Clavicle Fractures

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Objectives

• Understand the deforming forces affecting clavicle fractures

• Discuss factors affecting the decision to treat fractures operatively vs non-operatively

• Evaluate different operative techniques available
Epidemiology

• 2.6% of all fractures
• Higher energy
  • MVC
  • Collision sports
    • Football
    • Hockey
  • Cycling
• Demographic skews younger
  • Second peak later in life from osteoporotic patients with falls

Function

• “A strut for muscles to attach to”

• Not a weight bearing bone (for most people)

• Only connection between axial skeleton and the upper extremity

*Rockwood & Green’s Fractures in Adults, 9th Ed.*
Anatomy

• **Shape**
  - Flat lateral medially and laterally
    - Cancellous screws have better purchase
  - Tubular in central section
    - Cortical screws
  - Flat superior surface
  - S-shaped when viewed from above

• **Articulations**
  - Sternoclavicular joint
  - Acromioclavicular joint

*Rockwood & Green’s Fractures in Adults, 9th Ed.*
Anatomy/Deforming Forces

- Muscular
  - Sternocleidomastoid
    - Covers medial 60% of superior surface
    - Pulls medial segment proximally
  - Deltoid
    - Covers lateral 40% of superior surface
    - Holds distal fragment stable
  - Trapezius
    - Posterosuperior coverage
  - Pectoralis
    - Originates from anteroinferior surface
    - Pulls medially causing shortening
  - Subclavius
    - Undersurface muscle
    - Protects NV structures

*Rockwood & Green’s Fractures in Adults, 9th Ed.*
Anatomy

• Neurovascular
  • Superficial
    • Supraclavicular nerves (C3-4)
      • Skin sensation running vertically
      • Frequently cut on approach to midshaft clavicle
      • Sensation generally improves with time
  • Deep
    • Subclavian vein
    • Subclavian artery
    • Brachial plexus

*Supraclavicular nerve entrapment and clavicle fracture. O’Neill, K; Stutz, C; Duvernay, M; J Ortho Trauma. 26(6):e63-e65, June 2012.
Anatomy: Deep

- **Subclavian Vein**
  - Directly underneath clavicle separated only by subclavius mm
  - Closest to bone medially
  - Used for central lines

- **Subclavian Artery**
  - More posterior than vein
  - Protected by the scalenus mm

- **Brachial Plexus**
  - Also posterior to bone
  - Closest to bone in mid-portion of bone

Mechanism of Injury

• Midshaft:
  • Most common: lateral compression results in bending and axial load
  • Less common: direct blow
  • Thinnest portion of bone, fewer soft tissue attachments and therefore more likely to break

• Distal:
  • Lateral compression injuries
  • Older patients, lower energy

• Medial:
  • Rare, usually high energy direct blow

*Rockwood & Green’s Fractures in Adults, 9th Ed.*
Classification: OTA vs Robinson – nearly the same

Bone: Clavicle

Locations:

Robinson 3
Clavicle, proximal (medial) end segment
Location is determined by a square with sides the length of the widest portion of the medial end of the clavicle.
~5% of fractures

Robinson 2
Clavicle, diaphyseal segment
The portion between the two end segments.
~80% of fractures

Robinson 1
Clavicle, distal (lateral) end segment
Begins at line perpendicular to the medial edge of the coracoid process. The coracoclavicular ligaments are part of this lateral end segment.
~15% of fractures

*Journal of Orthopaedic Trauma 32:S105, January 2018.*
Associated Injuries

- Rib fractures
- Proximal humerus fractures
- Pneumothorax
- Scapular fractures
  - “Floating shoulder”
MIDSHAFT FRACTURES
Classification: OTA

Bone: Clavicle 15

Locations:

Clavicle, **proximal (medial) end segment** 15.1

Location is determined by a square with sides the length of the widest portion of the medial end of the clavicle.

\~5% of fractures

Clavicle, **diaphyseal segment** 15.2

The portion between the two end segments.

\~80% of fractures

Clavicle, **distal (lateral) end segment** 15.3

 Begins at line perpendicular to the medial edge of the coracoid process. The coracoclavicular ligaments are part of this lateral end segment.

\~15% of fractures

*Journal of Orthopaedic Trauma 32:S105, January 2018.*
Workup

• Physical Exam
  • Skin integrity
    • Overlying abrasions
    • Medial fragment can “button hole” through the platysma
  • NV status

• Radiographs: AP + cephalic/Zanca view
  — Prefer **upright** bilateral clavicles on same cassette – allows comparison to normal

*Rockwood & Green’s Fractures in Adults, 9th Ed.

*XR courtesy of author
Operative vs Non-operative: deciding factors

• Cosmesis: “bump or a scar”
  • Simple sling vs clavicle strap/“figure-of-8” brace: no benefit of strap
    • Sling for comfort only
    • Droopy shoulder?

