X. Subacromial Impingement and Rotator Cuff Disease

A. Introduction. The rotator cuff stabilizes the GH joint through the concavity-compression effect occurring with synchronized rotator cuff contraction. It also acts to steer and depress the humeral head relative to the glenoid and is a major contributor to shoulder abduction and external rotation strength. The subscapularis muscle contributes to internal rotation strength. The supraspinatus insertion is relatively hypovascular, which explains the common location of rotator cuff tears. This blood supply is further attenuated in adduction as vessels are placed under tension, providing a rationale for postoperative immobilization in slight abduction.

Subacromial impingement is a continuum of pathology and clinical symptoms that in its final stages may be associated with full-thickness rotator cuff tears (Table 4–8). Although rotator cuff tears are common in the older population in conjunction with chronic impingement syndrome, impingement and rotator cuff disease are increasingly recognized in overhead athletes. Tears associated with chronic impingement syndrome typically begin on the bursal surface or within the tendon substance in contrast to those that occur on the articular

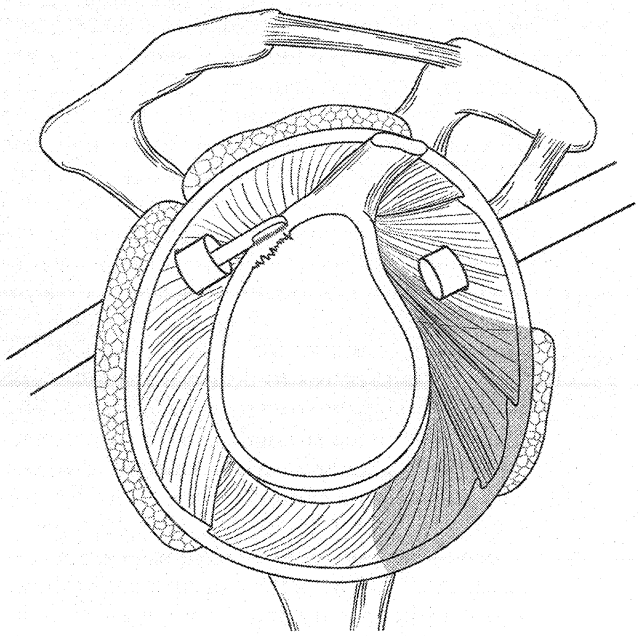


Figure 4–86. Patients with anterior microinstability or internal impingement without labral detachment can be treated with debridement of the posterosuperior labrum followed by thermal treatment of the anterior band of the inferior and middle glenohumeral ligaments *(shaded area)*. (From Cohen B, Cole BJ, Romeo AA: Thermal capsulorrhaphy of the shoulder. Op Tech Orthop 11:38–45, 2001.)

Table 4–8.

Stages of Subacromial Impingement Syndrome

Stage	Age (yr)	Pathology	Clinical Course	Treatment
I	<25	Edema and hemorrhage	Reversible	Conservative
II	25–40	Fibrosis and tendonitis	Activity-related pain	Therapy/operative
III	>40	Acromioclavicular spur and cuff tear	Progressive disability	Acromioplasty/repair

From Miller MD: Review of Orthopaedics. Philadelphia: WB Saunders, 1992, p 98.

surface due to tension failure in younger overhead athletes. Rotator cuff tears may be associated with SLAP lesions, subacromial and distal clavicle spurs, and rotator cuff arthropathy with fixed superior migration of the proximal humerus and severe GH arthrosis due to chronic loss of the concavity-compression effect.

B. Presentation. Patients typically present with the insidious onset of pain exacerbated by overhead activities. However, acute pain and weakness may be seen following traumatic rotator cuff rupture. It can be difficult to determine which patients with chronic impingement syndrome have associated rotator cuff tears because of their similar symptoms. Differentiating factors include patient age, symptom onset and chronicity, and the findings at the time of patient evaluation. In young athletes it is critical to exclude GH instability because primary impingement syndrome is less common in patients younger than 25 years old. Typically, these patients have associated nonoutlet impingement syndrome (secondary impingement) due to their instability without primary pathology located within the subacromial space.

With impingement syndrome and cuff pathology, pain is referred to the deltoid insertion or to the midarm. Impingement signs are usually positive. Patients with rotator cuff pathology often complain of night discomfort in addition to difficulties with overhead activities or with those that require internal rotation behind the back. Atrophy may be present in chronic cases and is more easily detected within the infraspinatus fossa. Weakness of flexion, abduction, and external rotation may be present, with the last-named being the most sensitive indicator of tear size. Pain relief with subacromial injection helps to confirm the diagnosis. A return of normal strength following the injection may indicate rotator cuff weakness due to pain rather than frank tearing.

Subscapularis tendon rupture is less common, but may occur in association with recurrent dislocations, following trauma in a younger patient, or with rupture of a previously repaired tendon. Increased passive external rotation, weak internal rotation, and a lift-off sign are diagnostic. MRI or ultrasound may be useful to confirm rupture.

Radiographs may demonstrate classic changes within the acromion or CAL (spurring and calcification) in addition to cystic changes within the GT. With chronic rotator cuff pathology, superior migration of the humeral head with extensive degenerative change may be present (Fig. 4–87).

C. Treatment

1. Nonoperative. Nonoperative treatment is initially indicated for impingement syndrome, chronic atraumatic cuff tears, noncompliant patients, medical contraindications to surgery, rotator cuff arthropathy, and athletes with a combined picture of instability or cuff tearing due to articular-sided partial-thickness failure. Patients with chronic cuff pathology may experience only minimal symptoms of pain or weakness due to longstanding compensation. With trauma or insidious decompensation, these patients may experience periods of symptoms that may respond favorably to nonoperative treatment.

Activity modification, avoiding repeated forward flexion beyond 90°, and an aggres-

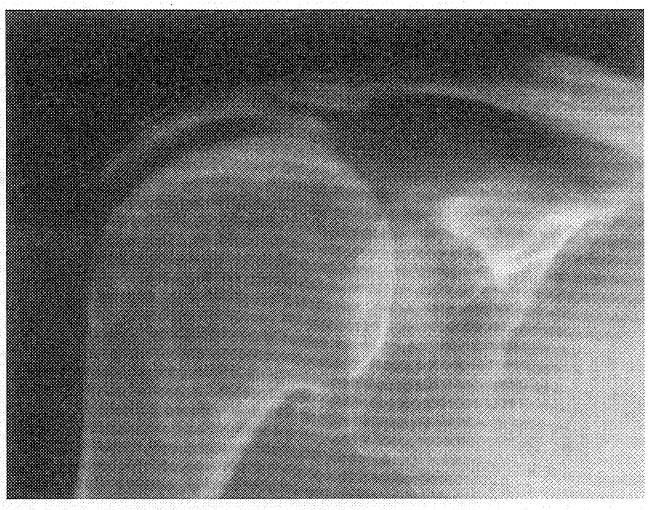


Figure 4–87. AP radiograph demonstrating superior migration of the proximal humerus with extensive degenerative change secondary to chronic rotator cuff arthropathy.

sive rotator cuff and scapular stabilizer strengthening program are initiated. Modification of throwing motion (tilting the thorax to the opposite side) as well as pre- and postparticipation stretching can be helpful in athletes. A course of nonsteroidal anti-inflammatory drugs (NSAIDs) may be particularly beneficial, especially in patients with impingement syndrome without rotator cuff tears. Therapeutic modalities such as ultrasound and iontophoresis may be helpful.

