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Video Content

PROCEDURE 1

Acromioclavicular Joint Injuries: Open Reduction and Internal Fixation

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INDICATIONS

- Acute injury
  - Grades IV, V, and VI in most patients unless surgery is contraindicated owing to medical or psychological factors
  - Grade III in selected patients, including heavy laborers (lifting, carrying) and overhead athletes/workers
- Chronic injury
  - Grade II in patients with symptomatic anterior-posterior instability
  - Grades III, IV, and V in patients with symptomatic instability

PHYSICAL EXAMINATION

- Evaluate shoulder posture.
- Determine the position of the distal clavicle relative to the acromion.
  - The deformity is more visible in standing or sitting position without support for the injured arm.
  - In grade IV dislocations, the clavicle is posterior to the acromion and stuck in the trapezius.
  - The distal end of the clavicle is level or superior to the acromion in other grades.
  - The distal clavicle is sitting subcutaneously, through the trapezius, in grade V injuries.
  - In contrast to higher grades, the acromioclavicular (AC) joint is reducible in grade III by applying an upward force on the ipsilateral elbow.
- Assess horizontal stability by grasping and moving the clavicle.
- Examine sternoclavicular (SC) joint for possible bipolar dislocation (synchronous AC and SC dislocation).
- Assess active and passive shoulder motions.
  - AC joint pain is accentuated by abduction and cross-body adduction.
  - Manage glenohumeral stiffness prior to reconstruction of chronic separation.
  - Isolated AC injury does not typically produce decreased shoulder range of motion.
- Evaluate deltoid and rotator cuff strength.
  - Consider the rare occurrence of concomitant rotator cuff pathology.
- Perform neurovascular examination.

IMAGING STUDIES

- Plain radiographs
  - True anteroposterior view of the shoulder
    - Evaluate the glenohumeral joint.
    - Look for bony signs of rotator cuff pathology.
  - Axillary view will demonstrate posterior displacement of the clavicle in grade IV injuries.
  - Outlet/scapular Y view
    - Evaluate acromial anatomy.
    - The presence of a spur may warrant acromioplasty.
  - Bilateral anteroposterior acromioclavicular views (Zanca view)
    - Evaluate the acromioclavicular joint position.
    - Look for possible arthritic changes.
    - Compare coracoclavicular distance on both sides.
    - Normal coracoclavicular distance is 11 to 13 mm.

PITFALLS

- Acute injury
  - Skin abrasion: wait until healed
  - Noncompliant patient
  - Patient with substance abuse
- Chronic injury
  - Noncompliant patient

CONTROVERSIES

There is no consensus on

- Optimum timing of surgery
- Anatomic vs. nonanatomic reconstruction
- Best type of graft
- Acute repair of grade III injuries
  - Operative treatment of acute injuries is the only treatment that will restore normal anatomy, but it is associated with greater risk of complications.
  - Although often recommended, insufficient evidence exists to recommend surgery for heavy laborers or overhead athletes.
  - Successful nonsurgical treatment of type III injuries in professional athletes has been reported.
- Inclusion of distal clavicle excision in management of chronic cases
  - Preserving distal clavicle may add to the stability of reduction.
  - Reduction of an already arthritic distal clavicle may produce or aggravate pain.
  - Resection of distal 1 cm of clavicle results in a 32% increase in posterior translation.
  - Resection of as little as 2.3 mm in women and 2.6 mm in men could release the clavicular insertion of the acromioclavicular (AC) ligaments in some patients.
  - Some studies suggest improved outcomes with preservation of the distal clavicle during AC reconstruction.

TREATMENT OPTIONS

- Nonoperative treatment
  - Indicated for grade I and II and most grade III injuries
    - Good short-term results
    - 10% to 20% of patients will have residual symptoms and may need subsequent surgery.
  - Nonoperative treatment of high-grade injuries (IV, V) may be acceptable, but has a higher rate of poor outcome.
  - A short course (1–3 weeks) of sling support or immobilization may be used for comfort,

Continued

TREATMENT OPTIONS—cont'd

but strict or prolonged immobilization should be avoided.
- Physical therapy
  - Early passive and active assisted range of motion (ROM) exercises
  - When painless ROM is achieved, proceed to isometric periscapular and rotator cuff strengthening, followed by isotonic exercises.
  - Avoid contact sports and heavy lifting for 3 months.
- Operative treatment
  - Components of optimal surgical technique
    - Anatomic reduction of acromioclavicular joint
    - Coracoclavicular ligament repair/reconstruction
    - Acromioclavicular ligament repair/reconstruction
    - Protection/augmentation of repair/reconstruction
    - Deltoid/trapezoid fascia repair
    - Distal clavicle resection, if arthritic
  - Acute injury
  - Coracoclavicular ligament repair and augmentation
    - Multiple techniques have been described to stabilize the AC joint with autograft/allograft tendon or ligament augmentation devices around the coracoid.
  - Transarticular acromioclavicular pin fixation
    - Needs limited dissection
    - Risk of pin migration/breakage significant, largely abandoned
  - Acromioclavicular hook plate
    - Mechanically very effective
    - May result in acromial wear or fracture
    - Newer hook designs that match acromial anatomy preferred
    - Avoid over-reduction
    - Most, but not all, patients require eventual hook plate removal.
  - Weaver-Dunn acromioclavicular ligament transfer
    - 40% failure rate, not used in isolation
    - Provides 25% of intact coracoclavicular ligament strength
    - Strength can be drastically increased by adding synthetic loop augmentation
  - Coracoclavicular screw fixation
  - Has a high failure rate, not used in isolation
    - Acromioclavicluar ligament repair
    - Imbrication of the torn AC ligaments
  - Chronic injury
    - Coracoclavicular ligament reconstruction with
      - Tendon graft
      - Synthetic loops
      - Weaver-Dunn procedure
      - Conjoined tendon transfer
    - Acromioclavicluar ligament reconstruction with
      - Suturing of the remaining coraco-calvicular (CC) graft around the AC joint
      - Intramedullary free tendon graft
      - Reverse coracoacromial ligament

