

ARTHROSCOPIC RECONSTRUCTION OF THE CORACOCLAVICULAR LIGAMENTS FOR ACROMIOCLAVICULAR JOINT SEPARATIONS

EUGENE M. WOLF, MD, and AUSTIN T. FRAGOMEN, MD

Acromioclavicular joint separations are common shoulder injuries whose treatment has remained largely nonoperative. Although most patients with these injuries fare well without surgery, experience has taught us that there are a significant number of people who would benefit from surgical intervention. Most surgical techniques used to treat symptomatic patients are open procedures that require partial detachment of the deltoid and subcoracoid dissection. The need for this anterior shoulder dissection and concerns about the final cosmetic results have discouraged many orthopaedists from attempting acromioclavicular joint reconstruction. Arthroscopic reconstruction of the coracoclavicular ligaments for acromioclavicular joint separation was created to introduce a less invasive approach to the anatomic reconstruction of the coracoclavicular ligaments while simultaneously achieving cosmetically pleasing results. The evolution of this technique has led to the development of reliable instrumentation, strong and resilient implants, and reproducible outcomes, making arthroscopic reconstruction an attractive method of treating significant acromioclavicular joint separations.

KEY WORDS: acromioclavicular separation, arthroscopic coracoclavicular reconstruction

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The functional anatomy of the coracoclavicular ligaments has been well described. Fukuda et al found the conoid ligament to be the primary restraint to anterior and superior displacement of the distal clavicle.¹ Lee et al showed that the trapezoid is a major restraint to posterior displacement of the clavicle.² Both authors concluded that under significant stresses the coracoclavicular ligaments together are the primary stabilizers of the acromioclavicular articulation. By addressing the primary pathology of significant acromioclavicular joint separations, coracoclavicular ligament reconstruction is a viable method of restoring normal acromioclavicular joint function. Open reconstruction of the coracoclavicular ligaments is a widely accepted technique for operative treatment of significant acromioclavicular joint separations. Open reconstruction achieves the goals of restoration of acromioclavicular joint anatomy and function and has yielded excellent results with long-term follow-up.³ However, the need for an extensive anterior shoulder dissection and concerns about the final cosmetic results have discouraged many orthopaedists from attempting coracoclavicular joint reconstruction, requiring a significant number of patients to live with chronic shoulder discomfort and deformity. Arthroscopic reconstruction of the acromioclavicular joint was created to introduce a less invasive approach to the anatomic reconstruction of the coracoclavicular ligaments while simultaneously achieving cosmetically

pleasing results. Arthroscopic acromioclavicular reconstruction is a reproducible, minimally invasive technique well suited for orthopaedic surgeons with experience in arthroscopic shoulder surgery. The entire procedure can be performed nearly percutaneously, or a small incision can be made for an open distal clavicle resection. This technique provides an anatomic reconstruction of the conoid and trapezoid ligaments with the goal of restoring normal shoulder kinematics. This technique will restore a strong coracoclavicular construct while preserving coracoid and clavicular bone. The arthroscopic nature of this procedure allows for a rapid rehabilitation and a full return to preinjury activities. The mechanical properties of the polyethylene sutures used for the coracoclavicular ligament reconstruction most closely mimic those of the nascent ligaments with regard to ultimate strength and stiffness.⁴ The addition of autogenous bone graft into the reconstruction site introduces a biologic component to the technique.

OPERATIVE TECHNIQUE

INDICATIONS

Arthroscopic acromioclavicular joint reconstruction is indicated for Rockwood type IV–VI acromioclavicular joint separations. Certain Rockwood type III separations are also indicated for reconstruction: chronic acromioclavicular joint separations that are painful and result in a dysfunctional shoulder girdle with significant deformity and acute acromioclavicular joint separations in active patients who are unwilling to accept any deformity, dysfunction, or pain in the affected shoulder.

Address reprint requests to Eugene M. Wolf, MD, 3000 California Street, San Francisco, CA 94115.

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Fig 1. Bony landmarks and portals of a right shoulder.

