Olecranon Fractures – A Case Based Approach to Understanding Management

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Introduction and Objectives

• Design: Interactive Case Based

• Objectives
  – Review pertinent bone and soft tissue anatomy to understand fracture patterns and associated instability
  – Review indications and strategies to stabilize fractures and restore stability
  – Provide pearls to help minimize risk of surgical complications and illustrate key points of management
Elbow Anatomy

- **Three distinct joints**
  - humeral(trochlea) – ulnar
  - humeral(capitelllar) – radial
  - proximal radial-ulnar(PRUI)
Factors Responsible for Elbow Stability: *Bony Anatomy*

- Normal muscle forces drive elbow posteriorly
  - **Brachialis**: base coronoid
  - **Biceps**: radial tuberosity

- Boney restraints that Resist posteriorly directed forces:
  - **Coronoid** process
  - Radial Head
Factors Responsible for Elbow Stability: *Bony Anatomy*

- **Varus/Valgus**
  - Radial Head
  - Trochlea
  - Medial **coronoid facet**
Ligamentous structures responsible for static stability...

- **Laterally** – ulna collateral ligament
- **Medial** – anterior bands of MCL
- **Anteriorly** – capsular tissues can be used to provide stability
Surgical Anatomy

- **Articular cartilage**
  - Sigmoid notch of ulna: bare spot centrally between tip and coronoid
  - Pearl: Beware of narrowing sigmoid fossa when treating comminuted olecranon fx’s.
- **Coronoid process: preserve height**
  - Coronoid Height ~ 2 x Olecranon height
  - Tip of Coronoid to tip of Olecranon subtends angle of ~30 degrees from long axis of ulnar shaft

Besar, C.G. et. al. *Redefining the proximal ulna anatomy* Surgical and Radiologic Anatomy 2014 (36):1023-1032
Surgical anatomy

- **Olecranon Process**
  - 96% of proximal ulna exhibit a ~ 4 degrees dorsal angulation (PUDA)
  - Proximally the ulna demonstrates ~ 12 degrees varus angulation
  - The articular surface extends beyond the “joint space” visualized on the lateral radiograph

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Olecranon Fractures
Mechanism of Injury

- **Acute Tension overload**: Tension applied by the triceps with flexion of the elbow

- **Direct Trauma**

- **Chronic overload**: eg. stress fractures seen commonly with osteopaenic or pediatric patients
Evaluation

• Check integrity of skin

• Check extension of elbow

• Evaluate neurovascular status, especially ulnar nerve

• X-rays - three views (AP, Lateral and Oblique, which shows radial head in profile)
Imaging

AP View

Lateral View

Oblique View
(sometimes helpful, good for Radial Head)

Core Curriculum V
Classification

- Many Classifications:
  - Colton
  - Morrey
  - Schatzker
  - AO/ASIF
  - OTA

- Criteria:
  - Displacement
  - Direction of fracture
  - Degree of comminution
  - Percent involvement
  - Associated injuries
Mayo Clinic (Olecranon) Classification

Type I: Nondisplaced 12%
Type II: Displaced/ elbow stable 82%
Type III: Elbow unstable 6%

• Both types II and III subdivided into:
  – A: noncomminuted
  – B: comminuted

Morrey BF, JBJS 77A: 718-21, 1995
Treatment Objectives

• Restoration of elbow motion and prevention of stiffness
  – Goal is to begin early ROM
• Restoration and preservation of the elbow extensor mechanism.
• Restoration of the articular surface.
• Prevention of complications.
Treatment Methods

• **Nonoperative**
  – Indicated in low demand individual with stable elbow joint.
    • (*Duckworth, et. al. JBJS AM 2014:96,67-72*)

• **Operative**
  – **Open reduction and internal fixation**
    • Tension band wire with pins or intramedullary screws
    • Plate
  – **Excision of olecranon and triceps repair**
    • Comminuted, unreconstructable fractures
    • Typically, Elderly patients with loss of active elbow extension
Nonoperative Treatment