- Stress views
  - Originally described to differentiate between type II and type III injuries
  - Stress views are costly and uncomfortable for the patient and rarely provide new information to help diagnose an unstable injury.
- Advanced imaging should be considered only if evaluation suggests rotator cuff or intraarticular glenohumeral pathology.
- Magnetic resonance imaging may be indicated to evaluate the rotator cuff in chronic injury.

SURGICAL ANATOMY

- Clavicle
  - The distal clavicle forms the medial articulation of the acromioclavicular joint.
- Acromion
  - The acromion forms the lateral aspect of the acromioclavicular joint and typically slopes posteriorly and laterally. Newer designs of hook plates recognize this.
  - The anterior acromion is also the site of coracoacromial ligament insertion, which is used in the Weaver-Dunn procedure.
- Acromioclavicular joint
  - The orientation of the joint varies from vertical to 50 degrees oblique from infero-medial to superolateral.
- The intraarticular meniscus
  - Made of fibrocartilage
  - True function unknown
  - Undergoes significant degeneration over time
- Acromioclavicular ligaments
  - The posterior acromioclavicular ligament is an important restraint to posterior translation of the acromioclavicular joint.
  - The superior acromioclavicular ligament contributes to a lesser extent to restraint of posterior translation of the acromioclavicular joint.
  - The inferior acromioclavicular ligament contributes to restraint of anterior translation of the acromioclavicular joint.
  - Isolated disruption of the acromioclavicular ligament occurs in grade II injuries.
- Coracoclavicular ligaments
  - The conoid ligament is a more medial structure that attaches on the conoid tubercle on the underside of the distal clavicle. The conoid tubercle is located at the juncture of the lateral and medial thirds of the clavicle.
  - The trapezoid ligament is more lateral and attaches on the trapezoid line of the inferior clavicle.
  - Disruption of the acromioclavicular and coracoclavicular ligaments occurs in grades III, IV, V, and VI injuries.
- Muscular anatomy
  - Trapezius, pectoralis major, and anterior deltoid muscles attach to the distal clavicle and acromion.
  - Their combined action provides dynamic stability to the acromioclavicular joint.
- Neurologic anatomy
  - Brachial plexus, suprascapular, and musculocutaneous nerves are in the vicinity and could be injured in reconstruction surgeries.
  - AC joint is innervated by lateral pectoral, axillary, and suprascapular nerves.
- Vascular anatomy
  - Branches of the thoracoacromial artery run in the vicinity of the distal clavicle and can bleed during the dissection and exposure of the base of the coracoid.

POSITIONING

- The patient is placed in the beach chair position, with the surgical field draped out, bony landmarks outlined, and the skin incision marked.
- Neck alignment should be in a neutral position with the head on an adjustable articulating headrest or gel pad "donut."

- If desired, an articulating arm holder is used to support and position the arm during the procedure. Alternatively, the arm may be secured at the patient's side.
- A side pad is placed against the lateral chest to keep the patient from falling off the side of the table.

PORTALS/EXPOSURES

- A superior surgical approach is used.
- An incision is made along Langer's lines over the distal end of the clavicle.
- Begin just posterior to the clavicle and extend toward the coracoid process.

PROCEDURE: HOOK PLATE FIXATION

Step 1: Skin Incision and Surgical Dissection

- Surgical incision is made along Langer's lines.
- Continue dissection through the subcutaneous tissue.
- The skin and subcutaneous tissue are elevated to extend exposure medially and laterally to expose the distal 3 to 4 cm of the clavicle and the acromion.

Step 2: Acromioclavicular Joint Exposure and Mobilization

- The deltotrapezial fascia is split over the distal clavicle and acromion.
- Typically the acromioclavicular joint capsule and ligaments are disrupted by the injury. Be alert for this disruption and work through any defects created by the injury.
- The meniscus is debrided.
- Look for arthritic changes. Distal clavicle resection should be considered in chronic cases with frank arthritic changes.
- Mobilize the distal clavicle and ensure that it can be reduced.

Step 3: Hook Plate Insertion

- Anterior deltoid is elevated off the distal clavicle, subperiosteally and retracted anteriorly.
- Cauterize vessels imbedded in subdeltoid fatty tissue.
- Open the subacromial space with a Cobb or periosteal elevator and insert the hook portion of the hook plate. This typically will be posterior in the subacromial space.
- Use the hook plate trials to determine the correct height of the hook plate to be inserted; be careful not to over-reduce the joint. The clavicle should not require excessive force to reduce (Fig. 1.1).
- Insert the chosen hook plate and then place the screws in the plate, which will bring the plate down to the clavicle.
- Be careful that insertion of the screws in the shaft portion of the clavicle does not "lever" the clavicle down further.
- If there is any question as to reduction, use radiographic imaging to ascertain this. Considerable variation exists in AC joint pathology: a preoperative radiograph of the opposite side can be useful to gauge proper reduction.