PATIENT POSITIONING

Although this technique describes the procedure in the lateral decubitus position it can also be performed in the beach chair position.

INTRAARTICULAR APPROACH TO THE CORACOID

Visualization of the coracoid will not be foreign to shoulder arthroscopists who are familiar with arthroscopic capsular release for frozen shoulder. Capsular releases, as well as this procedure, require resection of the rotator interval capsule. This usually involves partial resection of the superior glenohumeral and middle glenohumeral ligaments. In both cases the coracoid and coracoacromial ligament are visualized.

The bony landmarks and portals of the shoulder are outlined with a sterile marker to include the distal clavicle, the coracoid, and the acromion (Fig 1). A standard posterior portal is created through which the arthroscope is

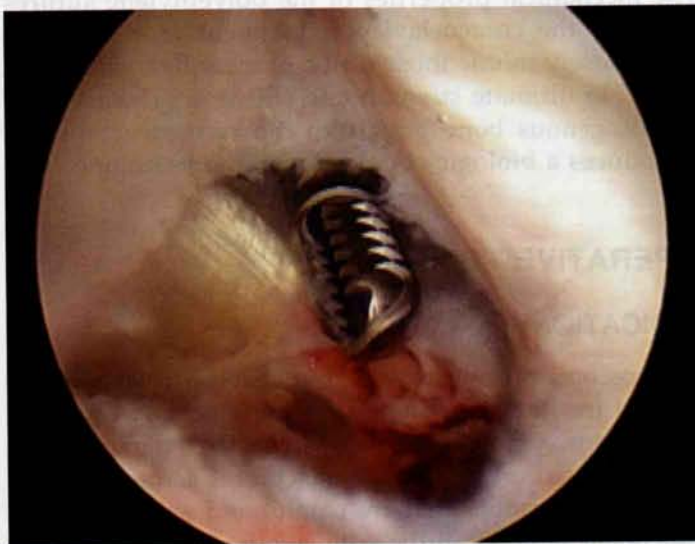


Fig 2. View from the posterior portal of a rotator interval capsule resection (right shoulder). The coracoacromial ligament is visualized through the interval resection.

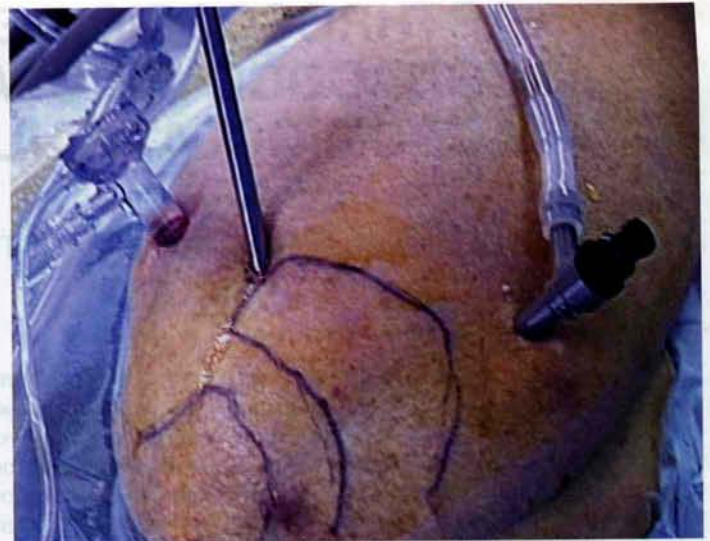


Fig 3. The ASP established with the scope in place.

inserted into the glenohumeral joint. An anterior inferior portal is created lateral to the tip of the coracoid. The portal is created with an outside-in technique by first placing a spinal needle in the rotator cuff interval, entering the joint at the superior margin of the subscapularis tendon. This is used to create the portal and guide a clear 8.25 mm × 7 cm Twist-In Cannula with reusable obturator into the joint. This cannula will serve as the primary working portal.