Corticosteroid injections may provide only temporary relief of symptoms and could potentially cause biologic tendon weakening. Thus, the decision to use subacromial corticosteroid injections depends upon many factors, including patient age,

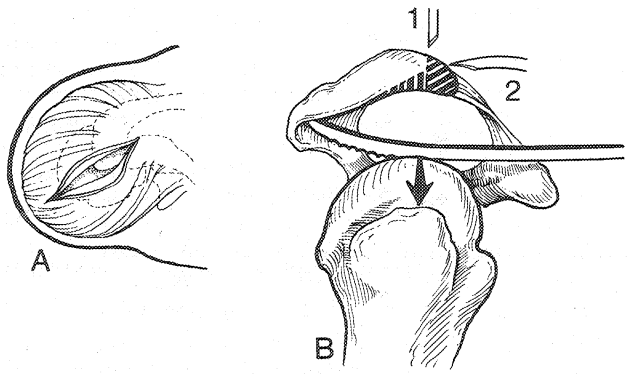
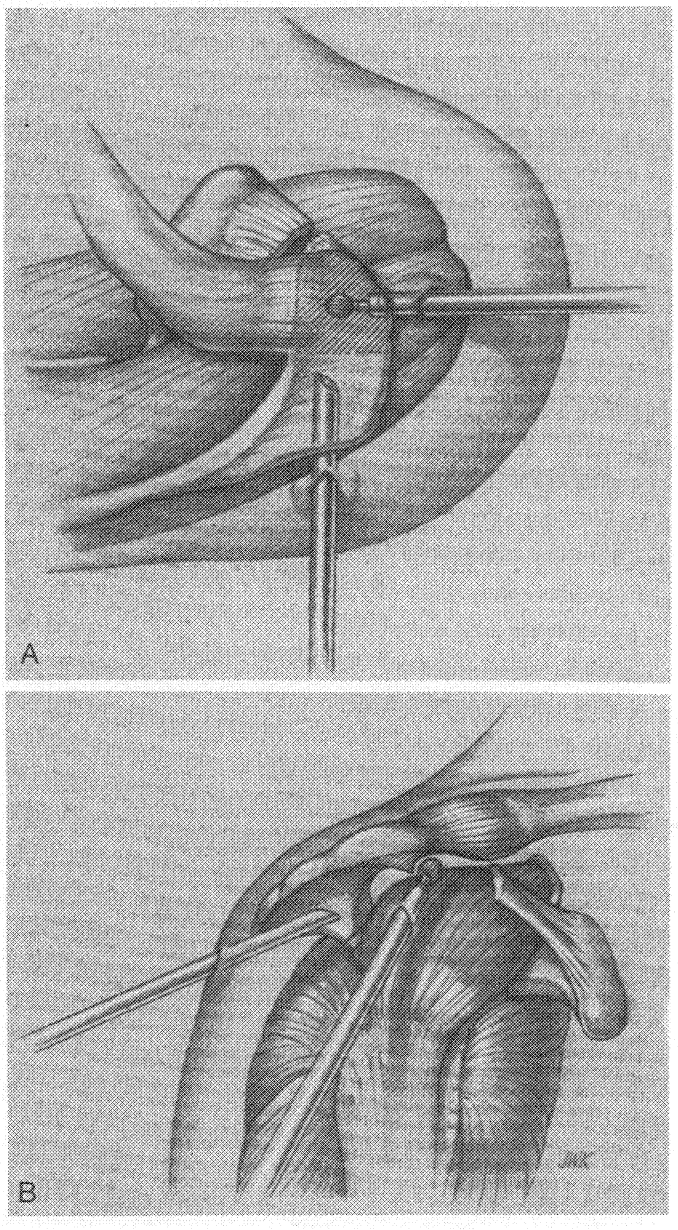


Figure 4–88. Technique for open acromioplasty. *A*, Exposure. *B*, Anterior (1) and inferior (2) acromioplasty.



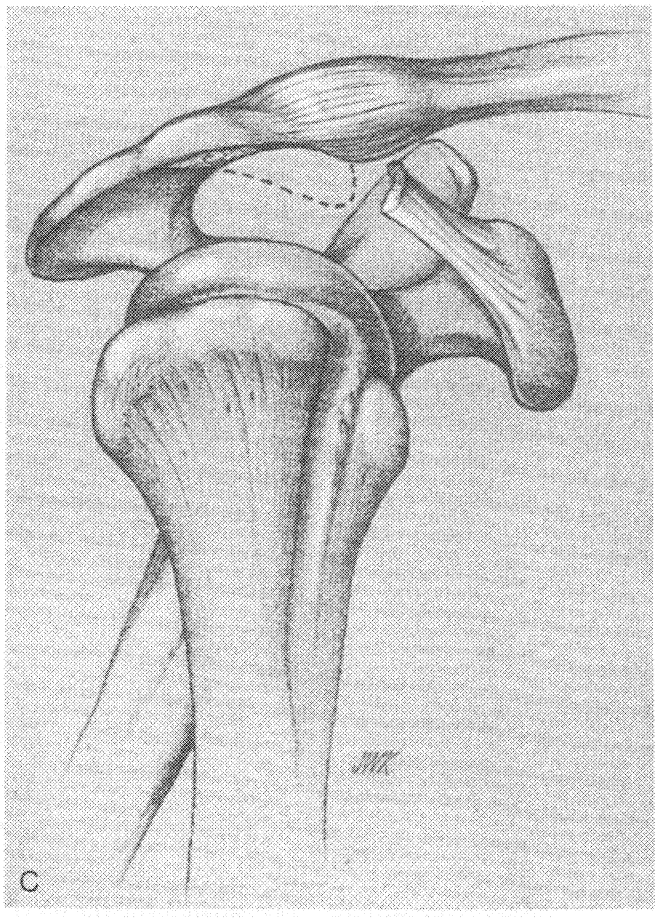


Figure 4–89. Technique for arthroscopic acromioplasty. *A*, Superior view. *Shaded area* represents extent of resection. *B*, Lateral view demonstrating decompression. *C*, Completion of decompressions results in conversion to a type I acromion. (From Harner CD: Arthroscopic subacromial decompression. Op Tech Orthop 1:229–234, 1991.)

symptom chronicity, response to other modalities, activity level, and symptom etiology. Those who benefit most from injections have classic impingement syndrome without frank rotator cuff pathology. While steroid injections may be useful in older patients with chronic rotator cuff tears, injections in younger patients with acute tears should generally be avoided. Judicious use of injections includes no more than one injection every 3 months.

2. Subacromial Decompression. Chronic impingement syndrome without a rotator cuff tear that is refractory to a minimum of 4 and, preferably, 6 months of nonoperative treatment may respond favorably to subacromial decompression (Figs. 4–88 through 4–90). Similarly, patients indicated for rotator cuff repair will often require concomitant subacromial decompression at the time of repair. Exceptions include massive irreparable rotator cuff tears, which may benefit from debridement with preservation of the CA arch to prevent anterosuperior humeral migration. Additional exceptions include the acute traumatic rotator cuff tear or the overhead athlete who may benefit from limited acromial smoothing and bursectomy required only for visualization and to minimize postoperative irritation of the repair site.

   Open decompression requires subperiosteal dissection of the deltoid off of the anterior acromion, excision of the CAL subacromial bursectomy, and removal of the anterior and inferior portions of the acromion (see Fig. 4–88). The rotator cuff may then be inspected in various degrees of humeral rotation and the pathology addressed (see below). Secure deltoid repair is critical, as discussed previously.

