38 CHAPTER

MIDSHAFT CLAVICLE FRACTURE OPEN REDUCTION AND INTERNAL FIXATION

Sanjeev Bhatia | Joshua A. Greenspoon | Maximilian Petri | Peter J. Millett

CASE MINIMUM REQUIREMENTS

- There are no ACGME case minimum requirements for clavicle fracture fixation.

COMMONLY USED CPT CODES

- CPT Code: 23515—Clavicle fracture open reduction and internal fixation

COMMONLY USED ICD9 CODES

- 810.0—Clavicle fracture

COMMONLY USED ICD10 CODES

- S42.021A—Displaced fracture of shaft of right clavicle
- S42.022A—Displaced fracture of shaft of left clavicle, initial encounter for closed fracture
- S42.023A—Displaced fracture of shaft of unspecified clavicle, initial encounter for closed fracture
- S42.024A—Nondisplaced fracture of shaft of right clavicle, initial encounter for closed fracture
- S42.025A—Nondisplaced fracture of shaft of left clavicle, initial encounter for closed fracture
- S42.026A—Nondisplaced fracture of shaft of unspecified clavicle, initial encounter for closed fracture

Clavicle fractures are extremely common and comprise 2.6% to 5% of all fractures in adults, with midshaft injuries accounting for almost 75% of all fracture types. Clavicle fractures typically occur when an axial load is applied to the bone, usually in the form of a sudden point load to the apex of the shoulder. When these fractures displace, the proximal fragment generally is pulled superiorly by the sternocleidomastoid muscle while the distal fragment is pulled laterally by the weight of the arm.

Most nondisplaced or minimally displaced clavicular fractures can be managed nonsurgically simply by placing the arm in a sling. In these instances, the nonunion and malunion rates are extremely low. However, when midshaft clavicular fractures present with complete displacement or significant shortening, the risk of nonunion is significantly higher with conservative management. The surgical decision making remains a matter of debate. At present, the only absolute indications for surgical treatment of clavicular fractures include open injuries and fractures associated with evolving skin compromise. Relative indications for open reduction and internal fixation of midshaft clavicular fractures include injuries with 15 to 20 mm of shortening, completely displaced fractures, fractures with significant comminution, floating shoulder injuries that involve a concomitant glenoid neck fracture, painful nonunions, and midshaft clavicular fractures in certain multisystem trauma cases.

Depending on fracture morphology, either closed or open reduction and intramedullary pin fixation or open reduction and plate fixation can be performed. Biomechanically, both methods provide similar repair strength for middle-third clavicle fractures. After hardware removal, clavicles previously treated with intramedullary fixation were shown to be stronger than those treated with plate fixation. Clinically, open reduction and internal fixation of clavicular fractures has shown marked success for union in a relatively predictable time frame with low complications. Intramedullary fixation offers the advantage of smaller scars and lower refracture potential but also bears the potential risk of hardware prominence and a slightly higher incidence of nonunion. General principles for a successful surgical outcome involve minimizing soft tissue disruption and periosteal stripping as much as possible during exposure, achieving an anatomic reduction, and preventing hardware irritation and wound complications as much as possible with appropriate soft tissue hardware coverage. Either dynamic compression plates or locked plating constructs can be used, depending on bone quality and fracture type. In general, the plate is placed on the anterosuperior, or tension side, of the clavicle to result in the most biomechanically sound construct.

SURGICAL TECHNIQUE

Room Set-Up

- The operating room table likely is rotated from the initial position to allow ease in accessing the shoulder.
- Fluoroscopy should be positioned over the top and from the cephalad portion of the operating room bed. Be sure to confirm that an anteroposterior view and 45 degree cephalic/caudad tilt views are possible before draping.

Patient Positioning

- The patient is placed in the modified beach chair position (Fig. 38-1).
- The ipsilateral arm can be positioned in a specialized arm holder or can simply be secured over the belly.
- A bump underneath the medial border of the ipsilateral scapula is helpful for achieving better length at the fracture site.

Prepping and Draping

- The clavicle is prepped and draped in a sterile fashion.
- Wide draping is used so distal and proximal clavicular ends are free and accessible (Fig. 38-2).

