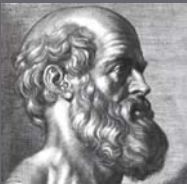


Clavicle Fractures Midshaft

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Midshaft Clavicle Fractures



When, then, a [clavicle] fracture has recently taken place, the patients attach much importance to it, as supposing the mischief greater than it really is, and the physicians bestow great pains in order that it may be properly bandaged; but in a little time the patients, having no pain, nor finding any impediment to their walking or eating, become negligent; and the physicians finding they cannot make the parts look well, take themselves off, and are not sorry at the neglect of the patient

Healing is still the rule rather than the exception



Clavicle Fractures

Clavicular fractures account for 5% to 10% of all fractures and 35% to 45% of shoulder girdle injuries. Traditionally, this was a non-operative case unless open (pending open), neuro-vascular issues or floating shoulder.



Clavicle Classification

- ❑ 1. Classification of lateral-third clavicular fractures is based on the integrity of the coracoclavicular ligament complex.
- ❑ 2. Midshaft fractures present with varying amounts of displacement and comminution.
- ❑ 3. Medial fractures are classified according to displacement and involvement of the SC joint.

	Lateral Third	Midshaft	Medial
	12% to 15%	80%	5% to 6%
A			
B			
C			

Midshaft Clavicle Fracture

- Questions to be answered.
 - Should they be fixed at all and if so when?
 - In whom should they be fixed
 - What is the best method of fixation



Standard Diagnostic Views

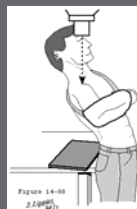
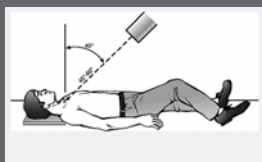
AP view of the clavicle

45° cephalic tilt view to evaluate superior/inferior or displacement

45° caudal tilt view to better evaluate displacement in the AP plane

CT rarely needed but are plain films

Are Plain Films able to determine displacement?



Plain film measurement error in acute displaced midshaft clavicle fractures

A review of 22 patients. Bland-Altman repeatability coefficient calculations indicated that radiograph and CT measurements of shortening could not be correlated owing to an unacceptable amount of measurement error (6 cm).

Can J Surg. 2016 Sep;59(5):311-6.
Plain film measurement error in acute displaced midshaft clavicle fractures. Archer LA1, Hunt SI, Squire DL, Moores CJ, Stone CJ, O'Dea FI, Furey AJ.

Measuring the Damage

- For **injured** clavicles, radiographic measurements significantly overestimated the clavicular length by a mean of 8.2 mm when compared to CT.

Measurement of Clavicle Fracture Shortening Using Computed Tomography and Chest Radiography
Clin Orthop Surg. 2016 Dec; 8(4): 367-372.
2016 Nov 4. Reza Omid, MD, Chris Kidd, MD, Anthony Yi, MD, Diego Villacis, MD, and Eric White, MD

The Traditional NO fix Hippocratic way

- Nordqvist and colleagues failed to demonstrate an association between shortening and functional shoulder outcome in a review of 71 patients with clavicle fractures.

Nordqvist A, Redlund-Johnell I, von Scheele A, et al. Shortening of clavicle after fracture. Incidence and clinical significance, a 5-year follow-up of 85 patients. Acta Orthop Scand. 1997;68:349-51.

More No Fix

- Oroko and colleagues found that shortening of the clavicle had no functional impact in 41 patients when evaluated 3 or more months after clavicle fracture.

Oroko PK, Buchan M, Winkler A, et al. Does shortening matter after clavicular fractures? Bull Hosp Jt Dis. 1999;58:6-8

No Fix with an Advisory

- ▣ Robinson could not demonstrate an improvement in shoulder function associated with ORIF of displaced midshaft fractures compared with fractures treated non-operatively in the absence of nonunion, suggesting that the benefit to ORIF lies in the decreased incidence of nonunion and not prevention of malunion.

Robinson CM, Goudie E, Murray I, et al. Open reduction and plate fixation versus nonoperative treatment for displaced midshaft clavicular fractures: a multicenter, randomized, controlled trial. J Bone Joint Surg Am. 2013;95:1576-84

Adding malunion to the mix

- ▣ Multiple high-level randomized controlled trials showed substantially improved function and decreased rates of nonunion or symptomatic mal-union (pain, weakness, fatigability, numbness, or paresthesias in the affected arm) after surgery for substantially displaced fractures of the clavicle in carefully selected young, healthy, active patients.

