8 Arthroscopic Treatment of Acromioclavicular Dislocations

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8.1 Introduction

Acromioclavicular (AC) joint serves as a primary connection between the upper appendicular skeleton and the axial skeleton. AC joint is commonly involved in traumatic injuries to the shoulder, and these injuries force surgeons in the diagnostic and therapeutic sense. Although AC joint injuries are seen especially in young athletes, they can also be seen in other age groups after traffic accidents and falls. Sports such as football, ice hockey, rugby, and wrestling are among the main reasons for AC joint injuries and more commonly seen in male athletes than in females (Hibberd et al. 2016; Pallis et al. 2012). This injury constitutes 30–50% of athletic shoulder injuries and represents 8% of all joint dislocations in the body (Pallis et al. 2012). But these values do not reflect the true incidence, as many cases have been overlooked.

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8.2 Anatomy and Biomechanics

The AC joint is a diarthrodial joint, and a thin, fibrocartilaginous, meniscus-like disc lies within the joint. In the first years of life, the articular surface is made up of hyaline cartilage and later transforms to fibrocartilage, degenerates over time, and becomes incompetent in most individuals beyond fourth decade (DePalma 1959). In superior-inferior plane, the average size of the AC joint is approximately 9 mm and 19 mm in anterior-posterior plane. And the width of the AC joint ranges from 1 to 3 mm (Bonsel et al. 2000).

The AC joint has both static and dynamic stabilizers. A thick joint capsule, four horizontally oriented AC ligaments (anterior, posterior, inferior, and superior ligaments), and the coracoclavicular and coracoacromial ligaments constitute the static stabilizers. The dynamic stabilizers include the deltoid and trapezius muscles. Pectoralis major and subclavius muscles have their primary effects on the sternoclavicular joint.

The AC joint capsule and the AC ligaments are the principle restraints of anteroposterior translation of the distal clavicle (Fukuda et al. 1986). The posterior and superior AC ligaments are the most significant contributor to joint stability in horizontal plane (Klimkiewics et al. 1999). In their biomechanical studies, Corteen and Teitge (2005) showed that 1 cm distal clavicle resection results in 32% increase in posterior translation compared with intact cadaveric joint.

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The vertically oriented coracoclavicular (CC) ligaments, including the conoid ligament medially and the trapezoid ligament laterally, contribute to the stability of the AC joint in vertical plane. These ligaments prevent superior and inferior translation of the clavicle. The CC ligaments also guide synchronous scapulohumeral motion by attaching the clavicle to the scapula, as well as AC joint strengthening function. The CC ligaments originate from superior surface of the coracoid process posterior to the pectoralis minor attachment, course superiorly, and insert inferior surface of the lateral aspect of clavicle with an average length of 13 mm (Salter et al. 1987). The distance of the distal end of clavicle to the conoid and trapezoid ligaments varies according to the sex; the average distance for conoid ligament is 47.2 ± 4.6 mm in males and 42.8 ± 5.6 mm in females; it is 25.4 ± 3.7 mm in males and 22.9 ± 3.7 mm in females for trapezoid ligament (Rios et al. 2007).

Fukuda et al. (1986) reported that the primary restraints to superior translation of clavicle were AC ligaments in small displacements; and it was the conoid ligament in larger displacements. The trapezoid ligament was found to be the primary restraint to compression of the AC joint. Mazzocca et al. (2008) have demonstrated that with superior load to AC joint, the cascade of injury consistently started with conoid ligament failure followed by trapezoid ligament.

The AC joint has micromotion in all planes. Worcester and Green (1968) have described three types of motion in the AC joint: rotation along the long axis of the clavicle, abduction and adduction of the scapula on clavicle, and anterior and posterior displacement of the scapula on clavicle. Ludewig et al. (2004) demonstrated that the clavicle undergoes elevation (11–15 °) and retraction (15–29 °) with respect to thorax during arm elevation. The AC joint rotates approximately 5–8 ° in line with scapula during forward elevation and abduction. Scapular motion plays a major role in the motion of AC joint. Small movements of acromion in anteroposterior direction provide maintenance of the relationship between glenoid cavity and humeral head in shoulder flexion and abduction. These movements are restricted by CC ligaments. The AC joint should not be fixed either by fusion or hardware like screws, plates, etc., because the rotation of the clavicle is associated with arm elevation and scapular motion. Fixation of AC joint will eventually result in functional limitation in shoulder or hardware failure.