Incision Placement

- A straight horizontal incision is created approximately 10 mm inferior to the anterior border of the clavicular fracture site (Figs. 38-3 and 38-4). This is done to reduce the likelihood of wound complications arising from an incision directly over the anterosuperior clavicular plate.
- Alternatively, a superior incision can be created directly on top of the clavicle. This incision can either be straight or slightly S-shaped, following the contour of the clavicle.

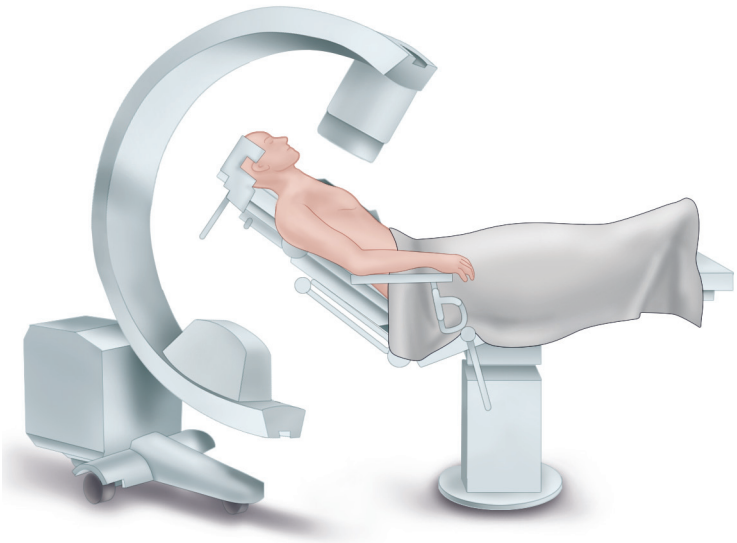

Figure 38-1 C-arm positioning for a midshaft clavicle fracture.

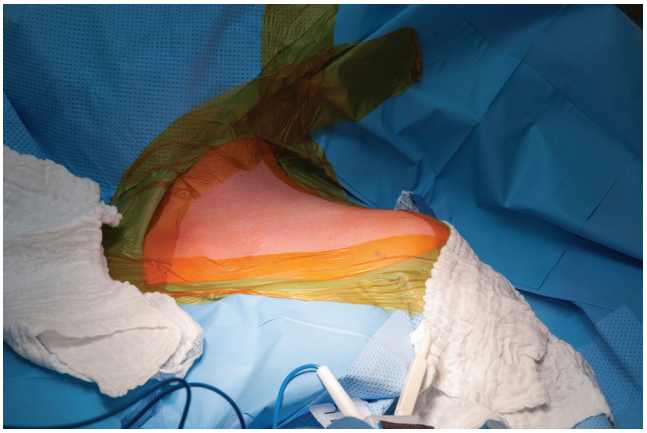

Figure 38-2 The clavicle is prepped and draped in a sterile fashion. It is important to drape widely so that both the proximal and distal clavicular ends are accessible.

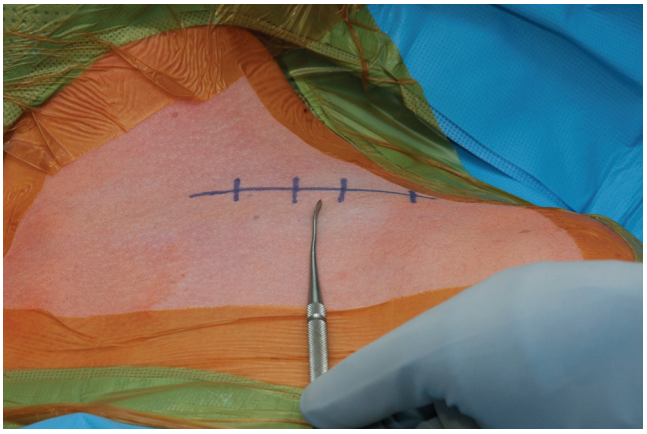

Figure 38-4 A straight horizontal incision is planned to expose the clavicle. The incision can either be made inferior to the anterior border of the clavicle or directly superficial to the clavicle.