What happens with a Malunion

- ▣ A cross-sectional study of 16 patients showed statistically significant loss of adduction, internal rotation and extension strength in shoulders with clavicle malunions (defined as shortening ≥ 15 mm as compared with the normal side measured on CT scan). The authors also demonstrated abnormal relationships of the sternoclavicular joint and increased scapular anteversion with clavicle malunions. A second biomechanical study of 12 cadaveric shoulders demonstrated decreased posterior tilt and external rotation of the scapula during shoulder motion with more than 10% shortening of the clavicle.

Malunion Issues

- ❑ Ledger M, Leeks N, Ackland T, et al. Short malunions of the clavicle: an anatomic and functional study. J Shoulder Elbow Surg. 2005;14:349-54
- ❑ Matsumura N, Ikegami H, Nakamichi N, et al. Effect of shortening deformity of the clavicle on scapular kinematics: a cadaveric study. Am J Sports Med. 2010;38:1000-6

More fuel on the fire to fix for preventing malunions or non-unions.

- ❑ Canadian Orthopaedic Trauma Society: Nonoperative treatment compared with plate fixation of displaced midshaft clavicular fractures: A multicenter, randomized clinical trial. J Bone Joint Surg Am 2007;89(1):1-10. Medline
- ❑ Virtanen KJ, Remes V, Pajarinen J, Savolainen V, Björkenheim JM, Paavola M: Sling compared with plate osteosynthesis for treatment of displaced midshaft clavicular fractures: A randomized clinical trial. J Bone Joint Surg Am 2012;94(17):1546-1553. Medline
- ❑ Robinson CM, Goudie EB, Murray IR, et al: Open reduction and plate fixation versus nonoperative treatment for displaced midshaft clavicular fractures: A multicenter, randomized, controlled trial. J Bone Joint Surg Am 2013;95(17):1576-1584. Medline

Meta-analysis

- ❑ A meta-analysis of six randomized studies with 412 patients compared surgical and nonsurgical management of acute displaced fractures of the clavicle. ORIF was found to result in significantly lower rates of nonunion and symptomatic malunion compared with nonsurgical treatment (combined nonunion-symptomatic malunion rate, 1.4% with surgery versus 23% without surgery).

Meta Analysis

- McKee RC, Whelan DB, Schemitsch EH, McKee MD: Operative versus nonoperative care of displaced midshaft clavicular fractures: A meta-analysis of randomized clinical trials. J Bone Joint Surg Am 2012;94(8):675-684.

What the literature supports ORIF is preventative for Nonunions and Malunions in significantly displaced clavicle fractures The NEXT questions

- What is a significantly displaced clavicle fracture?
- Do the benefits outweigh the risks?
- How should we fix them when we decided to do so?

2 cm isn't new news

- Hill and colleagues identified initial shortening of 20 mm or greater to be significantly correlated with risk of nonunion through their cross-sectional study of 242 patients with clavicle fractures.

Hill JM, McGuire MH, Crosby LA. Closed treatment of displaced middle-third fractures of the clavicle gives poor results. J Bone Joint Surg Br. 1997;79:537-9

The Modern Mendoza Line

- More than 1.5 to 2 cm of shortening through the fracture site after nonsurgical treatment was **predictive of both nonunion and symptomatic malunion.**

McKee MD, Pedersen EM, Jones C, et al: Deficits following nonoperative treatment of displaced midshaft clavicular fractures. *J Bone Joint Surg Am* 2006;88(1):35-40. Medline

Locking in on 2cm

- A randomized control trial by Altamimi and McKee, demonstrated significantly superior outcomes when operative therapy was selected for acute DMCF (10-point improvement in both mean **DASH and mean Constant scores** for operatively treated patients). Substantial additional literature supports accepting **20 mm** or more of shortening in an acute DMCF as a **relative, and potentially absolute, indication for ORIF.**

