Injuries of the acromioclavicular joint

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Abstract

Injuries to the acromioclavicular joint are extremely common, representing a significant proportion of all injuries around the shoulder girdle. The goal of treatment of these injuries is the return of pain-free function and strength to the shoulder girdle, and has traditionally been guided by appropriate injury classification according to the Rockwood classification. Consensus traditionally holds that low-grade injuries are best treated by conservative means, with high-grade injuries requiring surgical intervention. The treatment of mid-grade injuries however has long been the topic of much debate.

Likewise, though hundreds of procedures for the repair and reconstruction of acromioclavicular injuries have been described in the literature, no one technique has been identified as optimal treatment for these injuries. This review aims to provide a review of the current debate and best evidence around this topic, in order to guide the reader as to what might be considered as current best evidence-based practice.

Keywords acromioclavicular dislocation; acromioclavicular injury; acromioclavicular joint; acromioclavicular separation

Introduction

As the most mobile joint in the human body, the shoulder is particularly prone to injury, reliant as it is on a combination of bony stability provided via the clavicle, and soft tissue stabilizers providing support between the scapula and thorax, as well as between the bony structures that make up the shoulder girdle. The full range of shoulder motion represents a compound movement of the glenohumeral joint, in combination with the scapula, which is still to be fully understood, however a significant proportion of this involves movement of the mobile scapula around the strut-like clavicle, with the acromioclavicular (AC) joint acting as a pivot. As such, whilst the clavicle is the most common site of fracture around the shoulder, and indeed the human skeleton, the AC joint is also very commonly involved in injuries to the shoulder girdle.[1,2]

The majority of these are seen to occur in the young and athletic population, with slightly under half of all AC joint injuries occurring in patients in their 20s, the vast majority of

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which occur in males, and often those involved in contact sports such as rugby and hockey. In these populations, AC joint injuries account for up to half of all shoulder injuries.[2,3]

Traditionally there has been a clear body of opinion around conservative treatment of low-grade injuries, and operative management of high-grade, however there continues to be controversy and divided consensus regarding the optimal management of middle-grade injuries. As biomechanical understanding of these injuries, as well as surgical techniques for their treatment, improve and expand, this debate continues.

Surgical anatomy

The AC joint is a synovial joint, stabilized by a fibrous capsule and anterior, superior, posterior and inferior ligaments. It contains an intra-articular fibrocartilaginous disc which, functionally, is thought to provide little directly to the function of the AC joint but has been shown to undergo significant degeneration with age, particularly in the two decades up to the age of 40, suggesting at least that it bears some load during functional motion of the AC joint, particularly under loading of the upper limb.[4,5] In addition to these structures, the AC joint is stabilized by a number of static stabilizers, including the coraco-clavicular (CC) ligaments (the conoid and the trapezoid) and the coraco-acromial ligaments, and dynamic stabilizers including the deltoid, trapezius and serratus anterior muscles.[2,4]

The primary motion occurring at the AC joint appears to be rotational, with complex contributions of antero-posterior (AP) and vertical translation. The primary restraints to AP motion have been found to be the AC joint capsule and ligaments, with 56% of resistance to posterior translation provided by the superior ligament, and 25% by the posterior ligament.[6] The CC ligaments provide the primary restraint to superior translation of the AC joint, holding the CC distance at a range found to be between 1.1 and 1.3 cm.[7] The trapezoid originates from the lateral base of the corocoid, with the centre of its insertion into the inferior clavicle approximately 26 mm from the AC joint, and the conoid originating slightly more medial and anteriorly and inserting 35 mm from the AC joint.[8,9]

Studies into the biomechanics of the AC joint have long held that both the AC and CC ligaments play vital roles in stabilizing the joint and allowing pain-free function of the shoulder girdle.[2]

Radiographic assessment

Radiological diagnosis of an AC joint injury may usually be made satisfactorily on a standard two-view; AP and axillary, series of shoulder plain films. This allows for assessment of superior displacement of the dorsal surface of the distal clavicle relative to the acromion (although it is important to recall that it is in fact the scapular displacing inferiorly, rather than the clavicle superiorly) as well as the CC distance, and of any posterior translation of the distal clavicle, relative to the anterior acromion and the central axis of the glenoid.[10,11] Zanca views use cranial tilt of the X-ray beam to better visualize the AC joint in the coronal plane, weighted views may allow better appreciation of the anatomical structures involved and so injury type, and cross-body (adducted) views may demonstrate dynamic instability, with posterior or superior overriding of the distal clavicle on the acromion. For

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proper classification of AC joint injuries contralateral views, of the uninjured shoulder, are necessary.