• **Classically** Reserved for nondisplaced fractures

• **Historically** - Prolonged long arm cast was complicated by stiffness

• **More Recent** – short duration of “immobilization” provided reasonable results in low demand elderly...
  - Duckworth, et. al. (2017) 2 weeks collar and cuff, followed by supervised ROM with physiotherapist
  - Immobilization prolonged for pain
  - Although loss of reduction, similar functional results to ORIF group
Indications for Surgery

• Disruption of extensor mechanism
  – Unable to actively extend elbow

• Articular incongruity
  – Any displaced fracture
Case Example...

Elderly woman, moderate demand, multiple medical problems, falls and cannot extend her elbow...

What are your options?
Consider...Olecranon excision and triceps advancement

1 year later

Fragment much smaller when exposed...
Oblique fracture in frontal plane with comminution about sigmoid notch

Functional result...
Able to range and use elbow without pain
Olecranon Excision

Pearl... advance tendon anteriorly adjacent to distal humeral articular surface

• Elderly patients
  – those with osteoporosis
  – involving <50% of joint
• Re-attach triceps anteriorly
  – At joint surface
• No difference in isometric strength but fewer complications in the excision group

Gartsman et al, JBJS 63A:718, 1981-
Positioning

- **Posterior approach**
- **Arm position**
  - Supine with arm across chest.
  - Lateral or prone also may be used.
  - Supine with arm on hand table
- **Can Use Tourniquet (but may tighten extensor mechanism)**
- **Regional or general anesthesia**
Tension Band Wire

• For most simple, transverse, non-comminuted fractures

• Use 18- or 20-gauge steel wire or small braided cable.
  – Be sure wires cross over dorsal cortex.
  – 2 smaller (22 gauge) wires may be less prominent

• May use with either parallel K-wires or an intramedullary screw.
Tension Band Wire

Reduce fracture
- Reduce w/ tenaculum
- Or extend elbow to bring olecranon to shaft

Place K-wires across fracture
- Engage anterior cortex
- Pearl: Can use provision K-wires, arm extension or clamp to hold reduction while placing definitive wires

Pass Tension wire deep to tendon with angiocath
- Two knots over dorsal cortex
Case Example

Simple Transverse Fracture Pattern

• History: 25 year old falls off bicycle and can not extend elbow
• What is the fracture orientation?
• Amenable to Tension Band Wiring
Engage anterior cortex

Pins are directed “ulnarly” away from PRUJ
Potential Complications...

- K wires project though anterior cortex too far... irritate AIN
  - Solution, withdraw wire 5 mm prior to bending wires over olecranon tip
- K wires project to far radial... interfere with proximal radio-ulnar joint
  - Solution, start wires more radial and aim more ulnarly
Intramedullary Screw?

- Need to add tension band wire
- Long/large screw required
  - 6.5mm cancellous
  - 85-110 mm long
- Risk of shortening…
  osteopaenic bone, oblique fracture and comminution

Mal-reduction
Anatomy of the Proximal Ulna

• Beware of the varus bow of the proximal ulna, which may cause a medial shift of the tip of the olecranon if a long screw is used.

Pearl: ideal is center – center start point on tip of olecranon

Potter, GD, et. al. “What is the Ideal Starting Point for an Olecranon Screw? An Anatomic Study” JOT (32)6 2018; 313-319
How to decide Plate versus Tension Band Wire

• Evaluate comminution of **dorsal cortex**
  – If intact: tension band wire appropriate
  – If comminuted, plate appropriate

• Evaluate **orientation of fracture line**
  – Transverse: tension band wire
  – If Oblique Or Complex
    Then plate
Plate Fixation

- **Indications:**
  - comminuted fractures
  - fractures with shaft extension
  - oblique fracture line

- **Plate choice…**
  - Traditional…
    - LCDCP, recon, 1/3 tubular
    - Before locked plates
  - Anatomic, locking
    - Plates designed for proximal Ulna

- Screw placement crucial for stability
Case Example...

