Modified Weaver-Dunn Procedure for Acromioclavicular Joint Dislocations

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The majority of acromioclavicular joint injuries result from direct trauma to the shoulder. The magnitude of applied force determines the degree of injury. This article presents a modified Weaver-Dunn procedure consisting of lateral clavicle resection and reduction, coracoclavicular fixation with suture or surgical tape, and coracoacromial ligament transfer for the treatment of these injuries.

The acromioclavicular joint is commonly affected by trauma to the shoulder girdle due to its subcutaneous position. Athletes who participate in contact sports, such as hockey, football, rugby, and soccer, are particularly susceptible to such injuries. These injuries, however, also occur during noncontact sports such as baseball, skiing, and cycling. The majority of acromioclavicular injuries occur in men during the first 3 decades of life.1-5

ANATOMY

The acromioclavicular joint is a diarthrodial joint composed of the medial acromial facet and distal clavicle end. A fibrocartilaginous disk of variable size and shape is located within the joint and serves to improve its biomechanics by decreasing contact stresses. The joint orientation is variable with a medial inclination ranging from 10°-50° to the sagittal plane.6,7

The joint is stabilized by acromio- and coracoclavicular ligaments (Figure 1). Thickenings of the joint capsule form the anterior, posterior, superior, and inferior acromioclavicular ligaments. These ligaments confer horizontal stability to the acromioclavicular joint; the strongest is the superior ligament, which is reinforced by deltoid and trapezius insertional fibers.7,8

The coracoclavicular ligaments consist of the conoid and trapezoid ligaments and extend from the inferior surface of the distal clavicle to the base of the coracoid process. These strong ligaments provide vertical stability to the acromioclavicular joint and serve as the primary suspensory structures for the upper extremity.8 Disruption of the acromio- or coracoclavicular ligaments results in variable degrees of acromioclavicular dislocations.

INJURY MECHANISM

The majority of acromioclavicular joint injuries result from direct trauma such as a blow to the shoulder. Usually, impact to the acromion with the humerus in an adducted position results in acromioclavicular joint disruption.9 Indirect trauma, such as a fall on an outstretched hand or flexed elbow, forces the humeral head proximally into the acromion.5,8 Most of these injuries are incomplete, involving only the acromioclavicular ligaments.

A force applied to the anterior aspect of the distal clavicle or posterior

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aspect of the acromion also leads to acromioclavicular joint injury. In rare instances, severe arm abduction results in subacromial or subcoracoid displacement of the clavicle. The magnitude of the applied force determines the degree of injury with the acromioclavicular ligaments involved initially, followed by the coracoclavicular ligaments, and finally the deltoid and trapezius muscles.

**CLASSIFICATION**

Rockwood described six types of injuries to the acromioclavicular joint (Figure 2).\(^1,2\) This classification has proven useful in terms of prognosis and treatment.

Type I injuries involve acromioclavicular ligament sprain; the joint itself is not disrupted. In type II injuries, the acromioclavicular ligaments are completely torn and the coracoclavicular ligaments are sprained; this results in slight vertical subluxation of the clavicle. Type I and II injuries are incomplete in that the acromioclavicular joint is not dislocated.

Type III injuries are complete and involve disruption of the acromioclavicular and coracoclavicular ligaments, resulting in an acromioclavicular joint dislocation. The clavicle is displaced superiorly by 25%-100%. Type IV injuries also are complete; however, in these cases, the clavicle is displaced posteriorly into or through the trapezius muscle.

Type V injuries are severe type III injuries, in which detachment of the deltoid and trapezius from the distal clavicle is extensive, resulting in extreme superior displacement of the clavicle by 100%-300%.

Type VI injuries, which are extremely rare, involve inferior dislocations of the acromioclavicular joint in which the clavicle is displaced into a subacromial or subcoracoid position.

**IMAGING**

Injuries to the acromioclavicular joint are readily assessed by plain radiographs; however, the acromioclavicular joint often is overpenetrated and poorly visualized with routine anteroposterior...
(AP) shoulder views. A 10º-15º cephalic tilt is recommended to avoid the scapular spine. This view is useful to evaluate the degree of joint displacement and intra-articular fractures. As the appearance of the coracoclavicular interval varies with the angle of the radiograph beam and the distance between the beam and patient, both acromioclavicular joints should be imaged simultaneously on a single large cassette, whenever possible.

Axillary views reveal posterior displacement of the distal clavicle and any small intra-articular fractures.

