MR Imaging Appearances of Acromioclavicular Joint Dislocation[1]

CME FEATURE

See accompanying test at http://www.rsna.org/education/rg_cme.html

LEARNING OBJECTIVES FOR TEST 4

After reading this article and taking the test, the reader will be able to:

- Describe the normal anatomy of the ACJ and important stabilizers of this joint.
- Discuss the mechanisms of ACJ injuries and their classification.
- List the imaging findings of ACJ injuries with emphasis on the MR imaging features.

TEACHING POINTS

See last page

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The key structures involved in dislocation of the acromioclavicular joint (ACJ) are the joint itself and the strong accessory coracoclavicular ligament. ACJ dislocations are classified with the Rockwood system, which comprises six grades of injury. Treatment planning requires accurate grading of the ACJ disruption, but correct classification can be difficult with clinical assessment. Magnetic resonance (MR) imaging has a well-established role in evaluation of ACJ pain. MR imaging performed in the coronal oblique plane parallel to the distal clavicle allows assessment of the acromioclavicular and coracoclavicular ligaments owing to its in-plane orientation in relation to these structures. This technique enables distinction between grade 2 and grade 3 injuries, which can be difficult with conventional clinical and radiographic evaluation. In addition, diagnosis of grade 1 injuries is possible by demonstration of a ruptured superiodorsal acromioclavicular ligament. Resultant thickening of the acromioclavicular or coracoclavicular ligament allows identification of chronic ACJ injuries.

Abbreviations: ACJ = acromioclavicular joint, SE = spin-echo, STIR = short inversion time inversion-recovery

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Introduction

Sprain or disruption of the acromioclavicular joint (ACJ) accounts for approximately 12% of dislocations involving the shoulder and 10% of all shoulder injuries. This injury occurs five times more frequently in the male population, most commonly in the second decade of life (1). ACJ sprain or disruption occurs frequently in athletes playing contact sports such as rugby or American football and ice-based sports. Clinical assessment together with conventional radiography are used to assess instability. Classification is according to the well-established Rockwood system, which describes six grades of injury.

Grade 1 and 2 injuries are typically treated conservatively with a sling, ice, and a brief period of immobilization (usually 3–7 days). Grade 3–6 injuries result from double disruption of the superior shoulder suspensory complex, with some authors advocating surgical correction, depending on the severity of displacement (2). However, current reviews suggest that grade 4–6 injuries result in severe soft-tissue disruption, which can result in morbidity from persistent dislocation, and therefore generally require surgical repair (3). However, there is some evidence that even these injuries can be successfully treated by using closed reduction with a sling and harness (1,3).

For grade 3 injuries, treatment remains controversial despite evidence from randomized trials and meta-analyses demonstrating high rates of success with conservative management (4,5). Grade 3 injuries are treated on a case-by-case basis. In some cases surgery may be considered, including in those who fail conservative management, perform manual labor, are young or athletic, have scapulothoracic dysfunction, or are at high risk of reinjury due to an occupation or sport (in particular the throwing athlete) (1,3). When repair is considered, a number of surgical techniques can be used, and these include primary repair of the coracoclavicular ligaments, augmentation with autogenous tissue (coracoacromial ligament), augmentation with absorbable and nonabsorbable suture as well as prosthetic material, or coracoclavicular stabilization with metallic screws (3).

Teaching Point

Grade 2 and 3 lesions in particular may be difficult to distinguish with standard imaging protocols; in our practice, we use a nonstandard coronal magnetic resonance (MR) imaging technique to identify these cases (Fig 1).

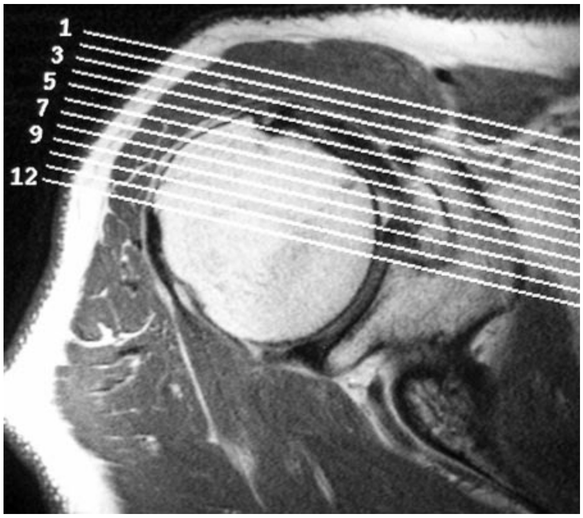


Figure 1. MR imaging technique. Axial T1-weighted spin-echo (SE) scout image (repetition time msec/echo time msec = 450/20) of a 26-year-old man shows the plane in which the coronal images are obtained: parallel to a line drawn from the coracoid process to the lesser tuberosity. Imaging is performed with the patient in the neutral position.

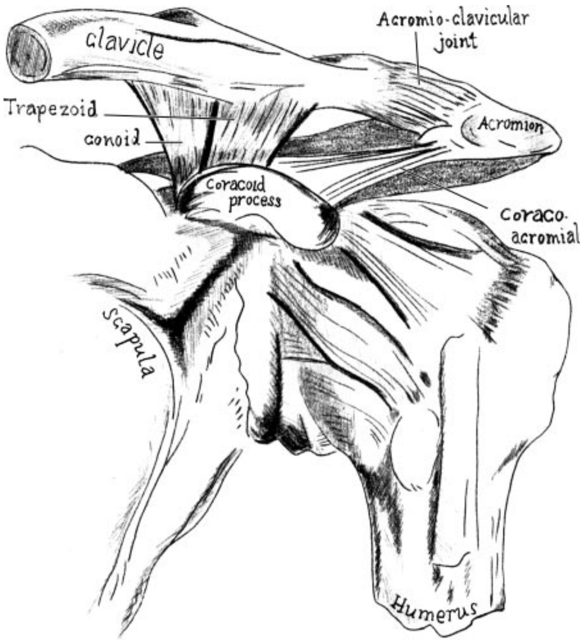
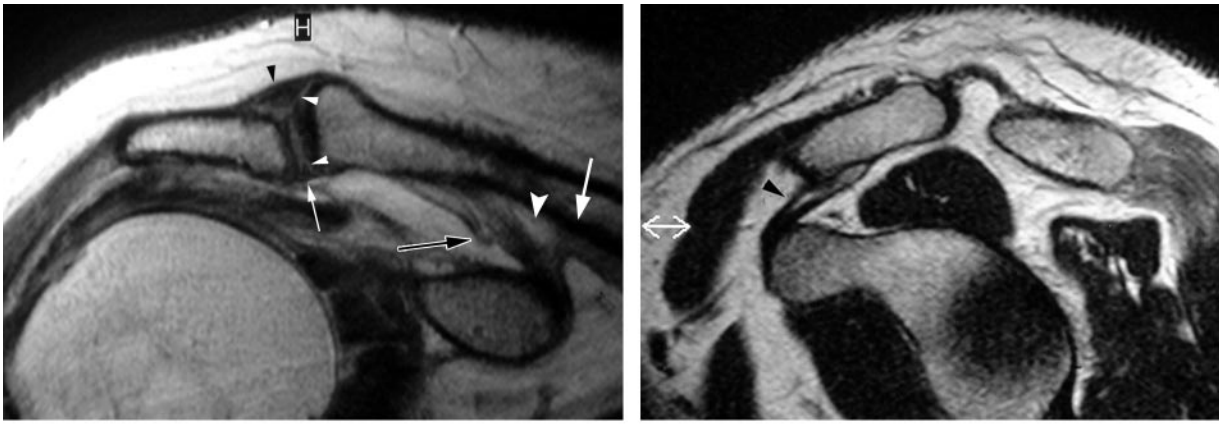


Figure 2. Normal anatomy of the ACJ. Drawing shows the superior and inferior acromioclavicular, coracoclavicular, and coracoacromial ligaments.

Treatment planning requires correct classification of ACJ disruption, which can be difficult clinically. Radiographic findings may be confounded by other factors. Widening of the ACJ may be seen with aging



a. b.

Figure 3. Normal anatomy of the ACJ at MR imaging. **(a)** Coronal proton-density–weighted image (3300/30) of a 27-year-old man shows the conoid (large white arrow) and trapezoid (black arrow) portions of the coracoclavicular ligament. Fat is seen between these ligaments (large white arrowhead). The superior (black arrowhead) and inferior (small white arrow) acromioclavicular ligaments and intraarticular disk (small white arrowheads) are also seen. The fibrocartilaginous intraarticular disk has the same signal intensity as the hyaline cartilage lining the joint. **(b)** Sagittal oblique proton-density–weighted image (3500/35) of a 35-year-old woman shows the conoid component of the coracoclavicular ligament (arrowhead).

and in certain disease processes (eg, posttraumatic osteolysis [6], rheumatoid arthritis, infection, and hyperparathyroidism). In addition, grade 3 injuries can be difficult to distinguish from grade 2 injuries on plain radiographs, even with weight bearing (7).

This article reviews the normal anatomy of the structures involved in ACJ dislocation: the ACJ and coracoclavicular ligaments. The mechanisms by which ACJ dislocation occurs are then described. The use of plain radiography as well as MR imaging and their limitations are discussed. Finally, the normal findings of the differing types of ACJ dislocation at plain radiography and MR imaging are presented with emphasis on the latter.

Anatomy

The ACJ is a plane synovial joint between the lateral surface of the clavicle and the medial surface of the acromion. Stabilization is by a combination of static reinforcement by ligaments (Fig 2) and dynamic reinforcement by muscles. In the majority of cases, the clavicular facet of the ACJ faces laterally and inferiorly and has a slightly rounded end, and the acromial shape and orientation are complementary. There is a wide variation in this angulation from near vertical to 50°, with a small proportion of clavicular facets facing superomedially. The superior surfaces of the ACJ may be incongruent (with the superior surface of the clavicle higher than the acromion) (1).