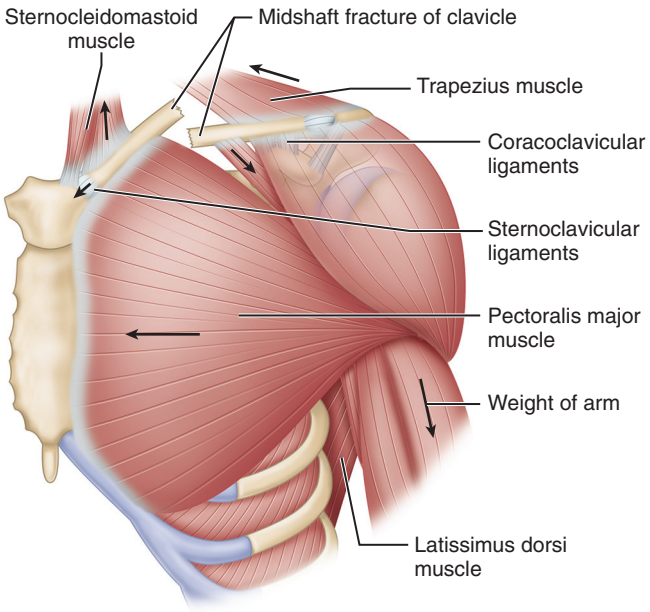

Figure 38-3 Anatomy of a midshaft clavicle fracture with displacing forces. The medial segment is displaced superiorly by the sternocleidomastoid and superiorly/posteriorly by the trapezius, and the lateral segment is displaced anteriorly and rotated inferiorly by the weight of the arm and is displaced medially by the pectoralis major and latissimus dorsi muscles (acting through the humerus).

Figure 38-5 Superficial dissection is performed carefully to preserve the supraclavicular nerves (pointed to with pickups), which typically run superoinferiorly along the transverse incision.

Exposure of Clavicle and Fracture Site

- After the skin is incised, subcutaneous dissection should be bluntly performed to identify the supraclavicular nerves, which typically run superoinferiorly along the transverse incision (Fig. 38-5).
- Supraclavicular nerves should be protected when possible to prevent numbness over the anterior chest wall or painful dysthesias from developing.
- The platysma layer is encountered next and should be sharply incised along the anterior border to facilitate preservation of this layer for closure at the conclusion of the case.
- The fracture can be further exposed with a #15 blade scalpel, small curettes, and periosteal elevators (Fig. 38-6).

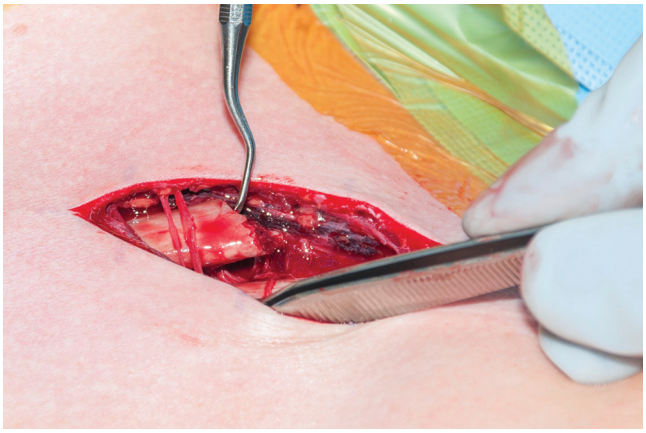

Figure 38-6 The clavicle fracture is exposed.

- Evaluation for concomittant muscle damage and perforation of the trapezial fascia is important.