The resection of the rotator interval capsule begins by backing out the anterior inferior cannula to a position just outside the capsule to allow the use of shaver to remove rotator interval tissue. A radiofrequency wand is used to control bleeding. There are considerable anatomic variations of the anterior capsule in the interval superior to the subscapularis tendon. The anterior capsular structures are resected until the coracoid is well visualized. Depending on the anatomy, resection of the superior glenohumeral ligament and partial release of the middle glenohumeral ligament are required to adequately visualize the subscap-



Fig 4. View of the base of the coracoid and anterior scapular neck from the ASP with the probe in place.

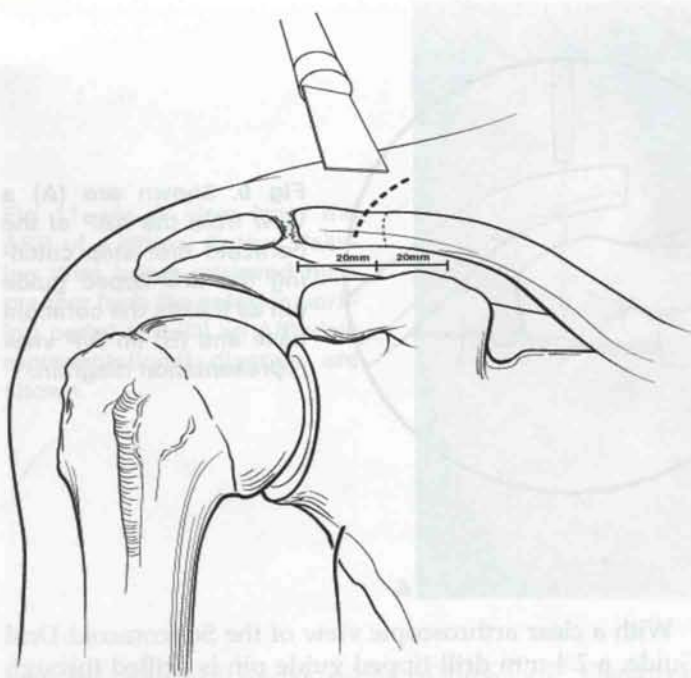


Fig 5. A/P view representational diagram of an open distal clavicle resection.

ularis recess and allow visualization of the base of the coracoid (Fig 2).

An anterior superior portal is then identified with a spinal needle at a point just anterior to the anterior margin of the acromion and entering the joint immediately anterior to the biceps tendon. A No. 11 scalpel blade is used and directed into the joint alongside the spinal needle. The scalpel is withdrawn and a switching stick inserted to maintain the newly created anterior superior portal (ASP). The scope is transferred to the ASP and a 5-mm cannula placed in the posterior portal (Fig 3).

This configuration allows direct visualization of the coracoid and anterior scapular neck (Fig 4). The surgeon could also opt to use a 70° scope from the posterior portal and use a two-portal configuration, but the direct visualization with a standard 30° scope in the ASP is preferred.



Fig 6. AC Tenodesis Screw Driver, 4.5-mm Cannulated Drill, and Adaptor C-Ring Drill Guide assembled with a Coracoid Drill Stop attachment.



Fig 7. View from the ASP of a Clear Cannula and Sub-Coracoid Drill Guide at the coracoid base.

With the scope in the ASP, the base of the coracoid is well defined as far medially as possible using a radiofrequency wand and a shaver.

DISTAL CLAVICLE RESECTION

The arthroscope is positioned into the subacromial space and an arthroscopic distal clavicular resection is performed to ensure complete reduction and avoid the potential of AC joint arthritis in the future. In cases of old, chronic AC separations, it may be necessary to carry out the arthroscopic dissection medially under the clavicle to resect the scarred and/or calcified scar tissue between the coracoid and the clavicle. The surgeon may opt to perform an open distal clavicle resection, since a small incision over the distal clavicle will be necessary in every case to drill through, and tie sutures over the distal clavicle (Fig 5).

