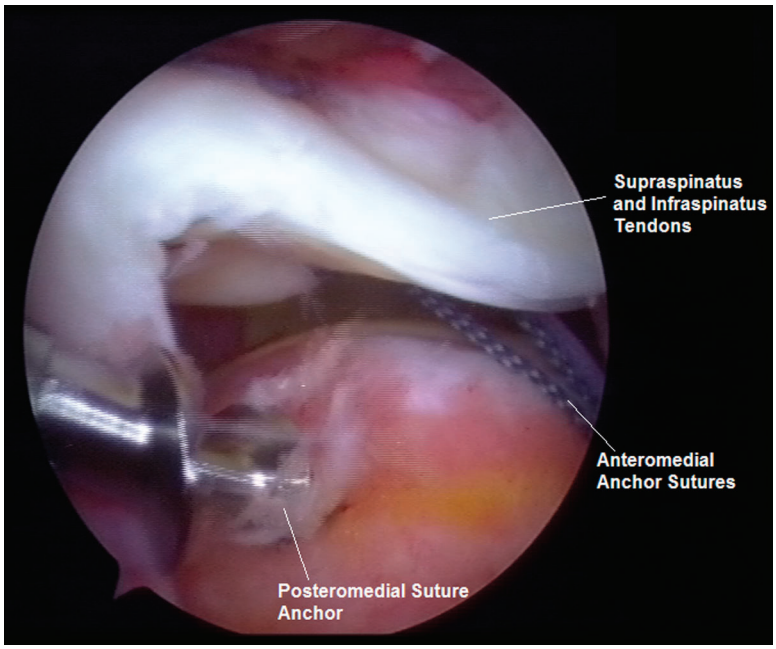

FIG. 4-B

A second medial-row anchor is often used for the double-row suture anchor technique. (Printed with permission of Alps Surgery Institute.)

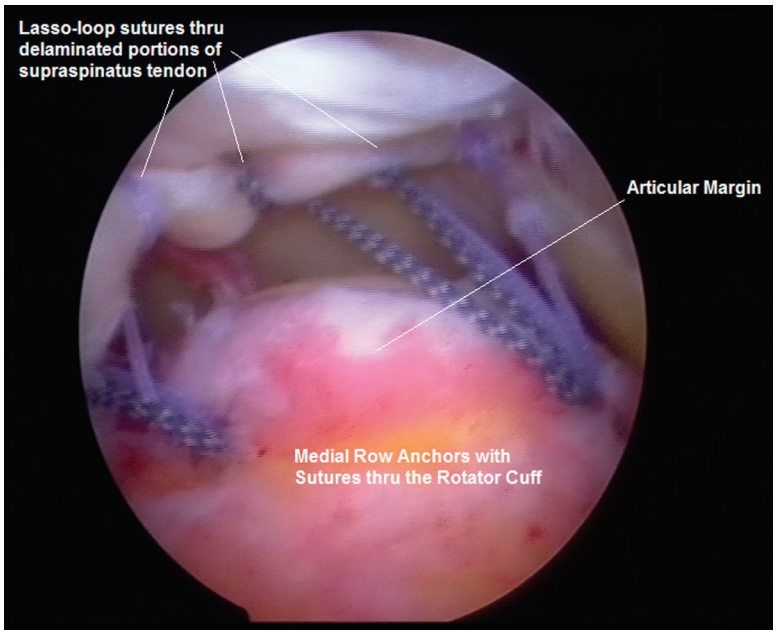

FIG. 4-C

The sutures are passed through the tendon medially prior to placement of the lateral-row anchors. (Printed with permission of Alps Surgery Institute.)