8.3 Mechanism of Injury

The AC joint injuries can be seen as a result of direct or indirect forces. The most common mechanism of injury is a direct trauma, caused by fall or blow to the lateral aspect of the shoulder with the arm in adduction. This acting force on shoulder causes inferior and medial displacement of the scapula and acromion. In the early stages of trauma, clavicle remains in its anatomical position. Further transmission of force initiates a cascade of injury that begins with AC joint capsule and ligamentous structures' failure, followed by rupture of CC ligaments. This condition is defined as complete AC joint dislocation. In cases of severe injury, disruption of muscular attachments of the trapezius and deltoid muscles from clavicle is observed. Indirect mechanisms of AC joint injuries are rare and may occur by falling on out-stretched hand or elbow in adducted position. This results in superior displacement of humeral head, leading to a pushing force against acromion.

8.4 Classification

The mechanism of AC joint injury was first described by Cadenet (1917), and Tossy et al. (1963) published a new classification system which forms the basis of today's most widely used system. In 1984, Rockwood (1984) developed a new classification system to categorize the degree as well as the direction of the injury. According to the Rockwood classification system, there are six types of AC joint injuries:

Type I: Sprain of the AC ligaments. Radiographically normal. Tenderness on the AC joint. CC ligaments are intact.
Type II: Complete tears of the AC ligaments. CC ligaments are intact. Unstable in anteroposterior plane, stable in superoinferior plane. Radiographic AC joint widening may be present.
Type III: Disruption of both AC and CC ligaments resulting in complete AC joint dislocation. Deltoid or trapezial fascia is usually intact. 25–100% increase in CC space compared to the contralateral side. Clavicle is unstable in both vertical and horizontal planes.
Type IV: Posterior displacement of the clavicle into or through the trapezius muscle and may tent posterior skin. Best seen on the axillary view. Often found incarcerated in this position at surgery.
Type V: More severe form of type III injury. Greater than 100% increase in radiographic distance between clavicle and coracoid process. Clavicle is often non reducible as it pierces deltotrapezial fascia.
Type VI: Rare. Inferior displacement of the distal end of clavicle. Usually result of a high energy trauma with multiple other injuries. Mechanism of injury is hyperabduction and external rotation of the arm. The distal clavicle ends up in a subacromial or subcoracoid position.

8.5 Clinical Evaluation

Clinical evaluation should be done in comparison with contralateral normal joint. In acute injuries, pain, tenderness and swelling at the AC joint are the main complaints. Significant deformity and stepping can be seen between distal end of the clavicle and acromion, especially in complete dislocations. Piano sign may be elicited with ballottement of the lateral end of the clavicle. In severe injuries, a hematoma may be present indicating the avulsion of the muscle attachments. It is important to evaluate the horizontal instability on the physical examination. Posterior displacement of the clavicle is assessed, while the acromion is stabilized with the other hand. Ipsilateral glenohumeral and sternoclavicular joints should be examined for accompanying injuries. The patient must also be assessed for neurovascular injury and fracture.

8.6 Radiographic Evaluation

Radiographical images should be obtained when AC joint injury is suspected in the patient's history and physical examination. Radiographic view of the contralateral normal joint should be taken for comparison. Anteroposterior, lateral, and axillary views are the standard views used for this purpose. The anteroposterior view is important in determining vertical instability, whereas the axillary view evaluates horizontal instability. But improved visualization of the AC joint can be obtained by the Zanca view (Zanca 1971). This view is performed with a 10–15 ° cephalic tilt of the X-ray beam and using only 50% of the standard shoulder anteroposterior penetration strength. Superimposition of the acromion on the distal clavicle can be avoided through using Zanca view. Stress views can be obtained to assess AC joint instability by holding weights in each arm. This is more useful in distinguishing type II injuries from occult type III injuries.

The AC joint width in the frontal plane (Zanca view) is normally 1–3 mm and decreases with age. An AC joint width greater than 7 mm in men and 6 mm in women is considered pathological. Bearden et al. (1973) reported that an increase of 25–50% in the CC distance relative to the normal side is suggestive of complete disruption of CC ligaments.

Magnetic resonance imaging can also be used in assessment of the stabilizing soft tissue structures (AC and CC ligaments, deltotrapezial fascia) and in clinical grading of dislocation.

