Clavicle Fractures: When to Fix Them...

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INTRODUCTION

- Clavicle one of the most commonly fractured bones
- 5% - 15% of all fractures
- 35% - 45% of shoulder girdle fractures


- Midshaft clavicle fractures account for 69% - 80%

Clavicle

- “S”-shaped bone
- Medial - sternoclavicular joint
- Lateral - acromioclavicular joint and coracoclavicular ligaments
- Muscle attachments:
  - Medial: sternocleidomastoid
  - Lateral: Trapezius, pectoralis major
Osseous anatomy and muscular/ligamentous attachments play a pivotal role in determining fracture patterns.

Fractures most common at junction of outer and middle 3\textsuperscript{rd}:
- Thinnest part of bone
- Not protected by muscle/ligamentous attachments

Deformity:
- SCM pulls proximal fragment superiorly and posteriorly
- Weight of arm and pectoralis muscles pull distal segment medially and inferiorly
MECHANISM OF INJURY

- Traditionally thought to occur from “FOOSH”

- Various mechanisms
  1. Direct blow onto the point of the shoulder
     - Shown to account for 85 to 94% of clavicle fractures
  2. Direct blow to clavicle
     - seat belt strap injuries
     - 10 to 13%
  3. FOOSH
     - 2 to 5%
Physical Examination

- Inspection
  - Evaluate deformity and/or displacement
  - Beware of rare inferior or posterior displacement of distal or medial ends of clavicle
  - Compare to opposite side.
  - Check Skin.....
Physical Examination

- Palpation
  - Evaluate pain
  - Look for instability with stress
Physical Examination

- Neurovascular examination
- Evaluate upper extremity motor and sensation
- Measure shoulder range-of-motion
RADIOGRAPHIC ASSESSMENT

- AP view
- 10 -15° cephalic tilt view
  - Fracture pattern
  - Comminution
  - Displacement
  - Shortening
- ± Chest, shoulder, c-spine
Middle Third Clavicle Fractures
Classification

Craig Classification

- Group I: Fracture of the middle third
- Group II: Fracture of the distal third. Subclassified according to the location of coracoclavicular ligaments relative to the fracture as follows:
  - Type I: Minimal displacement: interligamentous fracture between conoid and trapezoid or between the coracoclavicular and acromioclavicular ligaments
  - Type II: Displaced secondary to a fracture medial to the coracoclavicular ligaments – higher incidence of non-union

IIA: Conoid and trapezoid attached to the distal segment
IIB: Conoid torn, trapezoid attached to the distal segment
Type III: Fracture of the articular surface of the acromioclavicular joint with no ligamentous injury – may be confused with first degree acromioclavicular joint separation

Group III: Fracture of the proximal third:
- Type I: Minimal displacement
- Type II: Significant displaced (ligamentous rupture)
- Type III: Intraarticular
- Type IV: Epiphyseal separation
- Type V: Comminuted
Treatment Options

- Nonoperative
  - Sling
  - Brace

- Surgical
  - Plate Fixation
  - Screw or Pin Fixation
Simple Sling vs. Figure-of-8 Bandage

- Prospective randomized trial of 61 patients
- Simple sling
  - Less discomfort
- Functional and cosmetic results identical
- Alignment of healed fractures unchanged from the initial displacement in both groups

Traditionally been treated non-operatively, even when substantially displaced.

Early reports suggested non-union was extremely rare:
- 4 (0.8%) out of 556 (3.7% with surgery)
  - Rowe CR. An atlas of anatomy and treatment of midclavicular fractures. CORR 1968
- 3 (0.1%) out of 2235 (4.6% with surgery)
- Most important causal factor for non-union of a midshaft clavicular fracture is improper open surgery
  - Neer CS 2nd. Nonunion of the clavicle. JAMA 1960

Recent studies on non-operative mx report:
- Higher non-union rate (15-20%)
- Higher rate (32%) of unsatisfactory patient outcome

Several recent studies reported high union rates with surgical intervention using a variety of internal fixation devices:
NON-OPERATIVE MANAGEMENT

- Historically, has been the mainstay for clavicular fractures
- Indicated for non-displaced or minimally displaced midshaft clavicular fracture
- Consist of:
  - Most commonly, a sling or figure-of-8 brace applied in the acute setting
  - Immobilization typically for 2 to 6 weeks
  - Gradual return to normal activities


- Prospective, randomized study involving 61 patients
  - 26% of patients treated with a figure-of-8 bandage were dissatisfied compared with 7% of those treated with a sling
  - There was no difference in overall healing and alignment of the fractures indicating that a figure-of-8 bandage does little to obtain or maintain reduction
Nonoperative Treatment

- There is new evidence that the outcome of nonoperative management of displaced middle-third clavicle fractures is not as good as traditionally thought, with many patients having significant functional problems.
FRACTURE DISPLACEMENT / SHORTENING

1. Nowak J, Holgersson M, Larsson S: Can we predict long-term sequelae after fractures of the clavicle based on initial findings? A prospective study with nine to ten years of follow-up. *J Shoulder Elbow Surg* 2004
   - Prospective study 245 patients with 9-10 years follow-up
   - **Displacement without bony contact, especially with comminuted transverse fracture, and an elderly patients, strongly predictive of long term sequelae and persistent symptoms**

   - Prospective review of 581 midshaft clavicular fractures
   - 4.5 % non-union rate
   - **Fracture displacement, fracture comminution, female gender, advanced age significantly increase risk of non-union**
   • Retrospective analysis of 39 clavicle non-union / delayed union
   ➢ Shortening of 2 cm in midshaft clavicular fractures was associated with an increased risk of pain, limitation of motion, or nonunion

   • Prospective study of 30 cases with displaced midshaft clavicle #s (mean follow-up 55 months)
   • assessed functional outcome and noted significantly inferior scores for both the upper extremity–specific (DASH) outcome scores and the Constant scores compared with the general population.
   ➢ fractures with >2 cm of shortening tended to be associated with decreased abduction strength and greater patient dissatisfaction
The strength of the injured shoulder was 81% for maximum flexion, 75% for endurance of flexion, 82% for maximum abduction, 67% for endurance of abduction, 81% for maximum external rotation, 82% for endurance of external rotation, 85% for maximum internal rotation, and 78% for endurance of internal rotation (p < 0.05 for all).