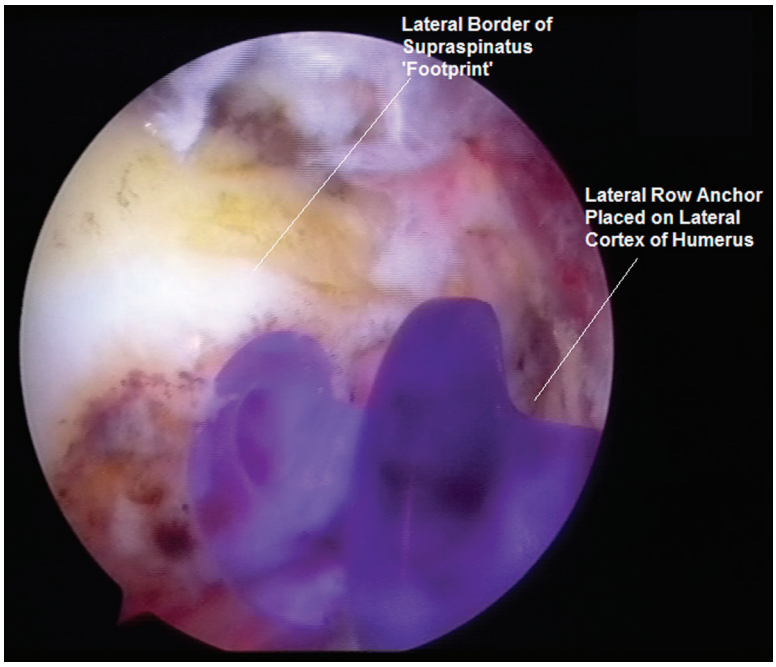

FIG. 5

The lateral-row anchor is placed lateral to the lateral edge of the supraspinatus and/or infraspinatus footprint on the greater tuberosity. This position is usually on the lateral cortex of the greater tuberosity. (Printed with permission of Alps Surgery Institute.)

joint. Systematic diagnostic arthroscopy is performed with the camera before the glenohumeral joint is distended with saline solution. In particular, the size of the rotator cuff tear is assessed along with other commonly observed lesions involving the subscapularis and biceps tendons, the glenohumeral articular surfaces, and the labrum.

At the conclusion of the diagnostic arthroscopy, the camera is removed from the joint and the trocar and the camera sheath are repositioned into the subacromial space through the posterior portal. The tip of the blunt trocar should palpate the coracoacromial ligament and rest lateral to it. The camera is introduced, and the subdeltoid space is filled with saline solution. A 20-gauge needle is used to establish a lateral portal ("C" in Figs. 2-A and 2-B). This portal should be approximately 1.5 to 2 cm lateral to the lateral edge of the acromion. A common error is to make the portal too superior, which results in difficulty with visualization of the rotator cuff as a result of the overhang of the acromion. The lateral portal is used to introduce the arthroscopic shaver and radiofrequency device for the subacromial decompression and acromioplasty (Fig. 3). First, the pathologically involved bursa is removed and is carefully coagulated, and the undersurface of the acromion is cleared of adhesions to facilitate identification of its anterior and lateral borders. Next, a burr is used to perform an acromioplasty. In our opinion, the amount of bone resected during the acromioplasty is dictated by the access needed to perform the rotator cuff repair and to achieve the visualization necessary to evaluate the rotator cuff after reconstruction.

Once the undersurface of the acromion has been cleared of adhesions and the bursal tissue lateral to the coracoacromial ligament has been resected, the camera is moved to the lateral ("C") portal. We believe that this portal provides the optimal view for evaluating the configuration of the rotator cuff tear, performing the releases necessary for tension-free rotator cuff recon-

struction, and passing and tying the sutures. Visualization through the lateral portal also affords the opportunity to reassess the adequacy of the acromioplasty since the three-dimensional shape of the acromion can best be appreciated from two different arthroscopic portals that are orthogonally placed.

Once the camera is in the lateral portal, the posterior portal can be used for instrumentation and completion of the rotator cuff release. If necessary, a spinal needle is used to create either an accessory anterolateral portal ("D" in Figs. 2-A and 2-B) or an accessory posterolateral portal ("B" in Figs. 2-A and 2-B) for instrumentation, according to the location and configuration of the tear. The spinal needle should be used as a guide for determining the most efficacious position for the accessory portals on the basis of the point that enables the most liberal access to the subdeltoid space. We often extend the subdeltoid débridement to the base of the coracoid anteromedially, to the spine of the scapula posteromedially, and circumferentially around the humerus anteriorly, laterally, and posteriorly, an area commonly referred to as the *lateral gutter*. The goal is to achieve a global perspective of the rotator cuff from the lateral ("C") portal so that the subscapularis, supraspinatus, infraspinatus, teres minor, and biceps can all be visualized easily.