Some authors advocate stress radiographs when evaluating the acromioclavicular joint. Routine AP radiographs are obtained with 10-15 lbs of weight suspended or hung, rather than held; however, this may be too painful in the acute situation. Although these radiographic views have been advocated to differentiate between type II and type III injuries, an observation often not clinically relevant in terms of treatment, this distinction can often be made on physical examination and with routine AP views.

**Treatment Options**

**Type I and II Injuries**

Most authors agree that the treatment of incomplete injuries to the acromioclavicular joint (ie, types I and II) should be nonoperative. This consists of a brief period of rest in a sling for comfort and analgesics medication and ice to reduce pain and swelling. Patients are encouraged to begin range of motion exercises as soon as symptoms permit. Return to contact sports is permitted when pain-free range of motion and strength are regained. Although a return to sports may occur within 1–2 weeks in type I injuries, it may take several weeks with type II injuries. Earlier return to sports may be attempted with the use of protective padding.

**Type III Injuries**

Type III injury treatment remains controversial, with a trend in most cases towards nonoperative management. The controversy is a result, in part, of an earlier classification system in which type III injuries included types III, IV, and V injuries, which are now differentiated in the current classification system. Consequently, the results of nonoperative treatment of acute type III injuries would be more variable in the prior classification system due to the inclusion of severe displacement cases (ie, types IV and V).

Prospective studies comparing nonoperative and surgical treatment of type III injuries in the current classification have shown similar results with no advantage of either treatment. Contact athletes, in particular, who sustain type III injuries, often are treated nonoperatively because of the high risk of reinjury. Some patients who sustain type III injuries, however, particularly those involved in overhead sports or heavy manual labor, develop persistent pain and mechanical symptoms that interfere with their ability to perform their usual sport or job. This response may be due, in part, to disruption of the normal synchronous scapuloclavicular motion that occurs with overhead activity. That possibility has led some authors to recommend surgical repair or reconstruction. It is uncertain, however, whether current surgical techniques restore normal anatomy and function adequate to allow return to unimpeded repetitive overhead activity. Nonoperative treatment of type III acromioclavicular dislocations is similar to that of type I and II injuries. This involves the initial use of a sling for comfort, ice, and analgesics. Early range of motion exercises are recommended with avoidance of contact sports and heavy manual labor for approximately 6–8 weeks. As with type I and II injuries, an earlier return to sports may be possible with a protective pad on the superior aspect of the shoulder.

Several authors recommend deformity correction with straps or braces. The Kenny-Howard brace, a sling combined with a strap, was designed to provide downward pressure over the distal clavicle while directing a superior force on the humerus. For this device to be effective, it had to be worn continuously for 6–8 weeks, holding the acromioclavicular joint in a reduced position. This device, which was cumbersome and painful to wear, often did not maintain a satisfactory reduction. In addition, skin necrosis beneath the strap was a potential complication. For these reasons, this device is no longer used.

**Complete Injuries**

Various operative procedures have been described for the treatment of complete (types III-VI) acromioclavicular joint injuries, including dynamic muscle transfers, acromioclavicular joint repairs, and coracoclavicular ligament reconstructions with or without distal clavicle excision.

Transfer of the tip of the coracoid process and its attached conjoined tendon to the undersurface of the clavicle is described by several authors. The transferred coracobrachialis and short head of the biceps stabilize the acromioclavicular joint by acting as dynamic depressors of the clavicle. As this procedure does not provide static stability, continued motion and thus pain at the acromioclavicular joint persists. Potential complications of this procedure include nonunion of the transferred coracoid process and musculocutaneous nerve injury.

Fixation across the acromioclavicular joint with wires, pins, screws, or plates has been reported. These procedures often are combined with repair or reconstruction of the acromioclavicular ligaments. With concern over pin migration, breakage, and fixation failure, this procedure has fallen out of favor. Reapproximation of the disrupted acromioclavicular joint with hardware may lead to further damage to the articular cartilage and meniscus, resulting in degenerative changes.

Bosworth reduced the acromioclavicular joint, which was later popularized by Rockwood. In this pro-
cEDURE, a specially designed screw with a low-profile head is inserted through the clavicle into the base of the coracoid process. This procedure may be combined with coracoclavicular ligament and overlying deltoid/pectoral fascia repair. The screw is subsequently removed once the coracoclavicular ligaments have healed.

To eliminate hardware removal, several authors advocated suture or synthetic loops of absorbable or nonabsorbable material to stabilize the clavicle to the coracoid. The loop is passed around the base of the coracoid and then through a drill hole in the clavicle or around the clavicle itself. Although coracoclavicular repairs may be performed alone, they often are combined with coracoclavicular ligament transfer, as popularized by Weaver and Dunn. In symptomatic, chronic, complete acromioclavicular dislocations with significant joint damage, a distal clavicle excision is performed. Simple excision of the distal clavicle is not sufficient for complete acromioclavicular disruptions because it does not stabilize the acromioclavicular articulation.