• Shoulder function

• Nonunion: fracture and patient-specific characteristics

• Associated Injuries

• Polytrauma
Shoulder Function with Non-operative Care

  - Motion preserved
  - Significantly reduced strength in max/endurance flexion, max/endurance abduction, max/endurance external rotation, max/endurance internal rotation.
  - Mean Constant score 71 points & mean DASH score 24.6 points = residual disability
  - However…. The amount of shortening not quantified

VS...

  - 13 year f/u, ~1 cm shortening; 18 adult patients
  - No significant long term deficits in strength

**Minimal shortening = minimal deficit? Literature unclear!**
Nonunion Risk

  - **Amount of displacement**: more displacement = less likely to heal
    - 2 cm displacement is frequently used in literature as a cutoff
    - *Currently, specific number found to be less clear*

- Smoking

- **Fracture comminution**: Z fragment

*XR courtesy of author*
Calculating Nonunion Risk: patient education

“Ready Reckoner” Score: Murray et al, Edinburgh 2013

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*Smoking and comminution each automatically increases risk ~3+x*

*Data from JBJS Am. 2013;95:1153-8.*
Associated Injuries: operative management

• Severe chest wall trauma
  • Vascular injury requiring repair
  • Progressive neurologic deficit/plexus palsy
    • ORIF clavicle stabilizes the vascular or neuro repair!

  • Ipsilateral upper extremity injuries/fractures?
  • Multiple ipsilateral upper rib fractures?

• Scapulothoracic dissociation
  • Traction injury
  • Widened space between scapula and spine
  • Distracted clavicle fracture
  • Beware of vascular & brachial plexus injuries!

*Rockwood & Green’s Fractures in Adults, 9th Ed.*
Associated Injuries: operative management

• “Floating shoulder”
  • Associated displaced glenoid neck fracture
  • Frequently can only fix the clavicle and the glenoid will reduce into acceptable alignment
Polytrauma

• Fixation can help advance WB in a patient with B UE injuries

“Give them back an arm to use”

• Facilitate physical therapy/mobilization
  • Shorten hospital stay
  • Minimize pain medication needs
Returning to Work as a Deciding Factor

• Manual laborers?

• Pro athletes?
  • NFL players returned to sport faster
    * Harris et al, Orthopaedics 2017
      • 44% returned the same season
      • 96% returned to sport at 1 year
      • However, QB’s and RB’s did worse compared to other positions

• Dr Peter Millett @ Steadman Clinic: “For example, in certain instances where there was an important event, I have had some athletes back to competition in as little as 2 weeks.”
Operative: Options

• ORIF: plating
  • Superior vs anterior

• Intramedullary fixation

• External fixation?
  • Not popular in the US
  • Ilizarov-type constructs
Intramedullary Implants

• Takes advantage of IM canal in central 1/3

• Advantage
  • Soft tissue friendly
  • Best for simple fracture patterns

• Disadvantage:
  • Can’t lock rotation with most devices
  • Rate of reduction loss is high
  • High rate of ROH with unlocked implants
  • Fear: pin migration with unlocked/non-threaded!

• Options
  • Commercially available products
  • Pediatric titanium elastic nails
  • Generic Steinmann pins
  • Cannulated screws

*The Community Orthopaedic Surgeon Taking Trauma Call: Pediatric Midshaft Clavicle Fracture Pearls and Pitfalls. Vargas-Vila, M; Mehlman, C; Pennock, A. J Ortho Trauma: August 2019 - V33, p S1-S5.
Fixation: Techniques

• ORIF: mainstay in US
  • Obtain anatomic reduction
    • Lag screw + neutralization plating
    • Compression mode plating
  • Stabilize with rigid implants

• Plate placement options
  • Superior = prominent, resists vertical translation, more extensile to both ends of bone
  • Anterior = less prominent, longer screws?, less extensile
    *No RCT comparing different plate locations*

• Dual mini-frag plates?
  • More soft tissue stripping but less (3.7%) removal of symptomatic hardware?

*XR courtesy of author
ORIF Technique

• Radiolucent OR table

• Position: semi-supine vs beach chair, usually with central bump under spine to hyper-extend chest

• XR views coming in from the head: AP + 30 deg cephalic tilt

• Arm can be prepped in or out
Technique Videos

• ORIF midshaft clavicle: NYU/Dr Egol

• IMN clavicle: Steadman Clinic/Dr Millett
Rehab Protocols

• Immediate post-op
  • Dry dressing over wound
  • Simple sling for comfort
  • Start pendulum exercises ASAP, OK for motion for hygiene as needed

• My philosophy: “motion first, then lifting”
  • Start gentle lifting once can obtain ~120 degrees elevation
  • No “real” lifting until 6 weeks
  • Avoid aggravating activities like heavy lifting, pushups until at least 3 months
Sequelae

• Supraclavicular nerve iatrogenic laceration
  • Patients report a numb patch centered on the incision
  • Usually improves with time (months/years)
  • Can be irritating to women who can’t feel their bra strap and backpack wearers

• Hardware Irritation/Removal of hardware: ~15-30%
  • Prefer > 1 year post-op to ensure complete healing
  • Backpackers, military personnel common to be irritated
Outcomes

• Union
  • >95% union with ORIF

• Clinical vs Radiographic Union
  • Asymptomatic nonunion does not necessarily need to be treated!