8.7 Treatment

Various surgical treatment modalities of unstable AC joint injuries have been described for years in the orthopaedic literature. But in general there are four main surgical strategies:

1. Primary AC joint fixation with or without ligament reconstruction/repair
2. Primary CC fixation with or without AC ligament reconstruction/repair
3. Distal clavicular resection with or without CC ligament repair/coracoacromial ligament transfer
4. Muscle transfers with or without distal clavicular resection

All of these surgical strategies share a common goal of stabilization and realigning of the distal clavicle. This can be achieved anatomically with reproduction of conoid and trapezoid ligaments or nonanatomically with reproduction of a single CC ligament or using internal fixation hardware (Martetschläger et al. 2016). One of the most commonly utilized treatment methods is the use of metal hardware (K wire, hook plate, screws, etc.). However this method should be used with caution, as it can change the biomechanics of the AC joint, and high rates of failure of fixation and complications can be seen with these nonanatomic procedures (Chiang et al. 2010; Kienast et al. 2011; Norrell and Llewellyn 1965; Sethi and Scott 1976; Warth et al. 2013). Also, these procedures almost always need a second surgery for implant removal (Babhulkar and Pawaskar 2014; Johansen et al. 2011) (Figs. 8.1 and 8.2).

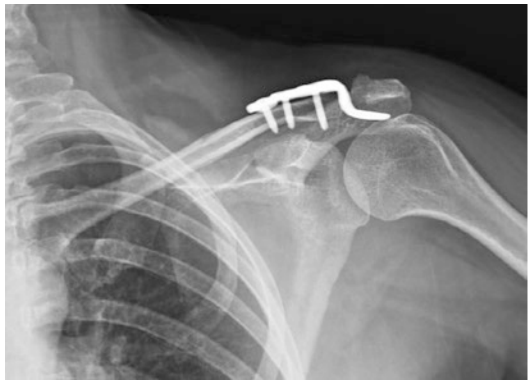

Fig. 8.1 Hook plate impinging on the humeral head which causes pain and limitation of shoulder abduction

Fig. 8.2 Second surgery is needed to remove hook plate

In the last 10–15 years, arthroscopically assisted treatment methods for unstable AC joint injuries have been developed and popularized with several advantages among open techniques using metal hardware (Baumgarten et al. 2006; Chernchujit et al. 2006; DeBerardino et al. 2010; Gille et al. 2013; Hosseini et al. 2009; Lafosse et al. 2005; Rolla et al. 2004; Wolf and Pennington 2001). One of the major advantages of these procedures is the possibility of detection and treatment of additional glenohumeral lesions. Concomitant glenohumeral injuries may be present in almost one third of the unstable AC joint injuries. Especially, the superior labrum, long head of biceps, and the rotator cuff are the affected structures (Arrigoni et al. 2014; Pauly et al. 2009, 2013; Tischer et al. 2009). Better cosmetic results with smaller incisions, minimal soft tissue dissection, and direct visualization of the base of the coracoid are the other main advantages of the arthroscopic approaches (Wolf and Pennington 2001). Direct visualization is especially important when placing CC fixation systems, as it ensures the more accurate tunnel placement at the coracoid process. There is no need for obligatory implant removal in arthroscopic procedures, except for arthroscopically assisted Bosworth technique. Apart from the significant disadvantages of open surgery, hematoma, infection, and implant loosening are less common in arthroscopic procedures.

8.7.1 Arthroscopy-Assisted Techniques

Arthroscopic treatment of AC joint dislocations was first described by Wolf and Pennington in 2001. They used SecureStrand cable (Surgical Dynamics, Norwalk, CT) which is manufactured from an ultra-high-molecular-weight polyethylene fiber and used in spinal reconstructive procedures. This technique requires release of the middle and superior glenohumeral ligament to allow access to the base of the coracoid. They performed this technique in four patients (1 type V, 3 type III), and the preliminary results were excellent with no recurrences of the deformity (Wolf and Pennington 2001).

In 2004, Trikha et al. used polydioxanone-sulfate (PDS) cord in arthroscopy-assisted treatment of five patients with AC joint dislocation. They reported one slight loss of reduction in the follow-up period with no symptoms, and there had been no other complications. Rolla et al. (2004) described a new technique of arthroscopically assisted Bosworth procedure. This technique consists of a closed reduction and stabilization of AC joint with a 7 mm cannulated screw positioned between coracoid process and clavicle. Nine patients were treated with this technique, and after a minimum 5-month follow-up period, all patients had a complete functional recovery, and no residual pain was seen (Rolla et al. 2004). Major difference from the classic Bosworth technique is that the patient and surgical team are not exposed to ionizing radiation. Obligatory screw removal and increased hardware failure have caused this technique not to be widely used.

