Distal Humerus Fractures

Edward J Harvey MD MSc FRCSC

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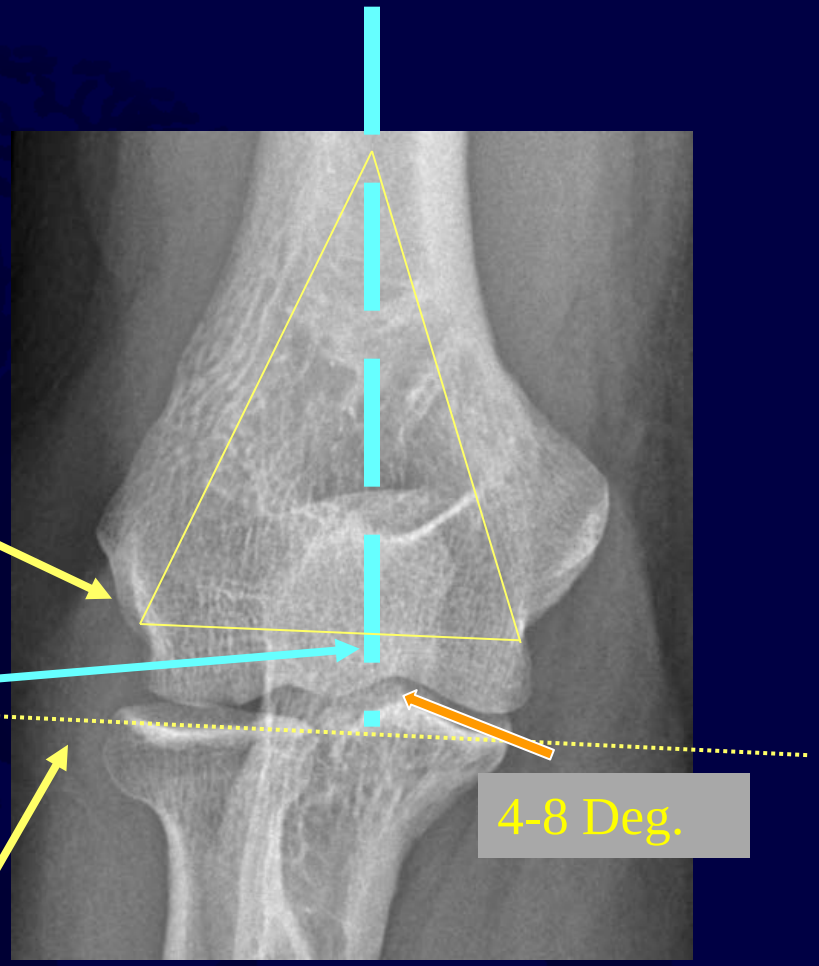
Fractures of the Distal Humerus

Previous authors and current contributors:
Jeffrey J. Stephany, MD and Gregory J. Schmeling, MD; March 2004
Laura S. Phieffer, MD; Revised January 2006
Gregory J. Della Rocca, MD, PhD; Revised October 2010

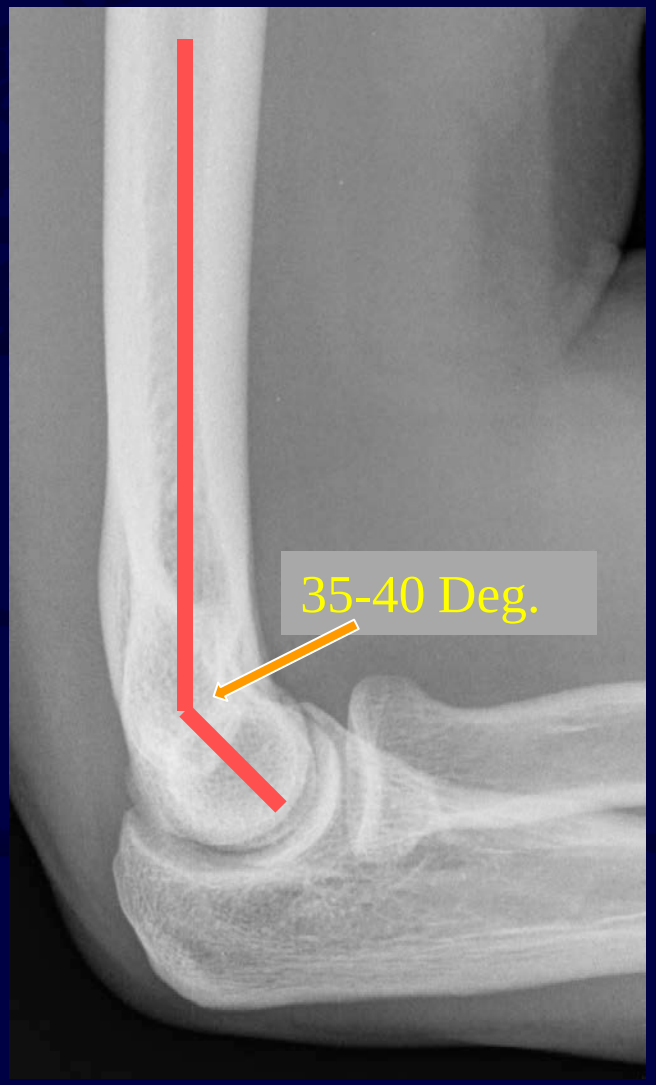
Anatomy

- Hinged joint with single axis of rotation (trochlear axis)
  - At bottom of virtual distal humeral triangle
- Trochlea is center point of AP with a lateral and medial column
- Trochlear axis compared to longitudinal axis is 4-8 degrees in valgus



Functional Anatomy

- The distal humerus angles forward- like a hockey stick!
- Lateral decubitus positioning during ORIF facilitates reconstruction
- The trochlear axis is 3-8 degrees externally rotated
  - (Least important to worry about if cartilage reconstructed)
  - Reason it is difficult to get a true lateral radiograph