Step 4: Optional Coraco-Acromial (CA) Ligament Transfer

- If desired, especially in the chronic situation where an acute healing response will not occur, a CA ligament transfer can be performed in addition.
- This Weaver-Dunn transfer can be performed by releasing the CA ligament from the acromion and inserting it through drill holes in the distal clavicle.
- Alternatively, a small fragment of acromion can be resected with the CA ligament and then secured with a lag screw to a corresponding slot cut into the distal anterior acromion. This provides biologic healing and ligamentous stability following eventual hook plate removal.

Step 5: Optional Coracoclavicular Augmentation

- Acute repair
  - The coracoclavicular sutures (nonabsorbable no. 5 suture or 5-mm suture tape) are passed under the coracoid.
  - The clavicle is held reduced to the acromion with direct downward push on the distal clavicle and upward pressure on the arm through the elbow.
  - Tie the sutures over the plate.

EQUIPMENT

- Articulating sterile arm holder
- Gel headrest
- Side pad

PITFALLS

- Keep the neck aligned in neutral rotation and flexion/extension position to protect the cervical spine and prevent brachial plexus injury.

PEARLS

- Drape high on the neck and inferior enough on the chest to have an adequate surgical field.
- If a difficult reduction is anticipated, drape the operative arm free.
- Position the shoulder in a way that imaging can be used if needed.

PEARLS

- An incision parallel to Langer's lines will heal with a very cosmetic scar.

PITFALLS

- An incision that is too lateral limits exposure of the clavicle.
- An incision that is too medial limits access to the acromion.
- A longitudinal incision in line with the clavicle, across Langer's lines, may heal with a thick, noncosmetic scar.

INSTRUMENTATION/IMPLANTATION

- Place a self-retaining retractor to hold the skin and subcutaneous tissue apart.

PEARLS

- Release enough capsule and soft tissue to facilitate anatomic reduction of the distal clavicle.
- Have a preoperative radiograph of the opposite side.

PITFALLS

- Avoid over-reduction of the AC joint: this leads to a painful, stiff shoulder with a high rate of subsequent mechanical failure (plate pull-off, acromial fracture) (Fig. 1.2)
- Excessive distal clavicle resection potentially destabilizes the acromioclavicular joint by releasing the acromioclavicular ligaments.

INSTRUMENTATION/IMPLANTATION

- Hook plate implants, including trials and definitive implants
- Newer hook plate designs provide a better fit to the undersurface of the acromion and may minimize complication and removal rates (Fig. 1.3).
- Power saw, osteotome or chisel for distal clavicle resection

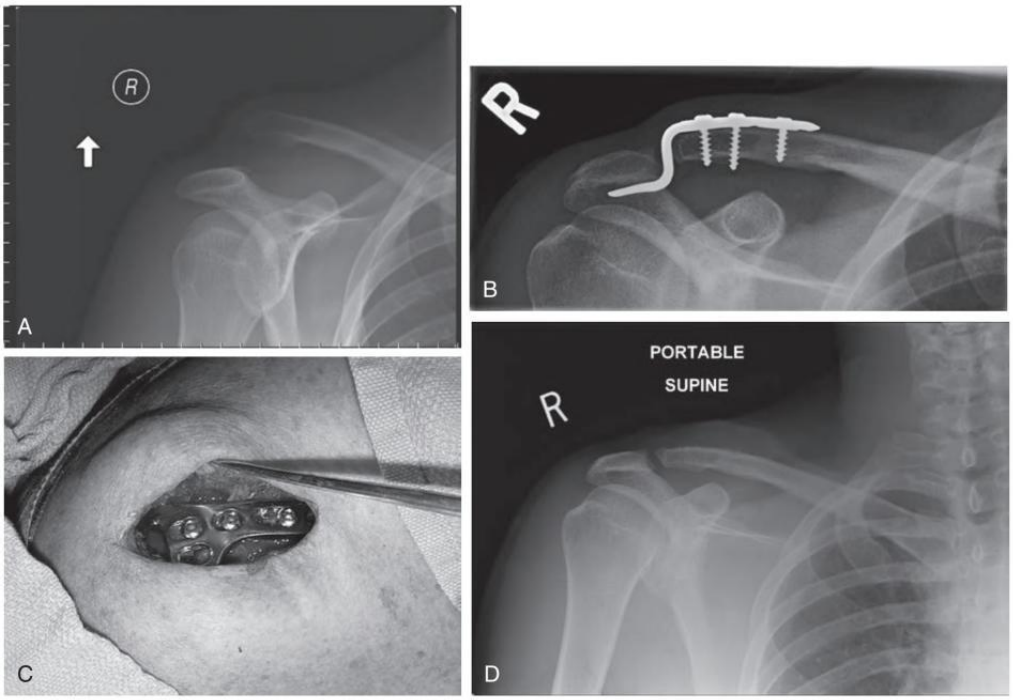

FIG. 1.1 Proper alignment and positioning of the hook plate results in rapid healing in an anatomic position.