There is an intervening wedge-shaped fibrocartilaginous disk projecting into the joint from below the superior acromioclavicular ligament (Fig 3a) and above the inferior acromioclavicular ligament in nondegenerated joints (8).

The joint capsule is relatively weak but toughest at its superior-posterior aspect, where the trapezius muscle attaches. Superior and inferior acromioclavicular ligaments strengthen the joint capsule (Figs 2, 3a), thus reinforcing the joint at small degrees of distraction (9). In addition, there are weaker anterior and posterior ligaments that reinforce the joint. The deltoid muscle attaches anteriorly to the lateral border of the clavicle and acromion and together with the trapezius provides dynamic stabilization, particularly when ligamentous structures are damaged. The superior acromioclavicular ligament blends anteriorly and posteriorly with the aponeuroses of these muscles, respectively, and when present is in contact with the articular disk (10,11).

The strong accessory coracoclavicular ligament is the main stabilizer of the ACJ, particularly at large degrees of separation (9). It is the primary suspender of the scapula and therefore of the upper limb from the clavicle. The coracoclavicular ligament consists of two parts that form a Vshape: the conoid ligament medially and trapezoid ligament laterally (Figs 2, 3a, 3b); their names are reflective of their shapes (triangular and quadrilateral, respectively).

Teaching Point

They face posterosuperiorly (Fig 3b) and are continuous posteriorly but separated anteriorly by fat or a bursa.

The conoid ligament has an apical lower attachment from the angle made between the root and horizontal part of the coracoid and spirals upward almost vertically. It has a wide attachment at the inferior surface of the clavicle on the rounded conoid tubercle, which lies at the junction of the middle and outer thirds of the clavicle posteriorly (Figs 2, 3a, 3b). The conoid ligament blends medially for a short distance with the clavipectorial fascia (10). This is the main stabilizer in preventing superior and anterior displacement and rotation (11).

The lower attachment of the trapezoid ligament is anterolateral to the conoid ligament at the posterior part of the superior surface of the base of the coracoid process. It courses posterosuperolaterally to a wider attachment on the trapezoid line, which extends forward and laterally from the conoid tubercle to the lateral end of the clavicular undersurface (Figs 2, 3a). The attachments of the trapezoid components are more nearly horizontal than vertical (10). This is the main stabilizer in the posterior direction and limits rotation (9).

The coracoacromial ligament is a triangular ligament attached by a broad base from the lateral horizontal portion of the coracoid process and inserts on the tip of the acromion in front of the ACJ (Fig 2). Together with the acromion, it forms an arch protecting the humerus from superior subluxation (10). The ligament also serves as a dynamic brace for the acromion and coracoid process, with a greater stabilizing effect on the former (12).

Mechanisms of ACJ Dislocation

The ACJ has two main movements, a gliding movement at the articular end of the clavicle and rotation of the scapula forward and backward, which are limited by the trapezoid and conoid ligaments respectively. The predominantly inferomedial orientation of the ACJ predisposes the clavicle to ride up over the acromion. The most common mechanism is a direct blow to the acromion with the shoulder in the adducted position. The scapula is pushed inferoanteriorly relative to the clavicle with resulting sequential stretching or tearing of the acromioclavicular ligaments, coracoclavicular ligaments, and trapezius insertion (1). Edema in the muscles and soft tissue overlying the acromion may be seen.

Teaching Point

Less common mechanisms of injury result from indirect forces on the ACJ. A fall onto the outstretched hand can drive the humeral head superiorly into the acromion, disrupting the acromioclavicular ligaments but not the coracoclavicular ligaments. The coracoacromial ligament may be involved in this type of injury. Alternatively, a downward force on the upper limb can also impart an indirect force on the ACJ (1).

Other mechanisms of injury include whiplash shoulder injury after seat belt restraint of the clavicle during a road traffic accident, which can result in grade 1 or 2 injuries (13). Surgical removal of the ACJ more than 1 cm from the clavicular end may cause instability if the coracoclavicular ligament is resected (14).

Radiography of ACJ Dislocation

Plain radiographs should be performed in the anteroposterior direction at 10°–15° cephalic angulation. This allows projection of the clavicle off the spine of the scapula, permitting assessment of the inferior aspect of the joint and subtle fractures or loose bodies. In addition, the radiographs require lower exposure (½ to ⅓) compared to normal shoulder images due to the reduced width of bony and soft tissues and the more superficial location of the ACJ. Simultaneous or same technique comparison views with the other side are also advocated, allowing for variations in anatomy and degree of tilt of the primary beam (1,15). Coracoid fractures proximal to the origin of the coracoclavicular ligament can occur rarely with ACJ dislocation instead of tearing of the coracoclavicular ligaments. They should be suspected in patients with ACJ dislocation and normal or equal coracoclavicular distance on comparison views. The coracoid is best seen in profile with a Stryker notch view (1,15).

Identification of increased ACJ distance and coracoclavicular distance is indicative of ACJ dislocation. The normal width of the ACJ in the coronal plane is variable, usually between 1 and 3 mm (15), and this normally decreases with age. An ACJ width of greater than 7 mm in men and 6 mm in women is pathologic (1). An increase in the normal coracoclavicular distance (11–13 mm) by 50% is indicative of complete ACJ dislocation (1).

Comparison views may be useful in distinguishing between such normal variation and variation in ACJ shape and incongruity between the superior end of the clavicle and acromion. This can aid in diagnosis of low-grade injuries. Plain radiography with the patient in the erect position is a simple, inexpensive way to uncover subtle abnormalities, which need to be documented even though they do not require surgical treatment. This is almost certainly the best way to image such low-grade injuries in almost all cases.

Weight-bearing views have been suggested to distinguish between grade 2 and 3 injuries, although the evidence for this is controversial. One study found that these were of limited benefit, unmasking only a low percentage (4%) of higher-grade (grade 3) injuries, not enough to warrant use in all patients (7). Weight-bearing views have no additional advantage in identification of grade 4 and higher dislocations (1). Different methods have been employed for weight bearing; although in theory hand-held weights can activate the trapezius and reduce any dislocation, some studies have found no difference in the degree of distraction created by hand-held weights versus weights suspended from the wrist (16). Some have advocated comparison views with and without weight bearing for distinguishing between grade 2 and 3 injuries.

Lateral and axial views are of particular benefit in diagnosing posterior dislocation (grade 4), where the coracoclavicular and acromioclavicular distances may be normal (17).

MR Imaging of ACJ Dislocation

MR imaging has a well-established role in assessment of ACJ pain. It allows adequate assessment of the ligamentous attachments of the ACJ, and its results can change the clinical grading of dislocation (18–20). There is the added advantage of assessment of the ACJ for osteoarthritis, the distal clavicle for osteolysis, and the adjacent shoulder structures (6,21,22). Use of the coronal oblique plane parallel to the distal clavicle and ACJ has been shown to be reproducible and practical; this orientation purposefully displays the coracoclavicular ligaments in the same plane in which they tear. Schaefer et al (18) recently demonstrated that the ACJ and its ligaments are also shown adequately in this plane. Schaefer et al (18) and Antonio et al (19) also showed that T1-weighted imaging best demonstrates the coracoclavicular ligaments and that fat-suppressed proton-density–weighted or T2-weighted imaging best demonstrates the ligamentous disruption when surrounded by blood or fluid. These authors also described how the ligaments themselves are difficult to visualize with these sequences if not disrupted.

At our institution, patients undergo coronal MR imaging performed parallel to the anterior acromion, in a plane parallel to a line drawn from the coracoid process to the lesser tuberosity, with the patient in the neutral position. This best approximates the plane of the ACJ and the coracoclavicular ligaments. Our imaging parameters are as follows: field of view = 145 × 145 mm to 150 × 150 mm, matrix size = 353 × 512 or 256 × 512, and 3.5-mm section thickness. Proton-density–weighted fast SE imaging (3000–3600/30–36) is performed by using a 1.5-T imaging unit in the described plane. This sequence is supplemented with sagittal and axial proton-density–weighted imaging, and injuries are graded according to the Rockwood classification.

Limitations of MR Imaging

Injuries of the ACJ are common and grade 3 injuries can account for up to 40% of injuries, hence adequate determination of the correct grade for treatment planning is essential. In a series of 13 cases, Schaefer et al (18) found that MR imaging results caused the clinical grade of some ACJ dislocations to be upgraded: 20% of grade 2 lesions and 50% of grade 1 dislocations. Similarly, other authors have found a lack of correlation between the clinical and radiographic findings and the MR imaging and pathologic findings (20). The debate as to the treatment of ACJ dislocation may reflect the greater spectrum of tears and sprain combinations than are described in the Rockwood system and the change in activity in the population.