Classification

Classification of AC joint injuries is based on the amount and direction of displacement occurring following an injury. Tossy et al. first classified AC joint injuries into types I, II and III in 1963, into which Rockwood et al. added types IV, V and VI in 1984 and which is still the most widely used and accepted system for the classification of these injuries.[12,13] This classification system is based on AP radiographs, used to assess the extent of superior displacement of the AC joint, with reference to the contralateral side (Figure 1).

Type I: Injury to the AC ligaments without complete rupture. This is essentially a sprain of the AC ligaments and presents as pain and tenderness without significant deformity and with normal radiographs.

Type II: Complete disruption of the AC ligaments with some, incomplete, injury to the CC ligaments. The disruption of the AC ligaments results in some AP instability of the AC joint, and often slight superior displacement of the distal clavicle relative to the acromion on radiographs.

Type III: Complete rupture of both the AC and CC ligaments. This potentially results in vertical and horizontal instability of the AC joint, with clear clinical deformity at the distal clavicle

and 100% displacement of the distal clavicle superior to the acromion.

Type IV: Rupture of both the AC and CC ligaments from posterior displacement of the distal clavicle during injury, often resulting in the distal clavicle being driven through the trapezius muscle posteriorly. Radiologically this may not present with gross vertical displacement of the AC joint, but clinical examination should demonstrate a clearly posteriorly displaced distal clavicle, and oblique radiographs will confirm the diagnosis.

Type V: Rupture of the AC and CC ligaments with partial detachment of deltoid and trapezius attachments to the distal clavicle, resulting in significantly increased CC displacement as compared to type III, often with buttonholing of the distal clavicle through the deltotrapezial fascia to sit subcutaneously (Figure 2).

Type VI: Inferior displacement of the clavicle, with likely rupture to the AC and CC ligaments, the deltoid and trapezius insertions. The distal clavicle sits below the acromion or the coracoid. This is a high-energy injury and gives significant concern for concomitant neurovascular injury.

Although the most widely used and accepted classification system for AC joint injuries, the Rockwood classification is not without its pitfalls. Much of the controversy around surgical versus conservative treatment of AC injuries centres on type III injuries, where patients with these injuries are found to have an
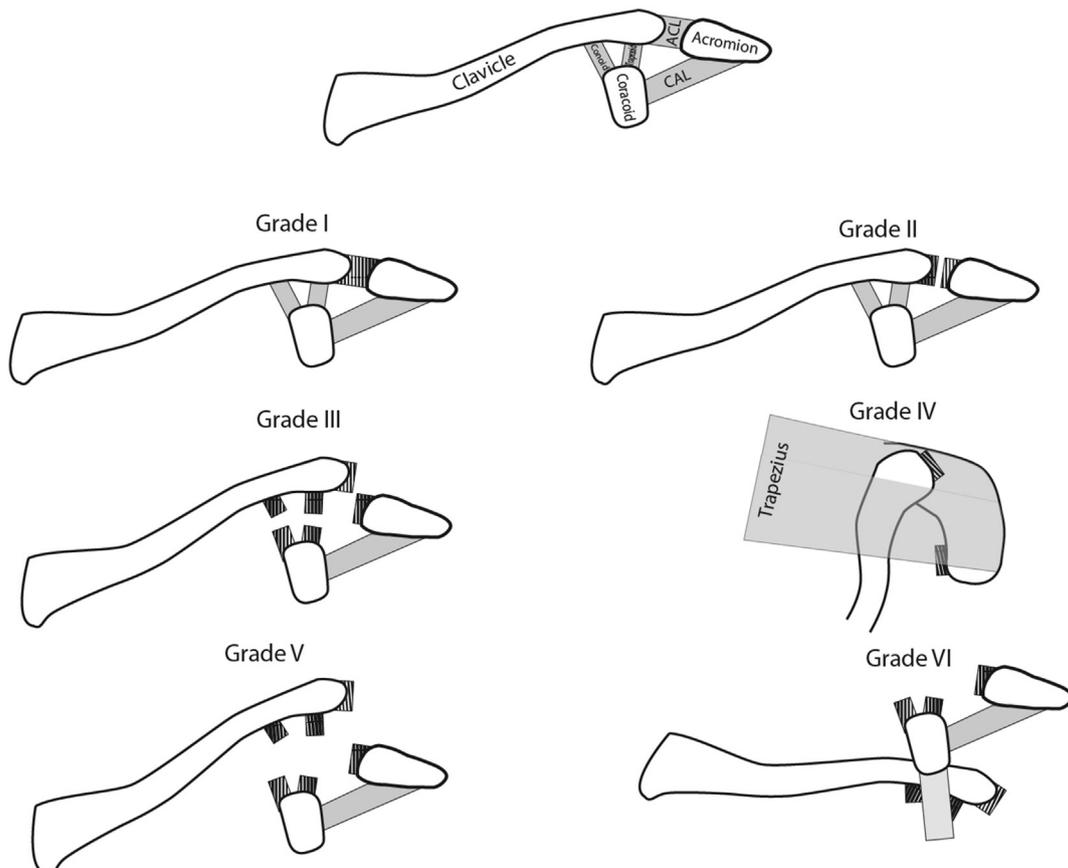