59 year old woman, right hand dominant, lives alone, falls, unable to extend elbow...

- So consider anatomic locked plate....

What is the fracture pattern
Is this a simple or oblique fracture pattern? Simple?
Is the dorsal cortex broken in more than one place

Yes and there is comminution
What plate: anatomic locking or traditional?

Fracture Pattern? Oblique, Segmental, Comminuted
Plate Fixation

Traditional plate...
- Screw placement critical

Anatomic Locked plating
- Again screw placement critical

Pearl: As fracture becomes more distal and oblique stabilization more amenable to plate fixation
Case Example...

- History: 63 year old woman falls on outstretched hand. Otherwise Healthy. Unable to extend elbow. What is the fracture pattern? **Oblique and Distal**

  - What fixation is appropriate?
  - How do these fractures do?

  - Plate fixation

  - Plate Fixation

  - ROM: ~ 20 degrees -Full

  - Restoration of Function, but all fixation may be prominent
Locked plating

• Relative indications
  – Comminution
  – Osteoporotic bone

• Removal of hardware...
  – 18-53%; probably irrespective of locking or non locking implant

  • Bailey, C.S. et. al. “*Outcome of Plate Fixation of Olecranon Fractures*” J. Ortho Trauma 2001: 15 (8) 542-548
  • Snoddy, MC, et. al. “*Olecranon Fractures: factors influencing re-operation*” Int Orthop. 2014:38(8) 1711-1716
Locked Anatomic Plates

Advantages

• Simplify plate fixation
  May accommodate
  - Slight varus proximal angulation
  - Slight rocker bottom proximal subcutaneous border
• Often allow for locked configurations
• Very proximal extended plate options
  - Requires extensive triceps split
  - May improve proximal fixation

Disadvantages

• More difficult to contour anatomically
• Locking configurations do not prevent violation of proximal articulations
• More expensive
• Not necessarily less prominent
Locked Anatomic Plates

Elements…

• “Anatomic” but often does not perfectly accommodate anatomy
  • ~4 degrees of proximal varus
  • ~12 degrees proximal dorsal angulation

• Typically, most plates have two proximal lengths…
  • **Shorter**, which does not require as much splitting and elevation of central insertion of triceps, but reduces proximal fixation opportunities
  • **Longer**, which requires more extensive proximal split and elevation of central insertion of triceps, but allow greater fixation opportunities
Proximal Ulna with Shaft Extension
Plate Location

- No mechanical difference between posterior or lateral placement
  (King et al, J Shoulder Elbow Surg 5:437, 1996)

- Less problems with plate prominence when placed laterally and one can get bicortical screw purchase

- Posterior Plate allows more advantageous screw placement
  - Coronoid screw
  - IM screw
  - Olecranon tip screw
Indirect Reduction

- sometimes useful

ex fix/distractor - push-pull;
*fix plate proximally first*
Case Example

- Hx: 73 yo women fell down stairs landing on her elbow with immediate pain and inability to move elbow...

What is the fracture pattern?
Olecranon and Coronoid fractures…
Transolecranon fracture
Operative plan? Simplify fracture and lag through the plate
Another example- Concurrent Coronoid and Olecranon fractures

- Hx: 55 year man falls from step ladder, sustaining olecranon and coronoid fractures

- To reduce fractures, it helps to understand the forces displacing fragments
Operative Plan

Reduce shaft to coronoid fragment and lag shaft to coronoid fragment.

Then reduce and stabilize olecranon fracture.

Pearl: Shown is pre-contoured "anatomic plate," ie plate designed for proximal ulna, which can help simplify stabilization.
Let’s look at that idea again…
Another Complex Proximal Ulna Fractures

- Complex fracture pattern
  - olecranon
  - ulna shaft
  - coronoid
- Requires stepwise repair
Identify the major fracture fragments... Coronoid, ulna shaft and olecranon
Understand the displacement of fragments
With all the comminution: how to hold reduction and repair coronoid fragment?
Solution: Use distal humerus as template.