Evaluation

- Physical exam
  - Soft tissue envelope
  - Vascular status
    - Radial and ulnar pulses
  - Neurologic status
    - Radial nerve - most commonly injured
      - 14 cm proximal to the lateral epicondyle
      - 20 cm proximal to the medial epicondyle
    - Median nerve - rarely injured
    - Ulnar nerve

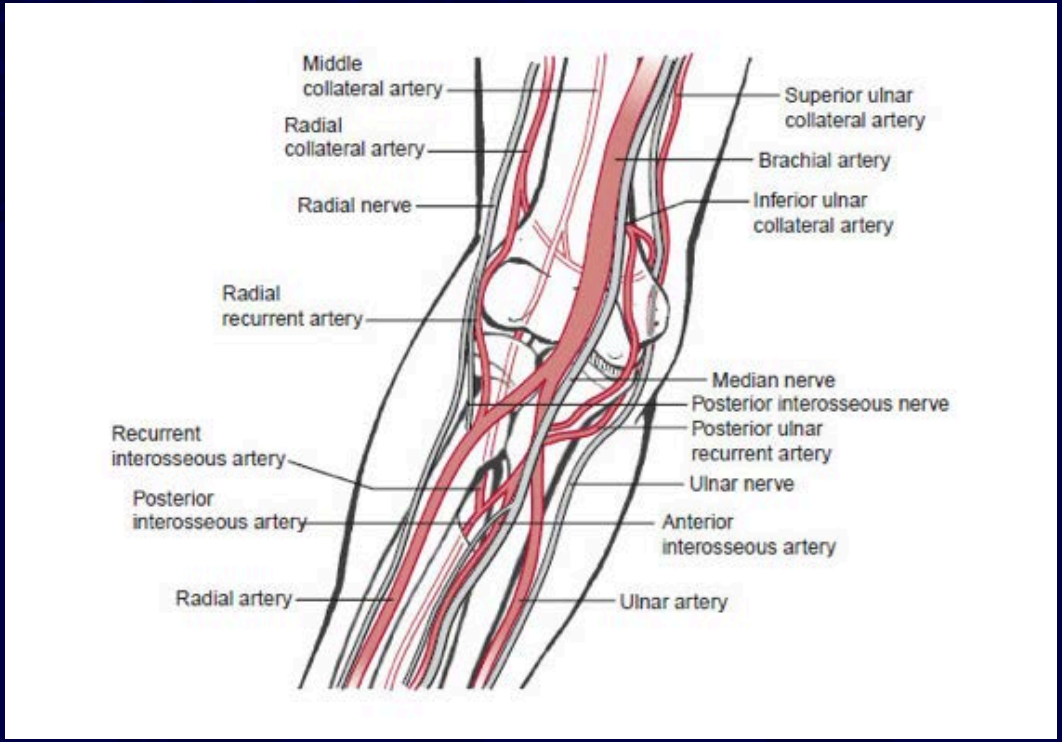


Fig. 33-7 Rockwood and Green

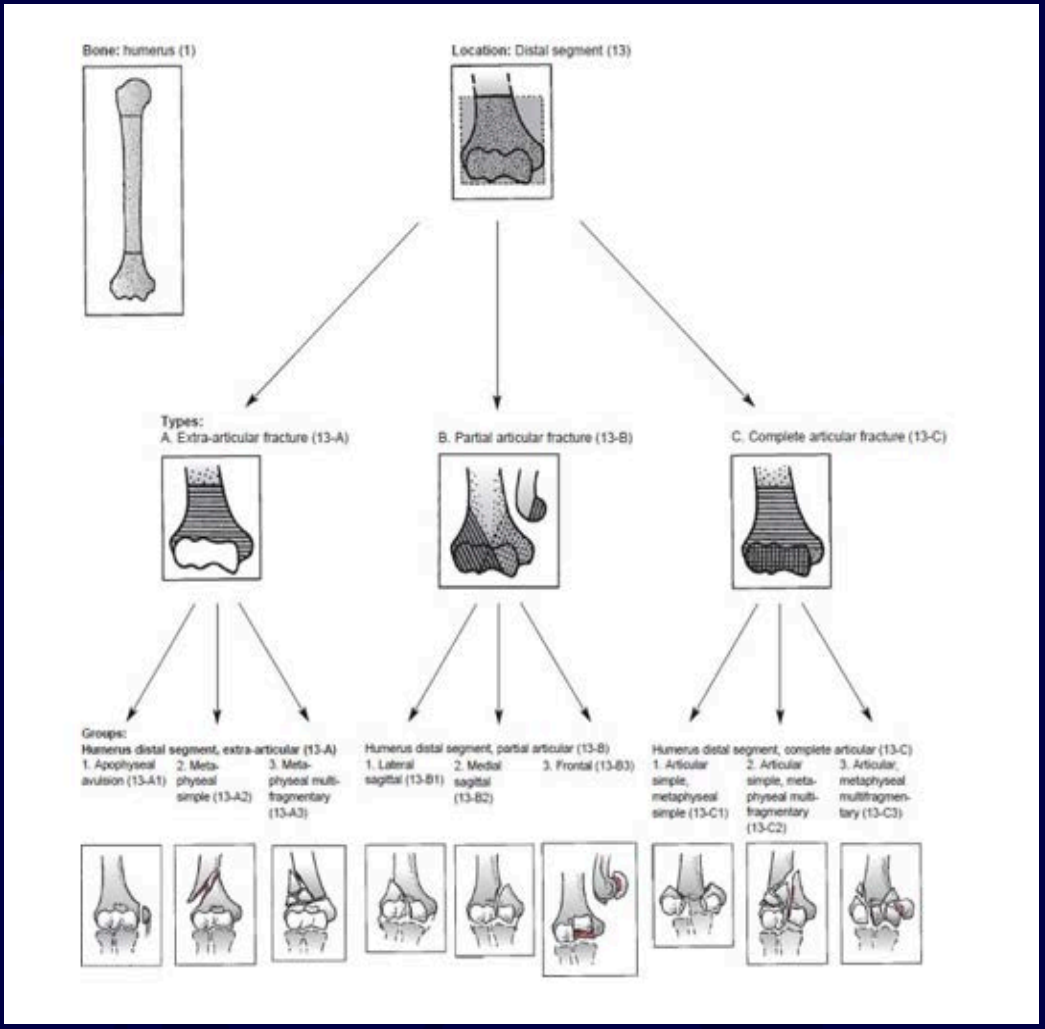
Evaluation

- Radiographic exam
  - Anterior-posterior and lateral radiographs
  - Traction views helpful
    - to evaluate intra-articular extension and for pre-operative planning (partial reduction via ligamentotaxis
    - Traction removes bone overlap
  - CT scan helpful in most cases
    - Comminuted capitellum or trochlea
    - Orientation of CT cut planes can be confusing
    - 3D CT is probably best for evaluation and planning