   Alternatively, subacromial decompression may be accomplished arthroscopically as described previously. A soft tissue ablation device (RF probe, arthroscopic shaver) is introduced through the lateral portal during bursoscopy through the posterior portal. A limited bursectomy is performed to aid visualization, and the CAL is released. Systematic anteroinferior acromion resection is accomplished from lateral to medial and anterior to posterior using a bur to convert a type II or III acromion into a thinner and flatter acromion (see Fig. 4–89). The scope is then inserted into the lateral portal and the entire subacromial space is visualized with completion of the acromioplasty, using a cutting block technique (see Fig. 4–90).

3. Operative Rotator Cuff Repair. Rotator cuff surgery reliably decreases pain and improves motion and function as well as general health status. The operative approach has evolved from a classic open approach, to a mini-open or deltoid-sparing, to an all-arthroscopic technique. Independent of the technique, the rate-limiting step for recovery is the biologic healing of the rotator cuff tendon to the humerus estimated to require a minimum of 8 to 12 weeks. The principles and steps of each technique are similar (Table 4–9). Independent of the repair

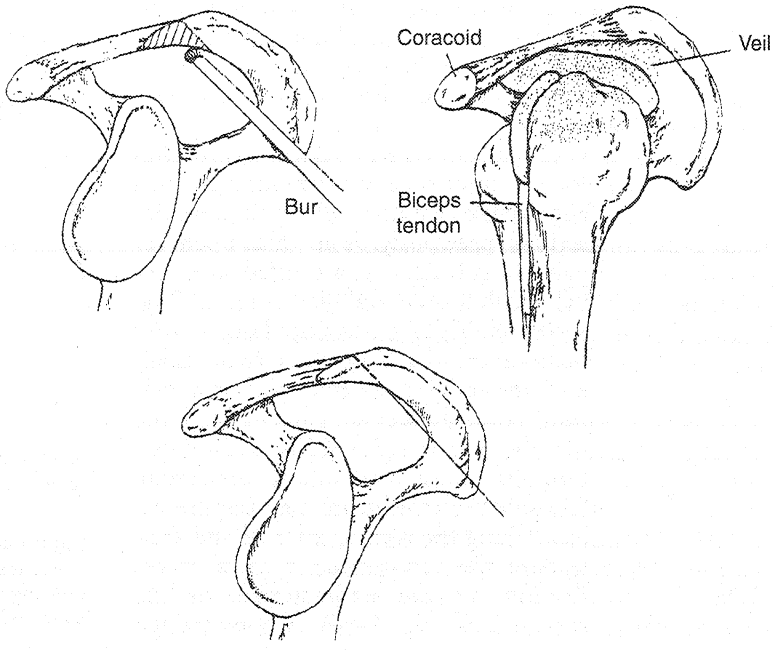


Figure 4–90. Cutting block technique with arthroscopic bur placed in the posterior portal while viewing from the lateral portal. (From Altchek DW, Carson EW: Arthroscopic acromioplasty: Current status. Orthop Clin North Am 28:157–168, 1997.)

Table 4–9.

Steps in Rotator Cuff Repair

- Glenohumeral joint inspection
- Subacromial space inspection
- Partial bursectomy
- Determination of cuff reparability
- Identification of tear geometry
- Coracoacromial ligament resection
- Acromioplasty
- Greater tuberosity repair site preparation
- Anchor placement
- Suture placement
- Knot tying

From Romeo AA, Cohen B, Cole BJ: Arthroscopic repair of full-thickness rotator cuff tears: Surgical technique and available instrumentation. Orthopedic Special Edition 7:25–30, 2001.

technique, a formal understanding of the possible tear configurations will determine the repair strategy and lead to restoration of the anatomy and biomechanics of the rotator cuff (Figs. 4–91, 4–92, and 4–93).

Treatment of partial-thickness articular-side tears with debridement versus repair remains controversial and considers the depth of the tear, the pattern of the tear (avulsion vs. degenerative), and the activity level of the patient. The ultimate decision is made by inspecting the corresponding bursal side of the rotator cuff, which is identified arthroscopically by passing a No. 0 or No. 1 PDS suture through the partial tear with an 18-gauge spinal needle. This suture is visualized both intra-articularly and from within the subacromial space (Fig. 4–94). Patients with partial-thickness tears in the setting of a normal subacromial space are good candidates for formal rotator cuff repair. Alternatively, patients with a preponderance of impingement findings with a tear of less than 50% thickness may benefit from debridement and subacromial decompression.

a. Open Repair. The surgical approaches for the mini-open and traditional open approach to rotator cuff repair were described previously. The mini-open repair is equivalent to a limited open repair without deltoid detachment (Fig. 4–95). Following acromioplasty (either open or arthroscopic) the tear is visualized and mobilized off of the bursa, deltoid, coracohumeral ligament, and the periphery of the glenoid by a combination of sharp and blunt dissection. Chronic retracted tears may require release along the rotator interval and incision of the intra-articular capsular reflection on the undersurface of the rotator cuff (Fig. 4–96). A bony trough