Figure 1 The Rockwood classification of acromioclavicular joint disruption.
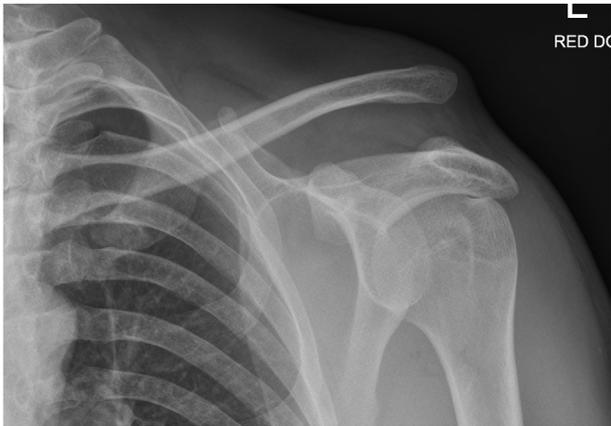
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Figure 2 Antero-posterior radiograph demonstrating a Rockwood grade V injury.

inconsistent response to either treatment path. It has been suggested that a contributing factor to this may be that type III injuries include both stable and unstable injuries, and there have previously been calls for subdivision of this injury type into IIIa, representing stable injuries, suggesting that the patient may do well with conservative management, and IIIb, unstable injuries likely to result in symptomatic AC instability, pain and dyskinesia if not stabilized surgically.[14]

Conservative management

Consensus traditionally recommends conservative management for type I and II injuries of the AC joint and, as such, there is little in the published literature to support or refute this approach, or examining outcomes. If delayed surgical intervention is considered as the marker of failure of conservative treatment, one cohort study by Pallis et al., in a military academy population with AC injuries, observed that 4% of type I and II AC injuries went on to have a surgical procedure for ongoing sypmtoms following conservative treatment.[15] In terms of functional outcomes, several studies have reported that around half of patients who sustained type I or II injuries, still describe at least occasional AC joint symptoms, even at 10 years' follow-up, with associated lower mean functional outcome scores on the injured side.[16,17] These outcomes seem likely to reflect the significant impact of these injuries on shoulder girdle function despite return of gross AC joint stability, and conservative management remains the mainstay of treatment for low-grade AC joint injuries.

Treatment of type III AC injuries has been, and remains, the topic of much debate in the literature and in meetings internationally. In the recent past conservative management was generally adopted in management of acute type III injuries, with historic studies having demonstrated that non-operative management resulted in fewer complications and faster return to work.[18–20] These studies, however, were largely performed in the 1980s and 1990s and compared conservative management with techniques such as acromioclavicular k-wire fixation and CC screw fixation, which have since been superseded by more modern techniques.