Stabilize and temporarily pin coronoid to trochlea
Outcomes

• Does Implant Matter...
  – Limited prospective data, myriad retrospective
  – Functional ROM; loss of terminal extension common
  – Chen, M. et. al. Metaanalysis J Ortho Trauma 2021
    • Union rates 94% TBW and plate
    • Reoperation rates TBW ~ 40%; plate ~ 33%
    • Adverse events…
      deep infection 9% plate, no TBW
      superficial infection 5% TBW, no plate
      wound problems 12% plate; 7 % TBW

Complications
Potential Surgical Complications

- Hardware symptoms in 3 - 80%
- 34-66% require hardware removal
- Nonunion/malunion rates < 5%; essentially all in TBW
- Infection 0-9%
- Pin migration up to ~ 44%; ~ 5-15% when anterior cortex engaged.
- Ulnar neuritis/AIN injury 2-5%
- Heterotopic ossification up to 33% with delayed unstable elbow

-Hak, D.J.; Golladay, GJ. Olecranon fractures: treatment options JAAOS 2000:8 (4) 266-275
Hardware Problems…

K-Wire/Tension Band Wire fixation…

– Macko & Szabo JBJS 1985 retrospective review
  • 16/20 Prominent K- Wires
  • 4 skin breakdown; 1 infection
  • 2 loss off reduction

– Romero, Miran & Jensen J Ortho Sci 2000 retrospective review
  • 55 patients, 71.7% reoperation rate
  • 61.3% complain of hardware prominence
Outcome

Plate fixation…

  - 37% symptomatic hardware
    - Painful
    - Restricts motion (39% of all had 10 degree or more loss of extension)
  - 15% elective removal of hardware
Outcomes

Plate (P) versus Tension Band Wire (TBW)

• Duckworth, et.al. JBJS 2017, Vol 99:1261-73
  Prospective Randomized Trial
  – TBW vs P – similar DASH and ROM
  – TBW higher rate of symptomatic hardware
  – P higher rate major complications of infection and revision
Take Home Principle…

• Treatment of olecranon fractures, requires an understanding of the fracture pattern and the patient’s functional demands.

• So When addressing Olecranon fractures Understand:
  – Who is the patient/what are his or her demands?
  – What is the fracture pattern and is it associated with other injuries?
  – If operative intervention indicated, run the check list to develop the most effective and cost-conscious treatment for the fracture.
Final Pearl

• Olecranon fractures may be associated with elbow instability…

• Be aware of associated radial head/neck and coronoid fractures.

If you would like to volunteer as an author for the Resident Slide Project or recommend updates to any of the following slides, please send an e-mail to ota@ota.org
Selective Bibliography

• Oldie but Goodie Reviews…
  – Hak, David J. MD; Golladay, Gregory J. MD *Olecranon Fractures: Treatment Options*; Journal of the American Academy of Orthopaedic Surgeons: *July 2000 - Volume 8 - Issue 4 - p 266-275*


Selective Bibliography

- A few classics


Selective Bibliography

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- De Giacomo, A. F. ; Tornetta, P; Sinicrope, B.J.; Cronin, P. K.; Althausen, P L.; Bray, T. J. ; Kain, M.S.; Marcantonio, A; Sagi, C; James, CR. Outcomes after plating of olecranon fractures: A multicenter evaluation, Injury, 47 (2016) Is7: 1466-1471,

- Duckworth, AD, Clement, ND; White, TO; Court-Brown, C; McQueen, M M Plate versus Tension Band Wire Fixation of Olecranon Fractures: A prospective randomized trial J Bone Joint Surg Am (2017) 99; 1261-12-73
Selective Bibliography

• A few key recent references (continued)…