Chernchujit et al. (2006) reported the arthroscopic stabilization of AC joint using suture anchors with fiberwire tied over a small titanium plate. Twelve out of thirteen patients showed a satisfactory result, whereas three had mild complaints (two had pain, one had loss of motion). Recurrent subluxation of AC joint was seen in two patients, and one patient had complete redislocation. No patient had post-traumatic arthritis. Lafosse et al. (2005) described the arthroscopic Weaver-Dunn procedure for treatment of acute and chronic AC joint dislocations. The acromial branch of the thoracoacromial artery on the coracoacromial ligament was preserved and transferred to the torn CC ligaments. Shorter healing period was expected due to the protection of the vascular structures. The major function of the coracoacromial ligament is to prevent the anterosuperior migration of the humeral head. Therefore, the authors warned that this technique should not be used in patients with an anterior or massive rotator cuff lesion (Lafosse et al. 2005). Snow and Funk (2006) reported their preliminary results of 12 patients operated arthroscopically using the Weaver-Dunn technique. They found promising results with a mean 3-month follow-up. Postoperatively ten patients' AC joints were anatomically reduced, and two patients had residual subluxation. However in these procedures, the strength of the transferred ligament can be only 25% of the normal, and the horizontal stability of the AC joint cannot be achieved, which can lead to recurrent subluxations up to 30% (Harris et al. 2000; Lee et al. 2003; Weaver and Dunn 1972; Weinstein et al. 1995).

The use of allograft or autograft for the anatomic reconstruction of AC and CC ligaments which was initially described by Jones et al. (2001) is a popular treatment method of AC joint injuries. Biomechanical studies have demonstrated that use of a free tendon graft in ligament reconstruction more closely mimics the normal functional anatomy and provides more stronger and stable constructs (Mazzocca et al.

2006; Michlitsch et al. 2010). Over time, this method has begun to be applied arthroscopically. In 2006, Baumgarten et al. defined a new arthroscopically assisted technique by using subacromial approach to pass the semitendinosus allograft or autograft around the coracoid to reconstruct the CC ligaments. Yoo et al. (2010) reconstructed CC ligaments of 13 patients with arthroscopically assisted double-bundle, three-tunnel method using a semitendinosus tendon. Excellent functional and subjective results with high-satisfaction rates were reported in all cases, although an incomplete reduction was observed in two patients postoperatively and mild displacement was observed in three patients who had postoperative anatomic reduction. A new arthroscopically assisted technique was described by DeBerardino et al. (2010). AC Graft-Rope system (Arthrex, Naples, FL/USA) was used in this technique. The Graft-Rope system consists of four strands of nonabsorbable sutures passing between clavicular washer and the coracoid button. The system was designed to accept allograft or autograft like anterior tibial tendon, gracilis, or semitendinosus tendon. The system was performed in ten patients with high-grade AC joint dislocations, and no complication or loss of reduction was observed in early period (DeBerardino et al. 2010). Jensen et al. (2013) have modified this technique by adding transacromial gracilis tendon loop to increase horizontal stability of AC joint in addition to vertical stability provided by Graft-Rope system. The authors suggested using biological substitute with allograft or autograft, especially in chronic cases, as the healing potential of ruptured ligaments is limited in these cases. Pühringer and Agneskirchner (2017) described an arthroscopic technique using a gracilis tendon graft for AC and CC ligament reconstruction in chronic instabilities. They looped the tendon in the figure of 8 around the coracoid, and the risk of fracture was reduced in this way. Also they used a sagittal clavicular tunnel instead of the vertical one. Increase in stabilization and force transmission was intended by using a sagittal tunnel and looping the tendon in figure of 8.

Hook plate has been widely used in AC joint dislocations for many years. Extensive surgical incisions are needed for open reduction of the joint and hook plate placement. And this leads to various complications (soft tissue trauma, blood loss, infection, etc.). Gille et al. (2013) defined a new technique that decreases the risks of open surgery. They performed the hook plate fixation with arthroscopic assistance. The early results of three patients on whom this technique was performed were reported as good to excellent. The authors stated that arthroscopy provides correct positioning of the transacromial drill hole under direct visualization (Gille et al. 2013). As is the case in the classical technique, the necessity of a second operation for implant removal is one of the major problem of this technique.