Classifications

- A good classification should do the following:
  - Describe injury
  - Direct the treatment
  - Point to a prognosis
  - Are useful for research
  - Have good inter-observer and intra-observer reliability
- Most classification schemes we currently use are not good for all of these parameters

OTA Classification



- 3 Main Types
  - Extra-articular fracture (13-AX)
  - Partial articular fracture (13-BX)
  - Complete articular fracture (13-CX)
- Each broad category further subdivided into 9 specific fracture types

OTA Classification

- Humerus, distal segment (13)
  - Types
    - Extra-articular fracture (13-A)
    - Partial articular fracture (13-B)
    - Complete articular fracture (13-C)

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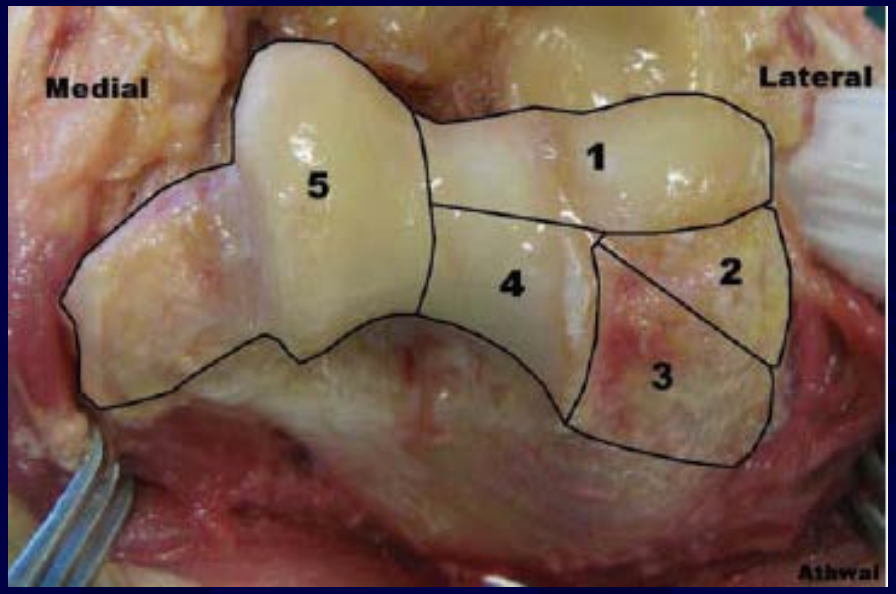
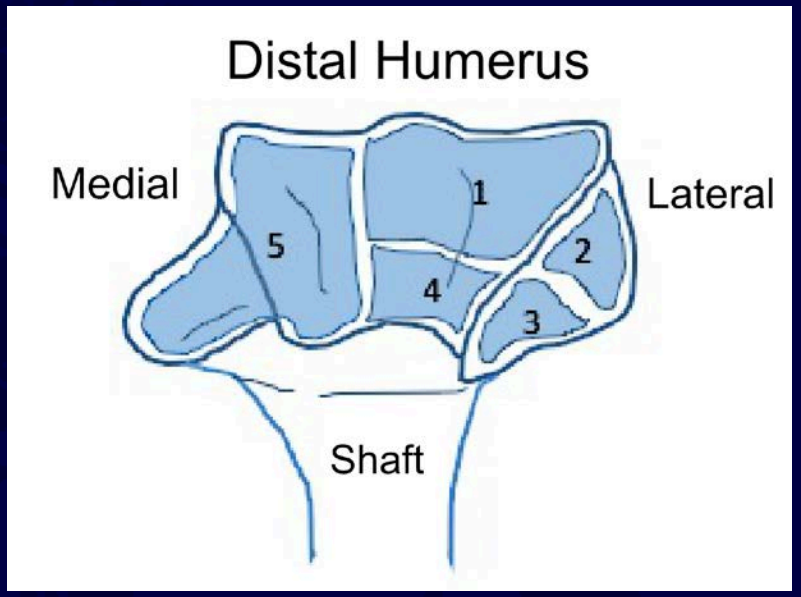
Classification by Pieces

Many different schemes over the years





- From Ring et al- for very distal comminuted fractures
  - Type 1 Capitellum and lateral trochlea
  - Type 2 is a type 1 with comminution of lateral condyle
  - Type 3 is a type 2 with comminution behind capitellum with impaction
  - Type 4 is a type 3 with trochlea posterior involvement
  - Type 5 is a type 4 with fracture of medial condyle
  - Osteoporoticbone can be associated with undisplaced supercondylar fx

Treatment: Open Fracture

- Antibiotic therapy with urgent I&D
- Avoid tourniquet in high energy injuries
- Definitive reduction and internal fixation
  - Primary closure acceptable in almost all circumstances
- Temporary external fixation across elbow if definitive fixation not possible
  - Definitive fixation at repeat evaluation
- Examination of nerves near opening- decompression or transposition if peri-operative swelling is a concern

Treatment Principle

(with reconstructable triangle)

1. Anatomic articular reduction
2. Stable internal fixation of articular surface
3. Restoration of articular axial alignment
4. Stable internal fixation of the articular segment to the metaphysis and diaphysis
5. Early range of motion of the elbow