• Shoulder function excellent

• Generally plateau by a year post-op regardless of treatment chosen

Recent Data: 94-100% union rates!
DISTAL FRACTURES
Distal: Anatomy

*Fragment stability determined by relationship to CC ligaments*

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*Interfragmentary Suture Fixation for Displaced Acute Type II Distal Clavicle Fractures Duralde, X; Pennington, S; Murray, D. J Ortho Trauma 28(11):653-658, Nov 2014.
Distal: Neer Classification

• Type I: CC ligaments intact

• Type II: CC ligaments detached from the medial fragment, trapezoid attached to the distal fragment
  - IIA (Rockwood mod): Both conoid and trapezoid attached to the distal fragment
  - IIB (Rockwood mod): Conoid detached from the medial fragment

• Type III: Extension into the AC joint.

• Type IV: Pediatric physeal fx

• Type V: Comminuted

*Rockwood & Green’s Fractures in Adults, 9th Ed.*
Distal: Op vs Non-op

Why does this classification matter???

Pattern determines Plan

Type 2’s and Type 5 are notorious nonunion generators!

2A: 56% nonunion with non-op
2B: 30 – 45% nonunion with non-op
Distal: Fixation Challenges

• Bone is largely cancellous laterally

• Templating important: ensure adequate purchase in small lateral fragment
Distal: Surgical Options

- ORIF with superior plating
- ORIF with hook plating
- Coracoclavicular ligament reconstruction
Distal: Superior plates

• Lateral versions of anatomic plates
  • Have more screw holes clustered together to obtain maximal fixation
    • Goal: At least 4 screws in the distal segment

• Locking options laterally

• Can be augmented with CC ligament constructs

*Rockwood & Green’s Fractures in Adults, 9th Ed.
Distal: Superior plates

- Anatomic lateral plates: augmented fixation via CC ligament constructs
  - CC screw augments
  - Suture/suture button fixation
  - Ligament allografts

*Rockwood & Green’s Fractures in Adults, 9th Ed.*

*Fixation of Unstable Type II Clavicle Fractures With Distal Clavicle Plate and Suture Button, Johnston, P; Sears, B; Lazarus, M; Frieman, B. J Ortho Trauma 28(11):e269-e272, November 2014.*
Distal: Hook plates

• Design: Superior plate with attached hook that wedges into the posterior subacromial space

• Advantage:
  • Resists superior displacement forces
  • Direct compression on the fracture fragment
  • Allows for slight motion at the AC joint

• Disadvantages:
  • Has to be removed due to subacromial irritation
  • Very little fixation directly into the lateral fragment
  • Can over-reduce the lateral segment
    • Measure the depth of the hook desired!

*XR: Rockwood & Green’s Fractures in Adults, 9th Ed.
Technique Videos

• ORIF using a hook plate: Michigan/Dr Hake

• ORIF using lateral plate + CC suture augment: Dr Millett
  • https://www.arthrex.com/resources/video/WUcrUwQXLk-lnQFSiP8_vA/distal-clavicle-fracture-repair-utilizing-a-knotless-coracoid-fixation-device
MEDIAL FRACTURES
Medial

- **Rare!**  
  - ~3% of all clavicle fractures
  - 80% are non-displaced
  - ~50% have associated thoracic/chest wall trauma

- Can be a variation on a sternoclavicular dislocation
  - 50% are intra-articular

- Pediatric physeal fracture possible
  - 80% of growth comes from medial physis
  - Physis may not be closed in 20-22 y/o patients
Medial

• Nearly all will do well non-operatively, esp if non/minimally displaced

Medial: Operative choices for displaced fx

- ORIF
  - Frequently challenging due to small working area
  - ROH often needed
  - Good results when can get appropriate fixation

- Other implants: k-wires, sternal wires, tension band constructs

- Soft tissue-only repairs
Conclusions

• Displaced midshaft clavicle fractures should be considered for fixation primarily if at risk for nonunion, though other criteria may affect decision making:
  • Smokers
  • Highly displaced
  • Comminuted

• Distal fractures of the Neer 2 and 5 groups should be treated surgically due to the high risk of nonunion

• ORIF with pre-contoured plates has a high success rate with few complications

• Medial fractures can be managed non-operatively most of the time with good success
Additional References