The use of synthetic CC ligament reconstruction became popular in recent years. Most commonly used synthetic device is the Tight-Rope system (Arthrex, Naples, FL/USA). The system originally has been developed for stabilization of the tibiofibular syndesmosis. Hernegger and Kadletz (2006) first used the Tight-Rope system in the AC joint dislocations and opened the way for its use in such injuries. The system contains two titanium buttons and a no. 5 fiberwire suture (Arthrex) that connects the buttons. The Tight-Rope system is threaded through the 4 mm drill hole in the clavicle and coracoid process using a special guiding device. After the endobutton has been flipped under coracoid, the system is tightened in the proper alignment and secured with 3–4 knots onto the clavicle. In the Tight-Rope system, the CC ligaments are not repaired; system acts as a guide for the healing ligaments. Also the AC and CC ligaments remnants are brought into contact by restoration of the AC joint, and this situation will facilitate healing (Loriaut et al. 2015; Venjakob et al. 2013). Although the system was initially performed with open surgery, the number of the arthroscopic applications increased in the following years.

Hosseini et al. (2009) used Tight-Rope device combined with a coracoacromial ligament transposition in arthroscopic reconstruction of chronic AC joint dislocations. In another study, ten patients treated with Tight-Rope technique for acute AC joint dislocations were evaluated (Gomez Vieira et al. 2015). Authors used UCLA scale as evaluation method and found good and excellent results after an average 15-month follow-up. Four patients had residual pain at the level of AC joint. El Sallakh (2012) reported clinical results of the ten patients with type IV and V AC joint injury treated arthroscopically with the Tight-Rope technique. Author reported one failure of fixation because of technical error, except that no complication was encountered, and all patients were happy with the outcome of the surgery (El Sallakh 2012). Although good clinical and functional outcomes were reported with the use of single Tight-Rope, failure of fixation and loss of reduction have been matters of concern. Defoort and Verborgt (2010) reported 5 residual subluxations in 16 patients treated with single Tight-Rope. Lim et al. (2007), Thiel et al. (2011), and Flinkkila and Ihanainen (2014) reported fixation failure rates 50%, 16.6%, and 16%, respectively. Flinkkila and Ihanainen (2014) argued that the cause of the early and late failures was the suture breakage as the sutures fail easily in cyclic loading. Chaudhary et al. (2015) reported two partial loss of reduction in their series. The authors focus on two views as the reason of loss of reduction. One of the reasons is osteolysis caused by anteroposterior instability of the joint that is not provided by single Tight-Rope, and the other is healing problems of the CC ligaments. If healing does not occur, partial or total loss of reduction may occur (Chaudhary et al. 2015). According to Patzer et al. (2013), the reasons for fixation failure are mainly mechanical. The biomechanics of the CC ligaments cannot be reproduced by only one suspension device, and the fixation is not strong enough to retain the reduction. The frequent recurrences of the postoperative subluxations/dislocations of the AC joint prompted new searches. The importance of the anatomic reconstruction of CC ligaments was elucidated over time, and the use of anatomically placed two Tight-Rope systems became popular.

In their biomechanical study, Walz et al. (2008) compared the cyclic loading and load to failure between anatomic reconstruction with double-bundle Tight-Rope and native CC ligaments in cadaver. The mean vertical and anterior forces measured in static load until failure was significantly greater in the Tight-Rope model. During cyclic loading, the Tight-Rope model had more repetitions until failure than the native ligaments. This study showed that two Tight-Rope systems used in anatomic reconstruction of the CC ligaments led to favorable in vitro results with forces equal to or greater than that of native CC ligaments (Walz et al. 2008). In another study, it is shown that no 5 fiberwire fails biomechanically at 485 N, which for the native CC ligaments is 589 N. So the tensile strength of two strands fiberwire is greater than that of the native CC ligaments (Imhoff and Chernchujit 2004). Ladermann et al. (2013) reported in vitro biomechanical study comparing three techniques used in the treatment of AC joint dislocations. According to this study, double-bundle Tight-Rope reconstruction restricted motion in superior direction more than the native ligaments. As the clavicle was fixed at two points by the two bundle reconstruction, anteroposterior stiffness could also be achieved.