**MODIFIED WEAVER-DUNN PROCEDURE**

**Rationale**

The authors’ preferred approach for types IV, V, and VI acromioclavicular joint injuries and symptomatic, chronic type III injuries is a modified Weaver-Dunn procedure. The authors’ also consider this procedure for acute type III injuries involving the dominant extremity of overhead throwing athletes or heavy laborers.

The original Weaver-Dunn procedure involves a lateral clavicle resection, reduction of the dislocated clavicle, and coracoclavicular ligament transfer to the lateral clavicle, without additional fixation. The authors’ modified procedure consists of a lateral clavicle resection, reduction of the dislocated clavicle, coracoclavicular fixation with heavy nonabsorbable suture or surgical tape, and coracoclavicular ligament transfer to the lateral clavicle.

**Technique**

The patient is placed in a semi-sitting or beach-chair position. At least 60°-70° of flexion at the wrist is preferred to facilitate visualization.

The procedure can be performed under regional (ie, interscalene block) or general anesthesia. Two or three folded sheets are placed behind the scapula to bring the shoulder girdle forward. This enhances visualization and facilitates access to the superior aspect of the shoulder. The affected shoulder and entire upper extremity are prepped and draped freely to allow for unrestricted arm positioning during the procedure.

The incision is designed based on an appreciation of the relevant anatomic landmarks: anterior aspect of the acromion, lateral clavicle, and coracoid process.

A “strap” incision is made from approximately 2-3 cm posterior to the acromioclavicular joint and is extended to the tip of the coracoid process (Figure 3). The strap incision is advantageous not only because it is cosmetically acceptable, but also because it allows visualization and exposure of the important anatomic areas.

The incision is carried down through the subcutaneous tissues, and soft-tissue flaps are established medially, laterally, posteriorly, and anteriorly, allowing for visualization of the deeper tissues, including the deltoid and trapezius muscles. These muscles are normally found inserting on the anterior and posterior aspects of the lateral clavicle. In a complete acromioclavicular injury, however, they may be avulsed from their insertion sites. When this occurs, the clavicle may be “button-holed” through the fascia and located in a subcutaneous position.

In deltoid and trapezius muscle avulsion, some soft-tissue remains attached to the lateral clavicle. The soft tissues overlying the lateral clavicle are divided longitudinally in line with the superior cortex. The incision is carried down directly to bone, while elevating the anterior and posterior soft tissues off the lateral clavicle with a scalpel or electrocautery. These should be full-thickness soft-tissue flaps to ensure an adequate soft-tissue envelope for closure.

The incision in the soft tissue should be carried laterally to the medial aspect of the acromion, exposing the entire lateral clavicle and acromioclavicular joint. The anterior and posterior flaps are tagged with number one nonabsorbable suture.

In acute dislocations, acromioclavicular joint exposure may reveal a remaining portion of the intra-articular disk (meniscus). In chronic dislocations, however, this area usually is filled with fibrous tissue that should be excised.

The lateral clavicle resection, performed using a pneumatic oscillating saw, involves removing 1-1.5 cm of bone. A slightly oblique resection line that is angled superolaterally to inferomedially is preferred; however, the obliquity should be limited and is included only to facilitate attachment of the coracoacromial ligament.

The arm is brought through a full range of motion while palpating for impingement of the distal clavicle against the acromion. If impingement occurs, a small portion of the medial aspect of the acromion can be resected rather than more of the distal clavicle.

The anterior deltoid is divided in line with its fibers, approximately 3 cm distally towards the tip of the coracoid process, facilitating exposure of the coracoid process and coracoacromial ligament. With mobilization of the anterior deltoid, the coracoacromial ligament is identified as it passes from the tip of the coracoid process and inserts along the undersurface of the anterior aspect of the acromion. After isolation of the ligament, it is carefully detached from its acromial insertion. A small piece of bone can be taken with the ligament from the acromion to allow bone-to-bone healing. Care should be taken to maximize the length of the ligament. Number two nonabsorbable braided sutures are passed in a horizontal mattress fashion through the
Figure 3: A “strap” incision is made from approximately 2-3 cm posterior to the acromioclavicular joint and extends to the tip of the coracid process. The incision is carried down through the subcutaneous tissues, and soft-tissue flaps are established in the surrounding area. Abbreviations: A=acromion, C=clavicle, P=coracoid process, and S=strap incision.