The Literature

- Altamimi SA, McKee MD. Nonoperative treatment compared with plate fixation of displaced midshaft clavicular fractures. *Surgical technique.* *J Bone Joint Surg Am.* 2008;90(Suppl 2):1-8. [PubMed]
- Jeray KJ. Acute midshaft clavicular fracture. *J Am Acad Orthop Surg.* 2007;15:239-48. [PubMed]
- McKee MD, Pedersen EM, Jones C, et al. Deficits following nonoperative treatment of displaced midshaft clavicular fractures. *J Bone Joint Surg Am.* 2006;88:35-40. [PubMed]
- Wick M, Müller EJ, Kollig E, et al. Midshaft fractures of the clavicle with a shortening of more than 2 cm predispose to nonunion. *Arch Orthop Trauma Surg.* 2001;121:207-11. [PubMed]
- Browner B, Jupiter J, Levine A, et al, editors. *Skeletal trauma: basic science, management and reconstruction.* 4th ed. Philadelphia, PA: W.B. Saunders Company; 2008.
- McKee MD, Wildt LM, Schemitsch EH. Midshaft malunions of the clavicle. *J Bone Joint Surg Am.* 2003;85-A:790-7.
- Buchholz RW, Heckman JD, Court-Brown CM, editors. *Rockwood & Green's fractures in adults,* 6th edition. 6th ed. Lippincott Williams & Wilkins; 2006.
- Böstman O, Manninen M, Pihlajamäki H. Complications of plate fixation in fresh displaced midclavicular fractures. *J Trauma.* 1997;43:778-83.

Reported Risks

- ❑ Hardware prominence ~30% of patient request plate removal
- ❑ Superior plates associated with increased irritation
- ❑ Neurovascular injury (3%)
- ❑ Superior plates associated with increased risk of subclavian artery or vein penetration
- ❑ Subclavian thrombosis
- ❑ Nonunion (1-5%)
- ❑ Infection (~4.8%)
- ❑ Mechanical failure (~1.4%)
- ❑ Pneumothorax ?
- ❑ Adhesive capsulitis (4%)

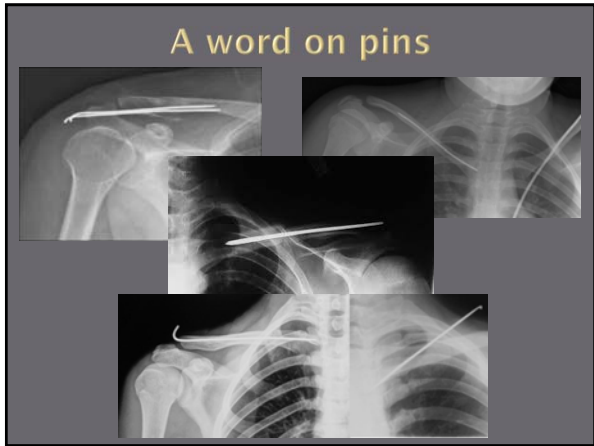
At 2cm the benefits outweigh the risks

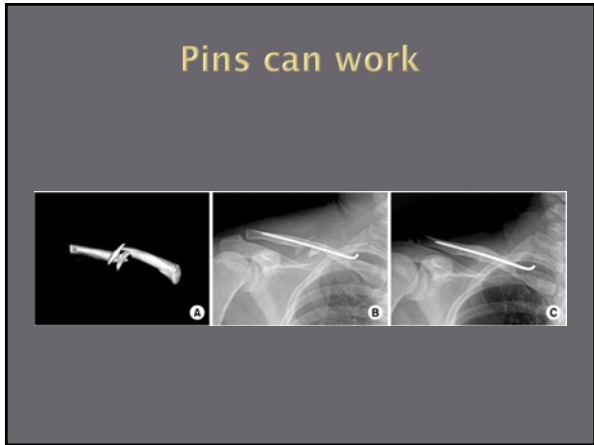
- ❑ Recent evidence suggests that the risks of surgical treatment may be outweighed by functional and financial benefits for patients with mid-shaft clavicle fractures shortened 20 mm or more.

Althausen PL, Shannon S, Lu M, et al. Clinical and financial comparison of operative and non-operative treatment of displaced clavicle fractures. J Shoulder Elbow Surg. 2013;22:608-11

Your going in...







