45 Acromioclavicular Joint Instability

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Epidemiology

Acromioclavicular (AC) joint injuries are common and account for about 12 % of all shoulder injuries in clinical practice [1]. This number increases to almost 50 % in athletes participating in contact sports. The true prevalence might even be underestimated since many individuals with low-grade (type I or II) injuries may not seek medical attention [2]. A recent longitudinal cohort study reported on an incidence of 9.2/1,000 injuries among young athletes, whereas male patients experienced a significantly higher incidence rate than female patients [3]. This is most likely due to a different risk-taking behavior and contact sports rather than anatomic differences between genders. The most AC joint injuries occur in the third decade, and the sports most likely to contribute to the incidence of AC joint dislocations are football, soccer, hockey, rugby, biking, and skiing [2, 4–6]. The mechanism of trauma is frequently a direct blow to the shoulder with the arm in an adducted position. Due to the excessive strength of the sternoclavicular joint, the AC joint and the clavicle represent the weak points for injury [4, 7].

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Pathophysiology

AC joint stability is provided by the joint capsule, with the superior, inferior, anterior, and posterior AC ligaments and the coracoclavicular (CC) ligaments. Native AC joint structures tolerate displacements of 4–6 mm in the anterior, posterior, and superior planes and under a 70 N loading [8]. Rotary motion of 5°–8° is experienced during scapulothoracic motion and 40°–45° during shoulder abduction and elevation [9, 10].

The four AC joint ligaments are horizontally directed and mainly contribute to horizontal stability, whereas the superior and the dorsal ligaments contribute the most to anterior-posterior stability [8], whereas the superior AC ligament is the largest and strongest ligament of the AC joint complex [11].

The CC ligaments, namely, the conoid (anteromedial) and trapezoid (posterolateral) ligaments, span from the inferior surface of the flattened distal clavicle to the base of the coracoid process. They mainly contribute to vertical stability. Rios et al. [11] determined a ratio of the CC ligament insertions to total clavicle length (17 % trapezoid, 31 % conoid), which appeared to be more accurate for AC ligament reconstruction compared to actual distance measurements, regardless of gender. The trapezoid ligament shows a quadrilateral shape, and the conoid ligament takes a conical shape with its base facing superiorly [7]. The ultimate failure load of the native AC capsule ligament complex during superior loading has been shown to be 590 ± 95 N [12], whereas a different study has reported the ultimate failure load of the separated CC ligaments to be 500 ± 134 N [13]. From ligament sectioning studies we know that the inferior AC capsular ligament is the primary restraint to anterior translation, while the trapezoid ligament primarily prevents posterior translation [14]. However, other studies have suggested the posterior and superior AC ligaments to primarily contribute to posterior stability [15, 16]. Restriction of superior translation and rotation appears to be mainly provided by the conoid ligament [8, 15].

G. Milano, A. Grasso (eds.), *Shoulder Arthroscopy*,
DOI 10.1007/978-1-4471-5427-3_45, © Springer-Verlag London 2014

Since in type II injuries the AC ligaments fail before the CC ligaments, one can conclude that the AC ligaments resist quantifiably smaller displacement moments than the CC ligaments. Therefore, complete disruption of the AC ligaments renders the CC ligaments the primary restraint for AC stability [8, 15].

The knowledge of this anatomy/pathoanatomy of the mechanical stabilizers is mandatory for the correct classification and surgical treatment, especially when using modern anatomic reconstruction techniques.

History

Patients with AC joint injuries typically complain of a generalized shoulder pain. Therefore, a thorough history is mandatory for correct diagnosis and treatment. A complete patient history includes a trauma anamnesis with exact mechanism of trauma and onset of symptoms. Usually the pain is acute with a history of trauma, typically including a direct force to the lateral aspect of the lateral shoulder [4, 7]. In more chronic cases with a trauma lying further in the past, the thorough anamnesis might be more difficult, but since symptoms can be unspecific, it is even more important for correct diagnosis. In the chronic setting patients typically complain of superior shoulder pain, which can be provoked when the arm is brought across the body or during weight lifting activities such as the bench press.