Figure 4: The entire coracoacromial ligament is exposed and detached from its insertion. Care is taken to minimize coracoid detachment to prevent avulsion following transfer. Number two absorbable braided sutures are passed in a horizontal mattress fashion through the proximal ligament. Abbreviations: CAL=coracoacromial ligament and DC=resected distal clavicle. (Reprinted with permission from Rokito AS et al. Acromioclavicular joint dislocation. In: Fu FH, Ticker JB, Imhoff AB, eds. An Atlas of Shoulder Surgery. London, United Kingdom: Martin Dunitz; 1998:287-294.)


Figure 6: The surgical tape and two number five sutures are passed around the posterior aspect of the clavicle. Three small drill holes are placed through the superior cortex of the distal clavicle, which are used for suture passage in the coracoacromial ligament. Care is taken to leave an adequate cortical bridge between the holes to prevent fracture. A shallow trough is prepared in the cancellous bone of the lateral clavicle for insertion of the transferred coracoclavicular ligament. (Reprinted with permission from Rokito AS et al. Acromioclavicular joint dislocation. In: Fu FH, Ticker JB, Imhoff AB, eds. An Atlas of Shoulder Surgery. London, United Kingdom: Martin Dunitz; 1998:287-294.)

Figure 7: With the clavicle held in a reduced position, the surgical tape and sutures are tied. The braided sutures are placed medial and lateral to the surgical tape. (Reprinted with permission from Rokito AS et al. Acromioclavicular joint dislocation. In: Fu FH, Ticker JB, Imhoff AB, eds. An Atlas of Shoulder Surgery. London, United Kingdom: Martin Dunitz; 1998:287-294.)

Figure 8: The coracoacromial ligament is pulled into the medullary canal and the sutures are passed through the drill holes, tied, and the coracoacromial ligament is seated in the lateral clavicle. (Reprinted with permission from Rokito AS et al. Acromioclavicular joint dislocation. In: Fu FH, Ticker JB, Imhoff AB, eds. An Atlas of Shoulder Surgery. London, United Kingdom: Martin Dunitz; 1998:287-294.)
pulling the ends back and forth in a
around the base of the coracoid by
more easily covered with soft tissues.
although not as strong, are more easily
operatively. The braided sutures,
and carries less risk of disruption post-
repair. The surgical tape is used
for the coracoclavicular portion of
braided sutures.
A single tape and two sutures are
used for the coracoclavicular portion of
the repair. The surgical tape is used
because it is stronger then the sutures
and carries less risk of disruption post-
operatively. The braided sutures,
although not as strong, are more easily
tied and not as bulky, and are thereby
more easily covered with soft tissues.
The tape and sutures are seated
around the base of the coracoid by
pulling the ends back and forth in a
sawing motion. The surgical tape and
sutures from the lateral side of the cora-
coid are passed around the posterior
aspect of the lateral clavicle. When pos-
sible, these sutures are passed through
the remaining soft-tissue attachments to
the clavicle. This allows the sutures to
be more securely placed, preventing lat-
eral sliding with fixation loss.
At this point, the lateral end of the
clavicle is prepared for coracoacromial
ligament transfer. Three small drill holes
are placed through the superior cortex of
the lateral clavicle with a 2-mm drill bit.
These drill holes should be evenly
spaced to avoid propagating a fracture
between the holes, which would result
in fixation loss. A rongeur or curette is
used to prepare a shallow trough in the
cancellous bone of the lateral clavicle
for insertion of the transferred cora-
coacromial ligament (Figure 6).
The clavicle is held in a reduced
position and one of the braided sutures
is tied. It is important to maintain the
clavicle in a slightly over-reduced posi-
tion as the suture is tied. While contin-
uing to hold the clavicle in a reduced
position, the surgical tape is tied. The
adequacy of the reduction is then
assessed; and if any concern over per-
sistent displacement exists, the sutures
should be removed and additional
sutures passed around the coracoid and
the repair undone.
The remaining braided suture is then
tied. The braided sutures should be
placed such that one is medial and the
other lateral to the surgical tape (Figure
7). This decreases the likelihood of tape
migration, thus compromising fixation.
It should be noted that completion of
this portion of the repair results in slight
anterior displacement of the lateral clavicle. This is a result of the direction
of the pull of the sutures and is not clin-
ically significant as the lateral clavicle
has been resected and the congruity of
the acromioclavicular joint is no longer
a concern.
The sutures that were placed in the
coracoacromial ligament are passed
through the drill holes in the lateral
clavicle. One limb of each suture is
passed through the center drill hole
whereas the other limb is passed
through the anterior or posterior hole;
two horizontal mattress sutures are now
available (Figure 8).
The length of the coracoacromial
ligament usually is sufficient to main-
tain contact with the cancellous bone of
the lateral clavicle. If not, a limited
release of the ligament from the cora-
coid can be performed to gain addition-
al length. If, however, the length is
excessive, the suture can be placed
more medially, rather than resecting
any portion of the ligament.
It is important to have the ligament
well seated in the lateral clavicle to
facilitate healing to the cancellous bone.
After the coracoacromial ligament has
been completed, tension should be
assessed.