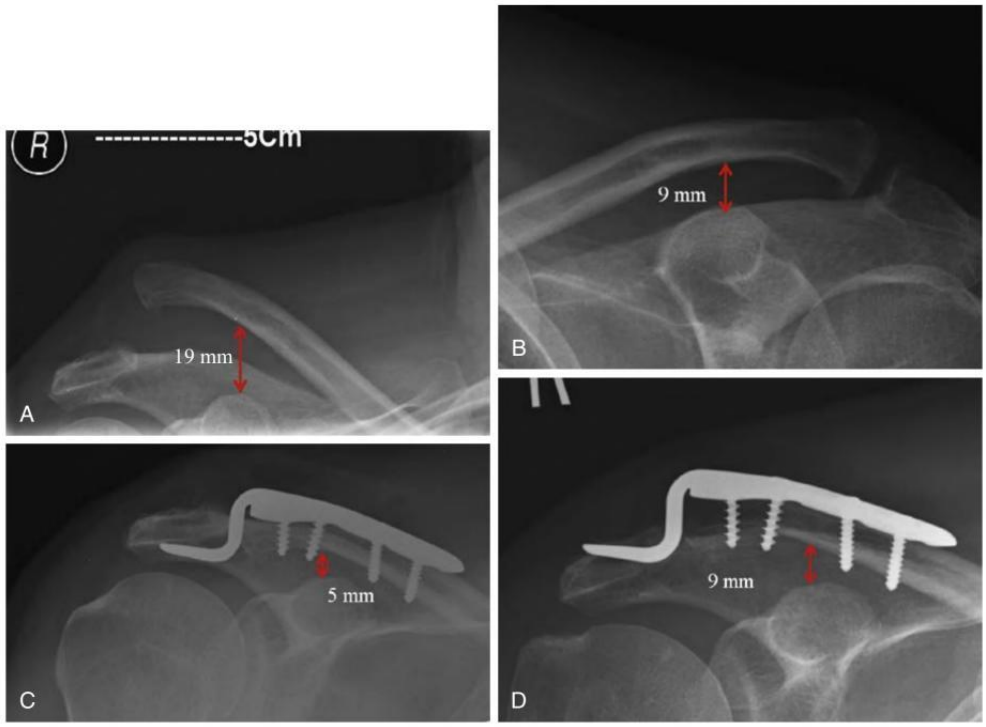

FIG. 1.2 Over reduction of the clavicle is to be avoided as it increases pain and can lead to acromial erosion of the hook.

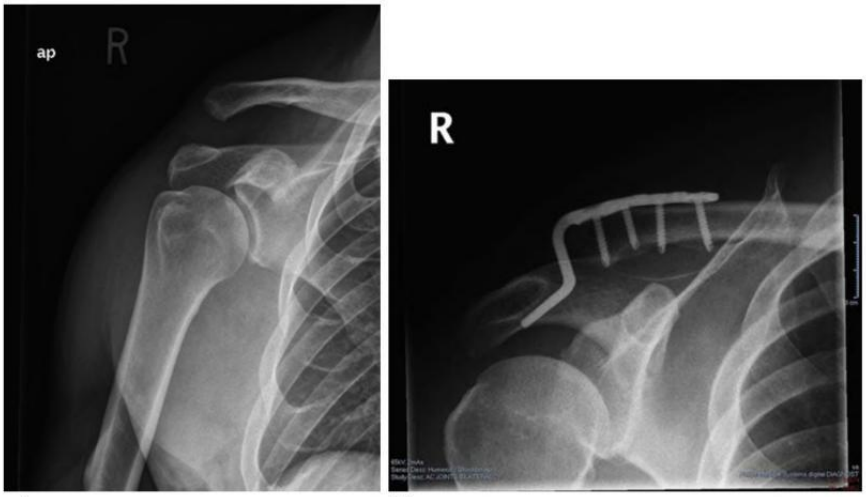

FIG. 1.3 The angle of the hook should match the usually sloped angle of the acromion.

- Chronic reconstruction
  - Tendon ends are prepared with passing sutures.
  - Tendon ends are passed under the coracoid.
  - The tendon ends are pulled up through clavicle drill holes or over the clavicle itself and tied into place. Avoid making the superior aspect of the graft too bulky: it will interfere with the hook plate placement.
  - Stability is then enhanced by the addition of the hook plate over top of the tendon graft. Once graft healing has occurred, typically 6 to 8 months postoperatively, the hook plate may be removed.

Step 6: Deltotrapezial and Acromioclavicular Repair

- The acromioclavicular ligaments and capsule are repaired over the acromioclavicular joint, incorporating the lateral extension of the tendon graft for a chronic reconstruction.
- The deltotrapezial fascia is sutured over the clavicle with nonabsorbable suture.

POSTOPERATIVE CARE AND EXPECTED OUTCOMES

- A sling is used to support the arm for 6 weeks.
- Physiotherapy protocol
  - 0–2 weeks: No shoulder motion is permitted.
  - 2–6 weeks: The sling is discontinued and supine passive and active assisted external rotation and scapular plane elevation is begun.
  - 6–12 weeks: Passive and active-assisted range of motion in all planes. Isometric deltoid and rotator cuff exercises below chest level are started.
  - >12 weeks: Progressive resisted exercises are begun.
  - 16 weeks: Return to sports is allowed if range of motion is full and strength is adequate.
  - Most patients attain a shoulder rating of 90+ after hook plate fixation of acute AC joint disruptions. The major complication rate is low, as long as over-reduction is avoided.
  - Most, but not all, patients require hook plate removal: it is recommended that the plate be left in place for at least 6 months prior to removal to allow adequate healing to occur to prevent re-displacement of the joint.

CONTROVERSIES

- Distal clavicle resection is controversial.
- Distal clavicle resection
  - May facilitate reduction
  - May prevent late acromioclavicular arthritis
  - At least partial resection is required for Weaver-Dunn procedure for ligament reattachment.
- Preserving the distal clavicle
  - May facilitate acromioclavicular ligament repair
  - May improve acromioclavicular joint stability
  - Isolated coracoclavicular ligament reconstruction does not require distal clavicle resection.