The techniques employed to carry out releases required for larger rotator cuff tears are based on the tear configuration, the degree of retraction, and the quality of the torn tendons. In general, the principles are the same as those used in the mobilization of retracted tissues during open surgical procedures. Common techniques include resection of the rotator interval all of the way to the base of the coracoid, release of adhesions between the undersurface of the rotator cuff and the glenoid labrum and capsule, and the so-called posterior interval slide as described by Lo and Burkhart[11]. The key to a tension-free repair of the rotator cuff, particularly one with a larger tear, is to perform an adequate release of the rotator cuff tendons and reapproximate the rotator cuff in line with the di-

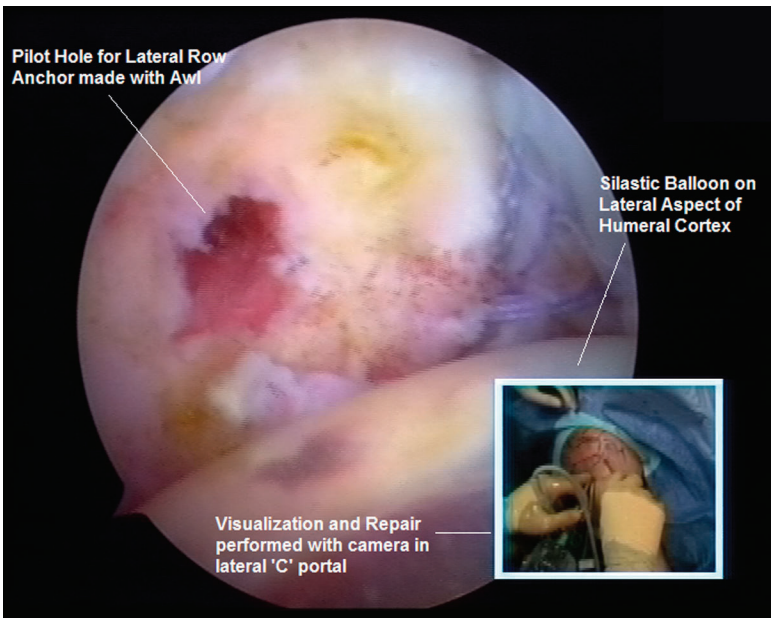

FIG. 6

The use of silicone balloons as internal retractors improves visualization about the proximal part of the humerus during the procedure. (Printed with permission of Alps Surgery Institute.)