Treatment Principles

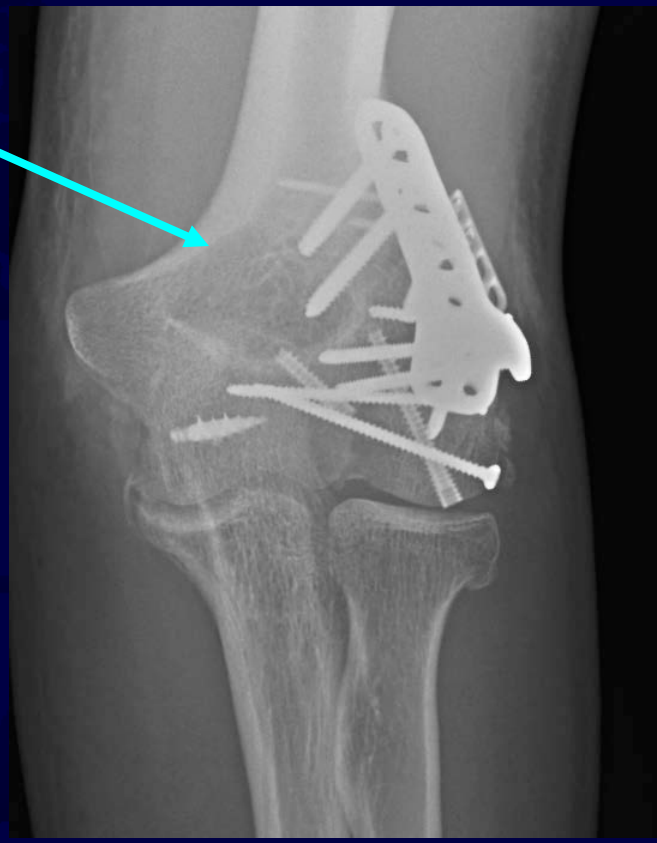
(with large supracondylar or cartilage defects)

1. Anatomic articular reduction and provisional fixation
   - as much as possible
2. Provisional internal fixation of articular surface to shaft
3. Application of contoured plates in buttress fashion (no distal fixation)
4. Provisional fixation (revision if needed) to allow restoration of articular axial alignment in all planes
5. Stable internal fixation of the articular segment to the metaphysis and diaphysis – distal fixation allowed
   - If graft is needed use allograft or autograft
6. Early range of motion of the elbow

Fixation

- Implants determined by fracture pattern- USE just as much as needed to permit early ROM with minimal soft tissue stripping

- Extra-articular fractures may be stabilized by one or two contoured plates
  - Locked vs. nonlocked – based upon bone quality, working length for fixation, surgeon preference
- Intra-articular fractures
  - Dual plates most often used in 1 of 2 ways
    - 90-90: medial and posterolateral
    - Medial and lateral plating



Fixation

- Implants determined by fracture pattern

- Elderly patients with non-displaced fractures can be treated with minimal lateral approach
  - direct application of plate without takedown of soft tissues
  - Formal approaches can destabilize pattern and turn case into a relative mess!

Dual plating configurations

- Schemitsch et al (1994) *J Orthop Trauma* 8:468
- Tested 2 different plate designs in 5 different configurations
- Distal humeral osteotomy with and without bone contact
- Conclusions:
  - For stable fixation the plates should be placed on the separate columns but not necessarily at 90 degrees to each other

Dual plating configurations

- Jacobson et al (1997) *J South Orthop Assoc* 6:241
- Biomechanical testing of five constructs
- All were stiffer in the coronal plane than the sagittal plane
- Strongest construct (before precontoured or locking plates)
  - medial reconstruction plate with posterolateral dynamic compression plate

Dual plating configurations

- I-beam or 90-90
- Use stiff plates
- Anatomic contour can be helpful
  - Plain recon can work just as well
    - Clin Biomech (Bristol, Avon). 2012 Aug;27(7):697-701
- Locking useful for comminution or missing pieces
- What you are comfortable with…

Other Potential Surgical Options

- Total elbow arthroplasty
  - Comminuted intra-articular fracture in the elderly
  - Promotes immediate ROM
  - Usually limited by poor remaining bone stock
- “Bag of bones” technique
  - Rarely indicated if at all
  - Distal impacted fractures in elderly with early ROM
- Cast or cast / brace
  - Indicated for completely non-displaced, stable fractures

Fixation in elderly patients

- John et al (1993) *Helv Chir Acta* 60:219
- 49 patients (75-90 yrs)
- 41/49 Type C
- Conclusions
  - No increase in failure of fixation, nonunion, nor ulnar nerve palsy
  - Age not a contra-indication for ORIF

Total elbow arthroplasty

- Cobb and Morrey (1997) JBJS-A 79:826
- 20 patients
  - avg age 72 yrs
- TEA for distal humeral fracture
- Conclusion
  - TEA is viable treatment option in elderly patient with distal humeral fracture