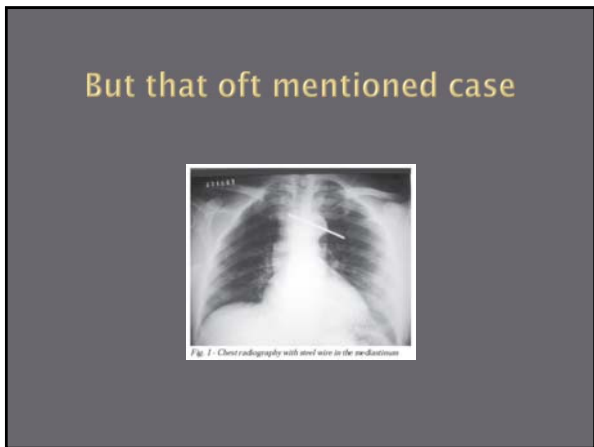


Plate or Nail

- Two randomized studies compared the use of plating and intramedullary nailing for displaced fractures of the mid-shaft clavicle. A study of 120 patients with a displaced clavicle fracture who were randomly assigned to surgical stabilization with a titanium elastic nail or standard plating found no substantial differences in function or complication rates at 6 month follow-up. The patients treated with **plating had substantially more rapid improvement in shoulder function during the first 6 months of recovery.**

Van der Meijden OA, Houwert RM, Hulsmans M, et al. : Plate or intramedullary nail fixation? A randomized controlled trial. J Bone Joint Surg Am 2015;97(8):613- 619.

- Single, superiorly placed reconstruction plate compared with flexible intramedullary nailing for mid-shaft clavicular fractures: A prospective, randomized controlled trial. This randomized study of 59 patients compared plate fixation with elastic intramedullary nail fixation for displaced fractures of the mid-shaft clavicle. **There were no substantial between-group differences. Level of evidence: I.**

Andrade-Silva FB, Kojima KE, Joeris A, Santos Silva J, Mattar R Jr J Bone Joint Surg Am 2015;97(8):620- 626.

What about Non Unions

- Non-union of the clavicle was reliably treated with compression plating, with the addition of bone grafting if there was evidence of atrophic nonunion.

Endrizzi DP, White RR, Babikian GM, Old AB: Non- union of the clavicle treated with plate fixation: A review of forty-seven consecutive cases. J Shoulder Elbow Surg 2008;17(6):951-953. Medline

Malunion Fix

- ▣ Patients with a symptomatic malunion may have pain, weakness, fatigability, numbness, or paresthesias in the affected arm. Symptomatic malunion can be effectively treated with corrective osteotomy and compression plating.

McKee MD, Wild LM, Schemitsch EH: Midshaft malunions of the clavicle. J Bone Joint Surg Am 2003;85(5):790-797