CLAVICLE AND CORACOID TUNNEL PREPARATION

The clavicular incision is located by palpating the anterior margin of the clavicle and coracoid. The coracoclavicular



Fig 8. Outside picture of the C-Ring at the shoulder.

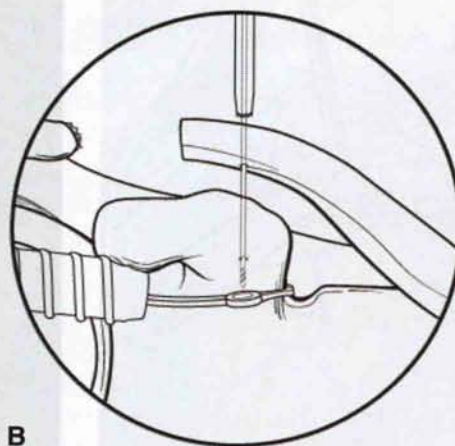


Fig 9. Shown are (A) a view from the ASP of the coracoid drill stop catching the drill-tipped guide pin as it exits the coracoid base and (B) an A/P view representation diagram.

ligaments insert on the undersurface of the clavicle at the level of the coracoid. A 2-cm incision is made in Langer's lines over the superior aspect of the clavicle. The skin is undermined and mobilized to maximize access to the clavicle. Subcutaneous dissection is followed by subperiosteal elevation of soft tissues on the superior surface of the clavicle. The resected end of the distal clavicle is identified.

The Subcoracoid Drill Guide on an Adapteur C-ring Drill Guide (Fig 6) is placed through the anterior inferior cannula onto the inferior surface at the base of the coracoid. The 8.25-mm clear cannula is advanced to the "axilla" of the coracoid base. The cannula needs to be advanced medially to this bony axilla so as not to limit the medial excursion of the Subcoracoid Drill Guide. The tip of the guide is advanced medially until the probelike tip of the guide falls off the medial border of the base of the coracoid. This will center the drill hole in the stronger, wider coracoid base (Fig 7). Traction is released and the clavicle reduced. The drill sleeve on the Adapteur C-ring Drill Guide is then advanced onto the superior aspect of the reduced distal clavicle (Fig 8).

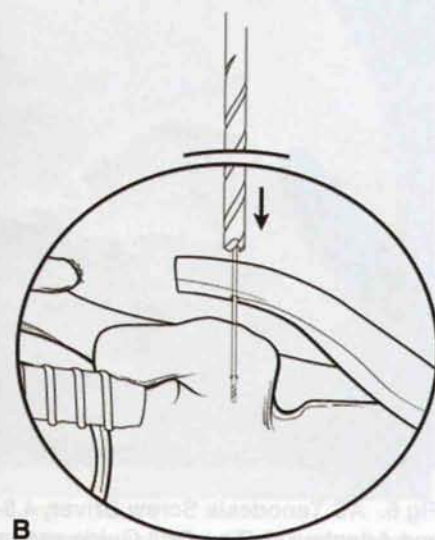
With a clear arthroscopic view of the Subcoracoid Drill Guide, a 2.4-mm drill-tipped guide pin is drilled through the clavicle and the base of the coracoid. The tip of the guide pin is viewed as it exits the base of the coracoid (Fig 9A,B).

When the guide pin is seen to exit the base of the coracoid it is left in place and a 4.5-mm cannulated drill is used over the guide pin to create a tunnel through the clavicle and the base of the coracoid. When the tip of the drill bit is seen exiting bone it is stopped and left in place (Fig 10A,B).

The 2.4-mm guide pin is removed, leaving the 4.0-mm drill in place. A Nitinol Suture Passing Wire is inserted loop first into the cannulation of the drill and is advanced until the loop exits the drill at the base of the coracoid. The Nitinol Wire is retrieved with a grasper and pulled out of the anterior working portal (Fig 11A,B). The 4.0-mm drill is removed and the Suture Passing Wire is left in place.