More recent studies do also appear to draw similar conclusions, however, including a large multicentre randomized control trial in Canada reported by Mah et al., which observed that operative treatment with clavicular hook plate for type III, IV and V AC injuries conferred no difference in patient-reported outcomes and quality of life as compared to conservative management.[21–23] Likewise, a 2015 study by De Carli et al., though demonstrating objectively better outcomes radiologically and on some scoring systems with use of a CC suspensory reconstructions system over conservative management, reported that patient-reported functional outcomes were not significantly different.[24] Concerns therefore remain regarding drawing firm conclusions from the existing literature about the superiority of non-operative treatment over surgical intervention, due to both the absence of robust studies comparing conservative measures to more modern anatomic AC joint stabilization techniques, suggested broadly to have superior outcomes to those resulting from hook plate use, but also due to the heterogeneous nature of type III injuries, as previously discussed, with 'unstable' type III injuries anecdotally suggested to be at higher risk of remaining symptomatic and failing conservative management, than 'stable' type III injuries.[25] Furthermore, biomechanical kinematic studies have more recently identified that chronic type III injuries are associated with poor shoulder kinematics and reduced function due to loss of AC stability, which possibly accounts for the high rates of surgical intervention still reported in longitudinal studies of these injuries, such as that of Pallis et al., where almost 70% of type III injuries in an athletic military population ultimately underwent stabilization.[15,26]

Treatment for type III injuries, therefore, on the basis of the current literature, remains controversial. Despite prior studies suggesting the contrary, some more recent studies, however, including that of Petri et al. in 2016, observed that even in cases of type III injuries who ultimately fail conservative management and opt for delayed surgical intervention, good functional outcomes may be expected, and so it may be considered reasonable to treat type III AC injuries conservatively as a first line, falling back on surgical intervention for those who have on-going functional impairment and instability.[27]

Type IV AC injuries are generally considered to require surgical management, due largely to their inherently unstable nature, particularly in cross-body adduction, causing functional difficulties, as well as by the often marked clinical deformity, with the distal clavicle lying subcutaneously in some cases. As a relatively rare entity, there are almost no studies which are able to adequately examine outcomes following management of type IV injuries, which are often lumped in with type III and V injuries as 'high grade', making subgroup analysis difficult.

Type V injuries are, again, generally unstable, by nature of the severity of ligamentous and muscular detachment involved, and consensus holds that these should generally be treated operatively. Few studies have directly examined the outcomes of conservative management of type V injuries specifically, again, often lumping them in as 'high-grade' injuries, but in a retrospective cohort, Dunphy et al. identified that at 34 months post-injury, and following at least 6 months of physiotherapy, 77% of their cohort were in work (100% of those who were in work at the time of their injury), and 41% in manual jobs, although almost all had reduced functional outcome scores on the injured side.[28]

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Though an extremely rare entity, there is little debate that type VI injuries require surgical intervention of some kind, both by the nature of the severity of the injury and the inevitable resulting instability, but also due to concerns about concomitant neurovascular injury or compression from the inferiorly displaced clavicle.

Complications of conservative management

The major complication of conservative treatment of AC joint injuries is failure of non-operative management, with on-going instability and shoulder girdle dysfunction, leading to delayed surgical reconstruction. Likewise, prolonged immobilization may raise concerns regarding development of adhesive capsulitis.

Operative management

Hundreds of surgical techniques have been described in the literature over the course of the past 100 years, indicating perhaps a singular failure to determine a single optimally effective method, however they may all be broadly classified as either AC repairs or ligament reconstructions, CC repairs or ligament reconstructions, or a combination of both. Generally, basic principles would suggest that for acute injuries, addressed with early surgical intervention, temporary reduction of the torn AC and CC ligaments should allow these structures to heal and return AC joint stability. By contrast, more chronic injuries, either due to delayed presentation, or failure of conservative measures, are likely to have less, if any, healing potential of these torn ligaments, and so reconstruction, using biologically active or inductive grafts, is vital.