There are few articles on MR imaging of ACJ dislocation. One study found visualization of the normal coracoclavicular ligaments difficult with fat-suppressed T2-weighted and proton-density–weighted imaging (18). This was similar to

Rockwood Classification of ACJ Dislocations

Grade of Injury	AC Ligaments	Joint Capsule	CC Ligaments	Trapezius and Deltoid Clavicular Attachments	Displacement of the Clavicle*	AC Distance	CC Distance
1	Partially torn superiodorsal ligament	Intact	Intact	Intact	None	Normal	Normal
2	Completely torn	Disrupted	Intact or sprained	Intact, minimally detached	50% superior	Widened	Slightly increased
3	Completely torn	Disrupted	Completely torn	Distal trapezius and deltoid may be torn	100% superior	Widened	Increased 25%–100%
4	Completely torn	Disrupted	Completely torn	Torn trapezius or buttonholed clavicle posteriorly	Posterior (with or without superior displacement)	Can be normal	Can be normal
5	Completely torn	Disrupted	Completely torn	Distal trapezius and deltoid torn	>100% superior	Widened	Increased 100%–300%
6	Completely torn (subacromial and subcoracoid)	Disrupted	Completely torn (subcoracoid type only)	Distal trapezius and deltoid torn	Inferior†	. . .	Negative

Note.—The injury grade depends on involvement of the dynamic and static stabilizers of the ACJ and the degree and direction of clavicular dislocation. AC = acromioclavicular, CC = coracoclavicular.
*Relative to the inferior border of the acromion.
†Below the acromion or behind the biceps and coracobrachialis tendons.

results of a previous review, which used the same sequences in the standard coronal oblique plane. These authors also suggested that contrast material could be used to delineate the location of soft-tissue injury (19). Similar to Schaefer et al (18), we have found adequate visualization of normal and injured coracoclavicular ligaments in the coronal oblique plane; however, we use proton-density–weighted fast SE imaging without fat suppression and without additional sequences in the same plane. We have also visualized disruptions of the acromioclavicular ligaments, thus distinguishing grade 1 dislocations. Other authors have found no specific features for this injury (18,19). The proton-density–weighted fast SE sequence allows visualization of the ligamentous structures. Fat suppression may make visualization of injuries to these structures difficult in the subacute or chronic phase, when soft-tissue and bone edema has subsided.

In patients with fractures or anterior or posterior dislocations of the clavicle, there may be problems in orienting the coronal imaging plane if the clavicle alone is used for alignment. Other limitations in our technique are lack of weight bearing and of comparison views, which can easily be obtained with erect radiography. These are particularly useful in determining subtle changes and normal variations in anatomy, as described earlier.

Imaging Work-up of ACJ Injury

In the majority of cases, comparison view plain radiography is easily accessible and cost-effective and together with clinical examination and history allows correct classification of ACJ injuries, particularly grades 1, 2, 4, 5, and 6. We have found MR imaging useful in a number of circumstances. Normal variations and age-related changes are commonplace, and MR imaging can be useful in distinguishing low-grade injury from

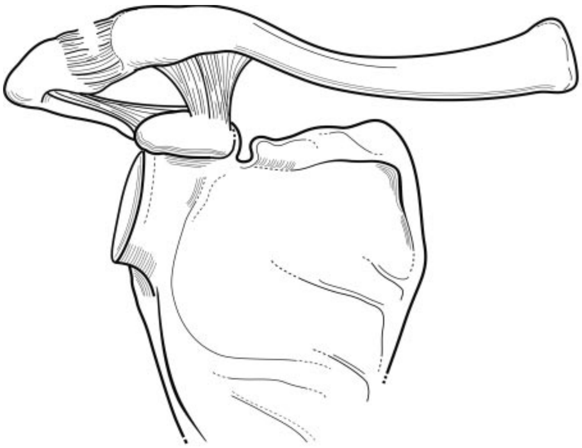


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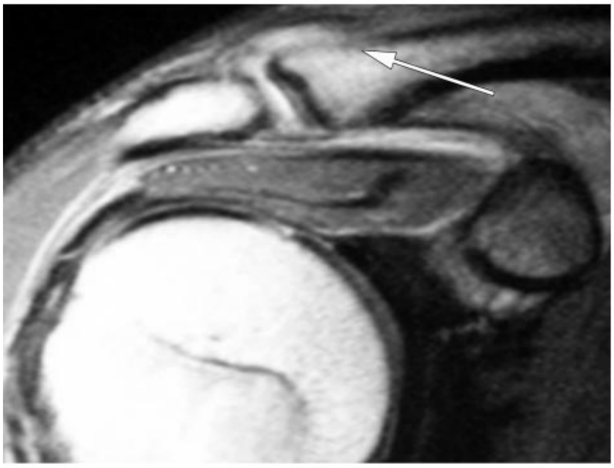
Figure 4. Grade 1 injury. **(a)** Diagram shows the feature of a grade 1 injury: an incomplete tear of the superior (dorsal) acromioclavicular ligament. **(b)** Proton-density–weighted image (3400/26) of a 26-year-old man shows a tear (arrow) of the clavicular side of the superior acromioclavicular ligament. The tear appears as high signal intensity, which is consistent with fluid or hemorrhage. The coracoclavicular and inferior acromioclavicular ligaments are intact. **(c)** Coronal short inversion time inversion-recovery (STIR) image (2300/25; inversion time, 150 msec) of a 25-year-old man shows edema and soft-tissue swelling in the adjacent ACJ. There is a tear of the superior acromioclavicular ligament (black arrow); the inferior ligament is intact (white arrow).



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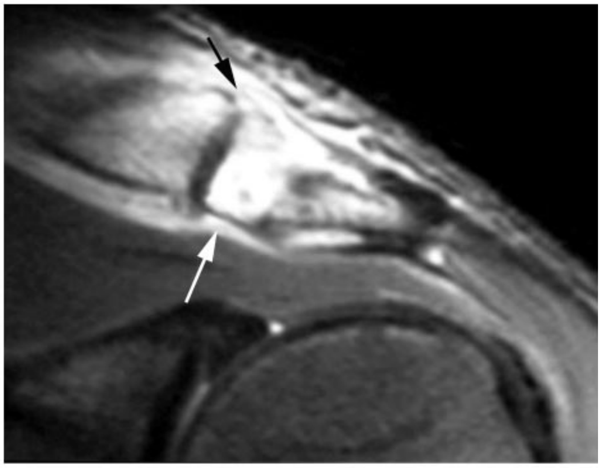

c.

a normal variation (1,19) when there is diagnostic uncertainty. When clinical and plain radiographic features are confounding (particularly in distinguishing between grade 2 and 3 injuries) or when there is limited clinician experience, again MR imaging is a useful aid. In particular, the relatively common grade 3 injuries can be difficult to evaluate with plain radiography, even when weighted (7,19), and we have found MR imaging assessment of the extent of soft-tissue injury invaluable in distinguishing these from grade 2 injuries (19). In cases where surgical repair is contemplated (due to an occupation, sport, instability, or deformity), the extent of soft-tissue injury can be used to make the decision to perform surgery and to help plan the procedure.

Imaging Findings

Teaching Point

The involved structures and imaging findings are summarized in the Table.

Grade 1 Injury

Grade 1 injuries result from a sprain of the acromioclavicular ligament only without a complete tear (Fig 4a). Radiographs may show mild swelling but are otherwise normal compared to the opposite side and with weight bearing. Authors have reported no specific MR imaging findings for this injury (18,19). A variety of signal intensity changes and joint appearances are present in the aging adult population, including joint hypertrophy, sclerosis, hypertrophy of the acromial end of the clavicle, and caudal dislocation (23). Our experience is that patients with clinical signs of grade 1 lesions have a tear of the superior ligaments only (Fig 4b). In the acute setting, there is edema, hemorrhage, or soft-tissue swelling in the bone marrow in these locations (Fig 4c).