INSTRUMENTATION/IMPLANTATION

- Power drill or burr to make holes in the clavicle for suture and tendon passing

CONTROVERSIES

- Coracoclavicular fixation can be achieved with heavy sutures, acromioclavicular hook plate, coracoclavicular screw, transarticular acromioclavicular screw, or pins.
- When patient compliance is a concern, early motion is desired, or in a revision setting, the tendon graft is best supplemented with a hook plate.
- Supplementing the graft with hook plate has been shown to result in less displacement in biomechanical testing.

PEARLS

- Early motion is advantageous.

PITFALLS

- Overly aggressive early rehabilitation can lead to attenuation or failure of the repair or reconstruction.

EVIDENCE

Li X, Ma R, Bedi A, Dines DM, Altchek DW, Dines JS. Management of acromioclavicular joint injuries. *J Bone Joint Surg [Am]*. 2014;96:73–84.
A comprehensive review of modern treatment methods for acromioclavicular joint injuries.

Galpin RD, Hawkins RJ, Grainger RW. A comparative analysis of operative versus nonoperative treatment of grade III acromioclavicular separations. *Clin Orthop*. 1985;193:150–155.
This older retrospective review revealed that there was little improvement with surgical treatment of acute acromioclavicular joint injuries and recommended nonoperative treatment in general.

Gstettner C, Tauber M, Hitzl W, Resch H. Rockwood type III acromioclavicular dislocation: surgical versus conservative treatment. *J Shoulder Elbow Surg*. 2008;17:220–225.
A retrospective study (mean follow-up 34 months) of 24 patients treated surgically with a hook plate and 17 patients treated conservatively. The mean Constant score was 80.7 in the conservative group and 90.4 in the hook plate group. The mean coracoclavicular distance was 15.9 mm in the conservatively treated group and 12.1 mm in the surgically treated group. In this study, better results were achieved by surgical treatment with the hook plate than by conservative treatment.

Salem KH, Schmelz A. Treatment of Tossy III acromioclavicular joint injuries using hook plates and ligament suture. *J Orthop Trauma*. 2009;23:565–569.
A study of 25 patients revealed the hook plate was a reliable fixation tool for complete AC joint dislocations, ensuring immediate stability and allowing early mobilization with good functional and cosmetic results (mean Constant score 97 points).

Bannister GC, Wallace WA, Stableforth PG, Hutson MA. The management of acute acromioclavicular dislocation. A randomized prospective controlled trial. *J Bone Joint Surg*. 1989;71B(5):848–850.
This study of 60 patients failed to reveal any improvement with surgery, in general. The authors postulate that patients with severe displacement (>2 cm) may benefit from surgery.

von Heideken J, Windhamre HB, Une-larsson V, Ekelund A. Acute surgical treatment of acromioclavicular dislocation type V with a hook plate: superiority to late reconstruction. *J Shoulder Elbow Surg*. 2013;22:9–17.
Patients treated with acute surgery (22) had a more satisfactory outcome than those with late surgery (15) after failed conservative treatment.

Pauly S, Kraus N, Greiner S, Scheibel M. Prevalence and pattern of glenohumeral injuries among acute high-grade acromioclavicular joint instabilities. *J Shoulder Elbow Surg*. 2013;22:760–766.
A review of 125 patients with high grade AC joint injuries who underwent shoulder arthroscopy revealed a high rate of intra-articular glenohumeral pathology (30%).

Canadian Orthopaedic Trauma Society. Multicenter randomized clinical trial of nonoperative versus operative treatment of acute acromio-clavicular joint dislocation. *J Orthop Trauma*. 2015;29(11):479–487.
A clinical trial of 83 patients randomized to hook plate fixation versus nonoperative treatment. Although hook plate fixation resulted in superior radiographic alignment, it was not clinically superior to nonoperative treatment of acute complete dislocations of the acromioclavicular joint. Both groups improved from a significant level of initial disability to a good or excellent result (mean DASH score, 5–6; mean Constant score, 91–95 in both groups) at 2 years.

PROCEDURE 2

Sternoclavicular Joint Open Reduction and Internal Fixation

Marissa Bonyun and Aaron Nauth

INDICATIONS

- Acute posterior injuries of the sternoclavicular (SC) joint having symptoms consistent with mediastinal compromise (~30%) representing a life-threatening emergency (e.g., dysphagia, dyspnea, limb tingling, feeling of choking or venous congestion in the neck or ipsilateral arm)
- Failed closed reduction of posterior SC dislocations
- Chronic recurrence of posterior SC dislocations
- Recurrent subluxation and/or dislocation of anterior SC dislocations

Examination/Imaging

- A careful examination should be performed to asses for neurovascular injuries in addition to examination of the chest to identify any associated injuries (e.g., rib fractures, pneumothorax).
- Initial imaging should consist of plain radiographs of the chest and clavicle (Fig. 2. 1).
- Computed tomography scan (with intravenous contrast to assess the vasculature) is the gold standard for assessing injuries to the SC joint (Fig. 2.1).

SURGICAL ANATOMY

- Important structures include the medial aspect of the clavicle, the sternum, the SC ligaments, the subclavian vessels, the great vessels of the neck, the brachial plexus, the trachea, the esophagus, the vagus nerve, and the superior aspect of the pleura (Fig. 2.2).
- The medial physis of the clavicle closes between the ages of 22 and 25, and injuries to the SC joint in patients below this age often represent physeal injuries as opposed to true dislocations.
- The closest structure at risk is the brachiocephalic vein (which can be as close as 1 mm from the SC joint in anatomic studies; the mean distance from the SC joint is 6 mm) (see Fig. 2.1).