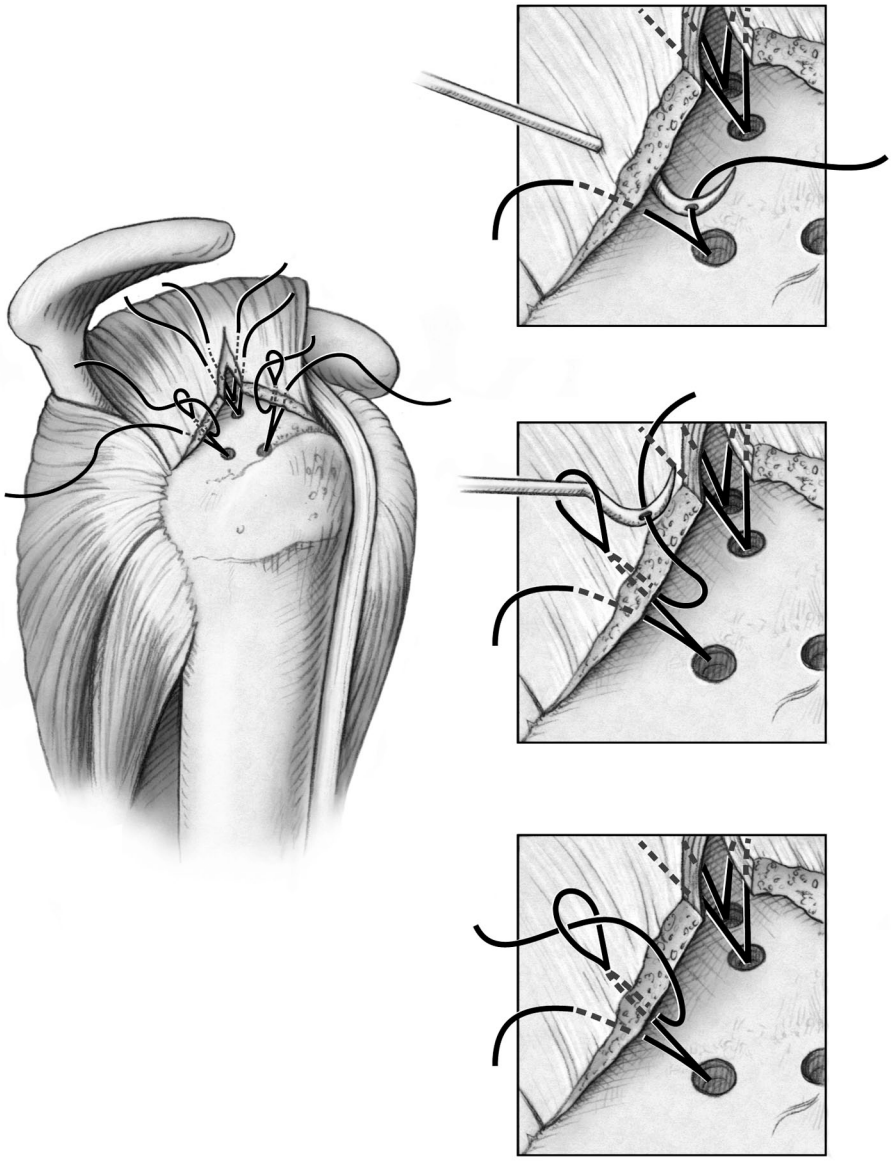

FIG. 7-A

Drawing (Fig. 7-A) and intraoperative photograph (Fig. 7-B) depicting the lasso-loop technique used for the lateral row of sutures. We believe that this technique provides tissue fixation that is superior to that achieved with the simple suture configuration for the lateral row. (Fig. 7-B printed with permission of Alps Surgery Institute.)

rection of retraction of the fibers of each muscle. This is the purpose of understanding the configuration of the rotator cuff tear—i.e., in order to understand the direction of retraction of the fibers of each rotator cuff tendon, so that the best reduction of the tear can be achieved. The key to performing an adequate release of a large, retracted anterosuperior rotator cuff tear is to identify the coracohumeral ligament and widely resect the rotator interval. If necessary, the coracohumeral ligament can be released from its attachment near the base of the coracoid; it is very important, however, to never separate the distal part of the supraspinatus tendon from its at-

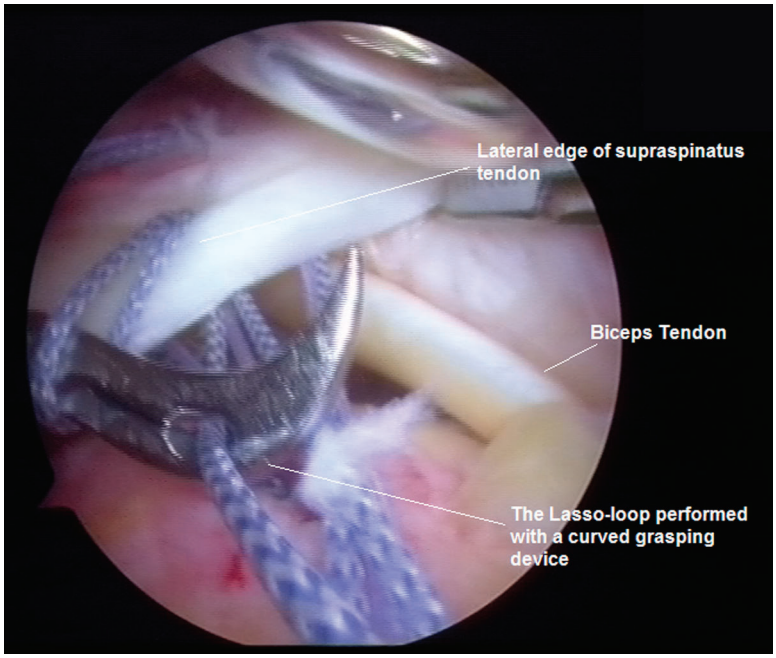

FIG. 7-B

tachment to the coracohumeral ligament and the subscapularis as this greatly compromises the strength of the distal part of the tendon. Traction sutures may further aid in exposing adhesions to the rotator cuff during the release of the tendon and muscle tissues.