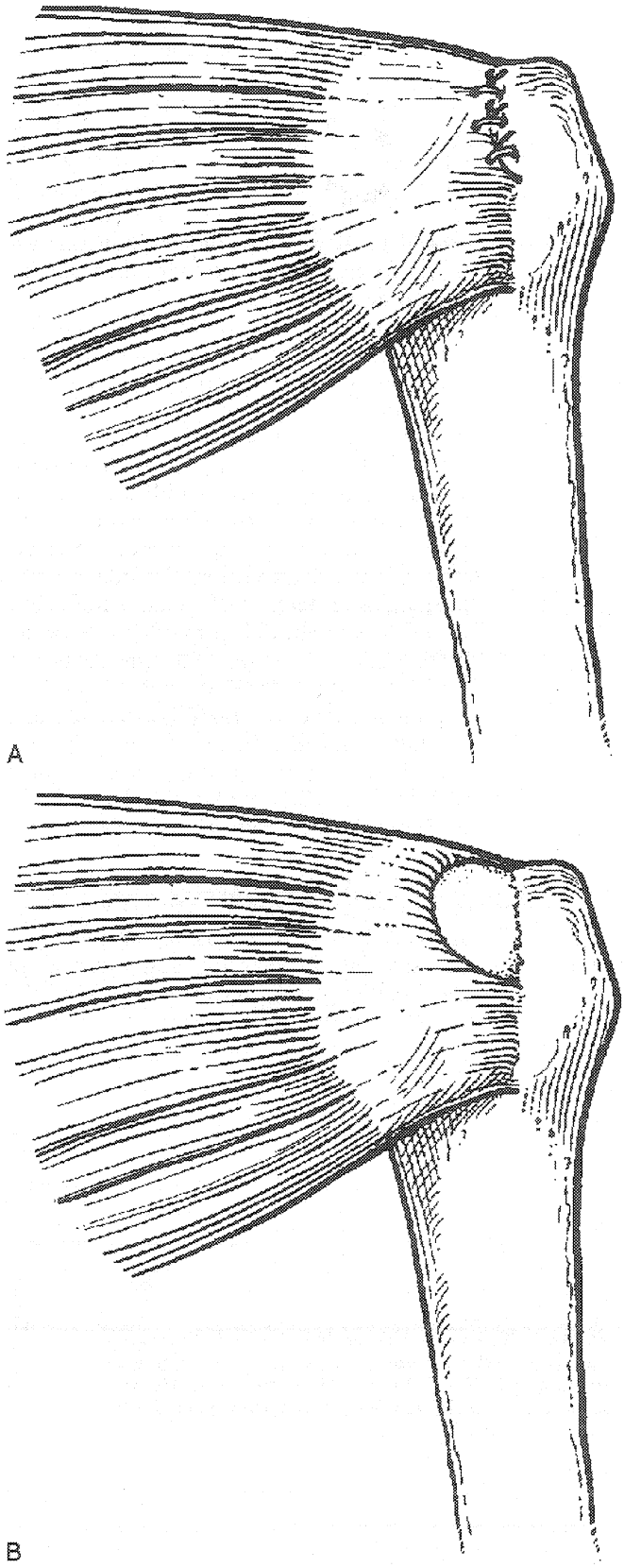
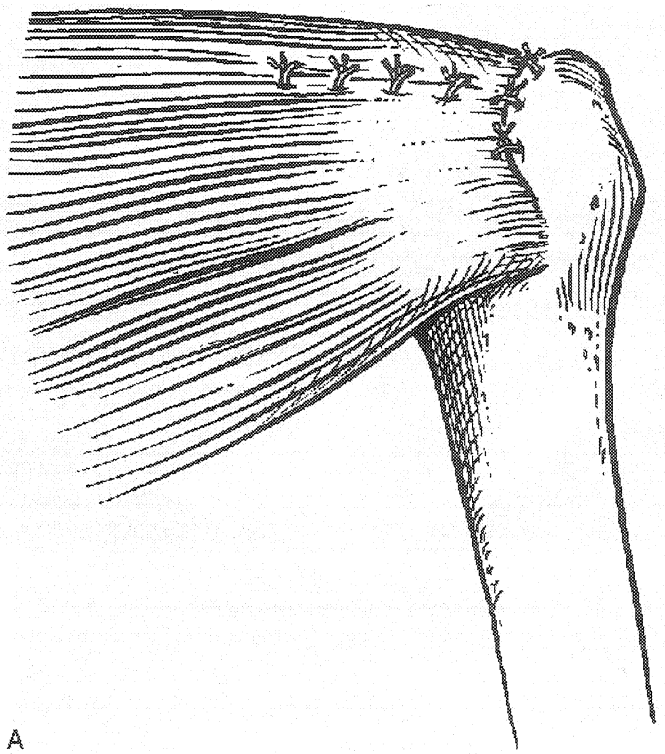


Figure 4–91. Crescent-shaped tear configuration. *A*, Schematic of a crescent tear configuration repaired by *(B)* securing the free lateral tendon edge to bone with simple sutures from laterally placed suture anchors. (Courtesy of Dr. Stephen S. Burkhart.)



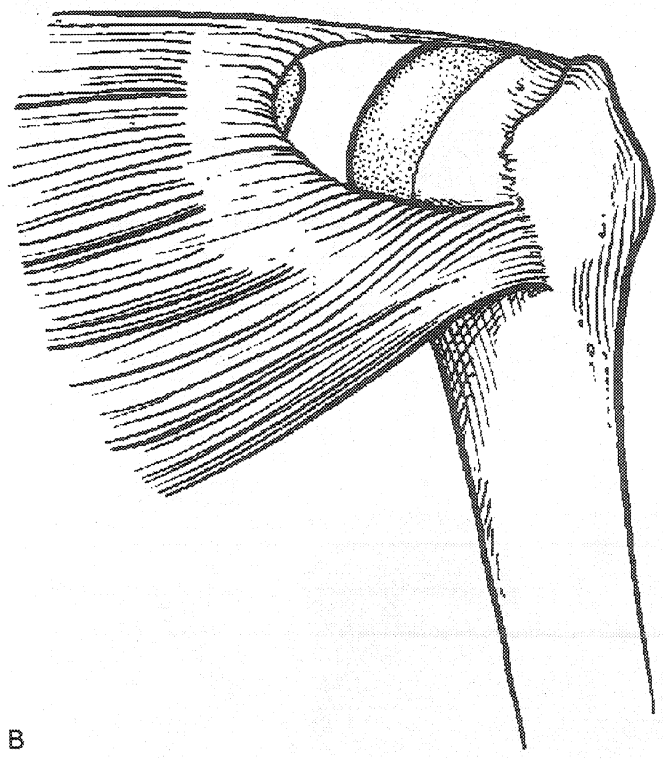


Figure 4–92. U-shaped tear configuration. *A*, Schematic of U-shaped tears repaired by *(B)* convergence of the posterior and anterior margins of the tear followed by fixation of the lateral tendon edge to bone with simple sutures from laterally placed suture anchors. (Courtesy of Dr. Stephen S. Burkhart.)

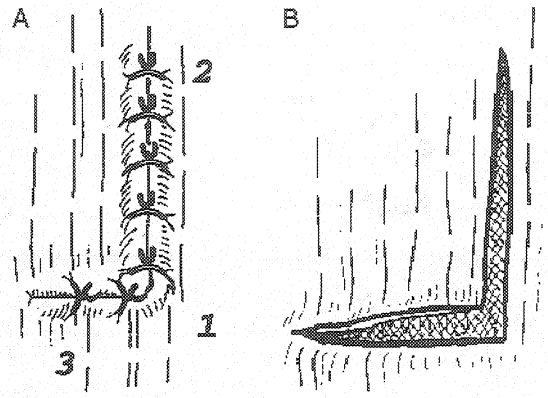


Figure 4–93. L-shaped tear configuration. *A*, Schematic of an L-shaped tear repaired by *(B)* anchor placement corresponding to the elbow of the L followed by repair of the soft tissue component of the elbow of the L to that point (1). Then, side-to-side repair (2) followed by repair of the remaining lateral margin to bone with suture from suture anchors (3). (Courtesy of Dr. Stephen S. Burkhart.)

is not required, but rather, simple decortication of the anatomic "footprint" of the rotator cuff just lateral to the edge of the articular surface is performed to create a bleeding bed suitable for biologic healing. Minimal debridement of the lateral edge of the rotator cuff is required. A modified Mason-Allen stitch is placed into the cuff (Fig. 4–97). Suture anchors offer an effective alternative to osseous tunnels, but increase the procedure expense and may prove ineffective in osteoporotic bone. Alternatively, holes for suture passage are made through the prepared bleeding surface of the tuberosity exiting and tied 1 to 2 cm distally on the lateral cortex of the humerus (Fig. 4–98). Surgical treatment is similar for suscapularis tendon tears, but is made challenging in part by the need to mobilize the axillary nerve. The wound is then closed following meticulous deltoid repair to the acromion through drill holes.

b. Arthroscopic Repair. The instrumentation and skills required for all-arthroscopic rotator cuff repair are similar to those described for arthroscopic stabilization. The posterior portal is placed slightly proximal to the usual location, the anterior portal is placed lateral to the coracoid at the level of the AC joint, and the lateral portal is placed 3 cm lateral to the acromion in line with the posterior border of the clavicle. An accessory anterolateral portal is created for instrumentation and suture management (Fig. 4–99). A systematic evaluation of the GH joint and subacromial space is per-