POSITIONING

- For closed reductions, the patient is positioned supine with a 3 to 4 inch thick pad placed between the scapulae.
- For acute (<72 hours) anterior dislocations of the SC joint, closed reduction can be attempted by providing conscious sedation to the patient and applying abduction, extension, and longitudinal traction to the arm combined with gentle, posterolateral pressure on the medial clavicle.
- For acute (<72 hours) posterior dislocations of the SC joint, closed reduction can be attempted by providing general anesthesia (for pain and muscle spasm) and applying abduction, extension, and longitudinal traction to the arm.
- If this is unsuccessful, the area over the SC joint can be prepared, and the medial end of the clavicle can be grasped percutaneously with a sharp towel clip to allow direct anterolateral manipulation of the medial clavicle in combination with the above maneuvers.
- For open reductions, the patient is positioned in a similar fashion and the SC joint and entire chest, as well as the affected arm are free draped.

INDICATIONS PITFALLS

- A large proportion of SC joint injuries in young patients (below age 25) are physeal fractures or pseudosubluxations (Salter-Harris I or II).
- Posterior SC joint injuries are frequently missed owing to their rare nature, the difficulty to diagnose them on plain radiographs, and their frequent occurrence in association with other significant, distracting traumatic injuries.
- Unreduced posterior dislocations are associated with complications including thoracic outlet syndrome, vascular compromise, and erosion of the medial clavicle into posterior vascular structures.

INDICATIONS CONTROVERSIES

- Controversy exists regarding open versus closed management of acute posterior SC joint dislocations.
- There is also controversy regarding nonoperative treatment versus closed reduction versus open reduction of acute anterior SC joint dislocations.

TREATMENT OPTIONS

- Acute anterior dislocations of the SC joint can be managed nonoperatively but should probably be reduced in most patients, if logistically possible and the patient has no contraindications to surgery. Treatment is with initial closed reduction followed by open reduction in those patients with recurrent instability.
- Acute posterior dislocations **with** symptoms of mediastinal compromise should be treated **emergently** with closed ± open reduction.
- Acute posterior dislocations **without** mediastinal symptoms should be treated urgently with closed ± open reduction.
- For posterior dislocations of the SC joint that are more than 72 hours old, fail closed reduction, or are unstable despite closed reduction, open reduction ± stabilization is indicated.
- Surgical options for stabilization of **acute** SC dislocations once reduction has been performed include:
  - No stabilization (i.e., closed or open reduction only)
  - Transosseous sutures or mersilene tape
  - Plate and screw fixation across the SC joint (with subsequent removal)
- Surgical options for stabilization of **chronic** or **recurrent** SC dislocations once reduction has been performed include:
  - Plate and screw fixation across the SC joint (with subsequent removal)
  - SC ligament reconstruction using autograft or allograft tendon

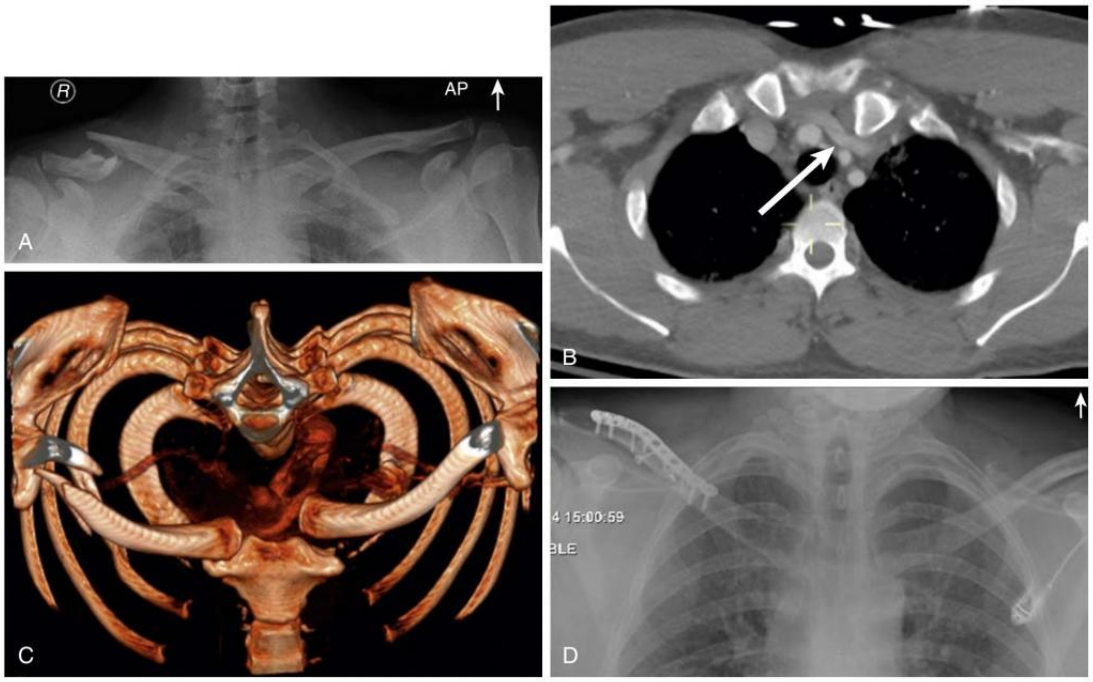

FIG. 2.1 AP chest radiograph, axial CT slice and 3D reconstruction of the thorax of a 32 year old male trauma patient involved in a motor vehicle accident. The images demonstrate a displaced right midshaft clavicle fracture and posterior dislocation of the left sternoclavicular joint (A-C). The white arrow demonstrates abutment of the posteriorly dislocated clavicle on the left brachiocephalic vein. Postoperative AP chest radiograph following ORIF of the right midshaft clavicle and open reduction and suture stabilization of the left posterior sternoclavicular dislocation (D). Prior to taking this patient to the operating room the on call cardiothoracic surgeon was notified about the procedure. The patient's surgery was uncomplicated and he had an excellent clinical outcome. Used with permission from Nauth A and McKee MD. Humerus and shoulder: fractures and nonunions. In Grauer J.N. and Ring D., Eds. *Orthopaedic Knowledge Update 12* (pp. 299–320), 2017. Rosemount, IL: AAOS.