Clinical Examination

Inspection of the shoulder girdle may reveal abrasions of the shoulder and apparent prominence of the distal clavicle resulting from inferior displacement of the scapula. The palpation of the AC joint will reveal tenderness in the acute setting and the direction of instability can be detected. Range of motion exercises typically show an impaired shoulder function limited by pain [17–20].

Clinical provocative tests for AC joint pathology (O'Brien, Paxinos, and scarf tests) might be helpful to localize anterior/superior shoulder pain to the AC joint. These tests are especially useful in patients with low-grade injuries (types I and II) in which palpable deformity may not be present [2, 4].

Since it has been shown that concomitant intra-articular injuries frequently occur in high-grade AC separations (types III–VI), it is important to rule out these injuries in addition. A study by Tischer et al. [19] demonstrated the presence of ancillary intra-articular injuries in 14 of 77 patients with type III–VI injuries, whereas 11 of 77 patients also had superior labral anterior-posterior (SLAP) lesions. In carefully selected cases an AC joint injection with lidocaine may be helpful in discriminating AC joint pain from other pathologies causing anterior/superior shoulder pain.

Imaging

The standard radiographic examination when detecting for AC joint injuries includes anterior-posterior (AP), scapular Y, and Alexander or Zanca films. The AP view allows for identification of the vertical displacement of the distal clavicle, whereas the Alexander view is used to identify displacement in anterior-posterior direction. The Zanca view, an AP view that is tilt 10–15° cephalad, is helpful in giving a clear view of the AC joint without superimposing structures [21]. Bearden et al. [22] found that a 25–50 % increase of the CC interval was indicative of complete CC ligament disruption. Therefore, the CC interval can be measured and compared to that of the contralateral shoulder in cases of uncertain degree of severity. Weighted stress radiographs have been used to distinguish type II from occult type III injuries [23, 24]; however, it has been shown that these films do not improve the diagnostic accuracy and cause needless patient discomfort [25, 26].

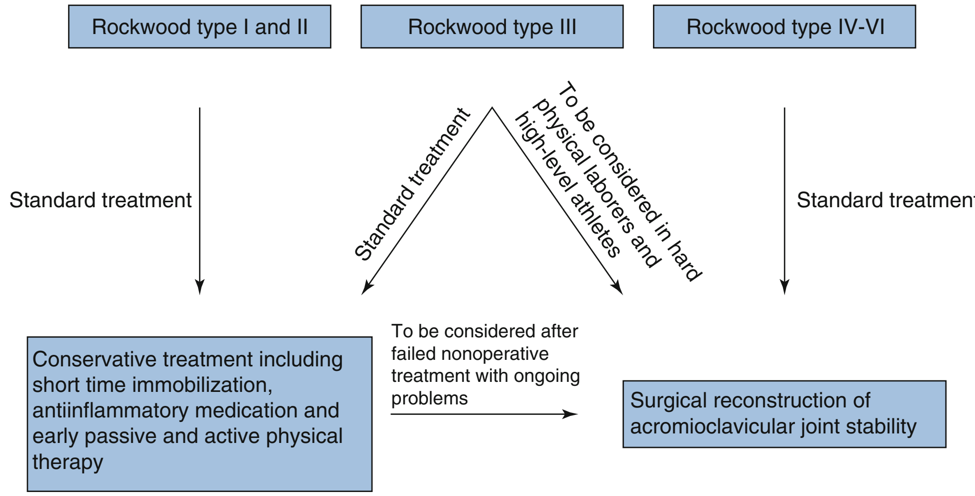
Treatment: Indications and Contraindications

Today, nonoperative treatment is generally recommended for type I and II injuries since several studies have shown satisfactory results [27–31]. This treatment typically includes a brief immobilization (1–3 weeks) of the shoulder followed by early range of motion exercises.

However, in contrast, several studies have described that persistent symptoms are common even after nonoperative treatment of low-grade injuries [27, 28, 32, 33]. Furthermore, data by Song et al. [34] suggest that early distal clavicle excision might be beneficial in some patients with type II injuries. However, to date there is no hard evidence for indicating surgical treatment for type I and II injuries.