Venjakob et al. (2013) reported satisfactory clinical results with arthroscopic anatomic reduction using two-bundle system after 58-month follow-up. This study included cases that were radiographically over- and undercorrected; however no significant difference was detected in clinical outcomes and patients' satisfaction when compared to patients with normal radiographs. Patzer et al. (2013) described lower coracoclavicular distances in their double Tight-Rope group compared to single Tight-Rope group without significance difference in scores. Scheibel et al. (2011) reported on their 2-year results of 28 patients treated arthroscopically with double Tight-Rope technique. Although partial recurrent anteroposterior and superoinferior instability was present in their study, high satisfaction rates and good clinical results were reported. In another study, favorable clinical results were reported with the use of arthroscopically assisted double Tight-Rope technique. However a posterior instability was detected in 53.3% of the patients on the radiographs (Gerhardt et al. 2013).

Good clinical and functional outcomes were reported in most studies with anatomic reconstruction of CC ligaments using two Tight-Rope systems. However, residual horizontal instability seen in this system can adversely affect the clinical result. This situation has led surgeons to more anatomic reconstructions in recent years. Saier et al. (2015) compared isolated anatomic CC ligaments reconstructions using two Tight-Rope systems to additional AC joint stabilization with suture tape cerclage in their biomechanical study. Significantly increased horizontal stability was found in combined AC joint and CC stabilization group. The authors concluded that physiologic horizontal stability of the AC joint could be achieved by AC and CC reconstructions (Saier et al. 2015). In a clinical study, Barth et al. (2015) found significant correlation between the anatomical outcome and functional outcome. They concluded that no matter which implant is used, only CC stabilization is not sufficient, and anatomic reduction and stabilization in both horizontal and vertical planes are essential to achieve good functional outcome. Tauber et al. (2016) compared triple-bundle (reconstruction of the AC and CC ligaments using autologous semitendinosus tendon graft) and single-bundle reconstructions. Superior clinical and radiological results had been obtained, and horizontal stability had been better restored with arthroscopically assisted anatomic triple-bundle reconstruction. Cutbush and Hirpara (2015) described an all arthroscopic technique in AC and CC ligament reconstruction. They reconstructed the CC ligaments using a single Tight-Rope system, and they used two Healix Advance Knotless anchors (Depuy) making an eight-stranded suture bridge between the clavicle and acromion to reconstruct AC ligaments. The authors' expectation is that this reconstruction technique increases the strength and therefore decreases the failure rate. Braun et al. (2015) reported pearls and pitfalls of their surgical technique they apply to arthroscopically AC and CC stabilization.

De Beer et al. (2017) described a new technique for arthroscopically assisted stabilization of AC joint and reported early clinical and radiographic results of six patients with a mean 7.4-month follow-up. This technique was designed to restore both horizontal and vertical instability. For this purpose, 20 mm open-weave polyester tape (Poly-Tape; Neoligaments, Leeds, UK) and 2 mm ultra-high-weight polyethylene-polyester tape (FiberTape; Arthrex, Naples, Florida) have been used. Stiffness of the repair is provided by the FiberTape and Poly-Tape that acts as a scaffold for fibrous ingrowth and prevents cut out through the bones. Early results of this technique were favorable (De Beer et al. 2017).

8.7.2 Arthroscopic Technique

An arthroscopic coracoclavicular fixation can be achieved with a simple arthroscopic technique without needing any sophisticated surgical instruments, but it should be emphasized that this will only stabilize the vertical instability, for the horizontal instability, acromioclavicular stabilization by using any of the available methods (open oto-allograft fixation of acromioclavicular joint) should be used, though arthroscopic acromioclavicular fixation methods are also evolving.

Our technique to stabilize coracoclavicular instability consists of two steps: First, after posterior portal is opened and scope is inserted into the joint, we open the anterior portal just lateral to coracoid by checking with a spinal needle (Fig. 8.3), then evaluate the shoulder joint in a regular manner, and fix any of the lesions encoun-