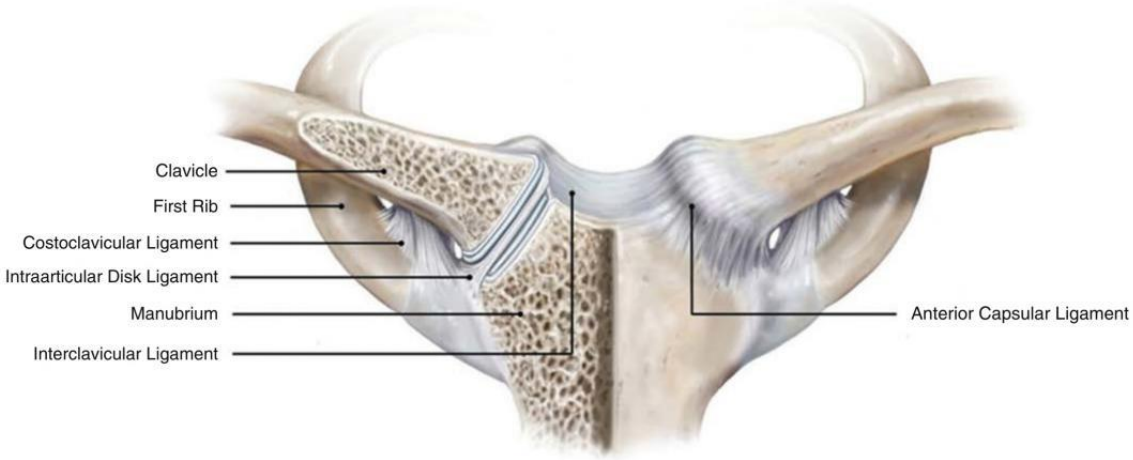

FIG. 2.2 Osseoligamentous anatomy of the sternoclavicular joint. Used with permission from Martetschlager F, Warth RJ, Millett PJ. Instability and degenerative arthritis of the sternoclavicular joint: a current concepts review. *Am J Sports Med.* 2014;42(4):999–1007.

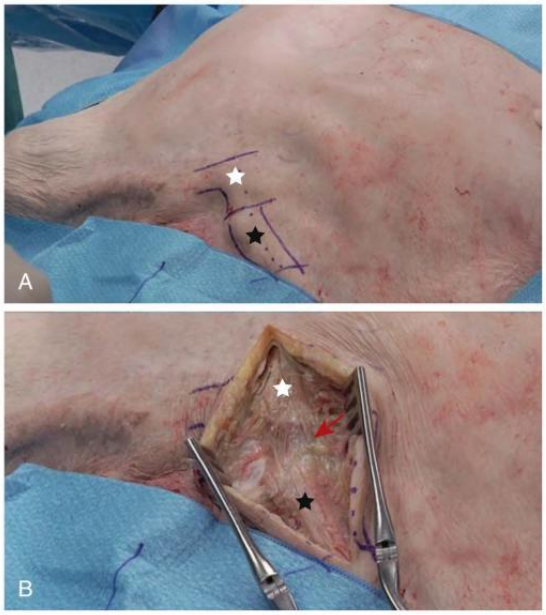

FIG. 2.3 Cadaveric photograph of the bony landmarks for exposure of the right SC Joint (A). For all cadveric photographs the right SC joint is viewed from the patient's right side with patient's head to the left of the photograph and their feet to the right. Cadaveric photograph of the exposed SC joint (B). White star = manubrium, black star = medial end of clavicle, red arrow = SC joint capsule.

PORTALS/EXPOSURES (VIDEO 2-1)

- For open reductions, mark out bony landmarks including the medial clavicle, sternal border, and SC joint (Fig. 2.3).
- A 5- to 10-cm skin incision is made directly over the medial clavicle, SC joint, and sternum.
- Often significant soft-tissue damage is seen in the vicinity of the SC joint; this should be identified and incorporated into the surgical approach.
- The SC joint capsule is exposed using electrocautery (**Fig. 2.3**).
- The periosteum and sternocleidomastoid muscle are dissected from the medial clavicle together as a continuous soft-tissue sleeve.
- A longitudinal split in the SC joint capsule is made and reflection superiorly and inferiorly is performed using electrocautery, thus allowing exposure of the SC joint.
- The intraarticular disk (which is usually torn or damaged in this setting) can be removed with careful sharp dissection.
- Further exposure of the medial clavicle and sternum can be carried out to allow the placement of malleable retractors or a Cobb elevator posterior to the sternum and clavicle to allow for safe suture/graft passage if a stabilization procedure is to be performed (Fig. 2.4).

PROCEDURE (VIDEO 2.1)

Step 1: Open Reduction of the SC Joint

- For posterior dislocations, the medial end of the clavicle will be seen to be displaced posteriorly and medially behind the sternum once the anterior capsule is reflected (Figs. 2.5 and 2.6).
- Reduction is performed by grasping the medial end of the clavicle with a small reduction forceps and applying traction and an anteriorly directed force (Figs. 2.5 and 2.6).
- Once reduction has been performed, stability of the SC joint should be assessed with a dynamic examination by moving the free-draped arm through a full range-of-motion.