Treatment of type III AC injuries is still controversial. Since clinical studies could not show significant advantages for either treatment, a trial of conservative treatment is typically recommended [35–38]. However, other studies suggest that early surgical treatment of type III injuries may result in better clinical outcomes compared to patients undergoing surgery at a point greater than 3 months beyond the injury after unsuccessful nonoperative therapy [39, 40]. Therefore, early surgical repair of type III AC lesions might be considered in manual workers or overhead athletes [35, 36, 40]. Type IV through VI lesions are typically treated surgically in order to avoid the reported long-term sequel [6, 28, 35, 36, 40].

Table 45.1 Decision-Making Algorithm for Treatment of AC Joint Instability



Possible contraindications or limitations for surgical interventions include concomitant acute fractures of the coracoid process or the distal clavicle and the common general contraindications for surgical treatment.

Fig. 45.1 Preoperative photograph of the shoulder girdle revealing a distinct prominence of the right lateral clavicle when compared to the contralateral side

Decision-Making Algorithm

A decision-making algorithm based on the review of the current literature is shown in Table 45.1. Primarily, the correct diagnosis has to be established and the lesion is graded according to the Rockwood classification [41]. Based on this classification, the lesions are divided in low-grade (types I and II), type III, and high-grade (types IV through VI) injuries. Patients with low-grade injuries are treated with conservative therapy, which includes a short period of immobilization (1–3 weeks) and early passive and active therapy. Nonsteroidal anti-inflammatory drugs (NSAIDs) are prescribed as necessary. The treatment of most type III injuries is identical; however, the time of immobilization in a sling may be extended as needed. Surgical treatment might be considered for hard laborers and high-level athletes as discussed above. Furthermore, persistent pain, discomfort, and impairment of shoulder function may be an indication for surgery, which has to be discussed with the patient. Acute surgical stabilization is typically recommended in high-grade injury separations.

Clinical Case/Example

A 22-year-old male suffered a traumatic AC joint dislocation during a handball match. The mechanism of injury was a direct force from a fall on the lateral aspect of the shoulder with the arm in an adducted position. Right after the fall the patient reported to have shoulder discomfort and a painfully restricted range of motion. Therefore, he presented to our department seeking medical treatment. Prior to the match, the patient was completely asymptomatic without a history of injury or trauma.

Inspection of the shoulder girdle revealed a distinct prominence of the lateral clavicle when compared to the contralateral side (Fig. 45.1).

During initial physical examination of the shoulder, there were tenderness to palpation over the AC joint and a significant vertical instability of the lateral clavicle. Range of motion exercises showed an impairment of active shoulder function limited by pain. Global testing for rotator cuff function and strength was uneventful and neurovascular examination was within normal limits.

Radiographs of the affected shoulder revealed no bony lesions. There was a significant displacement of the lateral clavicle, corresponding to a Rockwood type V lesion (Fig. 45.2).