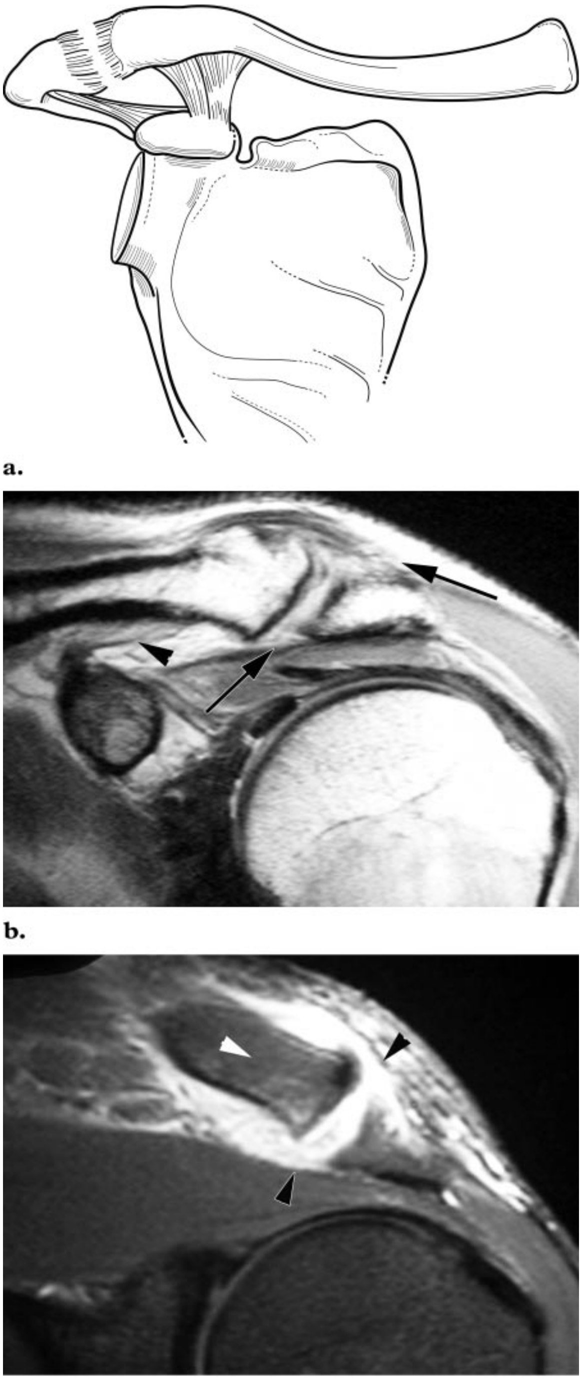

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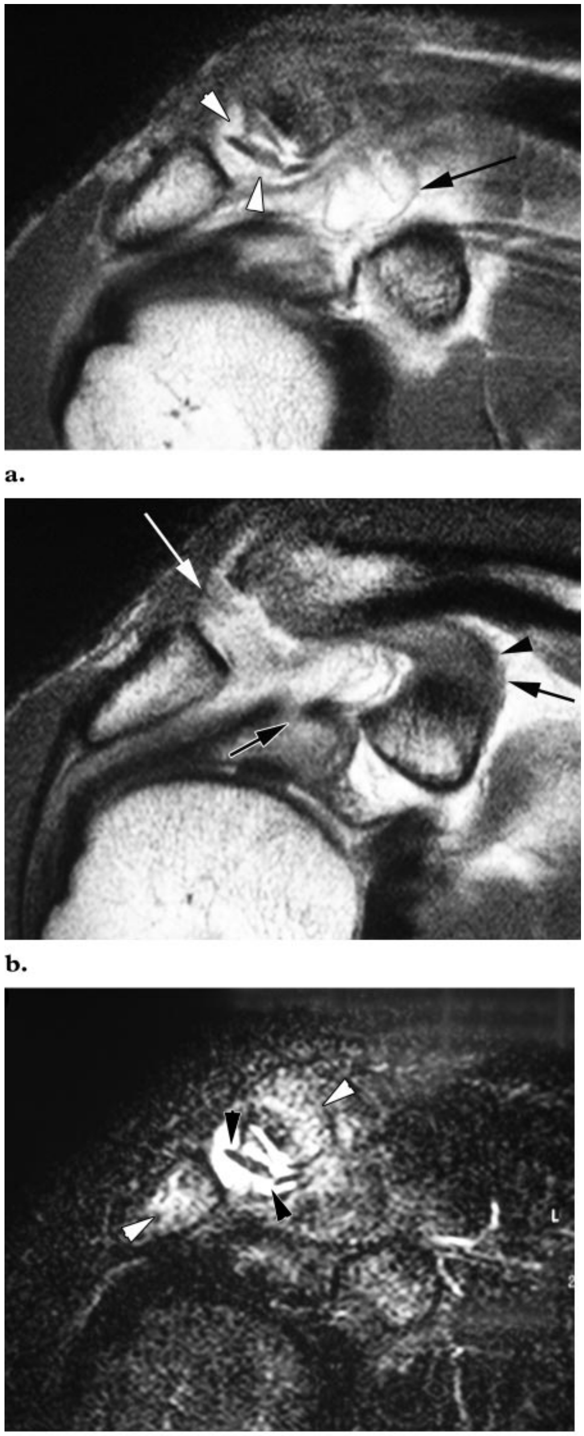
Figure 5. Grade 2 injury. **(a)** Diagram shows the features of a grade 2 injury: a complete tear of the acromioclavicular ligament and a sprain or partial tear of the coracoclavicular ligament. **(b)** Proton-density–weighted fast SE image (3600/36) of a 33-year-old man shows disruption of the superior and inferior acromioclavicular ligaments (arrows). The fibers of the trapezoid ligament are attenuated at the clavicular insertion (arrowhead), a finding consistent with a partial tear. **(c)** Coronal STIR image (2300/25; inversion time, 150 msec) of a 26-year-old woman shows a marrow contusion in the clavicular end of the ACJ (white arrowhead). There is fluid in the ACJ and edema in the soft tissues adjacent to the disrupted superior and inferior acromioclavicular ligaments (black arrowheads).



a.

b.

c.

Figure 6. Grade 2 injury involving the intraarticular disk in a 25-year-old man. **(a, b)** Sequential coronal proton-density–weighted fast SE images (3500/35) show disruption of the intraarticular disk (arrowheads in **a**). There is tearing of the superior acromioclavicular ligament (white arrow in **b**) and thickening and edema of the conoid component of the coracoclavicular ligament (arrowhead in **b**). Fluid is seen in the ACJ and the adjacent soft tissues (black arrows). The acromioclavicular distance is widened. **(c)** Coronal STIR image (2300/25; inversion time, 150 msec) shows high signal intensity around the clavicular and acromial portions of the disrupted intraarticular disk (black arrowheads) and around the ACJ (white arrowheads).

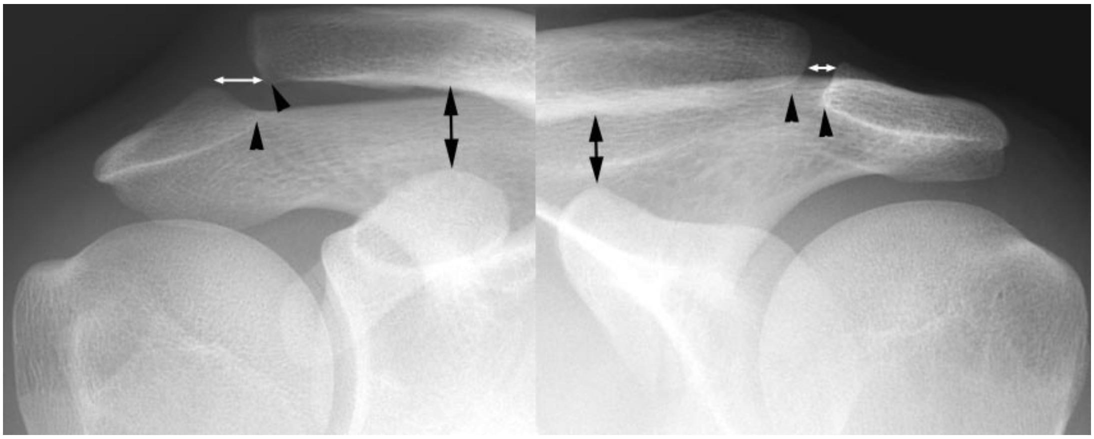


Figure 7. Grade 2 injury in an 18-year-old man. Left: Anteroposterior radiograph of the right shoulder shows a widened acromioclavicular distance (5 mm) (white arrows) and a slightly increased coracoclavicular distance (14 mm) (black arrows). The inferior clavicle is displaced superiorly relative to the acromion (arrowheads). Right: Comparison view of the left shoulder shows normal acromioclavicular (white arrows) and coracoclavicular (black arrows) distances with normal clavicular alignment (arrowheads).

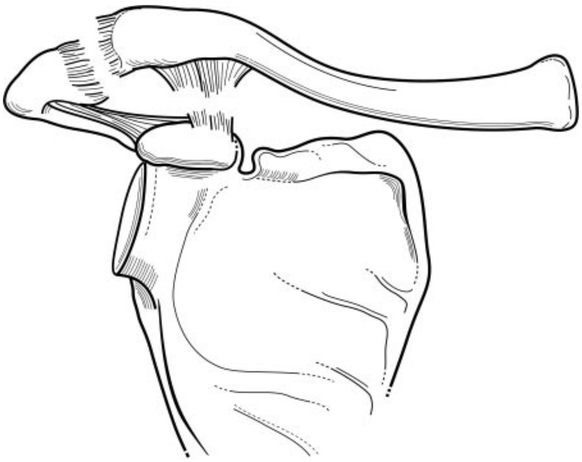


Figure 8. Diagram shows the features of a grade 3 injury: complete tears of the acromioclavicular and coracoclavicular ligaments.

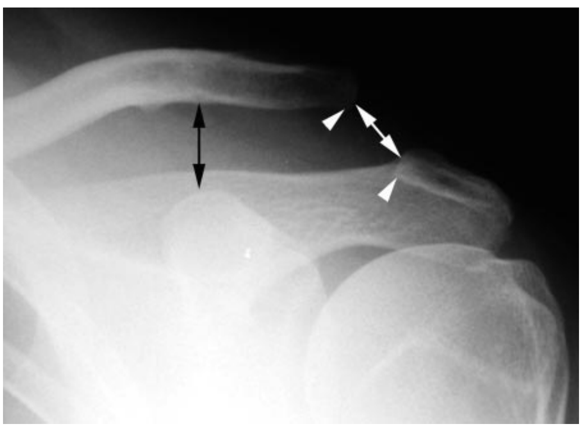


Figure 9. Grade 3 injury in a 25-year-old man. Anteroposterior radiograph of the left shoulder shows widening of the acromioclavicular distance to 10 mm (white arrows) and an increase in coracoclavicular distance to 20 mm (a 50% increase) (black arrows). There is superior subluxation of the clavicle relative to the acromion of 100% (arrowheads).

Grade 2 Injury

Grade 2 injuries result in disruption of the ACJ capsule and ligaments (Fig 5a). Radiographs show a widened ACJ secondary to medial scapular rotation, slight elevation of the lateral end of the clavicle, and a normal or slightly increased coracoclavicular distance (Figs 6a, 6b, 7). MR imaging can demonstrate that the acromioclavicular ligaments are torn and the coracoclavicular ligaments are sprained or partially torn, as indicated by attenuation, edema, or hemorrhage of the ligament (Fig 5b, 5c). The conoid component is most commonly involved in this injury (Fig 6a, 6b). The injury can also extend into the intraarticular disk (Fig 6a). Bone marrow edema in the adjacent articular ends and soft-tissue swelling can occur during the acute phase (Figs 5c, 6c).

Grade 3 Injury

Grade 3 injuries lead to complete disruptions of both the acromioclavicular and coracoclavicular ligaments. The tear may extend to involve the deltoid and trapezius muscles. Blood and fluid within the interspace of the coracoclavicular ligaments is best seen with long repetition time sequences. The ACJ is widened and the coracoclavicular distance is increased 25%–100% at both MR imaging and plain radiography. The lateral inferior border of the clavicle may lie above the inferior medial border of the acromion (Figs 8–10). Rarely, grade 3–equivalent injures can result from fracture of the coracoid process proximal to the conoid and trapezoid ligament insertions together with acromioclavicular ligament disruption.