POSITIONING PEARLS

- It is **critically important** to have a cardiothoracic surgeon notified and available prior to any attempt at closed or open reduction of a posterior SC joint dislocation.
- Draping of the entire chest is a necessary precaution should any cardiothoracic intervention be required.
- Free draping of the involved extremity allows for the application of traction to assist with reduction and dynamic intraoperative examination of SC joint stability once reduction ± stabilization has been performed.

PORTALS/EXPOSURES PEARLS

- The incision should be made parallel to the superior border of the medial clavicle, extending over the sternum.
- **Extreme care** should be carried out with any retrosternal dissection and/or instrument placement to avoid injury to the major vascular structures that are in close proximity to the SC joint.
- In the setting of a physeal injury (patients <25 years), take care to preserve the epiphysis, which will be retained within the SC joint.
- Careful repair of the anterior capsule can aid in maintaining stability of the SC joint.
- In the setting of chronic SC joint instability and painful degenerative changes, medial clavicle resection may be performed.

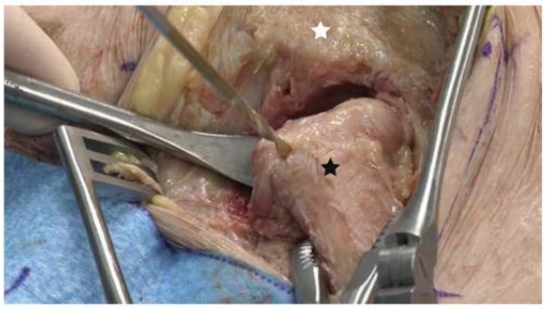

FIG. 2.4 Cadaveric photograph of the right SC Joint demonstrating placement of a cobb elevator posterior to the medial aspect of the clavicle to allow safe drilling of anterior to posterior bone tunnels. White star = manubrium, black star = medial end of clavicle.

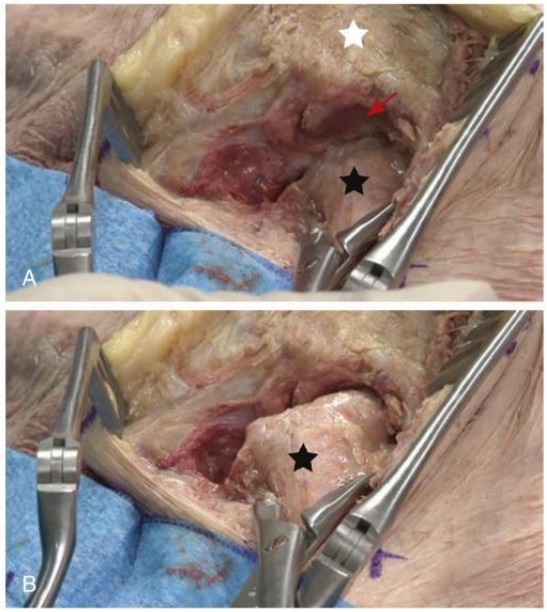

FIG. 2.5 Cadaveric photograph of the right SC Joint demonstrating posterior dislocation (A). Subsequent reduction of the SC joint using a small fragment reduction forcep to apply traction and anterior force to the medial aspect of the clavicle (B). White star = manubrium, black star = medial end of clavicle, red arrow = empty articular facet of the manubrium.

STEP 1 PITFALLS

- If there has been erosion or injury to any of the major vascular structures posteriorly, this is likely to become dramatically apparent at the time of reduction (although this is exceedingly rare, it is important that both the surgical and anesthetic teams are prepared for this potential life-threatening complication).

STEP 1 INSTRUMENTATION/ IMPLANTATION

- Small fragment reduction forceps

- If there is any instability of the SC joint, a stabilization procedure of some type should be carried out.

STEP 1 CONTROVERSIES

- There is relative controversy and a lack of high-level evidence regarding the need for surgical stabilization once an open reduction has been performed.
- One retrospective study showed a strong trend toward superior outcomes when open reduction was combined with a stabilization procedure.
- The preference of the authors is to perform a stabilization (most commonly with transosseous suture) in most cases once an open reduction has been performed.

Step 2: Technique 1: Suture or Autograft/Allograft Tendon Stabilization of the SC Joint

- Stabilization of the SC joint can be carried out by placing transosseous sutures or autograft/allograft tendon.
- A variety of suture/tendon configurations have been described; the authors prefer a figure-of-eight configuration using either mersilene tape suture (in the acute setting) or a combination of high tensile suture and autograft tendon (for reconstruction of the SC ligaments in the chronic setting):
  - If an autograft construct is planned, harvest the graft in a typical fashion using either semitendinosis autograft (authors' preference) or palmaris longus tendon (Fig. 2.7).
  - Two bone tunnels (2.5 mm for suture or 3.5 mm for tendon autograft) are drilled from anterior to posterior in the manubrium, medial to the sternal articular facet (Figs. 2.8–2.10).
  - Two bone tunnels (2.5 mm for suture or 3.5 mm for tendon autograft) are drilled at the medial end of the clavicle at the level of the condylar flare from anterior to posterior (see Figs. 2.8–2.10).
  - Suture and/or tendon autograft are passed through the holes in sequential fashion creating a figure-of-eight construct using either a blunt needle (mersilene) or a Hewson suture passer (tendon autograft) (see Figs. 2.8–2.10).