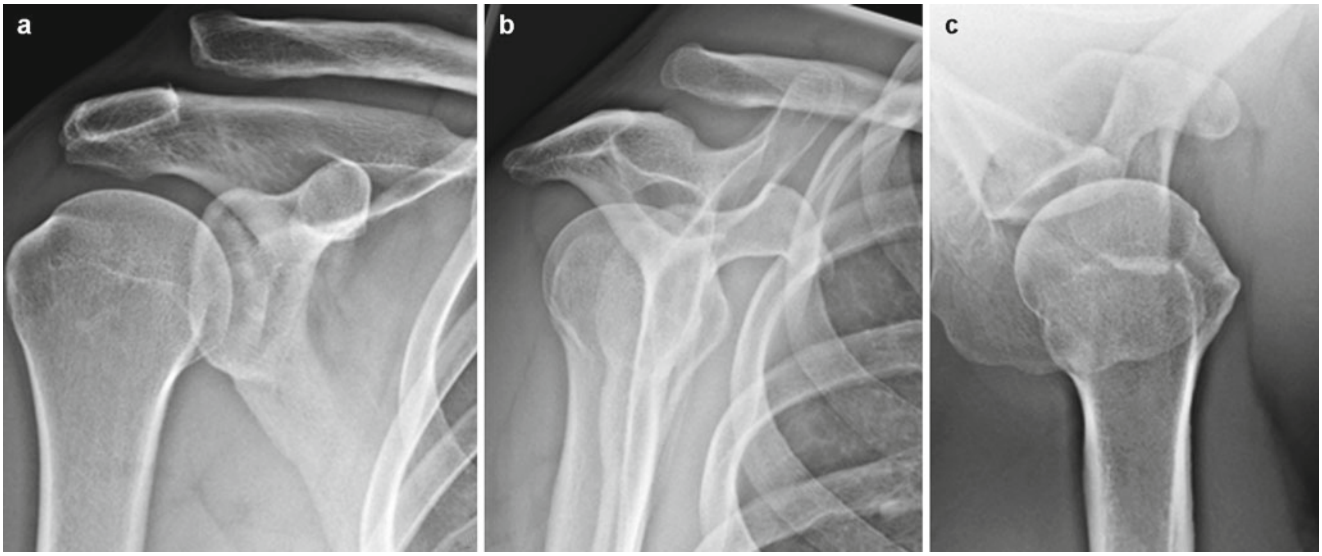


Fig. 45.2 Anteroposterior view (**a**), Y-view (**b**), and axial view (**c**) showing the severe displacement of the lateral clavicle, corresponding to a Rockwood type V lesion

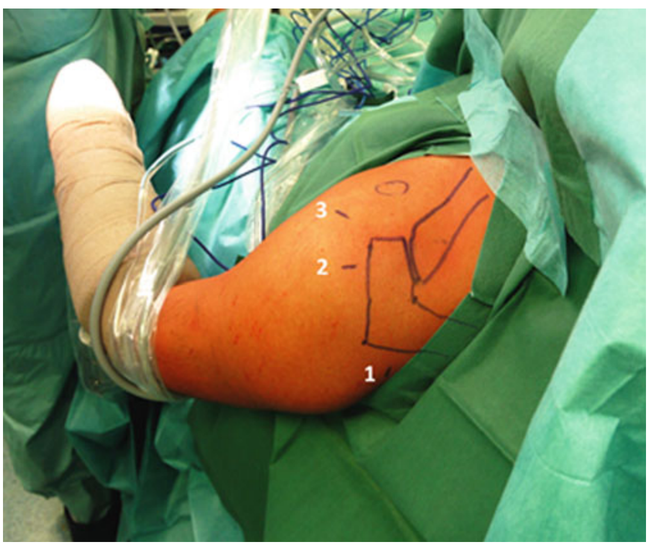


Fig. 45.3 Preoperative photograph showing the standard portals marked on the skin: *1* posterior portal, *2* lateral viewing portal, *3* anterolateral working portal

Discussion of the risks, benefits, and alternatives of each therapy modality was undertaken, and largely due to the high-grade instability, the patient decided to undergo AC joint reconstruction. Diagnostic arthroscopy revealed no concomitant injuries and the AC joint was repaired as described below.

Arthroscopic Treatment: Surgical Technique

Improvement of instruments and techniques within the last decade has enabled the orthopedic surgeon to perform acromioclavicular reconstructions mainly arthroscopically. Today, arthroscopic anatomic reconstruction techniques of the CC ligaments are state of the art. Typically, tendon grafts [42–44] and/or suture button devices [43–47] are used to reduce and stabilize the AC joint. Recent biomechanical studies have shown excellent mechanical properties for either technique [42, 47]. The authors' preferred techniques for arthroscopic anatomic AC reconstruction will be described in this section.

Patient Positioning

For the arthroscopic techniques, the patient is placed in the beach chair position. A mechanical arm holder (Trimano, Arthrex Inc., Naples, FL, USA) is used for easier management. After general anesthesia is induced, a thorough examination of both shoulders is performed. The operative shoulder is then prepared and draped in a standard fashion. The anatomic landmarks are marked on the skin after reduction of the AC joint with the mechanical arm holder (Fig. 45.3).