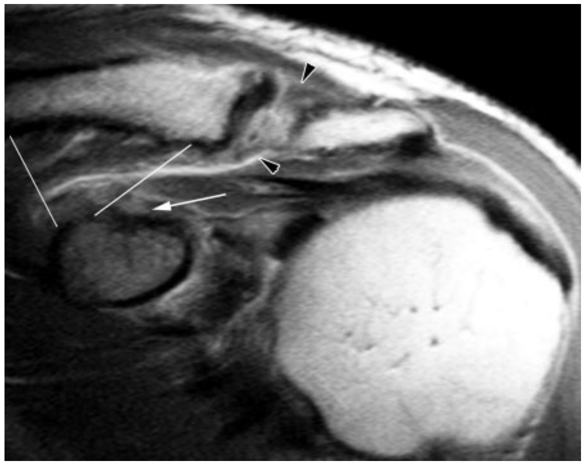
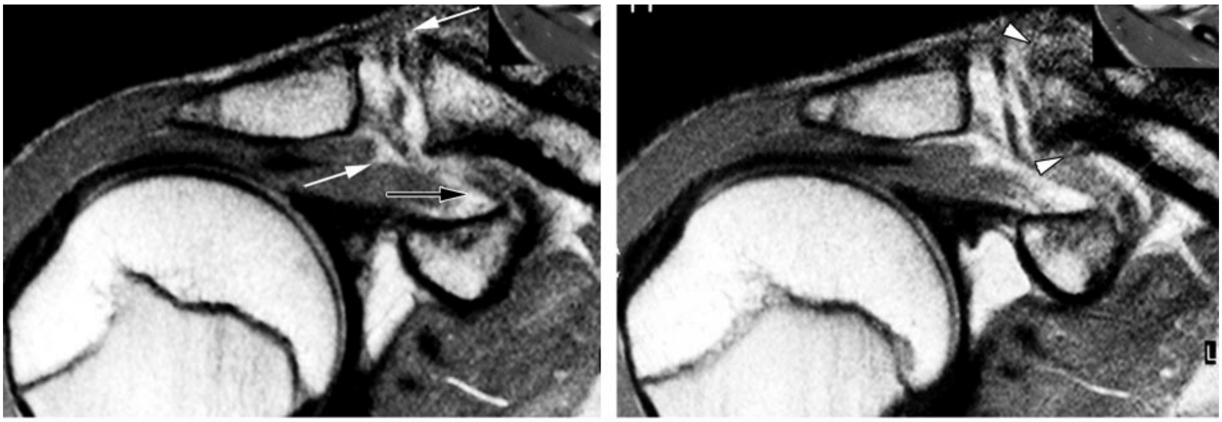


Figure 10. Grade 3 injury in a 46-year-old man. Coronal proton-density–weighted fast SE image (3400/36) shows tears of the superior and inferior acromioclavicular ligaments (arrowheads). There is disruption of the trapezoid and conoid ligaments, which are not clearly visualized in their expected positions and are replaced by fluid (arrow). (The normal medial and lateral borders of the coracoclavicular ligament are indicated by white lines.)



a. b.

Figure 11. Grade 3 injury variant in a 10-year-old boy. Coronal oblique proton-density–weighted fast SE images (3400/36) show disruption of the distal metaphysis of the clavicle superiorly (white arrows in **a**). The tear extends along the periosteum, stripping it from the bone (arrowheads in **b**). The trapezoid ligament has high signal intensity and is indistinct (black arrow in **a**), findings consistent with a partial tear. Further edema is seen along the ACJ and around the coracoclavicular ligaments.

The lateral clavicular epiphysis fuses at 19 years of age; in childhood, a thick periosteal tube, which is attached to the coracoclavicular ligaments, surrounds this bone. In children, a type I or II Salter-Harris fracture of the distal clavicular growth plate can result in another grade 3 variant. The distal clavicular metaphysis is displaced superiorly from the epiphysis, and coracoclavicular ligament disruption results in increased coracoclavicular distance (Fig 11). The ACJ remains intact, and the distal clavicle may be partially connected to a periosteal sleeve (24). This injury is sometimes referred to as a pseudo grade 3 injury.

Grade 4 Injury

Grade 4 injury results if a blow to the acromion pushes the scapula posteriorly with adequate force. In addition to acromioclavicular and coracoclavicular ligament disruptions, there is posterior displacement of the clavicle with respect to the acromion, which is best visualized on axillary or lateral radiographs. The trapezius and deltoid are detached from their distal clavicular insertions. Buttonholing occurs when the clavicle pierces through the trapezius (Fig 12).

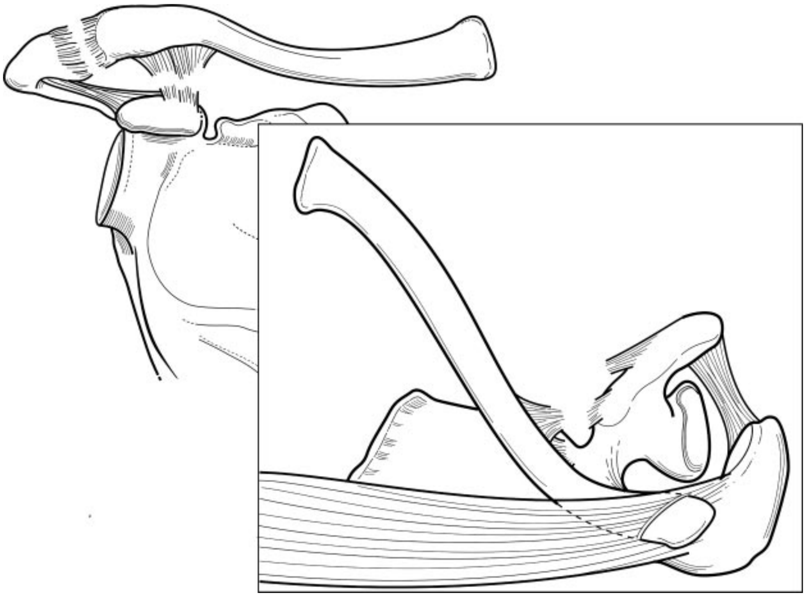


Figure 12. Diagram shows the features of a grade 4 injury: complete tears of the acromioclavicular and coracoclavicular ligaments with the clavicle dislocated posteriorly into or through the trapezius (inset).

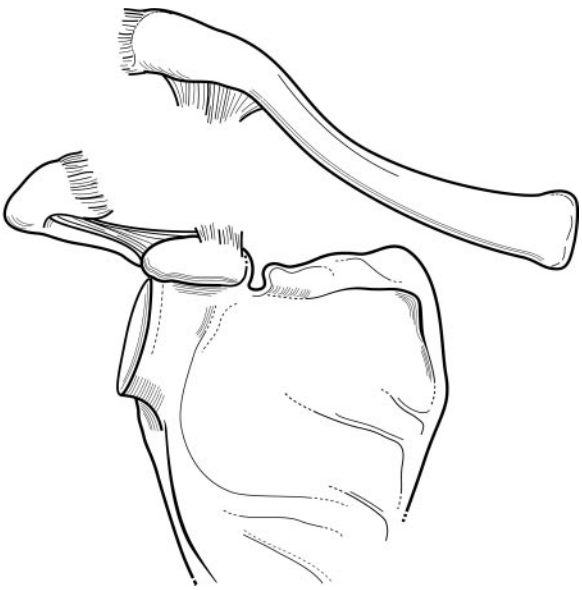


Figure 13. Diagram shows the features of a grade 5 injury: complete tears of the acromioclavicular and coracoclavicular ligaments along with tears of the trapezius and deltoid insertions, leading to wide separation of the ACJ.

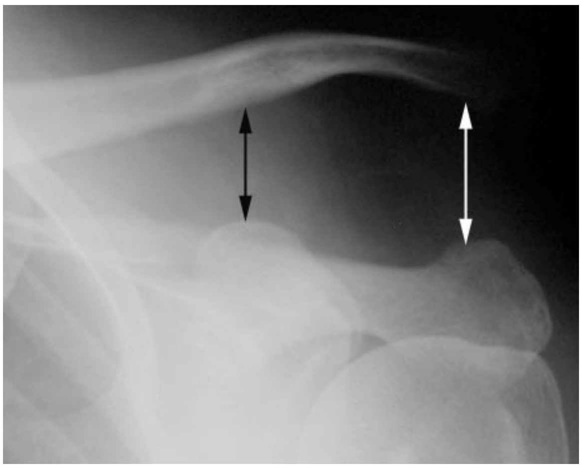


Figure 14. Grade 5 injury in a 40-year-old man. Anteroposterior radiograph shows a widely increased acromioclavicular distance (white arrows) and a coracoclavicular distance of 30 mm (>100% increase) (black arrows). The clavicle is displaced significantly superiorly relative to the acromion (>100% of clavicular width). Posttraumatic osteolysis has resulted in osteopenia of the distal clavicle.

Grade 5 Injury

A grade 5 injury is an exaggerated type 3 injury, where the lateral trapezius and deltoid insertions as well as the acromioclavicular and coracoclavicular ligaments are torn. In the acute setting, hemorrhage, edema, bone contusion, and swelling are present. Unopposed action of the sternocleidomastoid muscle results in a large separation of the coracoclavicular distance of 100%–300% (Figs 13–15).