Fracture Reduction

- Most midshaft clavicle fractures involve a spiral oblique pattern with a butterfly fragment.
- Length can be achieved on the fracture by gently extending the shoulder and arm.
- Pointed tenaculum clamps should be used for fracture reduction.
- K-wires are helpful to gain reduction.
- Reduction then can be maintained with a racking half-hitch cerclage suture because this obviates provisional fixation devices that block or restrict placement of the definitive plate fixation (see Millett PJ. *Plate fixation of midshaft clavicle fractures.* VuMedi-video, www.vumedi.com/video/plate-fixation-of-midshaft-clavicle-fractures-2/).
- In cases in which a large butterfly fragment is present, it can be joined with either the proximal or distal end with a mini-frag screw and plate construct, although the authors prefer to simply cerclage this with #2 Vicryl (Ethicon, Cincinnati, OH) sutures.
- If the fracture has a long oblique pattern, one to two lag screws (2.7-mm or 3.5-mm) may be placed perpendicular to the fracture site.
- Preliminary reduction can be held in place by lag screws, strategically placed pointed tenaculum clamps, racking half-hitch nonabsorbable suture, or a K-wire.
- In cases of severe comminution, bridge plating should be used.

Plate Fixation

- A 3.5-mm dynamic compression plate is generally preferred in most individuals, although a 2.7-mm dynamic compression plate may be used in younger patients.
- Locking plates are preferred in situations in which fixed angle construct stability is desired, such as excessive comminution or poor quality bone.
- A general rule of thumb is to place at least six cortices of purchase on either side of the fracture. More cortical sites of fixation may be desired in osteoporotic bone or when excessive comminution exists. In such cases, it is preferable to have eight cortices.
- The most biomechanically sound position for plate placement is on the anterosuperior or tension side of the clavicle fracture (Fig. 38-7), although superior placement is preferred with precontoured plates because they fit better in this location.
- Manual contouring of the clavicle plate may be necessary even if it has already been precontoured. Provisionally fixing the plate medially and laterally with K-wires or plate holding clamps ensures that the plate aligns properly.

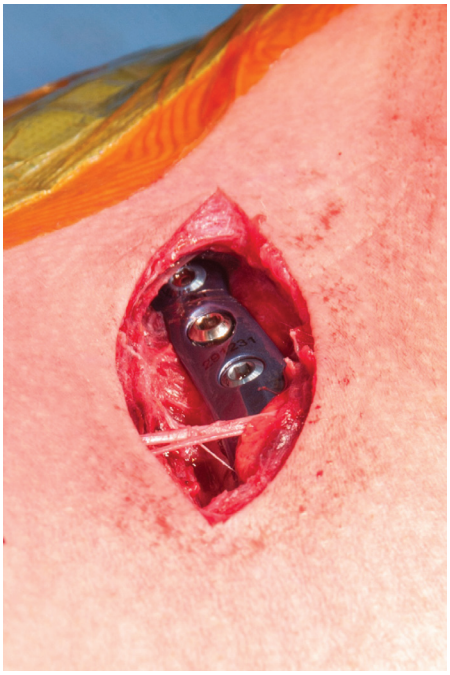

Figure 38-7 The plate should be placed on the anterosuperior side, or tension side, of the clavicle fracture because this is the most biomechanically sound position. If the supraclavicular nerve is in the way, the plate should be slid underneath it.

Figure 38-8 When drilling into the clavicle, avoid plunging inferiorly to prevent vascular damage. Use both hands to optimize control and to prevent overshooting of the drill bit.

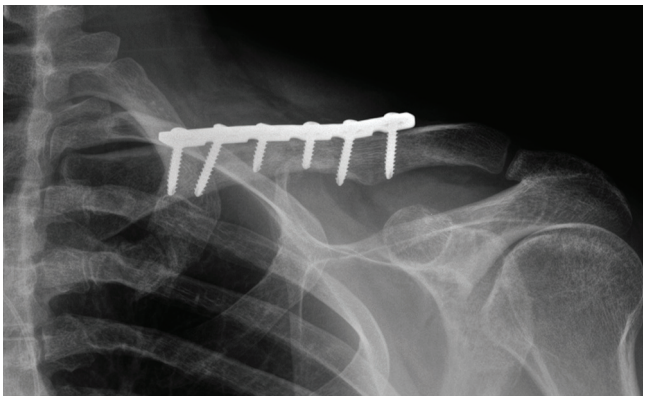

Figure 38-9 Postoperative x-ray of a midshaft clavicle fracture after open reduction and internal fixation.