The mean Constant score was 71 points, and the mean DASH score was 24.6 points, indicating substantial residual disability.

   • Retrospective review of 52 midshaft clavicular fractures
     ➢ final shortening ≥2 cm was associated with an unsatisfactory result but not with non-union

   • Evaluated the effects of clavicular malunion (15mm shortening) in 10 subjects using CT with #D recon, shoulder score assessments and biomechanical testing
     ➢ Significant increase in upward angulation of the SC joint and an increased scapular version compared with the uninjured side
     ➢ Significantly weaker muscle strength than that of the uninjured arm
     ➢ Significant poorer shoulder scores outcome

➢ These studies indicate that although clavicular deformities are complex and hard to assess, shortening of 1.5 to 2 cm results in an increased incidence of clinical symptoms
Thus, displaced midshaft clavicle fractures can cause significant, persistent disability, even if they heal uneventfully.
Definite Indications for Surgical Treatment of Clavicle Fractures

- 1) Open fractures
- 2) Associated neurovascular injury
- 3) Severe angulation/Skin tenting
- 4) Symptomatic Nonunion
Relative Indications for Acute Treatment of Clavicle Fractures

- 1) >100% displaced fractures
- 2) > 1.5-2cm shortening (15% of contralateral side)
- 3) Multiple trauma
- 3) Displaced distal-third fractures
Relative Indications for Acute Treatment of Clavicle Fractures

- 4) Floating shoulder
- 5) Seizure disorder
- 6) Cosmetic deformity
- 7) Earlier return to sport/work.
SURGICAL MANAGEMENT: PLATING

- Advantages of surgery
  - Early mobilization
  - Better early pain relief
  - Quicker return to sport
  - Improved Strength
  - Higher satisfaction scores
  - Lower nonunion risk

- Incision
  - Directly over clavicle along Langer’s line
  - Sabre cut incision
    - Preservation of supra-clavicular nerves
  - Inferior incision
    - Coupe et. al.: A new approach for plate fixation of midshaft clavicular fractures. *Injury* 2005
    - Proposed to prevent wound complications and improve cosmesis
Plate Fixation

- Traditional means of ORIF
- Plate applied superiorly or inferiorly
  - Inferior plating associated with lower risk of hardware prominence
- Used for acute displaced fractures and nonunions.
Risk Factors for the Development of Clavicular Nonunions

- Location of Fracture
  - (outer third)
- Degree of Displacement
  - (marked displacement)
- Degree of shortening
  - (>2-2.5cm)
- Age
- Comorbidities: Smoking
Intramedullary Fixation

- Large threaded cannulated screws
- Rockwood style pins
- Sonoma nail CRx
- Flexible elastic nails
- K-wires
  - Associated with risk of migration

- Useful when plate fixation contra-indicated
  - Bad skin
  - Severe osteopenia
Complications of Clavicular Fractures and its Treatment

- Nonunion
- Malunion
- Neurovascular Sequelae
- Post-Traumatic Arthritis
- Reoperation rates
  - High percentage of hardware removal (50-100%)
Techniques for Acute Operative Treatment of Distal Clavicle Fractures

- Kirschner wires inserted into the distal fragment
- Dorsal plate fixation
- CC screw fixation
- Tension-band wire or suture
- Transfer of coracoid process to the clavicle
- Clavicular Hook Plate
For most techniques of distal third clavicular fixation, coracoclavicular fixation is also needed to prevent redisplacement of the medial clavicle.
• The Hook Plate (Synthes USA, Paoli, PA) was specifically designed to avoid this problem of redisplacement.
Hook Plate - Results

- Recent series of distal clavicle fractures treated with the Hook Plate document high union rates of 88% - 100%. Complications are rare but potentially significant, including new fracture about the implant, rotator cuff tear, and frequent subacromial impingement.

- Recommend plate removal and requires second surgery
Preferred Technique for Fixation of Acute Distal Third Clavicle Fractures

- Horizontal incision
- Manual reduction of fracture
- Dorsal tension band suture and reconstruction/augmentation of coracoclavicular ligaments.
Indications for Late Surgery for Distal Clavicle Fractures

- Pain
- Weakness
- Deformity
- Delayed Union/Nonunion
- Malunion
Techniques for Late Surgery for Distal Clavicle Fractures

- Excision of distal clavicle
  - With or without reconstruction of coracoclavicular ligaments (Modified Weaver-Dunn procedure)
- Reduction and fixation of fracture
SUMMARY

1. Most mid-shaft clavicular fractures heal without incident when length and alignment are maintained

   Nondisplaced and minimally displaced fractures should be treated nonsurgically, preferably with a sling for patient comfort
   • acceptable cosmetic and functional results, as well as union rates can be expected

2. The risk of complications from non-surgical management may be significantly higher:
   • those with completely displaced (1.5 to 2cm) and comminuted fractures
   • Possibly those who are female or of advanced age

   The current literature suggests that surgical stabilization, with either plates or IM device, should be considered the preferred treatment option for these more complex acute midshaft clavicular fractures

   Excellent outcomes can be obtained with proper patient and treatment selection
Thank You

A surgeon’s Knot should Never give away.