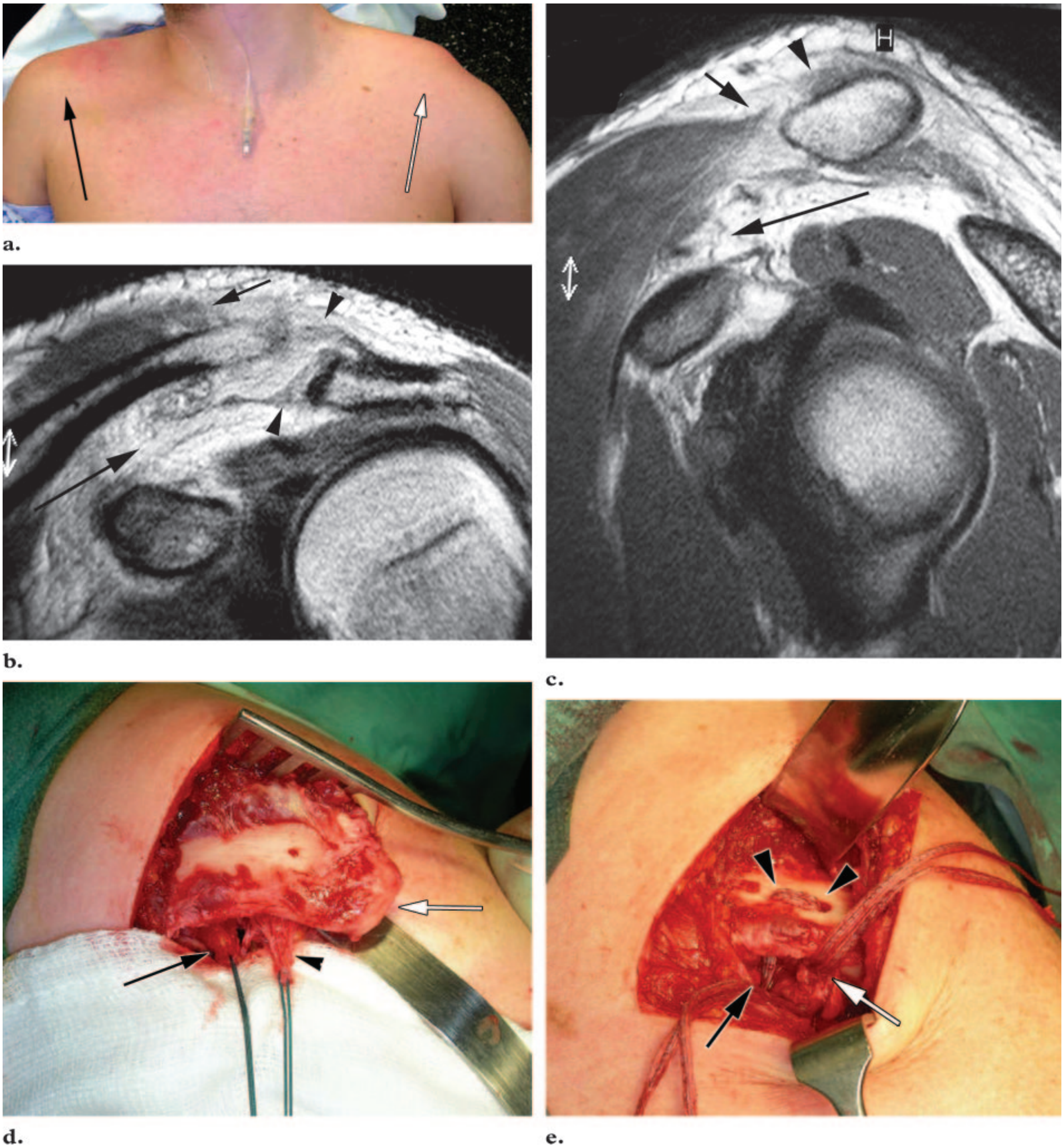


Figure 15. Grade 5 dislocation in a 19-year-old patient. **(a)** Photograph shows that the left clavicle (white arrow) is grossly elevated relative to the right clavicle (black arrow), an appearance consistent with a grade 5 injury. **(b)** Coronal proton-density–weighted fast SE image (3400/36) shows complete tears of the acromioclavicular (arrowheads) and coracoclavicular (long arrow) ligaments and the trapezius insertion on the clavicle (short arrow). **(c)** Sagittal oblique proton-density–weighted fast SE image (3400/36) shows tears of the coracoclavicular ligament (long arrow) and the trapezius (arrowhead) and deltoid (short arrow) insertions on the clavicle. **(d)** Intraoperative photograph shows the torn conoid (black arrow) and trapezoid (arrowhead) ligaments retracted with sutures. The degree of soft-tissue damage was obvious after the skin incision, with little dissection needed to free the clavicle (white arrow) from the trapezius and deltoid muscles. **(e)** Intraoperative photograph shows the method of repair, with a suture being passed through holes drilled in the distal clavicle (arrowheads), then attached to the coracoid process to replace the conoid (black arrow) and trapezoid (white arrow) ligaments.

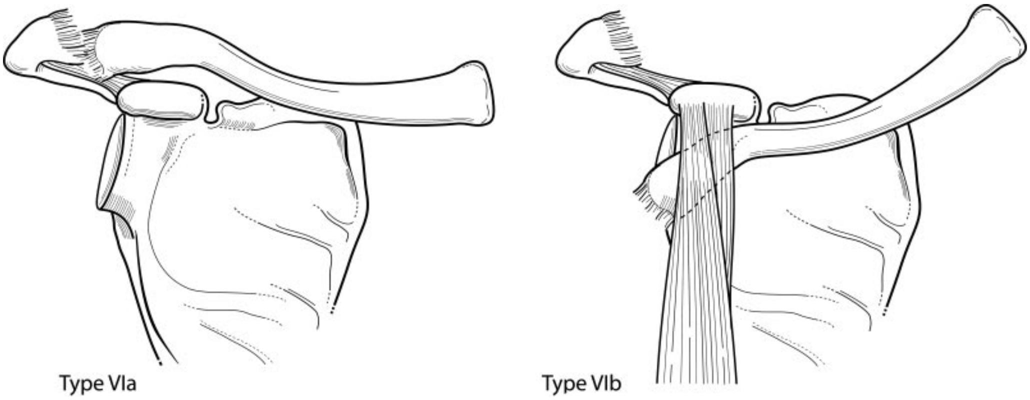
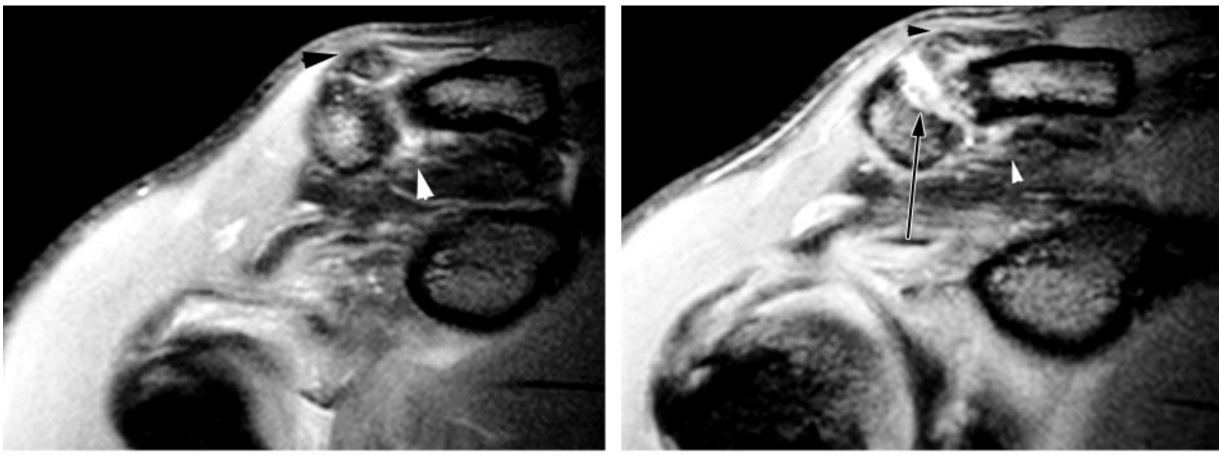


Figure 16. Diagram shows the features of a grade 6 injury: inferior subluxation of the clavicle relative to the acromion or coracoid process, resulting in tears of the acromioclavicular ligaments. Type 6a injury results in inferior subluxation of the clavicle relative to the acromion along with tears of the acromioclavicular ligaments. Type 6b injury results in subcoracoid dislocation of the clavicle as well as tears of the coracoclavicular ligaments.



a. b.

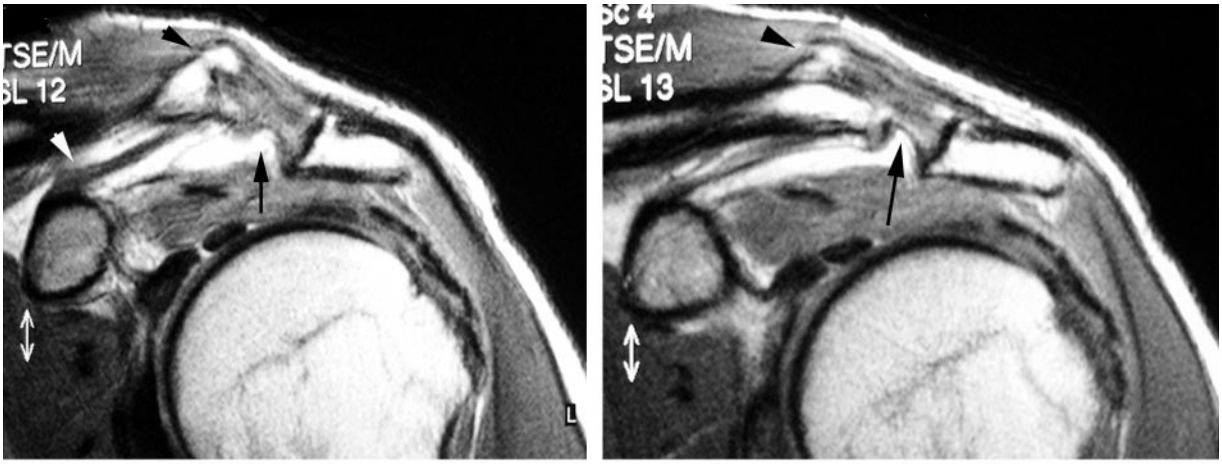
Figure 17. Grade 3 injury in a 35-year-old woman. Coronal oblique proton-density–weighted fast SE fat-suppressed images (3500/30) show avulsion of the superior acromioclavicular ligament at the acromion (black arrowhead). There is high signal intensity in the widened ACJ (arrow in **b**), a finding consistent with disruption of both acromioclavicular ligaments. The high signal intensity extends down into the coracoclavicular ligament, particularly the conoid component (white arrowhead), an appearance consistent with disruption.

