Clavicle Fractures: Non-operative vs Operative Management

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PAOS
May 5, 2023
Disclaimer

No conflict(s) of interest in relation to this presentation
17 yo football player
Mid October of senior year
Also wrestles and plays baseball
Dominate arm
Acute, mid-shaft clavicle fractures

So what’s the big deal?

- “They all do fine”
- “They all heal”

“Don’t worry about it”
Acute, mid-shaft clavicle fractures

*Non-operative treatment*

The existing literature is relatively clear: they don’t *all* do well with non-operative treatment!!
Acute, mid-shaft clavicle fractures

Non-operative treatment

  - 242 consecutive clavicle fractures
  - Patient-based outcome assessment (questionnaire)
  - 52 / 242 completely displaced, middle-third
    - 15% nonunion
    - 31% unsatisfactory clinical results (pain, brachial plexus sx)
  - Factor associated with nonunion / poor results: *initial shortening > or = 2 cm*
Acute, mid-shaft clavicle fractures

Non-operative treatment

- Can we predict long-term sequelae after fractures of the clavicle based on initial findings? A prospective study with 9 – 10 years follow-up (Nowak, et al 2000)
  - 245 consecutive clavicle fractures
  - 46% still with “sequelae” 9 years later (7% nonunion)
    - “No bony contact” was strongest predictor for sequelae
    - Comminuted fractures with “transverse” fragments
Acute, mid-shaft clavicle fractures

Non-operative treatment

  - 581 diaphyseal fractures
  - Overall 4.5% risk of nonunion
  - Significant increased incidence with . . .
    - Advancing age
    - Female gender
    - Displacement of fracture ("no contact")
    - Presence of comminution
Acute, mid-shaft clavicle fractures

**Non-operative treatment**

Acute, mid-shaft clavicle fractures

*Non-operative treatment*


<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>Females</th>
<th>Males</th>
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<tr>
<td>25</td>
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<td>45</td>
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<td>55</td>
<td>42%</td>
<td>29%</td>
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<td>65</td>
<td>47%</td>
<td>33%</td>
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Displaced mid-shaft clavicle fractures

*Deficits following non-operative treatment*

- McKee, et al. JBJS 2006
  - 30 patients
    - All healed
  - “Patient-based” outcome measurements
    - Residual Disability
  - Strength Testing
    - Decrease Max 18-19%
    - Decrease Endurance 18-33%
Acute, mid-shaft clavicle fractures

Not so fast, surgeons . . .

- **Nordqvist et al**
  - 69 displaced fractures with no bony contact and 85 displaced / comminuted fractures
  - Only 1 of 7 non-unions had a poor result
  - Permanent clavicular shortening is common with no clinical sequelae

- **Oroko et al**
  - 41 patients with clavicle shortening of 15mm or more
  - Could not demonstrate relationship between shortening and shoulder function

- **Pedersen et al**
  - 90% of 99 patients had no pain at follow-up
  - Shortening and displacement were not risk factors for pain

- **Blomer et al**
  - 151 patients
  - Neither axial angulation nor shortening caused shoulder dysfunction
Acute, mid-shaft clavicle fractures

*Why the contradictions in the literature?*

“It is clear that patient-based outcome measures reveal residual impairment that surgeon-based or radiographic measures do not.”

*McKee et al*
McKee, et al  JBJS  2007
Nonoperative vs plate fixation of displaced fractures

Multicenter, randomized clinical trial – 132 patients

- Operative treatment statistically better . . .
  - Constant / DASH score
  - Return to activities
  - Time to union
  - Non-unions
  - Symptomatic malunions
  - Patient satisfaction
Robinson, et al  JBJS  2013
Nonoperative vs plate fixation of displaced fractures

*Multicenter, randomized clinical trial — 200 patients (16-60yo)*

- At 1 year ORIF pts better than non-op
  - Lower Nonunion rate (1 vs 16)
  - Constant / DASH scores
    - Exclude non-unions then scores the same
  - Pt satisfaction
    - Shoulder droop/shoulder asymmetry/bump
- Higher cost
Acute, mid-shaft clavicle fractures

“Evolving” indications for surgery – general patient population

- Degree of displacement / shortening
  - “No contact”
  - > 2 cm
- Communution
- Amount of “energy”
- Fracture pattern (“zed”)
- Patient-specific factors
  - Contact athletes
  - Year round athletes
Acute, mid-shaft clavicle fractures

*Surgical technique options*

- Compression plating
  - IM fixation
- Other creative techniques (?)
Acute, mid-shaft clavicle fractures

**Technique options: plating**

- The most commonly utilized technique
- Complications associated with ORIF / plating primarily related to plate selection and technical issues
  - Pre-contoured, anatomic plates
Complications of ORIF – 9%

- 3 / 67 (4.4%) infections
  - All managed initially with antibiotics and local wound care
  - Hardware removal after healing
  - No sequelae
- 2 / 67 (3%) symptomatic hardware requiring removal
- 1 / 67 (1.5%) broken plate (ATV accident 6 weeks post-op)
- No catastrophic complications
Acute, mid-shaft clavicle fractures

Technique options: plating

The plate doesn’t do it by itself!!
Mid-shaft clavicle fractures

Surgical pearls - plating

- Identify / protect supraclavicular nerves
- Precise approach through delto-trapezial fascia
- Anatomic / compressive fixation
  - Pre-contoured anatomic plates
  - Avoid medial prominence
- Respect periosteum / soft-tissue attachments
- Bone graft substitute if comminuted
- Thick, “water-tight” delto-trapezial fascia repair
Acute, mid-shaft clavicle fractures