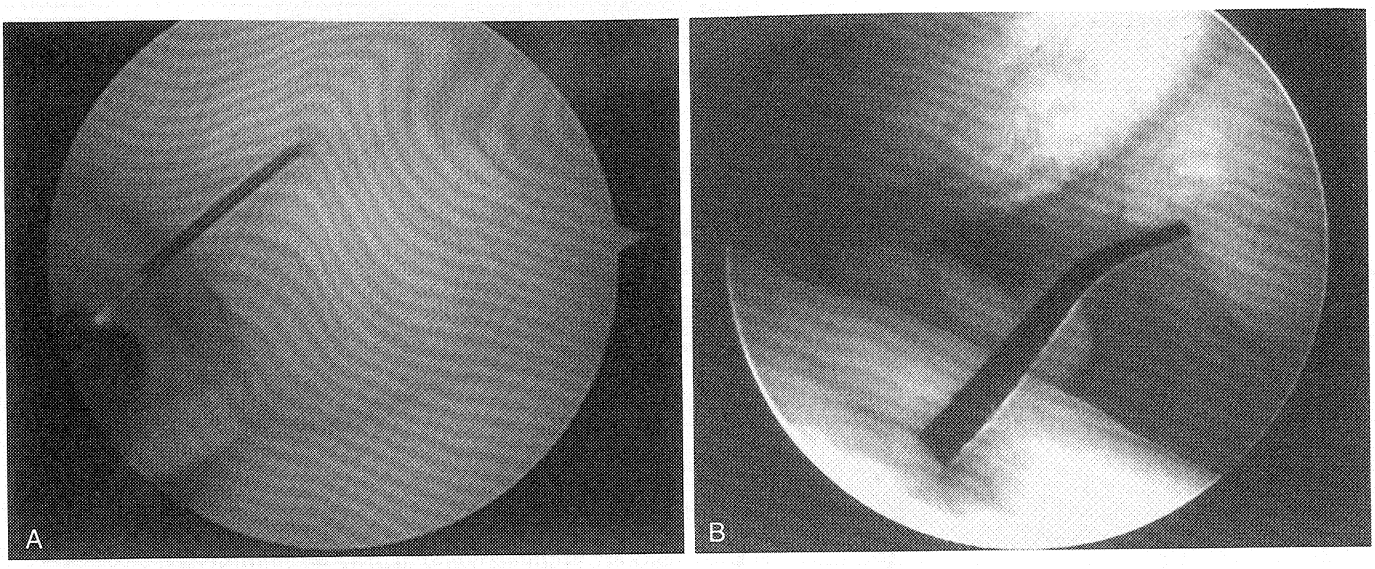


Figure 4–94. Identification and management of partial-thickness rotator cuff tears. *A*, Using an 18-gauge spinal needle as a guide, No. 0 or No. 1 PDS suture marker is placed through the partial-thickness articular side tear prior to completing the glenohumeral joint arthroscopy. *B*, Suture marker for the partial-thickness articular-sided rotator cuff tear is identified in the subacromial space to help determine the significance of the partial-thickness tear.

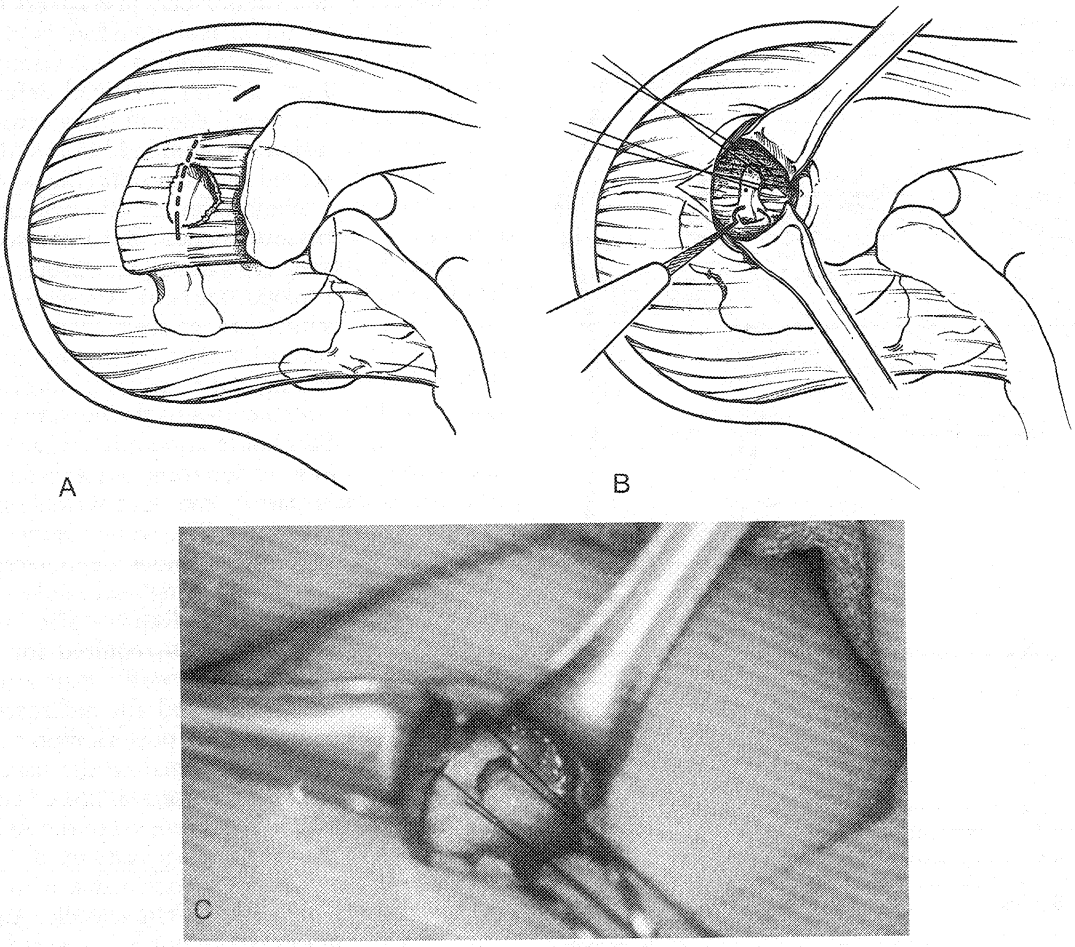


Figure 4–95. *A*, The "mini-open" incision is an extension of the anterolateral portal incision placed directly over the tear as localized arthroscopically following arthroscopic subacromial decompression. The deltoid is split (not detached) for 3 to 4 cm in line with its fibers. *B*, Rotator cuff repair is performed similarly to the standard open procedure (anchors or transosseous tunnels). *C*, Stay sutures placed to mobilize a small supraspinatus tendon tear. (From Pollock RG, Flatow EL: Full-thickness tears: mini-open repair. Orthop Clin North Am 28:169–177, 1997.)

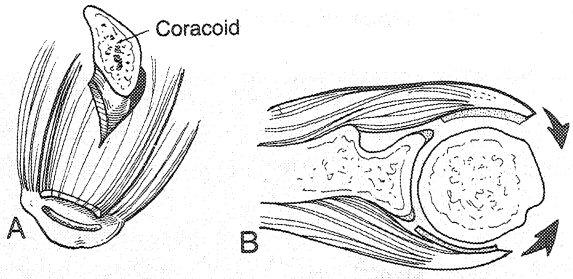


Figure 4–96. Techniques for mobilization of the rotator cuff. *A*, Mobilization from the coracoid. *B*, Mobilization from the glenoid labrum. Additional mobilization requires disinsertion-advancement of the affected rotator cuff muscles.