ORIF vs. elbow arthroplasty

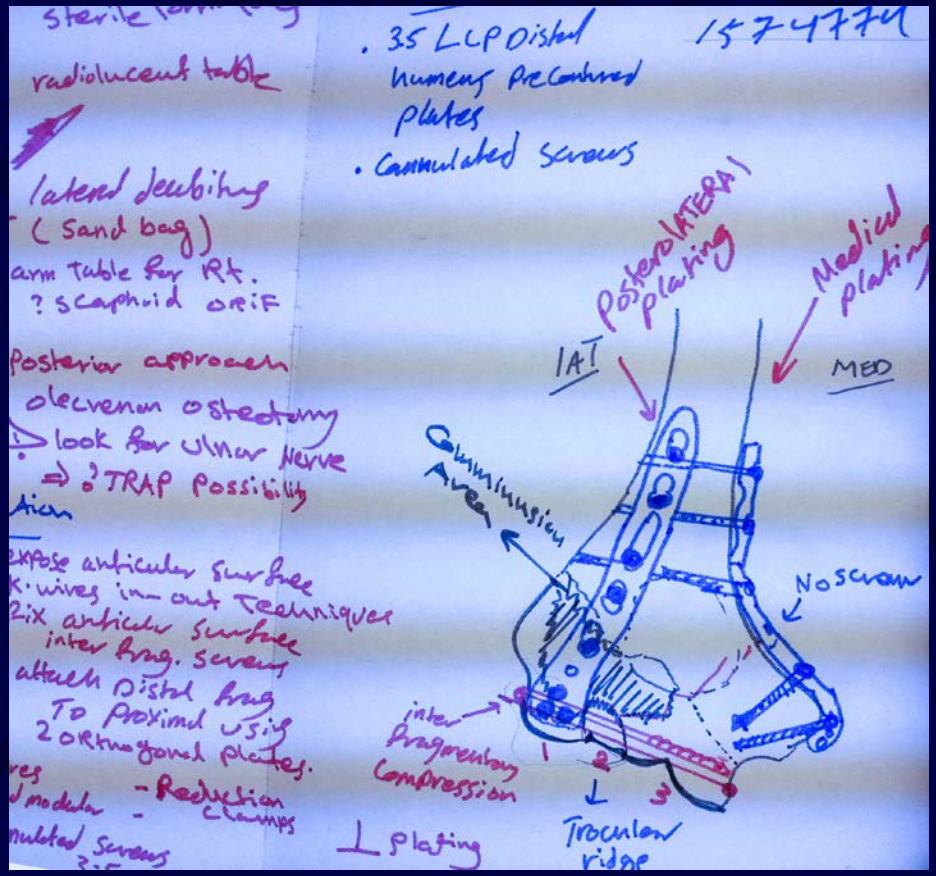
- Frankle et al (2003) *J Orthop Trauma* 17:473
- Comparison of ORIF vs. TEA for intra-articular distal humerus fxs (type C2 or C3) in women >65yo
- Retrospective review of 24 patients
- Outcomes
  - ORIF: 4 excellent, 4 good, 1 fair, 3 poor
  - TEA: 11 excellent, 1 good
- Conclusions: TEA is a viable treatment option for distal intra-articular humerus fxs in women >65yo

- McKee et al COTS Study JSES

Surgical Treatment

- Lateral decubitus position
  - Prone positioning possible
  - Supine position OK as well
- Arm hanging over a post
- I prefer a sterile bump in case convert to TEA
- Sterile tourniquet better- non-sterile in long arms if possible
- Midline posterior skin incision

Plan


radiolucent table
lateral decubitus
(sand bag)
arm Table for Rt.
? scaphoid ORIF
Posterior approach
olecranon osteotomy
look for ulnar nerve
⇒ ? TRAP possibility
. 35 LCP Distal Humeral Precontoured Plates
. Cannulated Screws
Posterolateral plating
Medial plating
LAT
MED
Comminution Area
No screw
inter fragmentary compression
Trochlear ridge
1
2
3
plating

Exposures

- Reduction seems to influence outcome in articular fractures
- Exposure affects ability to achieve reduction
- Many different exposures give good to complete **visualization** of articular surface
- Choose the exposure that fits the fracture pattern or your experience

Exposures

- Only 2 basic posterior approaches
  - Para-tricipetal (one or both sides of Triceps with or with out a slide or turndown)
    - Includes
      - Olecrenon osteotomy; TRAP; Bryan-Morrey; Triceps-On Slide, Bi-Triceps approaches
  - Triceps Splitting
  - Do not use triceps tongue!
  - Lateral , Anterior , Medial – more specialized or for pediatric cases

Surgical exposures

- Triceps splitting
  - Allows exposure of shaft to olecranon fossa
  - Can be extended by sliding off ulna on both sides with later repair
- Extra-articular olecranon osteotomy
  - Allows adequate exposure of the distal humerus but inadequate exposure of the articular surface
    - If no triceps slide involved

Surgical exposures

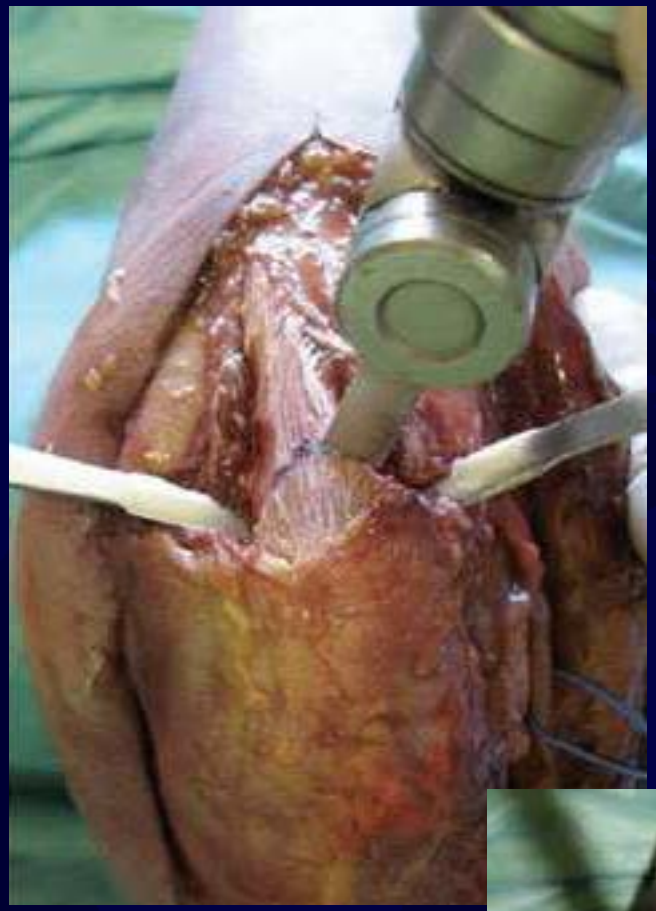
- Intra-articular olecranon osteotomy
- Most common approach
  - I have not done one for 10 years
  - Types
    - Transverse or Chevron
      - *Technically easier to do then slides or flaps*
      - Trade-off---30% incidence of nonunion
        - (Gainor et al, (1995) *J South Orthop Assoc* 4:263)
  - Olecranon implant removal may be necessary due to irritation !!
    - Plates or tension bands