Grade 6 Injury

Grade 6 injuries result from a superior blow to the clavicle during abduction of the humerus and retraction of the clavicle. The distal clavicle dislocates inferior to the acromion or coracoid (below the insertion of the short head of the biceps and the coracobrachialis origin) with a reduction of or negative coracoclavicular distance compared to the normal side. This results in a tear of the acromioclavicular ligament alone. Detachment of the distal insertion of the deltoid and trapezius muscles also occurs (Fig 16).

Fractures Associated with ACJ Injury

Fractures of the distal clavicle or acromion can occur coincidentally with some of these injuries, particularly grade 3 and 4 injuries. These can be fractures through the metaphysis or avulsion fractures involving the acromioclavicular ligaments superiorly or inferiorly (Figs 17–19). Grade 3–equivalent lesions as a result of a fractured coracoid process or a pseudo grade 3 lesion as a result of a metaphyseal fracture that extends along the periosteum (24) (Fig 11) were discussed earlier. Rarely, a dislocation of the sternoclavicular joint together with a grade 4 injury can result in a bipolar dislocation, resulting in a free-floating clavicle.



a. b.

Figure 18. Grade 3 injury in a 27-year-old woman. Coronal proton-density–weighted fast SE images (3500/30) show a fracture through the anterior superior aspect of the clavicle (black arrowhead). The fracture has disrupted the acromioclavicular ligaments (arrow), which demonstrate intermediate signal intensity, and has resulted in a wide ACJ. There is detachment of a portion of the conoid ligament, which is attached to the fragment (white arrowhead in **a**).

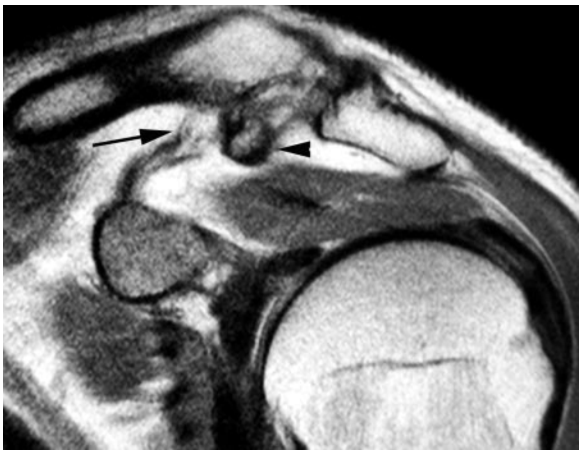


Figure 19. Grade 3 injury in a 29-year-old man. Coronal proton-density–weighted fast SE image (3500/30) shows avulsion of the clavicular insertion of the inferior acromioclavicular ligament (arrowhead). The tear extends into the conoid ligament, which is separated from its clavicular insertion (arrow).

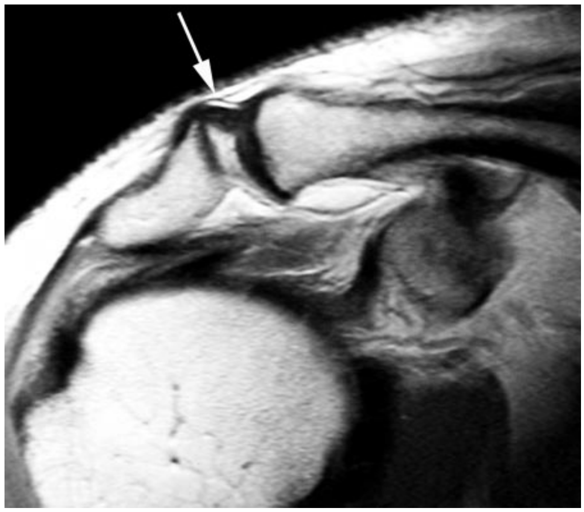


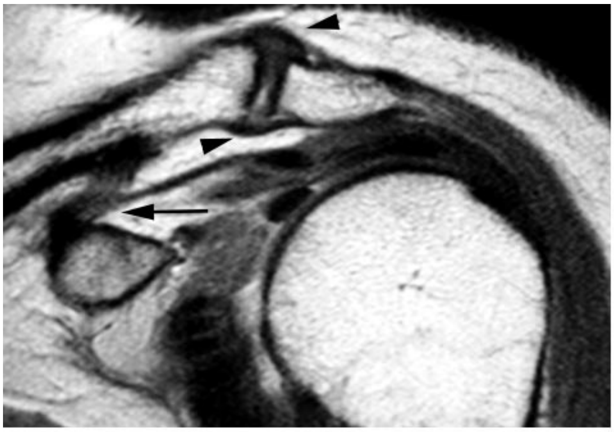
Figure 20. Chronic grade 1 tear in a 32-year-old man. Proton-density–weighted fast SE image (3500/30) shows thickening of the dorsal capsule (arrow).

In the posttraumatic phase of ACJ injury, osteolysis can occur at the distal end of the clavicle (Fig 14). A similar response occurs after repeated stress (6,25).

Chronic Tears, ACJ Degeneration, and Surgical Intervention

Many of our patients undergo scanning after an interval following acute injury, thus allowing healing of the injured ligaments. In our experience, chronic tears are visualized as thickening and reduced signal intensity of the coracoclavicular or acromioclavicular ligaments and intermittent healing at the position of dislocation (Figs 20–22). However, on occasion the torn ligaments do not heal adequately, resulting in persistent ACJ

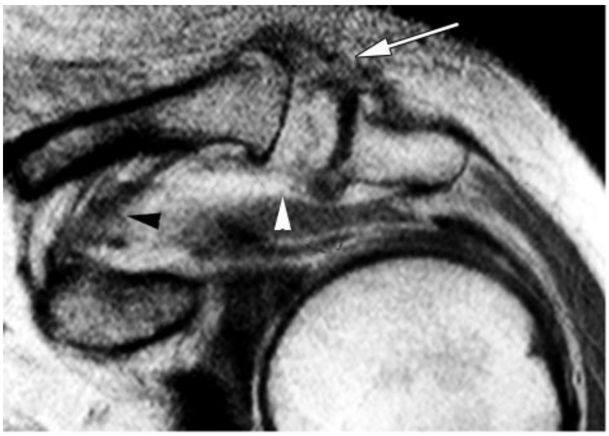
Teaching Point



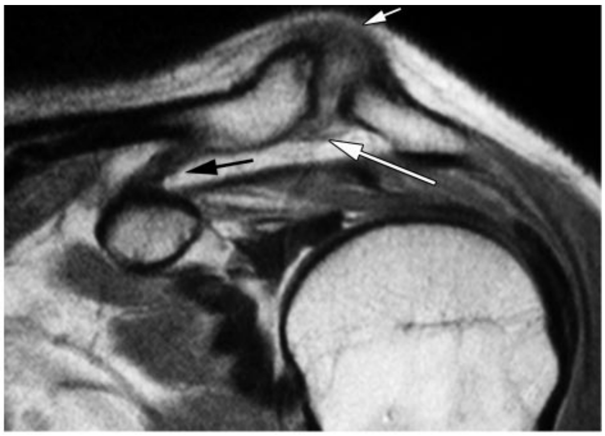
21.

22.

Figures 21, 22. **(21)** Old grade 2–3 injury in a 30-year-old man. Coronal proton-density–weighted fast SE image (3000/30) shows thickening of the superior and inferior acromioclavicular ligaments (arrowheads) with equivocal thickening of the coracoclavicular ligament (arrow). Thickening of the acromioclavicular ligaments and reduced signal intensity of the disk can also be seen in degeneration of the ACJ. **(22)** Chronic grade 3 injury in an 81-year-old man. Coronal proton-density–weighted fast SE image (3000/30) shows superior displacement of the clavicle and a thickened superior acromioclavicular ligament (arrow). Thickened and torn trapezoid and conoid ligaments are also evident (arrowheads). These changes reflect the chronicity of the injury.



23.



24.

Figures 23, 24. **(23)** Incidentally found chronic grade 3 injury in a 45-year-old man. Coronal proton-density–weighted fast SE image (3000/30) shows irregular low signal intensity in the region of the superior acromioclavicular ligament (arrow) and no healing of the inferior acromioclavicular ligament (white arrowhead). The acromioclavicular distance remains increased. The coracoclavicular ligament is slightly thickened (black arrowhead). These features suggest an old but unhealed ACJ injury. Osteophytes around the margins of the ACJ are consistent with previous degeneration of the ACJ. **(24)** Healing (subacute) grade 2 injury in a 27-year-old woman. Coronal proton-density–weighted fast SE image (3000/30) shows intermediate signal intensity and thickening of the acromioclavicular ligaments (white arrows). Early degeneration can have a similar appearance. There is a thickened hypointense conoid ligament that has also been injured (black arrow), a finding suggestive of a previous dislocation.

widening and increased coracoclavicular distance (Fig 23). A similar appearance can occur in the subacute stage of healing, with intermediate or low signal intensity incompletely bridging the site of old injury (Fig 24).