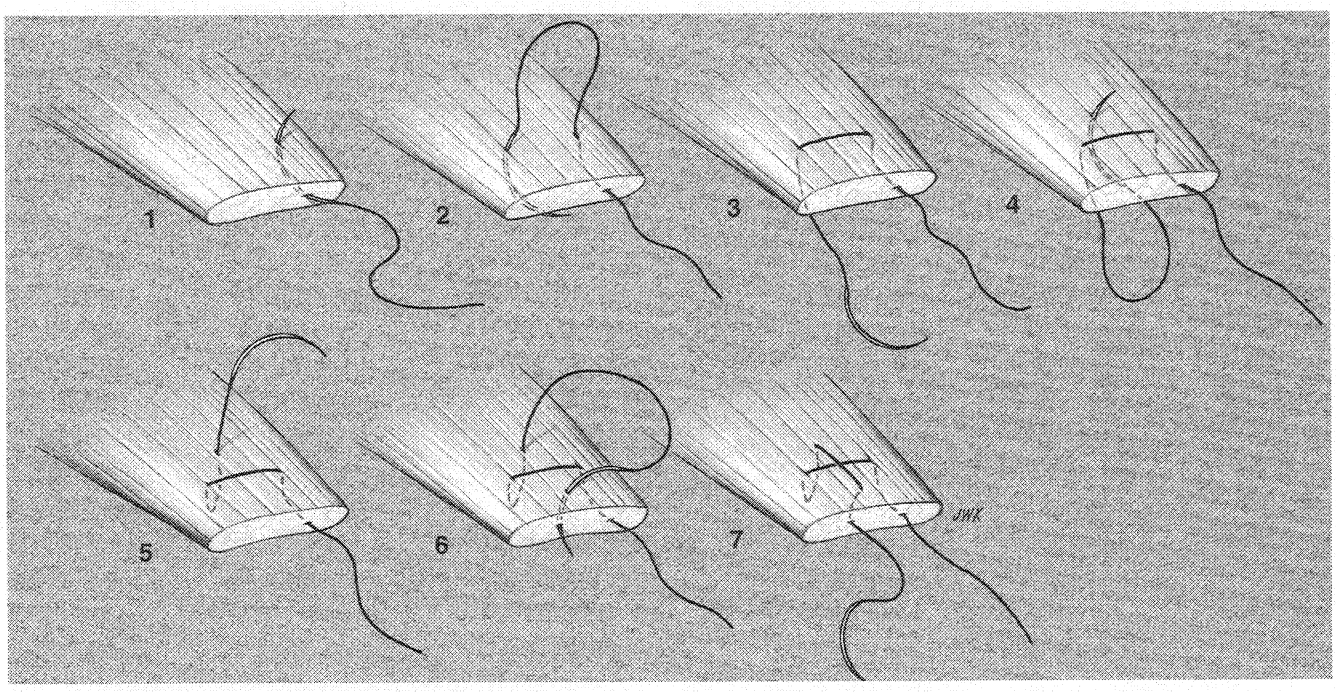


Figure 4–97. Modified Mason-Allen stitch. The entrance stitch (1) and exit stitch (6) can either be placed through the end of the tendon as shown or just proximal to it. (From Griggs S, Williams GR, Iannotti JP: Surgical management of full-thickness rotator cuff tears. Op Tech Orthop 8:205–217, 1998.)

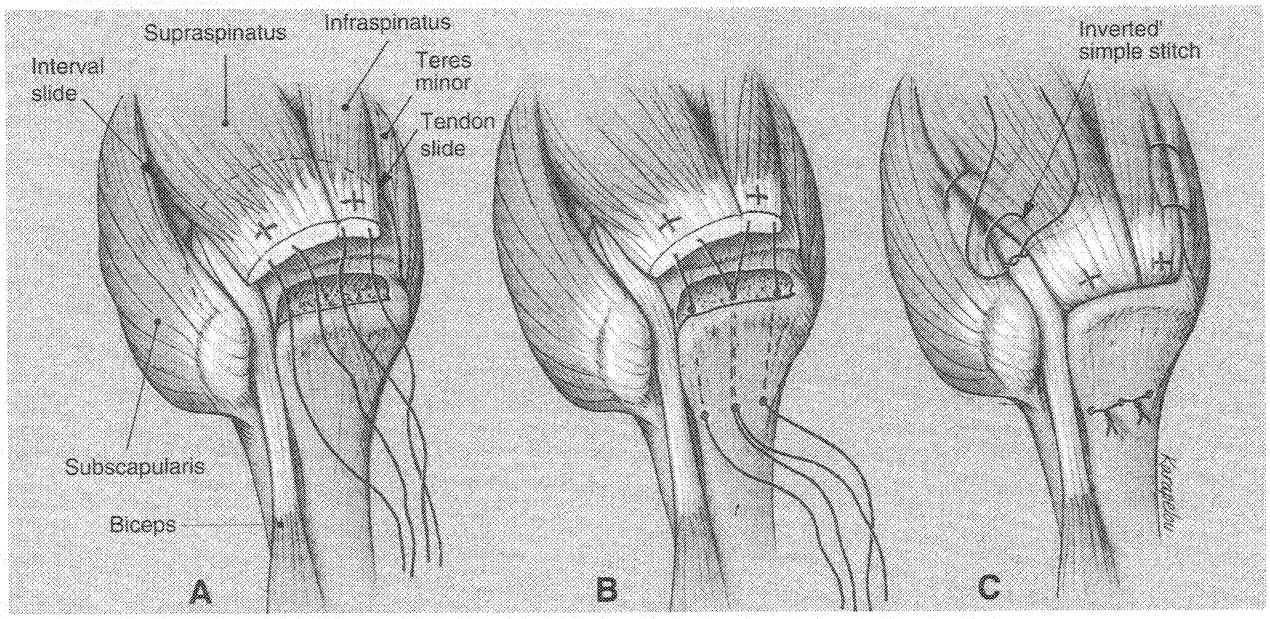


Figure 4–98. Schematic of the attachment of the rotator cuff to bone. *A*, The rotator cuff after placement of two modified Mason-Allen stitches and performance of an interval slide and a tendon slide. *B*, Placement of the sutures through three bone tunnels spaced 10 mm apart and exiting at least 10 to 20 mm down along the lateral aspect of the greater tuberosity. *C*, Final attachment of the rotator cuff to bone and closure of the rotator interval with an inverted simple stitch. (From Griggs S, Williams GR, Iannotti JP: Surgical management of full-thickness rotator cuff tears. Op Tech Orthop 8:205–217, 1998.)