Acute repair

Historically, many techniques have been applied to the temporary reduction of the AC joint while the ruptured ligaments heal, with varying success. Some of the earliest techniques aimed to stabilize the AC joint alone, with Cooper using a wire loop around the joint as early as 1861, and k-wire fixation across the AC joint becoming a mainstay of treatment of these injuries subsequently. In 1972, Balser then described use of a hook plate, screwed in to the clavicle, with a hook under the acromion, to stabilize the AC joint, without the risk of breakage or migration posed by k-wires.[29] This implant does, however, necessitate removal prior to returning to full range of motion, to avoid excessive acromial osteolysis and potential cuff issues.[30] Repairs of the CC ligaments followed the early AC stabilization techniques, with Delbet describing passage of a suture under the coracoid, secured in bone tunnels in the clavicle in 1917.[19] Later, Bosworth described his eponymous technique of stabilization of the CC ligaments by use of a screw between the clavicle and the coracoid.[31] These early techniques are essentially replicated in some form by almost all modern surgical repairs performed around the AC joint, guided by advances in surgical technology and understanding of the biomechanics of the shoulder girdle.

The most popular techniques currently in use for acute repair of AC joint injuries, on a recent survey of shoulder surgeons in the UK, comprise CC suspensory devices, whether implanted open or arthroscopically, and hook plates.[32]

Reviewing the current literature, there are many published studies comparing these two approaches. In a retrospective cohort study, Gao et al. observed improved pain, range of motion and functional outcomes following treatment with a titanium multi-strand cable suspensory fixation device as compared to hook plate fixation, and a retrospective study by Natera-Cisneros et al. demonstrated improved postoperative quality of life measures when treating AC joint injuries with an arthroscopic suspensory device versus hook plating.[33,34] A meta-analysis of 36 largely retrospective studies, reported by Arirachakaran et al., found that while both techniques resulted in acceptable postoperative outcomes, use of suspensory devices resulted in improved functional outcomes and lower pain scores as compared to hook plates.[35,36] More recently, a prospective randomized study by Cai et al., comparing the Tight-Rope suspensory system (Arthrex, Naples, Florida, USA) with hook plate found no functional or radiological differences in outcome, although they did observe the shorter incision, lower blood loss and removed requirement for secondary surgery to remove the hook plate.[37] Despite this, a prospective randomized study by Muller et al., into return to sport in athletes following AC joint injuries treated with either a suspensory suture-button system or hook plating, observed significantly improved sports-specific outcomes in the suture-button group, who returned to pre-injury levels of performance, as compared to the hook plating group who remained significantly impaired at 2 years' follow-up.[38]

These studies would seem to suggest that modern techniques of minimally invasive CC ligament repair using suspensory systems are probably superior to the more traditional hook plating, however, in addition to this, several cadaveric, as well as clinical studies, appear to demonstrate that, biomechanically, both the CC and AC ligament deficiencies should be stabilized in the acute setting in order to restore normal shoulder kinematics and AC stability, and so allow anatomical ligament healing.[39–41] A large multicentre prospective study by the French Arthroscopic Society in 2015, reported by Barth et al., went as far as to suggest that CC stabilization alone is insufficient for the treatment of AC joint injuries, and that both AC and CC stabilization, in some form, should always be performed.[42]

In summarizing this review of the literature, it appears that broadly speaking there is support for the use of suspensory CC stabilization over hook plating, and that irrespective of the implant used to achieve this, direct AC stabilization should be considered as part of any surgery addressing AC joint instability.

Delayed reconstruction

Consensus holds that beyond 30 days post-injury, or indeed as short as only 10 in some reports, reconstructive surgical techniques should be employed in the treatment of AC joint injuries.[32,42] Cadenat is credited with first having used the coracoacromial ligament to reconstruct the CC ligaments with a biological graft in 1917, but it was Weaver and Dunn in 1972 who described combining this procedure of transfer of the acromial insertion of the coracoacromial ligament, to the lateral clavicle following resection of the distal end in the procedure that still bears their names.[19,43] For a long time this was the surgical treatment of choice for chronic AC joint instability, with modifications using subcoracoid sutures and suspensory ststems, as well as hook plates to augment this reconstruction.[44,45] In 2004,