Portals

Diagnostic arthroscopy is performed through a standard dorsal viewing portal. A working portal is established under arthroscopic visualization through the rotator interval as a modified anterolateral portal with a spinal needle parallel to the subscapularis tendon. The arthroscope is switched to a lateral trans-supraspinatus viewing portal dorsal to the long head of the biceps tendon. Additional portals may be needed to address any concomitant intra-articular lesions, e.g., SLAP lesions. The deep anterolateral portal is secured with a flexible cannula (PassPort Cannula 8 mm×4 cm, Arthrex) and is used to expose the base of the coracoid (Fig. 45.3).

Diagnostic Arthroscopy: Understanding and Recognizing the Pathology

In patients with AC joint separations, the main pathology is located extra-articularly. However, since a high number of concomitant intra-articular lesions have been described for AC joint separations [19], a thorough diagnostic arthroscopy of the entire glenohumeral joint is mandatory. Especially in high-grade injuries, an incidence of SLAP lesions up to 20 % has been reported, and moreover, rotator cuff tears have been found.

Step-by-Step Procedure (Box 45.1)

After the diagnostic arthroscopy and addressing potential concomitant lesions, the focus is moved towards the actual reconstruction of the AC joint.

Box 45.1: Tips and Tricks

Arthroscopic stabilization of the AC joint can be challenging even for the experienced arthroscopic surgeons. The following recommendations can aid to facilitate the procedure and avoid complications:

- Make sure you are familiar with the instruments and implants needed for this procedure.
- Use additional portals for optimum visualization.
- Avoid dissection medial to the coracoid process in order not to jeopardize the brachial plexus.
- Allow enough time for a thorough subcoracoid debridement and exposure of the coracoid process which will then facilitate the rest of the procedure.
- Avoid tunnel placement within the coracoid process too close to each other and too close to the cortex in order to minimize risk for fracture and breakout of the tunnels.
- Use fluoroscopy to control the position of the drill tip guides before over-reaming.
- Control AC joint reduction and position manually and under fluoroscopy.

Coracoid Exposure

A trans-articular approach is used for exposure of the coracoid process through the rotator interval. The coracoid process is identified just anterior to the subscapularis tendon. For better visualization, the arthroscope is switched to a trans-subscapularis viewing portal as described above. A radio-frequency device is used through the deep anterolateral portal to open the anterior joint capsule and expose the coracoid process from the tip to the base by removing soft tissue carefully with a radio-frequency device. The attachment of the pectoralis minor and the conjoined tendons is preserved. Dissection medial to the coracoid process is avoided not to injure the neurovascular structures. This step has to be performed thoroughly since good exposure and visualization of the subcoracoid space is mandatory for the following drilling and placement of any implant or graft.

Superior Approach to the Distal Clavicle

For exposure of the distal clavicle, a 3–4 cm skin incision is made within Langer's lines perpendicular to the clavicle approximately 40 mm medial to the AC joint. Next, the trapezius-deltoid fascia is exposed and incised in line with the fibers of the trapezius muscle and the clavicle. Thus, the anterior and posterior cortical margins of the clavicle can be exposed. The AC joint capsule is carefully mobilized elevating the anterior and posterior flaps subperiosteally as a single layer. By doing so, one facilitates the later repair of the joint capsule over the reconstructed AC joint. The AC joint can now be directly visualized.

Tunnel Placement

For arthroscopic anatomic AC joint reconstruction, two suture button devices (TightRope, Arthrex) are used in order to separately reconstruct the conoid and trapezoid ligaments as previously described [45, 48]. Two 4 mm drill holes are established through the clavicle and coracoid according to the attachments of the native CC ligaments as described by Rios et al. [11] and Salzmann et al. [48]. This step is performed under direct visualization from intra-articular using a special drill guide, which is inserted through the anterolateral portal. A 2.4 mm drill tip guide is placed approximately 4.5 cm medial of the AC joint transclavicular and close to the base of the coracoid. After this, a second 2.4 mm drill tip guide is introduced in the same way with the drill guide with approximately 2 cm distance lateral in the clavicle and lateral in the coracoid. Correct positioning of the two drill tip guides is verified under fluoroscopy with a C-arm (Fig. 45.4). Subsequently, the 2.4 mm drill tip guides are overdrilled starting medial with a cannulated 4 mm drill while protecting the tip of the 2.4 mm drill with a drill stop or curette. A SutureLasso wire loop (Arthrex) is inserted through the cannulated drill bit before it is removed. The second lateral 2.4 mm drill tip guide is overdrilled next and the cannulated drill is left in place.