Osteotomy Fixation Options

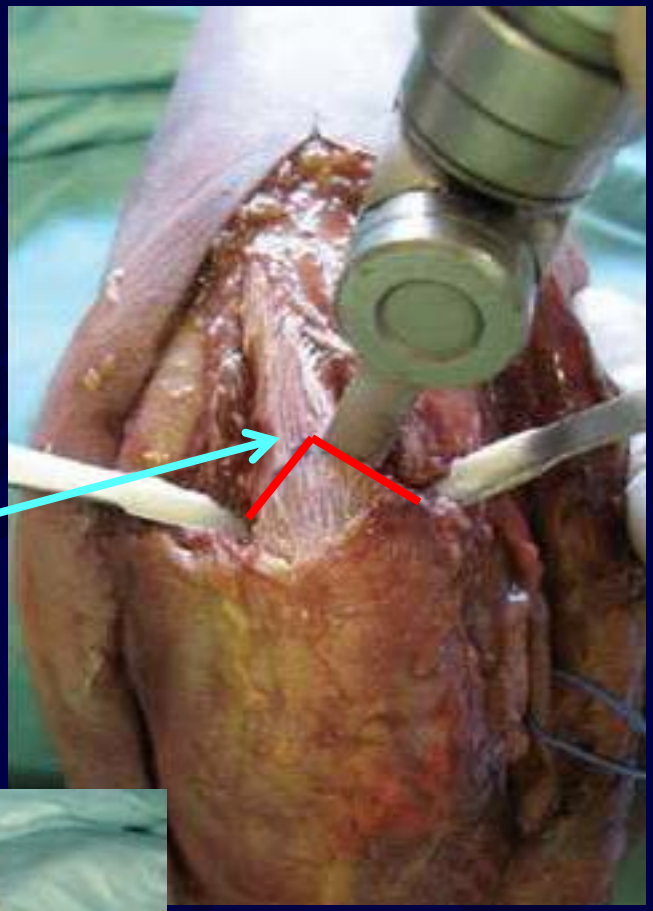
- Tension band technique
- Dorsal plating
- Single screw

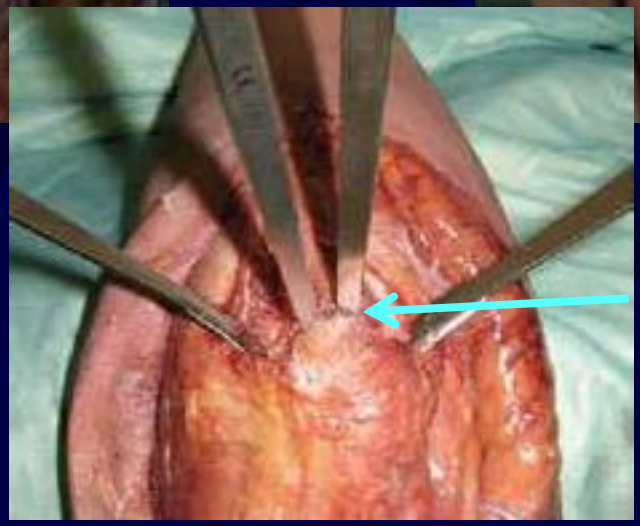
Chevron Osteotomy

- Expose olecranon and mobilize ulnar nerve
- If using screw/TBW fixation, pre-drill and tap for screw placement down the ulna canal
- Small, thin oscillating saw used to cut 95% of the osteotomy
- Osteotome used to crack and complete it



Chevron pointed distally in bald spot of cartilage





Finish with osteotomes
Last 5%

Chevron osteotomy

- Coles et al (2006) *J Orthop Trauma* 20:164
- 70 chevron osteotomies
  - All fixed with screw plus tension band or with plate-and-screw construct
  - 67 with adequate follow-up: all healed
  - 2 required revision fixation prior to healing
  - 18 of 61 with sufficient follow-up required implant removal

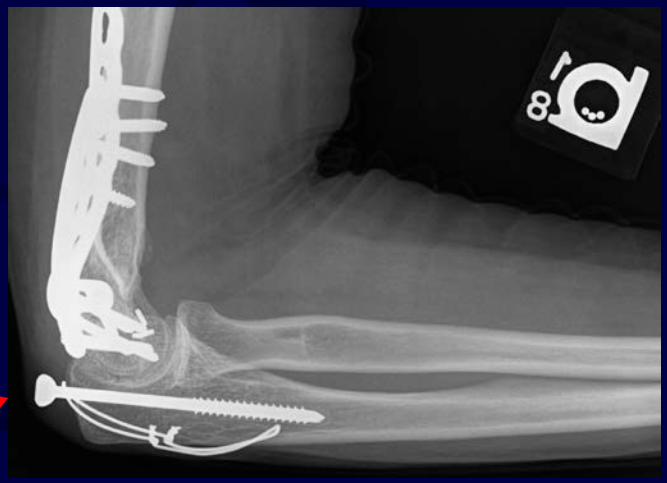
Osteotomy Fixation

- Single screw technique
  - Large screw +/- washer
  - Beware of the bow of the proximal ulna, which may cause a malreduction of the tip of the olecranon if a long screw is used.
    - Eccentric placement of screw may be helpful

Hak and Golladay, JAAOS, 8:266-75, 2000

Osteotomy Fixation

- Single screw technique
  - Large screw +/- washer
  - BEWARE: large-diameter screw threads may engage ulnar diaphysis (small medullary canal) prior to full seating of screw head
    - "Bite" of screw may be strong without full compression
    - Careful scrutiny of lateral radiograph important to assure full seating of screw head