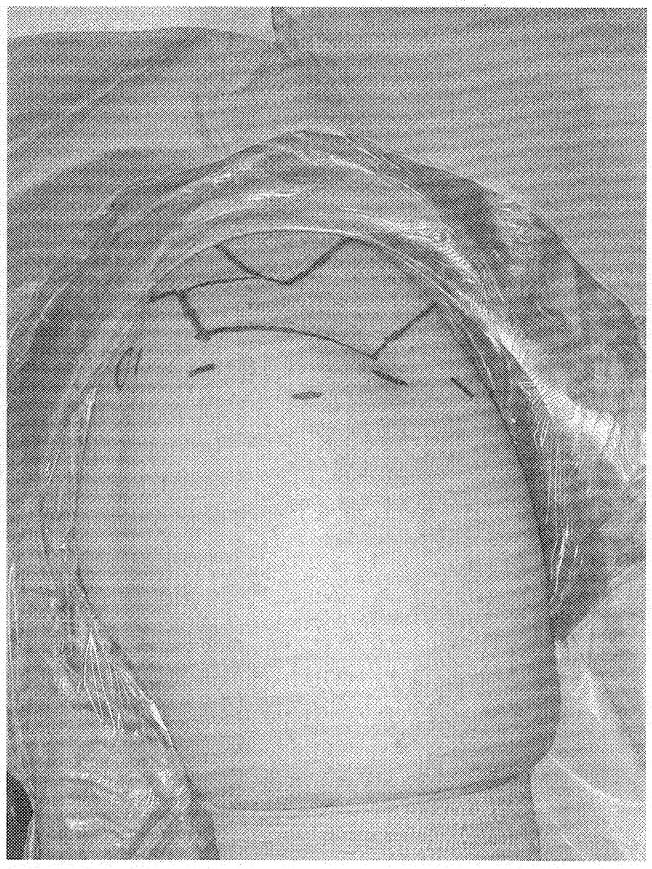


Figure 4–99. Osseous, soft tissue landmarks, and portals outlined on the skin before incision.

formed, followed by subacromial decompression to increase the working space for cuff repair and to protect the repaired tissue. Distal clavicle resection may be carried out when indicated.

The tear pattern and treatment strategy is defined as summarized in Table 4–10. The repair sequence is demonstrated in Figure 4–100. The cuff is mobilized by releasing subacromial and capsular adhesions. A traction suture or arthroscopic grasper may aid release. Care is taken to avoid injury to the suprascapular nerve and vessels located 1 to 2 cm medial to the lateral edge of the glenoid. Tendon edges should be minimally debrided. The GT repair site is then prepared with an arthroscopic bur over an area 1 to 2 mm deep and 5 to 8 mm wide corresponding to the rotator cuff footprint. Intra- and intertendinous tears are repaired in a side-to-side fashion, typically with a suture-passing device and arthroscopic knot-tying techniques performed through the anterior or posterior portal. This concept of "margin convergence," which occurs from medial to lateral as side-to-side tendon repair is performed, facilitates the repair and reduces the strain at the lateral repair site prior to suturing the tendon edge to bone.

Anchors are then placed laterally within the prepared footprint through the anterolateral cannula at 90° to the axis of tendon pull (about a 45° insertion angle). Generally, two or three anchors are placed per tendon. Sutures are then passed through the tendinous tissue using an antegrade technique (i.e., placing a sharp suture grasper through the anterior or posterior cannula, penetrating the tendon, and grasping the suture) or a shuttle technique (i.e., a technique that "shuttles" the suture from within the anterolateral cannula through the tissue). Simple or horizontal mattress suture configurations are tied over the bursal side of the cuff through the anterolateral cannula.

4. Rehabilitation. The rehabilitation protocol is individualized based on tear- and patient-specific factors. The basic principles are summarized in Table 4–11.
5. Results. In general, pain relief is predictable following rotator cuff repair with any method in 70% to 100% of patients treated. Functional improvement, including recovery of strength, is somewhat less pre-

Table 4–10.

Tear Configuration and Repair Strategy for Open and Arthroscopic Rotator Cuff Repair

Tear Configuration	Repair Technique
Crescent	Repair of free margin of cuff tendon directly to bone with suture from suture anchors
U-shaped	Side-to-side repair of medial to lateral extent of tear leading to tear margin convergence, then repair of the free lateral margin of the cuff tendon directly to the bone with sutures from the anchor
L-shaped/reverse L-shaped	Anchor placement corresponding to the elbow of the L followed by repair of the soft tissue component of the elbow of the L to that point; then, side-to-side repair followed by repair of the remaining lateral margin to bone with suture from suture anchors

From Romeo AA, Cohen B, Cole BJ: Arthroscopic repair of full-thickness rotator cuff tears: Surgical technique and available instrumentation. Orthopedic Special Edition 7:25–30, 2001.