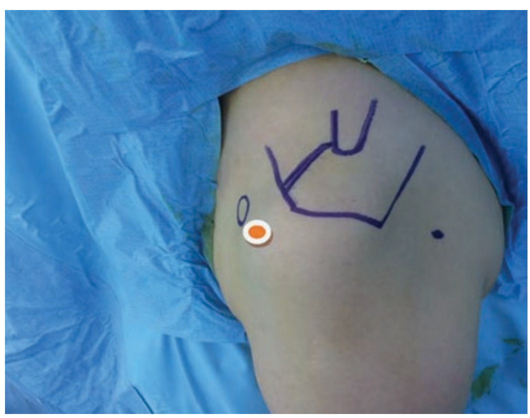

Fig. 8.3 Anterior portal is opened just lateral to coracoid tip

tered (superior labrum, biceps, cartilage, rotator cuff, etc.). Second, while viewing from the posterior portal, we open the joint capsule moderately between subscapularis and biceps tendons (interval) from anterior portal by using RF probe (Fig. 8.4), after this, coracoid is seen 1–1.5 cm superior to the subscapularis tendon's upper edge, and soft tissue of its posterior and inferior surface is cleared off (Fig. 8.5). A 30 degree scope is routinely used, but if the angle of view is not satisfactory, there are two options to get a wider and better view: using a 70 ° scope from posterior viewing portal or opening an extra portal anteriorly (Fig. 8.6), for viewing purpose. After the coracoid is clearly visible posteriorly from tip to base, an ACL (anterior cruciate ligament) guide is placed undersurface of its base and on the clavicle, 3–3.5 cm away from AC joint (Fig. 8.7). A small skin incision parallel to the bone is made and guide pin drilled through the middle of the clavicle to undersurface of coracoid, aiming to center of its base. In this step, viewing from posterior portal is crucial to watch

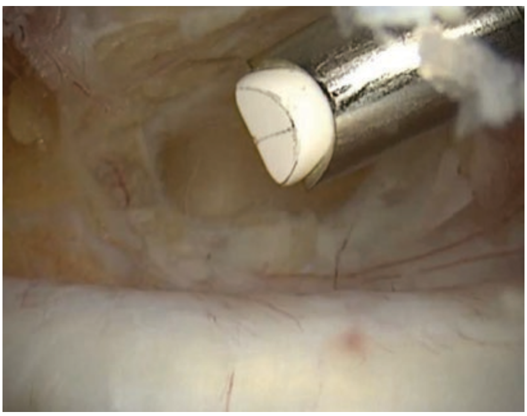

Fig. 8.4 Anterior capsule is opened just above the subscapularis tendon by using RF probe

Fig. 8.5 Soft tissue on the posterior and inferior surface of the coracoid is cleared off

Fig. 8.6 Accessory anterior portal is opened by checking with a needle

Fig. 8.7 An ACL guide is inserted from anterior portal and placed on the clavicle 3–3.5 cm away from AC joint

guide pin exiting undersurface of coracoid. After this step, a cannulated drill is used to over drilling the tunnels to 4.5 mm. Then, an adjustable loop two-button fixation system (there are many on the market) with heavy nonabsorbable four-strand sutures is pushed from the clavicular tunnel until it exits under surface of the coracoid while viewing from the posterior portal. After button exists, it is flipped under coracoid, and sutures are gently tightened by pulling ends coming from the clavicular button (Fig. 8.8). At this step, checking the reduction of AC joint with C-arm is crucial not to under or over-reduce (Fig. 8.9). If the reduction is satisfactory, we then cut the sutures, or only one security knot is tied, because these fixation systems can be locked without knot tying. After the coracoclavicular vertical stability is achieved, then we evaluate the horizontal stability by moving the clavicle in anteroposterior direction. If it is unstable, we add an acromioclavicular fixation by using any of the methods available.

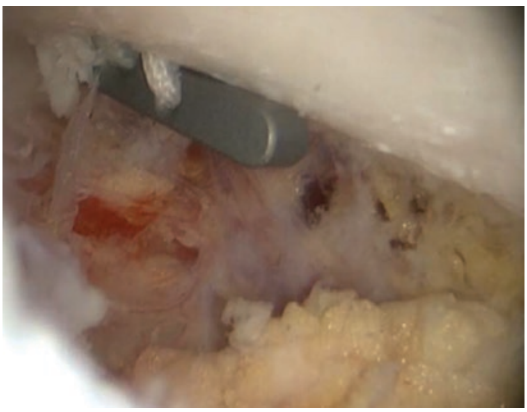

Fig. 8.8 Button is flipped under the coracoid and placed parallel to undersurface

8.8 Complications

Shoulder pain, fractures, loss of reduction, infection, and CC calcification are most commonly documented complications following arthroscopically assisted treatment of AC joint injuries.