Hak and Golladay, JAAOS, 8:266-75, 2000

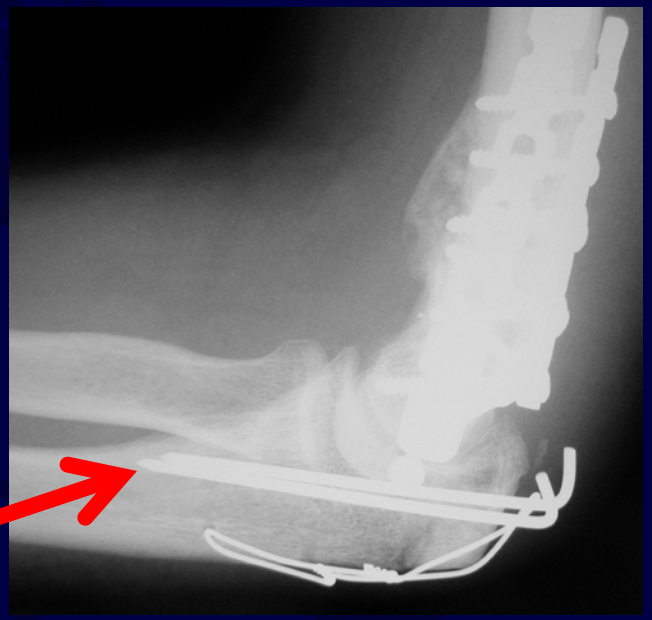
Osteotomy Fixation

- Single screw technique
  - Long screw may be beneficial for adequate fixation
    - Short screw may loosen or toggle with contraction of triceps against olecranon segment

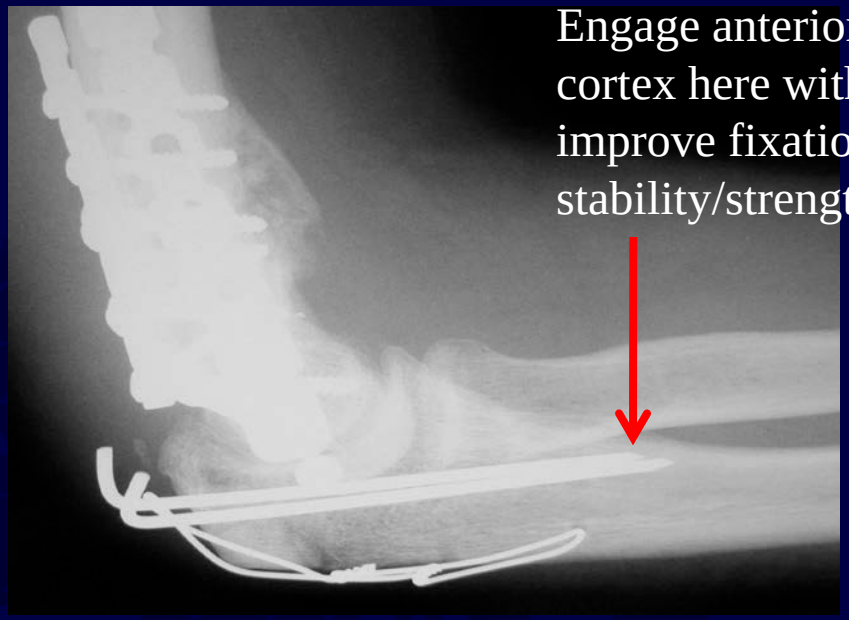
Hak and Golladay, JAAOS, 8:266-75, 2000

Osteotomy Fixation

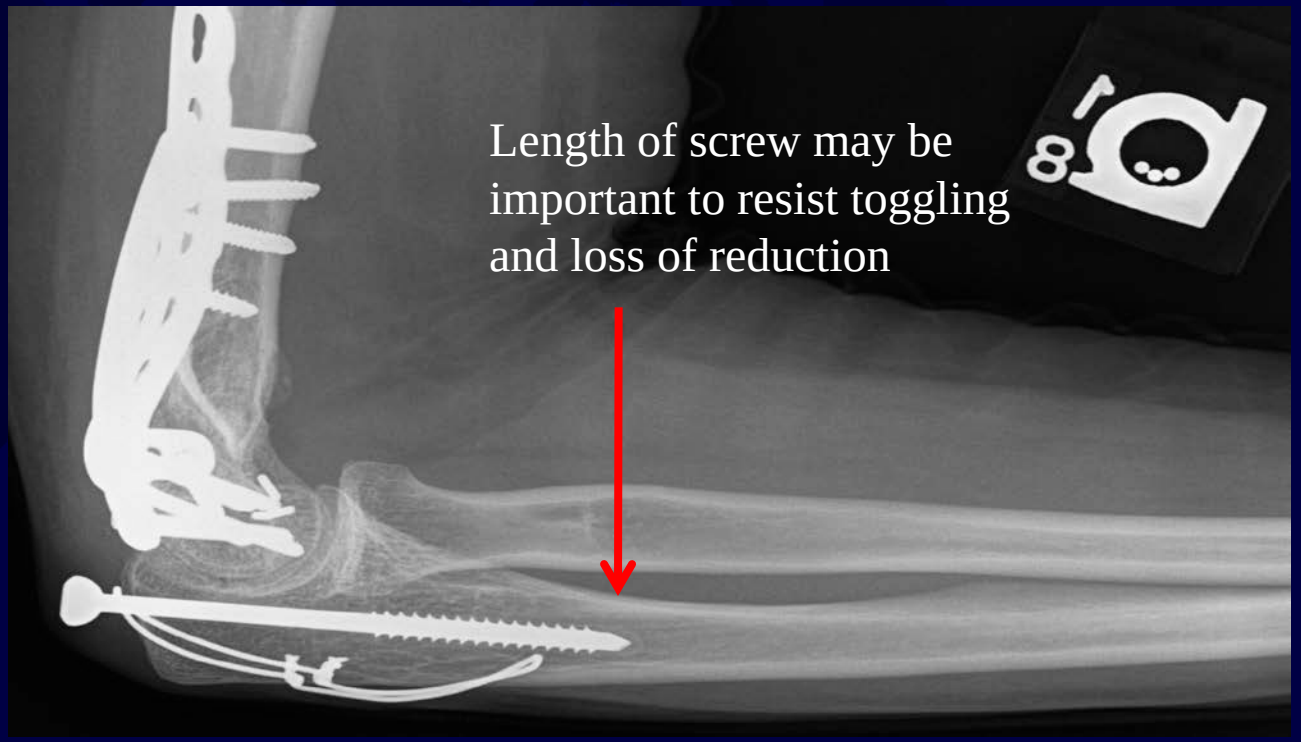
- Tension band technique
  - K-wires or screw with figure-of-8 wire
    - Easy to place (?)
    - May be less stable than independent lag screw or plate
    - Implant irritation
  - K-wires – try to engage anterior ulnar cortex near coronoid base
    - Mullett et al (2000) *Injury* 31:427,
    - Prayson et al (1997) *J Orthop Trauma* 11:565