however, Mazzocca described a technique for anatomic CC reconstruction, using tendon autograft looped under the coracoid and secured in two drill holes in the clavicle, to replicate the anatomical positions of the conoid and trapezoid ligaments, which appeared, biomechanically, to produce superior initial stability at the AC joint.[46,47] Since then many permutations of the anatomic technique have been derived, using differing biological and synthetic graft materials, and varying methods of implantation and fixation, but all with the aim of replicating the function of both the conoid and trapezoid ligaments. There are several studies comparing the Weaver Dunn procedure with anatomical techniques in the literature, which generally report both superior biomechanical and functional results with anatomic reconstruction, which also correlates with reported surgeon preference for use of these techniques for the reconstruction of chronic AC instability.[19,32,48–50] In order to avoid donor-site morbidity, synthetic grafts are increasingly being used for anatomic reconstruction, with some excellent reported outcomes, however Fauci et al. compared outcomes following synthetic versus auto-graft and observed improved functional outcome scores, at 1 and 4 years, with use of biological graft.[51–53]

As with acute repair, however, in order to restore shoulder girdle kinematics and function, stability at the AC joint must also be achieved, and so techniques have been described which additionally reconstruct the AC joint capsule and ligaments in addition to an anatomic CC reconstruction. Beitzel et al. describe use of a tendon autograft to recreate the insertion of the superior AC ligaments, with good radiological and clinical outcomes, with similar techniques also described with use of synthetic graft.[25,54,55] In both cases, having performed a traditional anatomic CC reconstruction, with cerclage of the coracoid and passage through the clavicle, remaining graft material is then passed over the AC joint and either secured to, or passed through drill holes in the acromion.[25]

Surgical complications

AC joint repair or reconstruction carries with it the attendant risk of complication associated with any surgical procedure as well as those specific to orthopaedic shoulder procedures including adhesive capsulitis, whether associated with prolonged immobilisation or not. In addition to these risks in common, loss of reduction, and thereafter, potential failure of surgical treatment with recurrent symptoms and reduced function is perhaps the most relevant. As discussed previously, the goal of modern surgical techniques and their further development is to reduce the incidence of this as an early or late complication, and certainly to improve upon the rates of over 50% recurrence of recurrent deformity reported for some techniques in the literature.[56,57] Additionally, techniques utilising bone tunnels in the clavicle and/or coracoid, have been associated with postoperative fractures of both of those structures calculated, in a systematic review by Woodmass et al., to occur in around 5% of cases utilising an arthroscopic techniques.[58] As a late complication, it has often been considered that an AC joint injury predisposes a patient to future risk of degenerative change and symptomatic AC arthritis, possibly as a result of altered biomechanics, however the few studies into whether some form of AC joint excision at the time of repair or reconstruction makes a difference to post-

operative outcome have failed to demonstrate a significant difference.[56,57] Given this, as well as the importance of the role of the AC joint capsule demonstrated in biomechanical and anatomical studies, distal clavicular excision at the time of repair or reconstruction surgery should probably be reserved for only those cases where this is required in order to achieve adequate AC reduction.[25,59]

Summary

To summarize this review of the current state-of-the-art management of ACJ injuries, the evidence would seem to broadly support the consensus that low-grade (I-II) injuries be treated conservatively, with initial rest, but early mobilization as pain allows. Equally, acute surgical repair, ideally within 10, but at least within 30 days of injury should be considered for grades IV-VI. For grade III injuries, though still the subject of much debate, the literature would seem to suggest that it is reasonable to treat conservatively initially, opting for delayed reconstruction for those who remain symptomatic following full rehabilitation. Based on some military studies, however, in young, high physical demand patients, acute surgical intervention may also be a reasonable consideration given the high (>70%) incidence of delayed surgical intervention, and so prolonged morbidity, in this population.

In considering surgical intervention, whether acute or delayed, it seems clear that whichever surgical technique is utilised stabilization of both the CC and AC ligaments should be addressed, and in the case of delayed reconstruction, with some form of biologically active, or inductive, graft. ◆

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