Fracture of the coracoid or clavicle is one of the major problems of arthroscopic AC joint reconstructions using bone tunnel drilling techniques. Fractures often occur perioperatively and are caused by technical errors such as incorrect tunnel position or multiple passes of the drill during the implant positioning (Glanzmann et al. 2013; Kany et al. 2012; Martetschlager et al. 2013; Milewski et al. 2012; Scheibel et al. 2011). Coracoid fractures were also reported postoperatively in coracoid loop technique (Tomlinson et al. 2008). Accurate placement of bony tunnels through the center of the bone on a single pass and maximizing the distance between other tunnels and the terminal bone end play a vital role in preventing this complication. Also, the tunnels should not be drilled more than 5 mm in diameter.

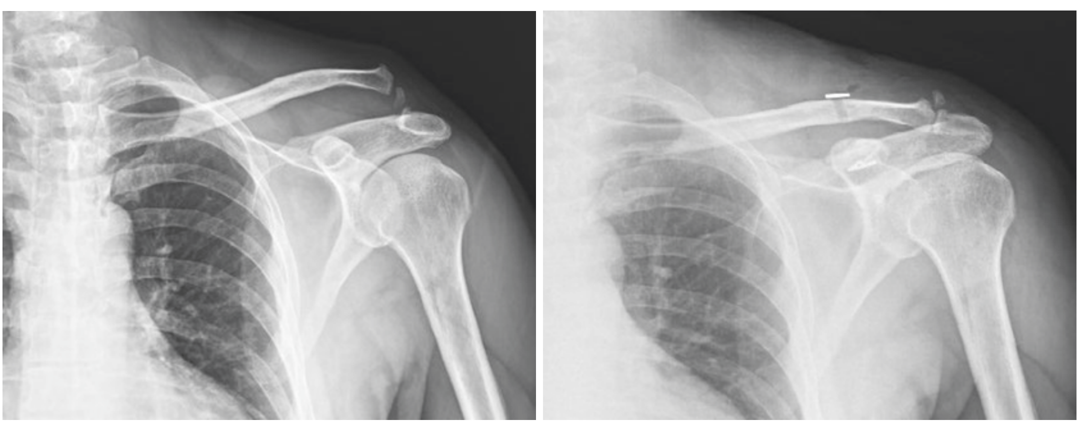

Fig. 8.9 Anatomic reduction is achieved by checking with C-arm

Fig. 8.10 Loss of reduction due to technical error

Loss of reduction is another important complication seen in arthroscopic techniques (Fig. 8.10). High failure rates were observed especially in arthroscopic autograft or allograft ligament reconstruction techniques (Cook et al. 2012; Milewski et al. 2012). Tight-Rope system can be more safer, but this system has a specific complication. Hardware migration into the coracoid, the clavicle, or both was commonly reported with Tight-Rope systems (Scheibel et al. 2011; Vascellari et al. 2015). Hardware migration can be one of the causes of loss of reduction, as well as weakening of the bone and associated stress fractures or fractures after a secondary trauma. For this reason, second-generation TR systems were developed with its round, larger clavicular button that provides better load distribution in the clavicle upper cortex.

Infection rates are lower in arthroscopic techniques than open procedures. Infections reported after arthroscopic procedures were more superficial rather than deep infections (Woodmass et al. 2015). Postoperative shoulder pain can sometimes be an annoying complication and is commonly caused by hardware irritation. Most studies reporting hardware irritation have used the Tight-Rope systems, and the patients usually complained over the superior clavicle fixation site (Cohen et al. 2011; Glanzmann et al. 2013; Salzmann et al. 2010; Scheibel et al. 2011). Clavert et al. (2015) reported this complication up to 46% of cases. Menge et al. (2017) reported an arthroscopic AC joint reconstruction technique using knotless CC fixation device (Knotless AC Tight-Rope device; Arthrex) to overcome this complication. The device is secured by a self-locking mechanism, so there are no knots that cause irritation over the clavicle.

8.9 Conclusion

Recently, many arthroscopically assisted techniques have been described in the treatment of AC joint dislocations. Anatomic reduction and both AC joint and CC stabilization are essential to restore horizontal and vertical instability and achieve good functional outcome. Preliminary results of these studies are encouraging. However, more accurate decisions about the success of these techniques can be made in the following years by obtaining midterm and long-term results.

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