Button Placement

The two suture button devices can now be inserted through the superior approach by the use of the wire loop, again

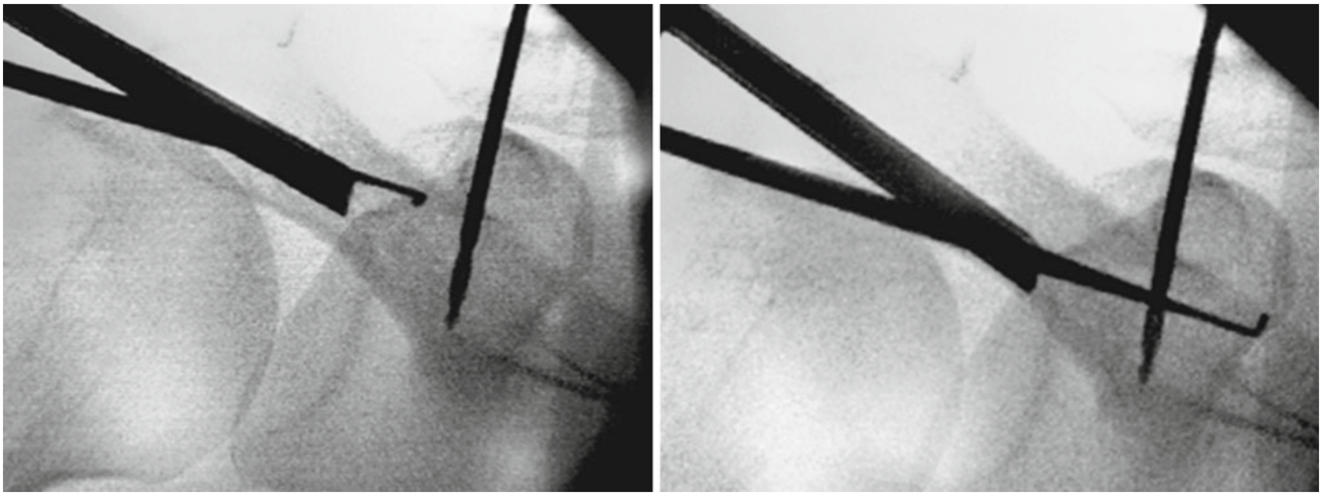


Fig. 45.4 Intraoperative fluoroscopy used to verify correct positioning of the two drill tip guides. A hooked probe is used to verify the lateral (*left*) and medial (*right*) borders of the coracoid process

starting medial. The SutureLasso is then introduced in the 4 mm cannulated drill that is still in position and the second suture button device is pulled in. Correct placement of the implants under the coracoid is controlled by direct visualization (Fig. 45.5). The AC joint is then manually reduced by elevating the arm against the scapula. When anatomic reduction is achieved, the clavicular buttons are placed on top of the clavicle. The medial and finally the lateral device is tightened using the pulley system and secured by alternating knots (Fig. 45.6).

Tendon Graft Augmentation

In revision or chronic AC joint separations, an autologous tendon graft augmentation is performed in order to add stability and enhance biological healing. For this reason, we prefer to use the gracilis tendon as a graft. The graft is typically harvested from the ipsilateral knee in a standard fashion and prepared with sutures on both ends.

The technique is modified, and we use FiberTape (Arthrex) with bigger buttons for the medial tunnels to support the graft in this tunnel. Therefore, the graft and one limb of FiberTape are pulled in the tunnel and out of the anterolateral working portal. Outside the joint, the bigger button (Dog Bone, Arthrex) is clipped on the FiberTape, and the free limb is pulled back superior in the joint and back through the coracoid and clavicular tunnel. A second Dog Bone button is used superior of the clavicle. The graft itself is pulled out with a grasper that is introduced anterior of the clavicle and finds the graft sutures lateral of the coracoid. By doing so, the graft forms a figure of eight with one limb through the bony tunnels and one around. The graft is then knotted around the clavicle and secured under tension with additional sutures, and the free ends of the graft are cut off.