Suction drain placement should be
individualized based on the degree of
bleeding encountered. The anterior del-
toid and posterior trapezius flaps are
reapproximated over the superior
aspect of the lateral clavicle using num-
ber two nonabsorbable braided sutures.
The repair should be secure, and the
underlying suture material completely
covered.
The split in the anterior deltoid is
repaired with zero absorbable suture
material. The subcutaneous tissue is
closed with 2-0 absorbable suture, and

Take Home “Pearl”...

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proximal portion of the ligament. The
ligament is retracted anteriorly and dis-
tally to facilitate exposure of the cora-
coid process (Figure 4).
An electrocautery device is used to
divide the soft tissues over the superior
aspect of the coracoid process. A
curved soft-tissue elevator and curved
clamp are used to bluntly dissect the
soft tissues medially and laterally, facilitat-
ing suture passage around the coracoid
process.
A curved suture passer directs the
surgical tape around the base of the
coracoid process (Figure 5). Right and
left passers are available, which allows
the sutures to be passed from a medial
to lateral direction, thus minimizing
risk of injury to the neurovascular
structures.
The surgical tape is knotted at one
end so it can be grasped with a clamp
as it is passed around the base of the
coracoid. The suture passer is backed
out, leaving the tape in position around
the coracoid process. This tape is used
to pass an additional surgical tape, as
well as two number five nonabsorbable
braided sutures.
A single tape and two sutures are
used for the coracoclavicular portion of
the repair. The surgical tape is used
because it is stronger then the sutures
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operatively. The braided sutures,
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more easily covered with soft tissues.
The tape and sutures are seated
around the base of the coracoid by
pulling the ends back and forth in a

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the skin is reapproximated with a running subcuticular closure using 3-0 prolene or monocril.

A sling is applied and the arm is secured to the chest wall with two 6-inch elastic bandages placed in a crisscross manner—one around the forearm and chest and the other around the elbow and opposite shoulder.

**POSTOPERATIVE CONSIDERATIONS**

The elastic bandages are removed on the evening or morning postoperatively. The suction drain, if present, usually is removed on postoperative day 1, and rehabilitation is begun. Rehabilitation initially consists of hand gripping exercises and active range of motion exercises for the elbow, wrists, and hand. The patient is discharged on the same day postoperatively.

Shoulder range of motion exercises are begun 2 weeks postoperatively and consist of passive and active-assistive range of motion with forward elevation limited to 90°, external rotation to 30°, and internal rotation allowed only to the chest wall. Forward elevation is limited to 90° to minimize clavicular rotation, which may compromise the repair. Range of motion is advanced at 4 weeks, and the sling is discontinued at 6 weeks.

Following sling removal, active range of motion exercises are started. These are performed first in a supine position, and then progressed to a sitting position. The patient is instructed to avoid lifting anything weighing >1-2 lbs. When full active range of motion is regained, a strengthening program is started, which includes isometric exercises with progression to resistive exercises. Heavy lifting or any other activity that would result in significant downward traction on the upper extremity is avoided for 4 months postoperatively.

Strenuous use of the arm, including significant athletic activity, is not advised until 6 months postoperatively. Contact sports usually are avoided until 9 months postoperatively.

**COMPLICATIONS**

Several complications related to the surgical treatment of acromioclavicular dislocations have been reported. The most common complications include infection, clavicular erosion, neurovascular injury, and continued pain or acromioclavicular joint instability. Infection and erosion of the distal clavicle caused by the synthetic loop was reported by several authors.\(^{52,60-62}\)

Neurovascular injury can occur as sutures are passed around the base of the coracoid process. Special care should be taken to pass these sutures from a medial to lateral direction, keeping the suture passer in close proximity to the bone at all times.

Inadequate distal clavicle resection may result in continued pain at the acromioclavicular joint, whereas an excessive resection may result in persistent instability.

Early range of motion exercises prior to sufficient healing may compromise fixation and lead to early repair failure.

**REFERENCES**


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