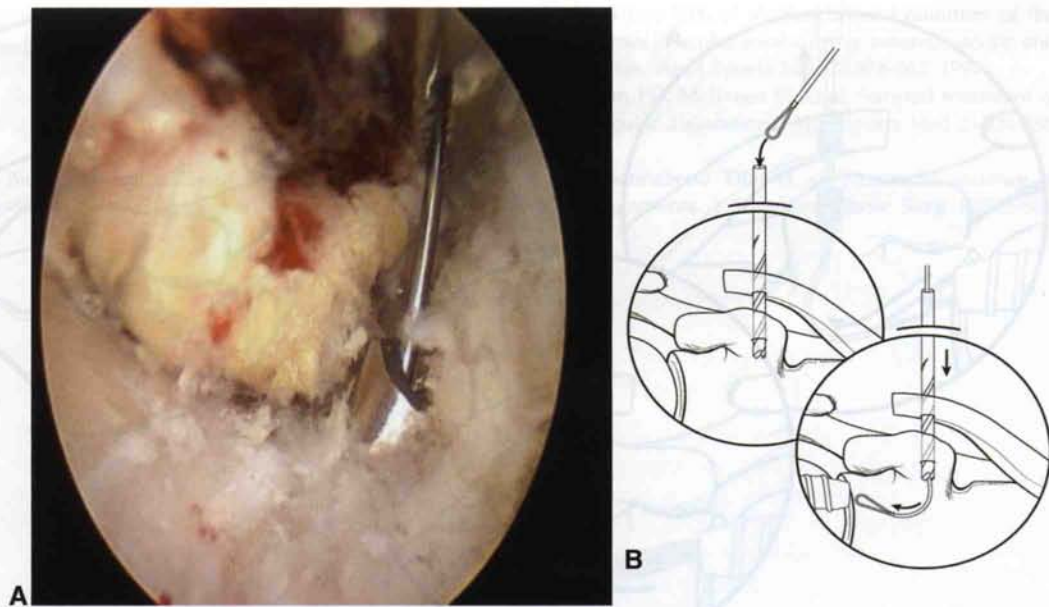
The headless Threaded Titanium Tunnel Liner (coracoid) is inserted first over the Nitinol Suture Passing Wire with the Screw Driver through the clavicle and

Fig 10. (A) A view from the ASP of the drill tip extending through the clavicle and exiting the coracoid base over the drill tip guide pin and (B) an A/P view representational diagram are shown.



REFERENCES

Fig 11. (A) A view from the ASP of a Nitinol Suture Passing Wire being retrieved by a grasper from the anterior working portal and (B) an A/P view representational diagram are shown.



into the coracoid under direct arthroscopic visualization. The liner is advanced until its distal thread extends just beyond the cortex at the base of the coracoid (Fig 12A,B).

The headed clavicle screw is then inserted over the Nitinol Suture Passing Wire with the Screw Driver into the clavicle and advanced under direct visualization until the threads are all within the clavicle and the head is proud on the superior clavicular cortex.

Two No. 5 FiberWire sutures are inserted into the loop of the Nitinol Suture Passing Wire and are pulled halfway through, creating a four-strand configuration. The FiberWire strands are pulled through the coracoid and clavicular screws so that the looped ends exit the top of the clavicle and the free ends are exiting the anterior working portal (Fig 13A,B). A Penetrator suture retriever is used anterior to and at the distal end of the clavicle to retrieve the free ends of the sutures (Fig 14).

The free ends are pulled out of the existing incision up over the anterior border and over the distal end of the clavicle. With traction released, compression is applied

to the clavicle by an assistant as the No. 5 FiberWire is tied over anterior and lateral borders of the clavicle with a racking hitch (Fig 15A,B). Unfortunately this figure does not accurately depict the final appearance of the sutures with one suture tied over the lateral cut edge of the acromion and the other suture tied as depicted.)