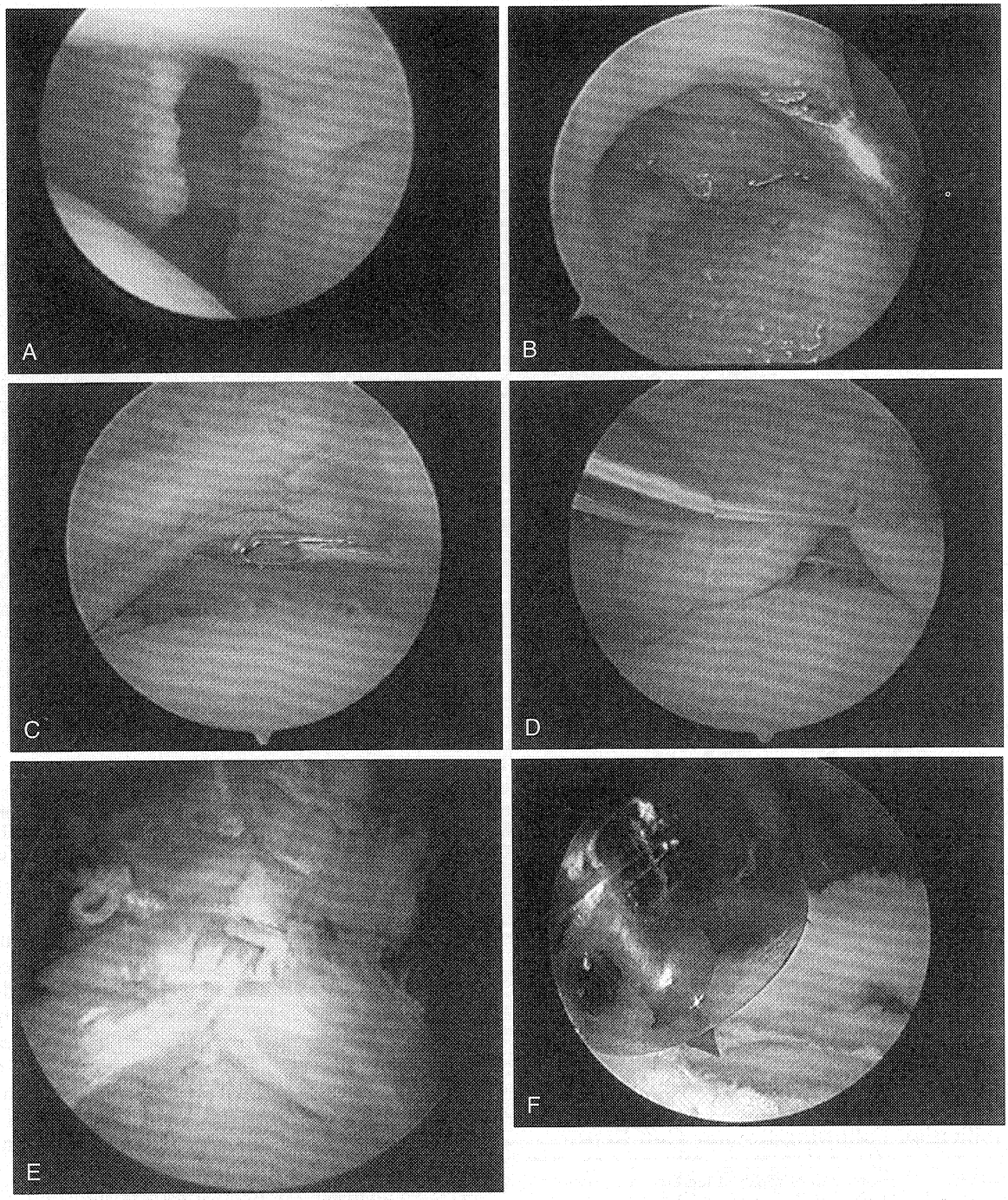


Figure 4–100. Sequence for arthroscopic rotator cuff repair of a U-shaped tear. The arthroscope is in the lateral portal in the subacromial space following subacromial decompression. *A*, Capsular release performed in an effort to arthroscopically mobilize the rotator cuff. *B*, Gentle debridement of the rotator cuff tendon edge and preparation of the rotator cuff footprint on the greater tuberosity is performed with an arthroscopic shaver and bur, respectively. *C*, Arthrex (Arthrex Corp., Naples, Fla.) penetrator (suture retriever) placed through the anterior or posterior portal to facilitate side-to-side repair. *D*, First side-to-side suture placed prior to tying. *E*, Side-to-side repair demonstrating margin convergence, leading to reduction in tension on final tendon-to-bone repair. *F*, Dual-eyelet double-suture (Mitek, Johnson & Johnson, New Brunswick, NJ) anchor placed through the accessory anterolateral portal into the footprint at approximately a 45° angle. (*Figure continues on following page.*)

dictable, occurring in nearly 70% to 80% of patients treated. Generally, single-tendon repairs have a recurrence rate of 20% and two-tendon repairs have about a 50% recurrence rate at 5 years. Early reports indicate that all-arthroscopic repair results are equivalent to those following open repair. This technique, however, is technically demanding, with a relatively difficult learning curve. Complications are related to the repair technique and include deltoid denervation or detachment, postoperative stiffness, cuff denervation, and rotator cuff retearing at the same or at a new location.

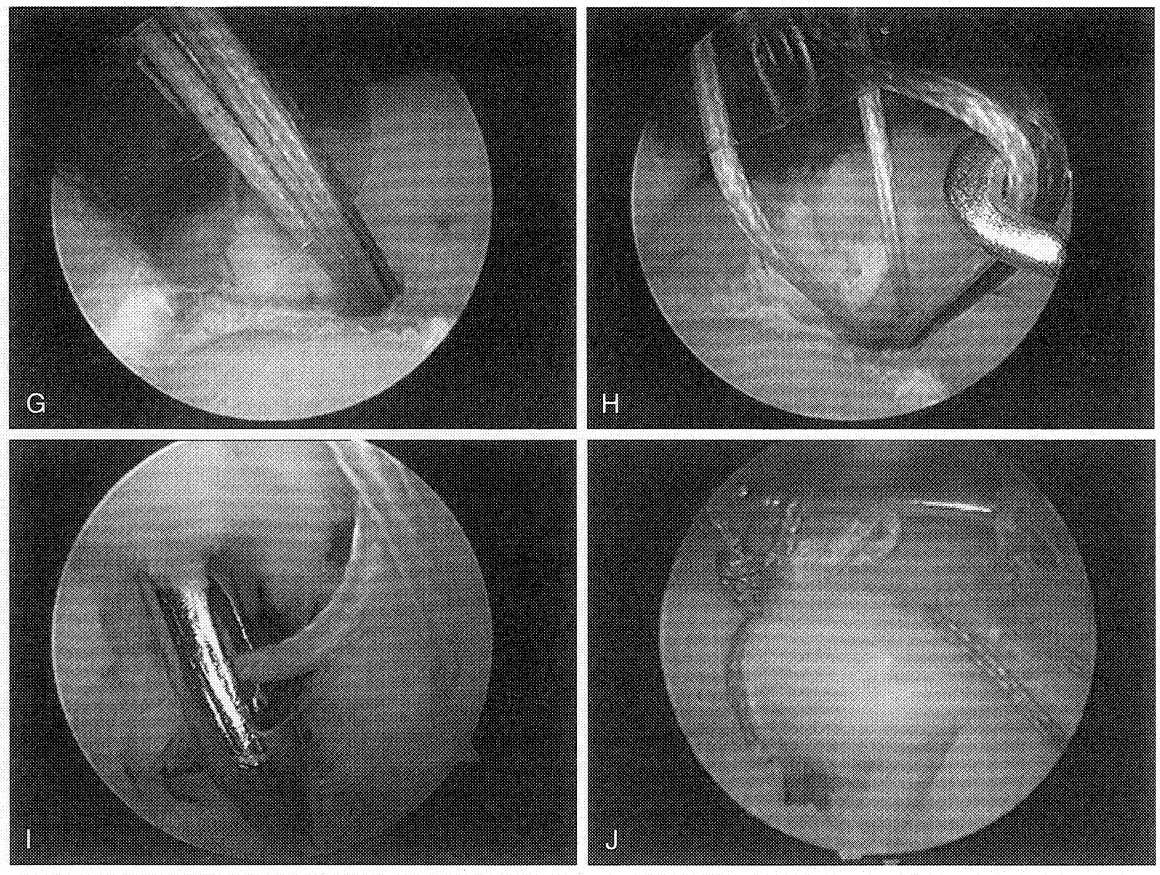


Figure 4–100. (*Continued*) *G*, Sutures seen exiting the anterolateral portal prior to passage through the rotator cuff tendon. *H*, Crochet hook placed through the anterior or posterior portal separating one set of sutures for suture management. *I*, Suture retriever piercing tendon edge to retrieve first suture limb. Arthroscopic knots are tied over the edge of the cuff ("post" limb through tendon) and the steps are repeated until (*J*) the tendon edge is secured to the greater tuberosity. (From Romeo AA, Cohen B, Cole BJ: Arthroscopic repair of full-thickness rotator cuff tears: Surgical technique and available instrumentation. Orthopedic Special Edition 7:25–30, 2001.)

D. Subcoracoid Impingement. Patients with long or excessively laterally placed coracoid processes may have impingement of this process on the proximal humerus with forward flexion (120°–130°) and internal rotation of the arm. This condition may occur following surgery that causes posterior capsular tightness and loss of internal rotation. Local anesthetic injection should relieve these symptoms. CT scan performed with the arms crossed on the chest is helpful to evaluate this problem. Treatment of chronic symptoms involves resection of the lateral aspect of the coracoid process and reattachment of the conjoined tendon to the remaining coracoid (Fig. 4–101).

Table 4–11.

Rehabilitation Following Rotator Cuff Repair

Phase I (0–6 wk)	Protection of repaired tendon
	Passive range of motion within specified limits
	Active assisted or active motion for small tears with good-quality tissue
Phase II (6–12 wk)	Progress to full passive motion
	Begin active assisted and active motion
	Advance to light strengthening for small tears with good-quality tissue
	Advance strengthening of intact cuff
	Light strengthening of scapular stabilizers
Phase III (12–16 wk)	Passive stretching at end ranges of motion
	Advance strengthening of repaired cuff
	Progressive strengthening of scapular stabilizers
Phase IV	Functional strengthening
	Proprioception reeducation
	Sports-specific rehabilitation

From Romeo AA, Cohen B, Cole BJ: Arthroscopic repair of full-thickness rotator cuff tears: Surgical technique and available instrumentation. Orthopedic Special Edition 7:25–30, 2001.