Technique options: IM fixation

- Stable fixation with thread on one end and “bolt” on the other

Technique:
- Open fracture site
- Retro / anterograde placement of pin from behind AC joint
- Engage medial, anterior cortex
- Bolt behind AC joint to prevent migration
Acute, mid-shaft clavicle fractures

**Technique options:** IM fixation
Acute, mid-shaft clavicle fractures

Technique options: IM fixation

- **Advantages**
  - Less dissection
  - More cosmetic
  - No long-term retained hardware issues
  - Ideal in younger patients with severe, acute fractures

- **Disadvantages**
  - All require hardware removal (2\textsuperscript{nd} surgery)
  - Bolt symptomatic
Acute, mid-shaft clavicle fractures

Technique options: intramedullary fixation

Neither does the pin !!
Acute, mid-shaft clavicle fractures

Complications of IM fixation

- Device dependent
  - Rockwood pin
  - Knowles pin
  - Hagie pin
  - Threaded Steinman pin
  - K-wires
- Complication rate very variable in the literature
- Range: 5% - 50%

Grass, Strauss, Chu, Ngarmukos, Boehme
Acute, mid-shaft clavicle fractures

*Surgical pearls – intramedullary fixation*

- Small incision over fracture; extend prn
- Largest diameter pin that will traverse canal
- Look via C-arm in different planes; stay centered
- Threads cross fracture site; reduce fragments anatomically
- Don’t exit too high laterally
- “Cold weld” medial and lateral bolts together
- Cut pin as short as possible to minimize symptoms
- Suture comminution and delto-trapezial fascia closure
Timing? 

Does delay matter?

- Potter, McKee, et al. JSES 2007
  - 15 immediate vs 15 delayed fixation
  - No differences . . .
    - Healing
    - Strength of shoulder flexion
    - Shoulder abduction
    - ER
    - IR
    - DASH scores
  - Marginally better outcomes in Constant scores and in endurance strength with acute fracture repair
Case examples . . .
Acute, mid-shaft clavicle fractures

*Patient-specific factors: HS FB Player*
Acute, mid-shaft clavicle fractures

Patient-specific factors: 25 YOM manual laborer
Acute, mid-shaft clavicle fractures

Patient-specific factors: 36 YOM construction worker
Dirt bike injury
Acute, mid-shaft clavicle fractures

*Patient-specific factors: Missionary*
Acute, mid-shaft clavicle fractures

Patient-specific factors: Missionary

6 months later
Acute fracture

15 year old boy
Malunion + thoracic outlet symptoms
Mid-shaft clavicle fractures

Implant selection: my personal preference

- Acute fractures
  - IM pin
    - Younger patients
  - Plate
    - Most patients
    - 2\textsuperscript{nd} operation less desirable

- Nonunions
  - Plate
Acute, mid-shaft clavicle fractures

Summary

Although displaced mid-third clavicle fractures can be managed successfully without surgery...

Patient-based outcome studies suggest that a larger percentage of displaced mid-clavicle fracture results are “less than ideal”
Acute, mid-shaft clavicle fractures

Summary

- Factors potentially associated with poorer results include...
  - Degree of displacement / shortening > 2 cm ("no contact")
  - High-energy / comminuted fractures
  - Fracture pattern ("zed")
  - Displaced Type II distal clavicle fractures
  - Patient-specific factors (contact athletes)

- Operative management should be considered in these higher-risk clinical scenarios
Mid-shaft clavicle fractures

*Implant selection: talking points*

- Time to heal – return to activities
- Nonunion risks
- Expected outcomes
- Non-op complaints
- Operative complaints
- Cost (surgery, time lost from work)
Lateral clavicle fractures
10-15% of all clavicle fractures
Lateral clavicle fractures

40 yo teacher – bike accident at the beach
Lateral clavicle fractures

10-15% of all clavicle fractures

- Natural history . . .
  - Charles S. Neer II, MD ~ 1/3 problematic
  - Nordquist  Acta Orthop Scand  ’93 → 25% pain / nonunion
  - Robinson  JBJS  ’04 → 21% required surgery
Displaced lateral clavicle fractures

- Treatment options . . .
  - Plating
    - Multiple “standard” options
    - Anatomic, pre-contoured plate
  - Coracoid fixation
    - Primary
    - Supplemental with other technique(s)
  - Hook plate
  - K-wires / TBW across AC joint
  - Other creative techniques . . .
  - Excise distal bone fragment(s) + modified Weaver-Dunn
Lateral clavicle fractures

**Plating**

- Often inadequate lateral bone for standard plates
- Options . . .
  - Anatomic, pre-contoured plates
  - Strongly consider supplemental coracoid sling fixation
    - Sutures or +/- graft
Lateral clavicle fractures

Coracoid fixation in isolation
Lateral clavicle fractures

other techniques . . .
Lateral clavicle fractures

“Hook plate”

  - 22 patients
  - 12 month minimum follow-up
  - Until plate removal, only 90° FE allowed
  - ROH 3-4 months
  - 21/22 ultimately healed
  - 86% satisfaction
Lateral clavicle fractures

“Hook plate”

Haidar, et al  JSES 2006

- “4 (18%) complications”
  - 1 malunion
  - 1 nonunion (“marked, subcutaneous bony prominence“)
  - 1 wound breakdown / exposed plate
  - 2 failure of fixation
  - 1 stress fracture medial to plate
  - (3 patients with asymptomatic “acromial erosion”)

- 6/22 (27%) complications
Lateral clavicle fractures

Teacher