Degeneration of the ACJ may be a consequence of ACJ injury. A purely degenerative joint has a number of findings: disk extrusion or dehydration, capsular thickening, osteophytosis, and subchondral cyst formation (Fig 25). Early degeneration can be difficult to distinguish from old grade 1–2 injuries, both of which can show capsular thickening alone (Figs 21, 24). Superimposed findings of chronic ACJ injury particularly with coracoclavicular involvement can be valuable in identifying those with a component of ACJ injury as well as degeneration (Figs 21, 22, 24). Identifying which injury came first may be of academic interest only. Chronic injury and dislocation of the ACJ can also result in calcification along the acromioclavicular and coracoclavicular ligaments near their insertions.

Surgical removal of the joint should be recognized as a cause of pseudowidening of the ACJ. The remaining ligaments can be thickened as a consequence of surgery (Fig 26).

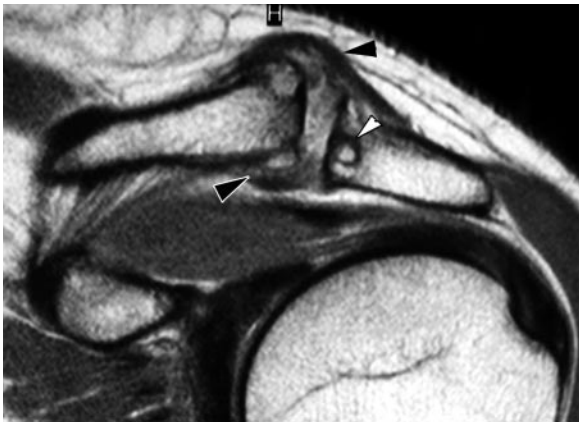


Figure 25. Degeneration of the ACJ in a 41-year-old woman. Coronal proton-density–weighted fast SE image (3000/30) shows capsular thickening (black arrowheads) and subchondral cystic change (white arrowhead).

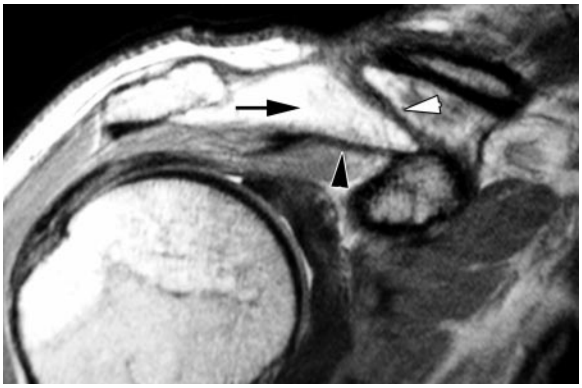


Figure 26. Resection of the ACJ in a 45-year-old woman. Coronal proton-density–weighted fast SE image (3500/35) shows a resected ACJ (arrow) and thickening of the remaining trapezoid (white arrowhead) and acromioclavicular (black arrowhead) ligaments.

Conclusions

MR imaging assessment of ACJ sprain or dislocation can be useful in further assessing clinically low-grade injuries that have not settled, thus excluding higher-grade injury. It is also useful if surgery is considered to identify additional disease and again to identify underestimated injury.

A coronal oblique plane parallel to the coracoclavicular ligament allows adequate visualization of the accessory and ACJ ligaments. This is due to the plane being approximately parallel to the accessory ligaments and perpendicular to the direction of tear. In addition, valuable information about soft-tissue healing can be obtained with this imaging modality.

References

1. Bucholz RW, Heckman JD. Chapter 29: acromioclavicular joint injuries. In: Rockwood and Green's fractures in adults. 5th ed. Philadelphia, Pa: Lippincott Williams & Wilkins, 2001; 1210–1244.

2. Goss TP. Double disruptions of the superior shoulder suspensory complex. J Orthop Trauma 1993;7:99–106.
3. Mazzocca AD, Arciero RA, Bicos J. Evaluation and treatment of acromioclavicular joint injuries. Am J Sports Med 2007;35:316–329.
4. Schlegel TF, Burks RT, Marcus RL, Dunn HK. A prospective evaluation of untreated acute grade III acromioclavicular separations. Am J Sports Med 2001;29:699–703.
5. Phillips A, Smart C, Groom A. Acromioclavicular dislocation. Clin Orthop Relat Res 1998;353:10–17.
6. Yu YS, Dardani M, Fischer RA. MR observations of posttraumatic osteolysis of the distal clavicle after traumatic separation of the acromioclavicular joint. J Comput Assist Tomogr 2000;24:159–164.
7. Bossart PJ, Joyce SM, Manaster BJ, Packer SM. Lack of efficacy of "weighted" radiographs in diagnosing acute acromioclavicular separation. Ann Emerg Med 1988;17:20–24.
8. Heers G, Gotz J, Schubert T, et al. MR imaging of the intraarticular disk of the acromioclavicular joint: a comparison with anatomical, histological and in-vivo findings. Skeletal Radiol 2007;36:23–28.
9. Lee KW, Debski RE, Chen CH, Woo SL, Fu FH. Functional evaluation of the ligaments at the acromioclavicular joint during anteroposterior and superoinferior translation. Am J Sports Med 1997;25:858–862.
10. Romanes GJ, ed. Cunningham's textbook of anatomy. 10th ed. London, England: Oxford University Press, 1964; 148–152, 231–232.
11. Fukuda K, Craig EV, An KN, Cofield RH, Chao EY. Biomechanical study of the ligamentous system of the acromioclavicular joint. J Bone Joint Surg Am 1986;68:434–440.
12. Prescher A. Anatomical basics, variations, and degenerative changes of the shoulder joint and shoulder girdle. Eur J Radiol 2000;35:88–102.
13. Levy O, Rath E. Traumatic soft tissue injuries of the shoulder girdle. Trauma 2002;4:223–235.
14. Boehm TD, Kirschner S, Fischer A, Gohlke F. The relation of the coracoclavicular ligament insertion to the acromioclavicular joint: a cadaver study of relevance to lateral clavicle resection. Acta Orthop Scand 2003;74:718–721.
15. Zanca P. Shoulder pain: involvement of the acromioclavicular joint (analysis of 1,000 cases). Am J Roentgenol Radium Ther Nucl Med 1971;112:493–506.
16. Sluming VA. A comparison of the methods of distraction for stress examination of the acromioclavicular joint. Br J Radiol 1995;68:1181–1184.
17. Waldrop JI, Norwood LA, Alvarez RG. Lateral roentgenographic projections of the acromioclavicular joint. Am J Sports Med 1981;9:337–341.
18. Schaefer FK, Schaefer PJ, Brossmann J, Hilgert RE, Heller M, Jahnke T. Experimental and clinical evaluation of acromioclavicular joint structures with new scan orientations in MRI. Eur Radiol 2006;16:1488–1493.
19. Antonio GE, Cho JH, Chung CB, Trudell DJ, Resnick D. Pictorial essay: MR imaging appearance and classification of acromioclavicular joint injury. AJR Am J Roentgenol 2003;180:1103–1110.
20. Barnes CJ, Higgins LD, Major NM, Basamania CJ. Magnetic resonance imaging of the coracoclavicular ligaments: its role in defining pathoanatomy at the acromioclavicular joint. J Surg Orthop Adv 2004;13:69–75.
21. de Abreu MR, Chung CB, Wesselly M, Jin-Kim H, Resnick D. Acromioclavicular joint osteoarthritis: comparison of findings derived from MR imaging and conventional radiography. Clin Imaging 2005;29:273–277.
22. Stein BE, Wiater JM, Pfaff HC, Bigliani LU, Levine WN. Detection of acromioclavicular joint pathology in asymptomatic shoulders with magnetic resonance imaging. J Shoulder Elbow Surg 2001;10:204–208.
23. Olah J. The radiographic appearances of the acromio-clavicular joints in old age. Rofo 1977;127:334–337.
24. Black GB, McPherson JA, Reed MH. Traumatic pseudodislocation of the acromioclavicular joint in children: a fifteen year review. Am J Sports Med 1991;19:644–646.
25. de la Puente R, Boutin RD, Theodorou DJ, Hooper A, Schweitzer M, Resnick D. Post-traumatic and stress-induced osteolysis of the distal clavicle: MR imaging findings in 17 patients. Skeletal Radiol 1999;28:202–208.

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MR Imaging Appearances of Acromioclavicular Joint Dislocation

Faisal Alyas, FRCR, et al

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Grade 2 and 3 lesions in particular may be difficult to distinguish with standard imaging protocols; in our practice, we use a nonstandard coronal magnetic resonance (MR) imaging technique to identify these cases (Fig 1).

Page 465
The coracoclavicular ligament consists of two parts that form a V shape: the conoid ligament medially and trapezoid ligament laterally (Figs 2, 3a, 3b); their names are reflective of their shapes (triangular and quadrilateral, respectively).

Page 466
The most common mechanism is a direct blow to the acromion with the shoulder in the adducted position. The scapula is pushed inferoanteriorly relative to the clavicle with resulting sequential stretching or tearing of the acromioclavicular ligaments, coracoclavicular ligaments, and trapezius insertion (1).

Page 469
The involved structures and imaging findings are summarized in the Table.

Page 476
In our experience, chronic tears are visualized as thickening and reduced signal intensity of the coracoclavicular or acromioclavicular ligaments and intermittent healing at the position of dislocation (Figs 20–22).