Once an adequate release of the rotator cuff has been performed and the débridement of the subdeltoid space has been completed, the greater tuberosity footprint is cleared of the rotator cuff remnant and adhesions with use of either electrocautery or an arthroscopic shaver. We no longer decorticate the greater tuberosity as we believe that preserving the strength of the cortical bone in the tuberosity provides improved fixation strength for the suture anchors and, therefore, superior durability of the repair.

Next, the suture anchors are placed along the medial border of the anatomic footprint on the greater tuberosity. Typically, anchors can be placed from the anterolateral ("D") portal, or, as is sometimes necessary because of the size of the tear and its configuration, a posterolateral ("B") portal is established for this purpose. In most double-row suture anchor reconstructions, two anchors are placed medially at the junction of the articulating surface of the humerus and the greater tuberosity footprint and the sutures are passed through the tendon prior to the placement of another one or two anchors on the lateral edge of the footprint or the lateral cortex of the humerus (Figs. 4-A, 4-B, and 4-C). The angle of insertion of the suture anchors should be at approximately 45°, or the "deadman's angle" as described by Burkhart[12], in order to maximize the pull-out strength of the anchors and minimize the tension on the sutures used to repair the rotator cuff.

Once an anchor has been inserted, the posterolateral and anterolateral ("B" and "D") portals are usually used to retrieve the sutures with a hook device, depending on the pattern and size of the tear. It is important to always shuttle the sutures out of a different portal than the one used to retrieve the sutures with the hook prior to passing the sutures through the rotator cuff. When all of the sutures from each anchor are passed through the rotator cuff, they should be clamped together outside of the skin in order to optimize suture management and avoid entan-

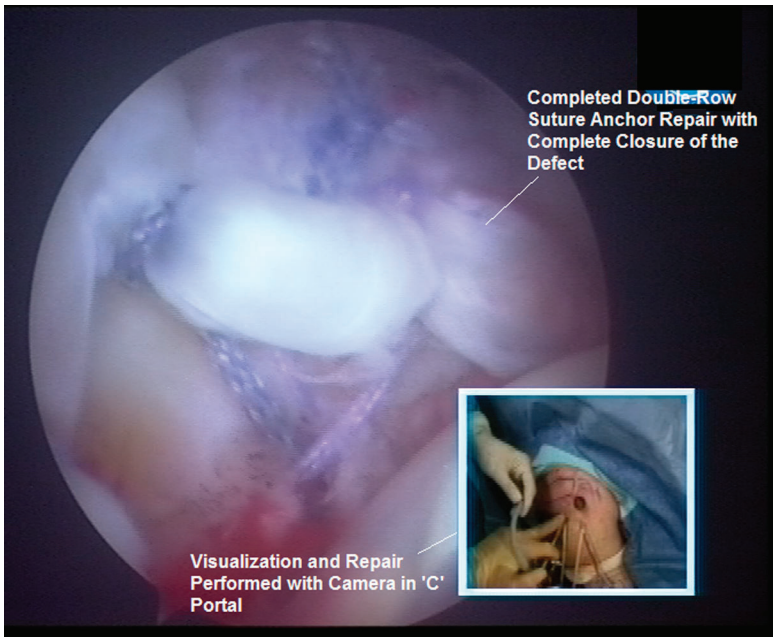

FIG. 8

The completed double-row repair with reduction of the tendon over the entire surface area of the tendon footprint. (Printed with permission of Alps Surgery Institute.)

glement. All of the sutures coming from the same anchor are grasped and are placed in a small silicone catheter; the catheter is pushed into the subacromial space with tension on the sutures so that a reduction of the rotator cuff to the tuberosity is achieved. Once all of the sutures from the medial anchors are passed through the rotator cuff, the lateral-row anchors can be placed with use of either or both the posterolateral and anterolateral portals, as determined by the pattern and size of the rotator cuff tear (Fig. 5).