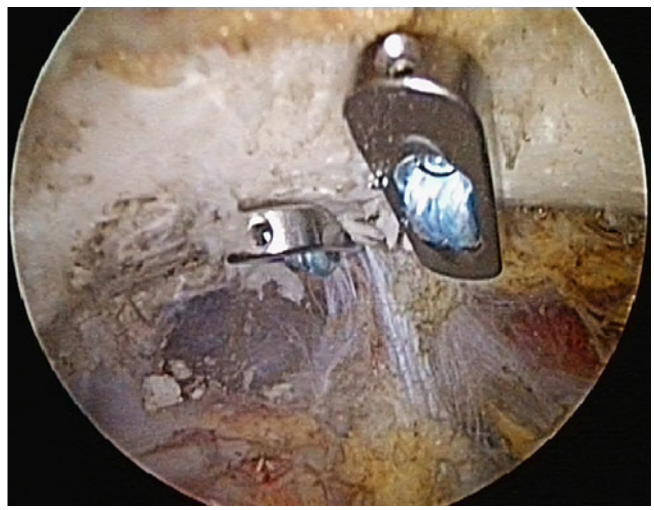


Fig. 45.5 Intraoperative view through the lateral portal of a right shoulder showing the base of the skeletonized coracoid process with the two button devices in correct position

Finally, the trapezius-deltoid fascia and the joint capsule are repaired meticulously and the skin is closed in a standard manner.

Postoperative Care

The shoulder is immobilized in a sling for 6 weeks postoperatively to minimize strain on the CC ligament reconstruction. Patients are allowed full active elbow, wrist, and hand exercises. Within the first 2 weeks, passive motion exercises are performed limited to 30° of flexion and abduction as well as to 80° internal rotation and 0° external rotation. Within weeks three and four, range of motion exercises are performed up to 45° flexion and abduction in an active-assisted