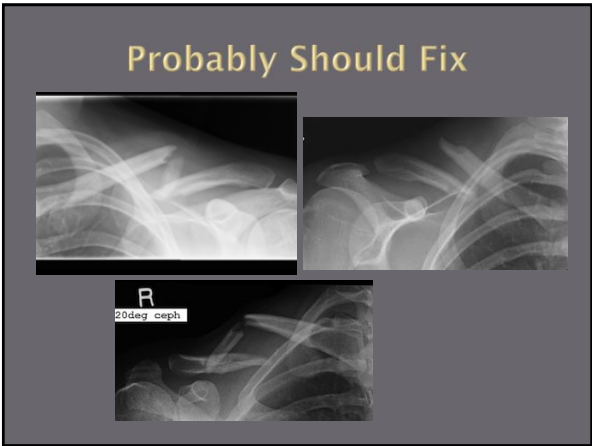
What I do

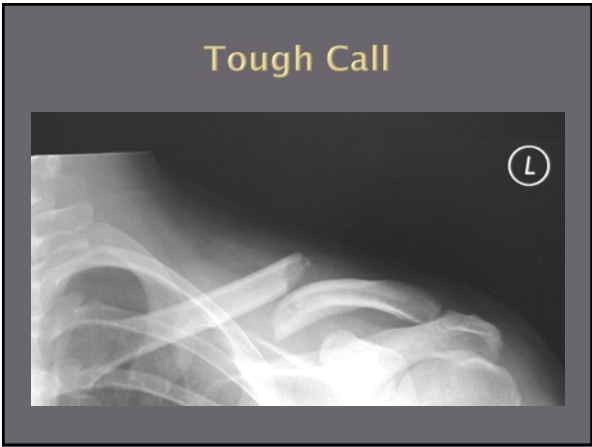


Likely observe

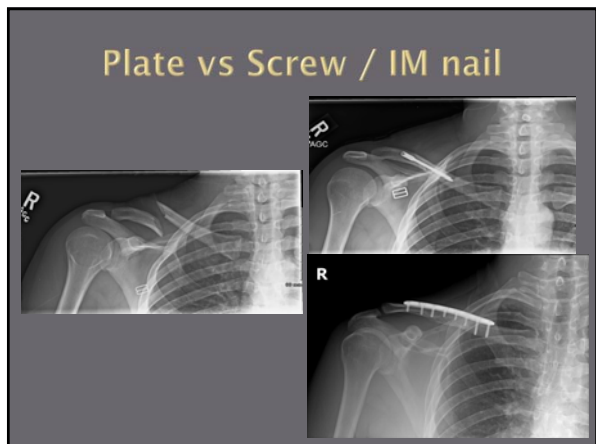
Leave Alone









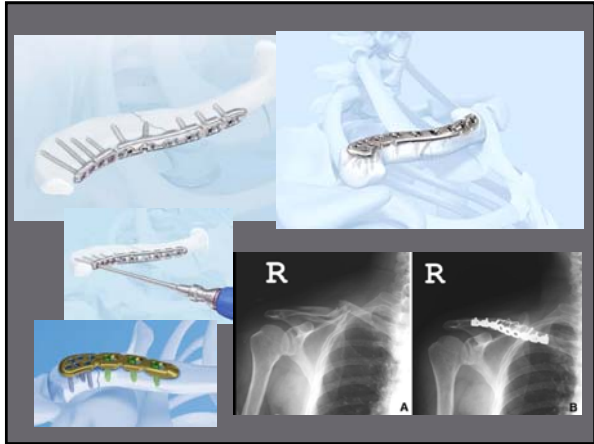


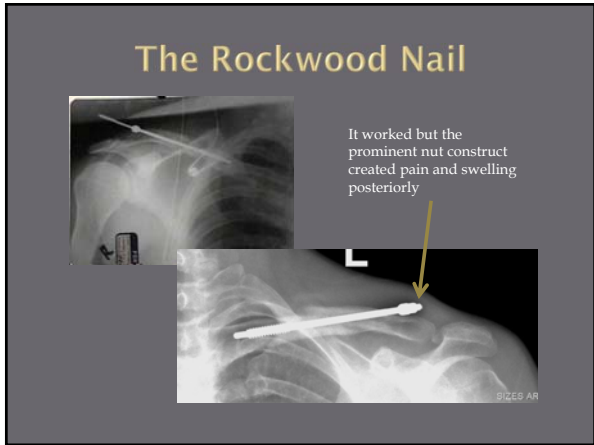
Plates

- More stable
- Comminution** (lag in small fragments)
- Thin females tend to dislike their scars and plate prominence (30-40% request removal)
- Infections are a nightmare (5%)

Top or Front Clavicle Plating

- Front to back is safer as drills to not target subclavian N/V structures
- Top plates are **mechanically stronger**
- Locking plates helpful for the poor bone quality found laterally
- Lag screw** very effective when it can be employed.
- Plates best for comminuted patterns...**in my opinion**







Clavicle Screws



Fast, small incisions, cosmetic, may be less effective with comminuted patterns?

I wonder about cerclage sutures for comminuted fragments causing AVN and resorption



The Odd Case C spine fractures in Halo



Rehabilitation concerns led us to fix both clavicles

Literature Supports

- ▣ Surgery is indicated for **open** midshaft clavicular fractures or fractures with subclavian neurovascular injuries. Relative indications for surgery include **skin compromise** or tenting, and a displaced mid-shaft clavicular **fracture associated with a scapular neck fracture or double disruption of the shoulder suspensory mechanism.**
- ▣ **Fractures with 100% displacement and 2 cm or more of shortening do better with ORIF particularly in younger patients.**
- ▣ For displaced mid-shaft clavicular fractures associated with flail chest, surgery facilitates pulmonary care.

Final Points

- ▣ Have a **defendable** and well thought out reason to fix which includes comorbidities, expectations and risks
- ▣ Discuss scars with patient, particularly women as many like the IM incision more than the plate
- ▣ Non unions (1-2%) infections (4.5%) and Neurovascular complications (2-3 %)do occur.
- ▣ Beware of adhesive capsulitis, pneumothorax.

Thanks