REHABILITATION AND RETURN TO SPORTS

Patients are placed in a sling at the completion of the procedure and are encouraged to maintain it for 6 weeks. They are instructed to begin internal and external rotation and pulley exercises on the first postoperative day. Pendulum exercises and any lifting are to be avoided. Patients remove the sling daily for bathing and to perform activities of daily living. Normal use of the elbow, wrist, and hand will prevent elbow stiffness and excessive swelling of the upper extremity. Six weeks after surgery, active resistive exercises are begun. By 3

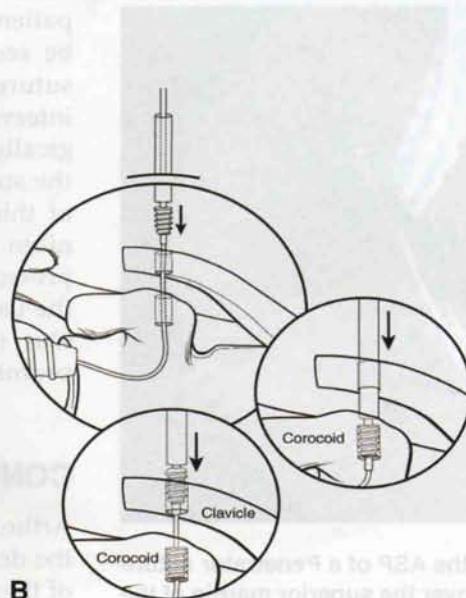


Fig 12. (A) A view from the ASP of a Screw Driver tip and coracoid screw exiting the base of the coracoid and (B) an A/P view representational diagram are shown.

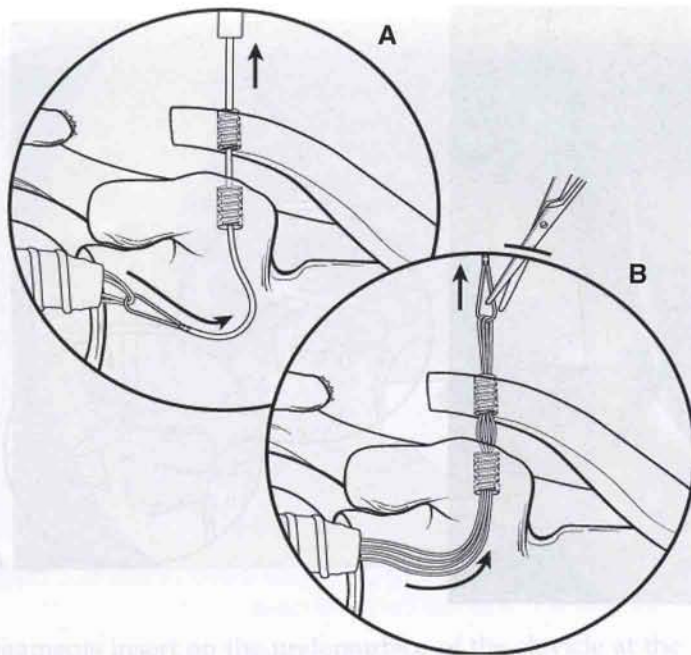


Fig 13. An A/P view diagram representing (A) Nitinol Suture Passing Wire pulled cephalad to thread screws with doubled FiberWire strands and (B) a Nitinol loop cut to free FiberWire strands are shown.

months postoperatively patients have regained most of their motion and much of their strength. By 6 months postoperatively patients are fully recovered and allowed to resume full preinjury activities.

CLINICAL EXPERIENCE

Twenty-one patients underwent arthroscopic reconstruction for acromioclavicular joint separation between October 2000 and December 2002 with a minimum of 1 year of follow up and an average of 2 years of follow up. The most common reasons that our patients were seek-