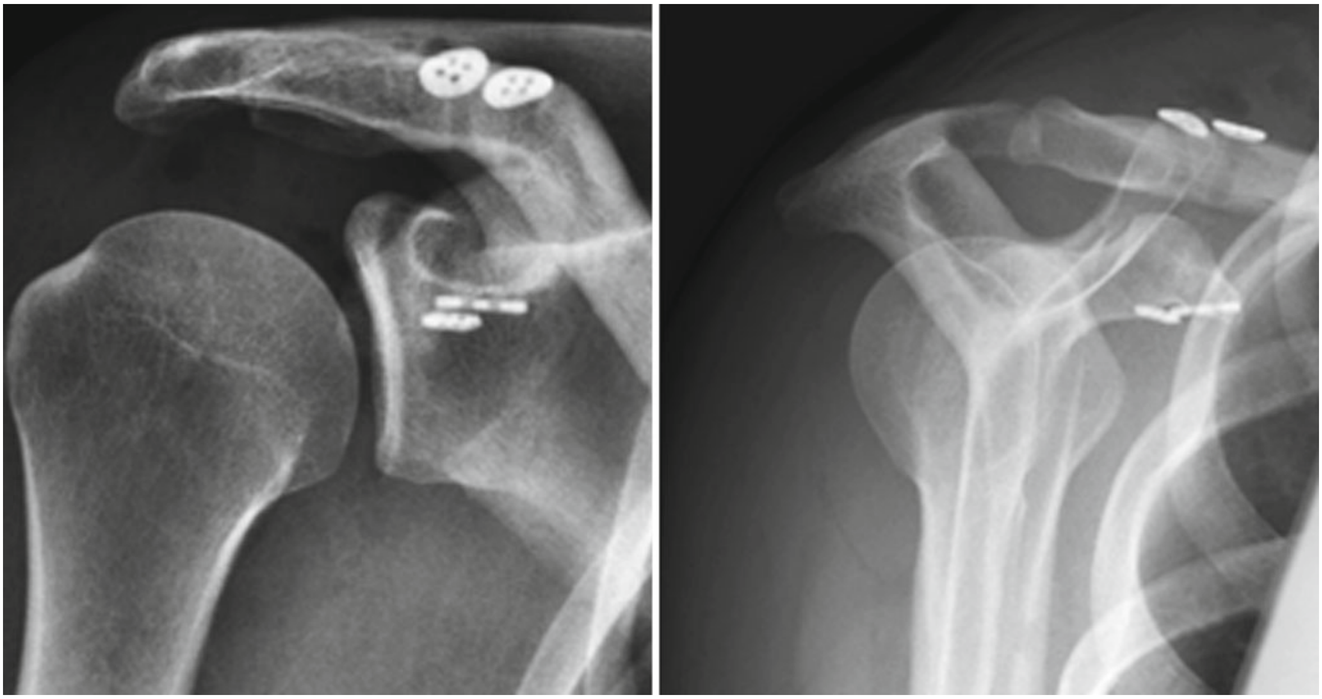


Fig. 45.6 Postoperative radiographs showing anatomic reconstruction of the AC joint and the TightRope devices in correct position

manner. Within weeks five and six, the range of motion exercises are advanced to 60° of flexion and abduction with an unlimited rotation. Active motion in the upright position is then advanced per the patient's tolerance. After regaining pain-free full active range of motion, strengthening exercises, which primarily focus on scapula stabilization, can start around the twelfth postoperative week. Return to work without any restrictions is typically allowed at 12–16 weeks after surgery. The patients are usually allowed to go back to full-contact athletics after 5–6 months, assuming the range of motion and strength are within 90 % of the unaffected shoulder [4].

Literature Review

Since Weaver and Dunn [49] published their popular technique in 1972, a vast number of different open and arthroscopic techniques have been described for surgical treatment of AC joint reconstruction. In order to improve the techniques and decrease the reported high failure rates, which were reported to be as high as 30 % [40, 49], new techniques have been evolved continuously. Furthermore, several biomechanical studies have been conducted showing the advantages and downsides of current AC repair techniques [12, 47, 50–56]. In 2008, Walz et al. [47] have reported on the biomechanical strength of an anatomic suture button repair, which showed comparable stability to the native ligaments. Also, excellent biomechanical properties have been shown for different graft reconstruction techniques [42, 52, 54, 55, 57, 58].

Anatomic reconstruction techniques have already shown good clinical outcomes; however, high complication rates have also been described [44, 45, 59, 60]. Since these techniques typically use tunnels through the coracoid and/or the distal clavicle for suture button or graft fixation, complications like fractures of the coracoid process or the clavicle have been described [44, 45, 61]. Coale et al. [62] showed in a recent CT-based study that an anatomic graft reconstruction with transclavicular-transcoracoid drilling (6 mm) significantly increases the risk of cortical breach and fracture of the coracoid process and in some cases may be not feasible. These finding are supported by recent clinical studies showing high complication and failure rates when the small coracoid process is weakened by a 6 mm drill hole [44, 60]. Using an anatomic double TightRope suture button technique, Scheibel et al. [46] reported on good to excellent early clinical results (mean follow-up: 26.5 months) in 37 patients without any coracoid fracture or early loss of reduction (within 6 weeks). Using a similar technique, Salzmann et al. [45] showed satisfactory clinical results in 23 patients with acute AC injuries after at least 24-month follow-up. However, they described a revision rate of 11.5 % (3/26) in this first published series of the double TightRope technique. Causes for revision surgery included one coracoid fracture, one cranial button slippage, and one wound infection. The caudal migration (four patients) or breakout (one patient) of the clavicular buttons, noted in 22 % of the patients, has not shown to have a negative influence on the clinical outcome.

Summary

AC joint separations are common injuries of the shoulder girdle and numerous treatment options have been proposed in literature. Low-grade injuries (types I and II) should be initially managed nonsurgically. Surgical treatment is typically reserved for high-grade lesions (types IV through VI) and might be beneficial in some type III lesions for heavy laborers or high-level athletes. Due to recently published biomechanical data, there is a current trend towards an anatomic reconstruction of the CC ligaments. While some reports have shown encouraging results using these techniques, relatively high complication rates have been reported at the same time. Moreover, anatomic reconstructive techniques have introduced a new complication profile including migration of suture buttons and coracoid or clavicle fracture. Therefore, the ideal technique for AC joint reconstruction has yet to be firmly established.

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