In order to maximize visualization of the lateral cortex of the humerus during the procedure and to prevent encroachment of the bursa into the visual field, we utilize silicone balloons, from urological catheters, placed through the inferolateral portals (Fig. 6). The lateral-row sutures are passed through the rotator cuff with use of either the posterolateral or the anterolateral ("B" or "D") portal, as was done with the medial-row sutures, except that the lasso-loop configuration[13] is employed (Fig. 7). In order to perform the lasso loop, the retrieval hook is used on the lateral edge of the rotator cuff tendon to retrieve a suture from the anchor. When the suture is pulled through the superior surface of the rotator cuff, it makes a loop. The suture is released from the retrieval hook at this point, and the curved tip of this device is used to enter the loop formed by the retrieved suture having been pulled through the superior aspect of the rotator cuff. The hook is then used to retrieve the free end of the same suture that is forming the loop and to pull the end of the suture through the loop and outside of the body. The lasso-loop technique, we believe, allows superior fixation of the tissues by approximating a Mason-Allen suture configuration through the rotator cuff[1].

Once all of the sutures are passed, the lateral-row sutures are first tied in order to effect the reduction of the rotator cuff. The medial-row sutures are then tied to appose the rotator cuff tissue to the medial footprint adjacent to the articular surface of the humeral head (Fig. 8). The suture ends are cut, and the reconstruction is complete.

CRITICAL CONCEPTS

INDICATIONS:

We believe that the majority of large or massive rotator cuff tears are amenable to double-row suture anchor repair. While it is usually technically possible to fix a small rotator cuff tear with a double-row suture anchor technique, we do not think that it is necessary in the majority of cases. In general, we prefer to repair most full-thickness rotator cuff tears that are smaller than 10 mm in the sagittal plane with a single suture anchor placed on the lateral edge of the supraspinatus footprint with use of the lasso-loop suture configuration. Otherwise, we repair all rotator cuff tears using the double-row suture anchor repair.

CONTRAINDICATIONS:

- Partial-thickness rotator cuff tears. We do not recommend double-row rotator cuff repair for partial-thickness rotator cuff tears. Most of these tears are quite small even if they are completed by the surgeon. It has been our experience that use of a single double-loaded suture anchor usually results in a satisfactory repair.
- Partial repairs of massive rotator cuff tears. Certain massive rotator cuff tears can be only partially repaired because of the degree of retraction and the poor quality of the involved tissue. These tears usually include an irreparable supraspinatus tear with a Patte Stage-3 infraspinatus tear[14]. In these relatively rare cases, the goal of the partial rotator cuff repair is to reconstruct the posterior part of the rotator cuff and restore the force couple between the subscapularis anteriorly and the infraspinatus and teres minor posteriorly[15]. Tears with extensive retraction often do not lend themselves to double-row suture anchor repair since it is not possible to mobilize the superior part of the rotator cuff adequately to accomplish a tension-free repair. We recommend single-row repairs for these cases if the ability to mobilize the infraspinatus laterally is limited by the loss of plasticity in the muscle and the degree of retraction does not enable a footprint reconstruction that is tension-free.

PITFALLS:

- Inadequate bursectomy and rotator cuff release. It is imperative that the surgeon take the time to do an extensive débridement of the subacromial space and perform an adequate release of the rotator cuff. If visualization is hampered by an inadequate débridement, the quality of the rotator cuff repair will undoubtedly be diminished. Likewise, if the rotator cuff is not adequately released, then the rotator cuff, even if it is repaired, may fail postoperatively as a result of tension overload at the medial anchors[16].
- Portal placement. One should use a spinal needle to determine the optimum location for portal placement prior to cutting the skin and establishing the definitive portal. A poorly placed portal can make rotator cuff repair technically very difficult. The surgeon should consider the tear configuration and the direction of the reduction when making each portal.
- The lasso-loop technique. When performing the lasso-loop technique, the surgeon must remain aware of the danger of dethreading the anchor when pulling the suture through the loop. In order to avoid this complication, visualization of the anchor should be maintained when the suture is pulled out through the loop.
- Suture management. The sutures from each anchor should be kept separate by clamping all of the sutures from the same anchor together outside of the skin.

AUTHOR UPDATE:

There have been no changes in the technique since the publication of the original article.

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The line drawings in this article are the work of Joanne Haderer Müller of Haderer & Müller (biomedart@haderermuller.com).

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