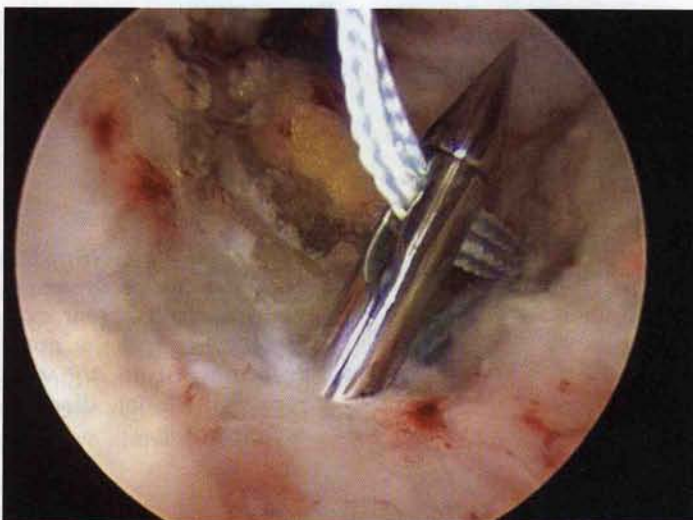


Fig 14. A view is shown from the ASP of a Penetrator suture retriever pulling FiberWire up over the superior margin of the coracoid into the clavicular incision.

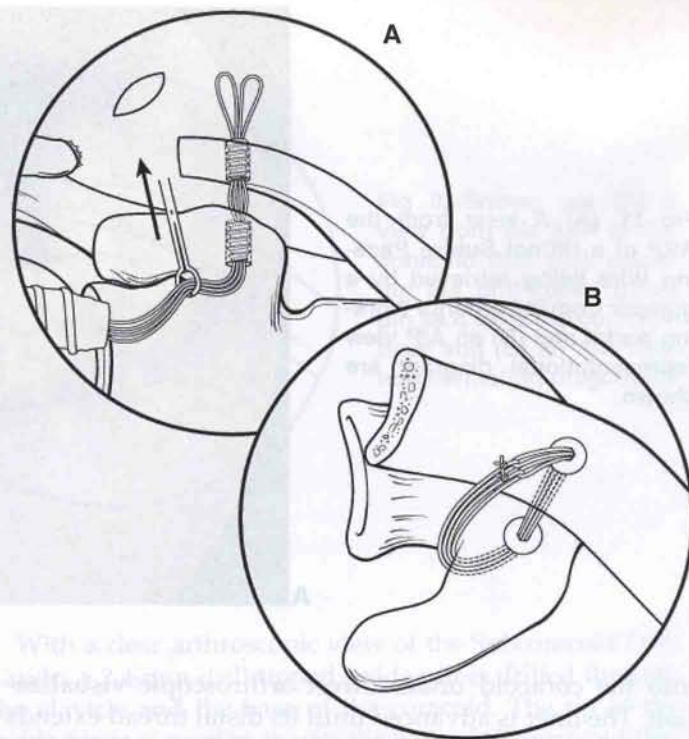


Fig 15. (A) A Penetrator is advanced through a superior clavicle incision, anterior to the clavicle, and (B) free ends of FiberWire are brought up to tie over the top of a clavicle screw with a racking hitch.

ing surgery were pain over the acromioclavicular joint, popping or grinding in the joint or a feeling of acromioclavicular joint instability, and deformity of the shoulder with poor body image. All injuries were rated as Rockwood type III-V acromioclavicular joint separations. All patients underwent identical procedures using either Secure Strand or FiberWire fixation through drill holes in the clavicle and coracoid. A 2-cm distal clavicle resection was performed in all cases. Eighty-one percent of the patients contacted obtained good to excellent results from this surgery. Nineteen percent of the patients had poor results. The failures were thought to be secondary to erosion of the coracoid bone by the suture material. (All patients refused further surgical intervention, and the mode of failure could not be surgically confirmed.) These failures occurred early on in the study and represent a previous era in the evolution of this technique. Currently, we favor the use of titanium tunnel liners placed through the bone tunnels as protection against the sawing action of the sutures and the use of FiberWire sutures for their superior strength. Our early results with these modifications are very promising.

CONCLUSION

Arthroscopic acromioclavicular joint reconstruction offers the desirable features of an open anatomic reconstruction of the coracoclavicular ligaments with the additional benefit of less invasive surgery. It represents an alternative to