- When drilling into the clavicle, avoid plunging inferior to the clavicle to prevent vascular injury (Fig. 38-8). This is most important in the medial third of the clavicle.
- Confirm appropriate screw length with depth gauge and fluoroscopy.
- Figure 38-9 shows postoperative x-ray of a midshaft clavicle fracture after open reduction and internal fixation.

Wound Closure

- The platysma layer should be carefully closed over all areas of the plate with a 0 Vicryl suture (Fig. 38-10). This is followed by a 2-0 Vicryl for the subcutaneous layer placed in an inverted, interrupted fashion. The epidermis is reapproximated with a running, subcuticular monofilament suture such as an absorbable 4-0 Monocryl (Ethicon, Cincinnati, OH).

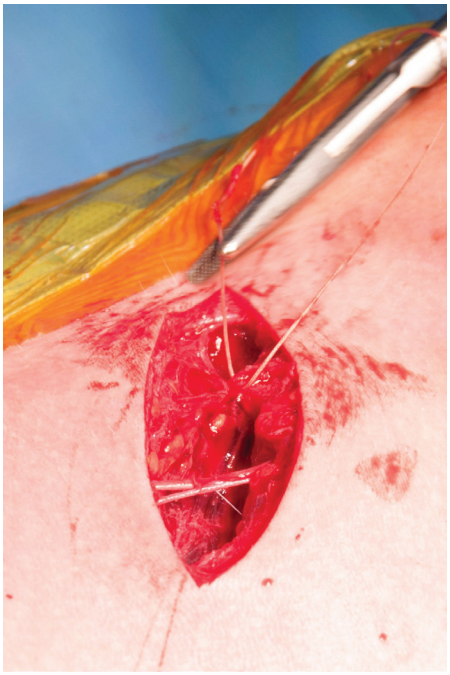

Figure 38-10 The platysma layer is carefully closed with an interrupted figure-of-8 stitch.

BRIEF SUMMARY OF SURGICAL STEPS

- Skin incision
- Exposure of clavicle
- Exposure of fracture site and removal of callus or hematoma
- Fracture reduction with or without lag screws or cerclage sutures to reconstitute the "tube"
- Placement of plate over fracture site with at least six cortices of fixation on either side of fracture
- Wound closure

REQUIRED EQUIPMENT

Appropriately sized anterosuperior 3.5-mm or 2.7-mm precontoured clavicular plate

2.7-mm lag screws

Fluoroscopy

Pointed tenaculum bone clamps

K-wires

TECHNICAL PEARLS

- Make an incision 1 cm distal to the anterior border of the clavicle to avoid placing the wound directly over the clavicular plate
- Look out for the supraclavicular nerve in the subcutaneous layer
- Incise the platysma sharply to allow for a clean layer for closure
- Use a pointed reduction clamp
- Use a 2.7-mm or 3.5-mm lag screw if the fracture pattern has a long oblique component to it
- If a large butterfly fragment exists, a mini-frag screw set may be helpful for reduction or cerclage sutures
- Do not plunge when drilling to avoid neurovascular injury

COMMON PITFALLS

(When to call for the attending physician)

- Inadvertently cutting of the supraclavicular nerve when it is avoidable
- Excessive soft tissue and periosteal stripping, which unnecessarily compromises healing
- Failure to achieve reduction
- Not centering the plate directly over the clavicle on both sides of the fracture
- Poor soft tissue coverage of the plate during wound closure

POSTOPERATIVE PROTOCOL

A sling is applied immediately after the surgery in an effort to reduce tension on the fracture site. Pendulums can be performed, but more aggressive range of motion is not necessary initially. The patient should be seen 1 week after surgery for clinical and radiographic follow-up. Full passive and active-assisted range of motion can be initiated at this point and should continue until 6 weeks after surgery. The patient then should begin more aggressive active range of motion and light lifting. Twelve weeks after surgery is typically when all restrictions are lifted, assuming radiographs show good healing of the fracture site.

POSTOPERATIVE CLINIC VISIT PROTOCOL

Patients are scheduled to return to the clinic for follow-up visits at 1 to 2 weeks, 6 to 8 weeks, and 12 weeks.

SUGGESTED READINGS

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