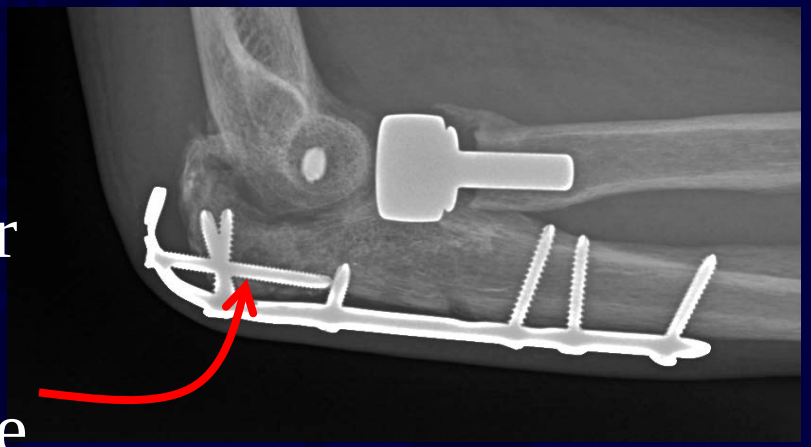
Tension band wire



Tension band screw



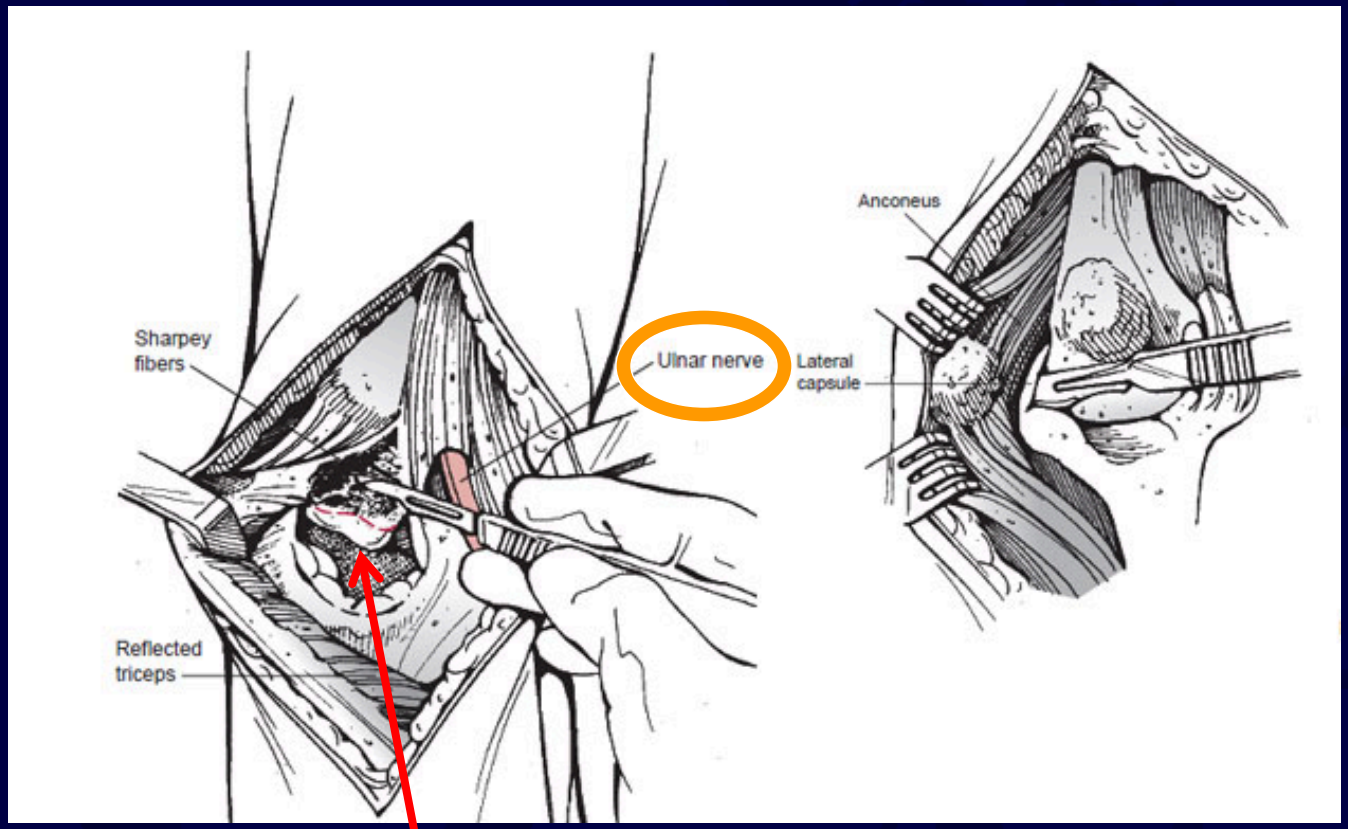
Osteotomy Fixation



- Dorsal plating
  - Low profile peri-articular implants now available
  - Axial screw through plate
  - Good results after plate fixation
    - Hewin et al (2007) *J Orthop Trauma* 21:58
    - Tejwani et al (2002) *Bull Hosp Jt Dis* 61:27

Surgical exposure

- Triceps-sparing postero-medial approach (Byran-Morrey Approach)
  - Midline incision
  - Ulnar nerve identified and mobilized
  - Medial edge of triceps and distal forearm fascia elevated as single unit off olecranon and reflected laterally
  - Resection of extra-articular tip of olecranon
  - See 95% of joint
  - Can do TEA



Bryan-Morrey Approach

Resect tip- take off a big piece

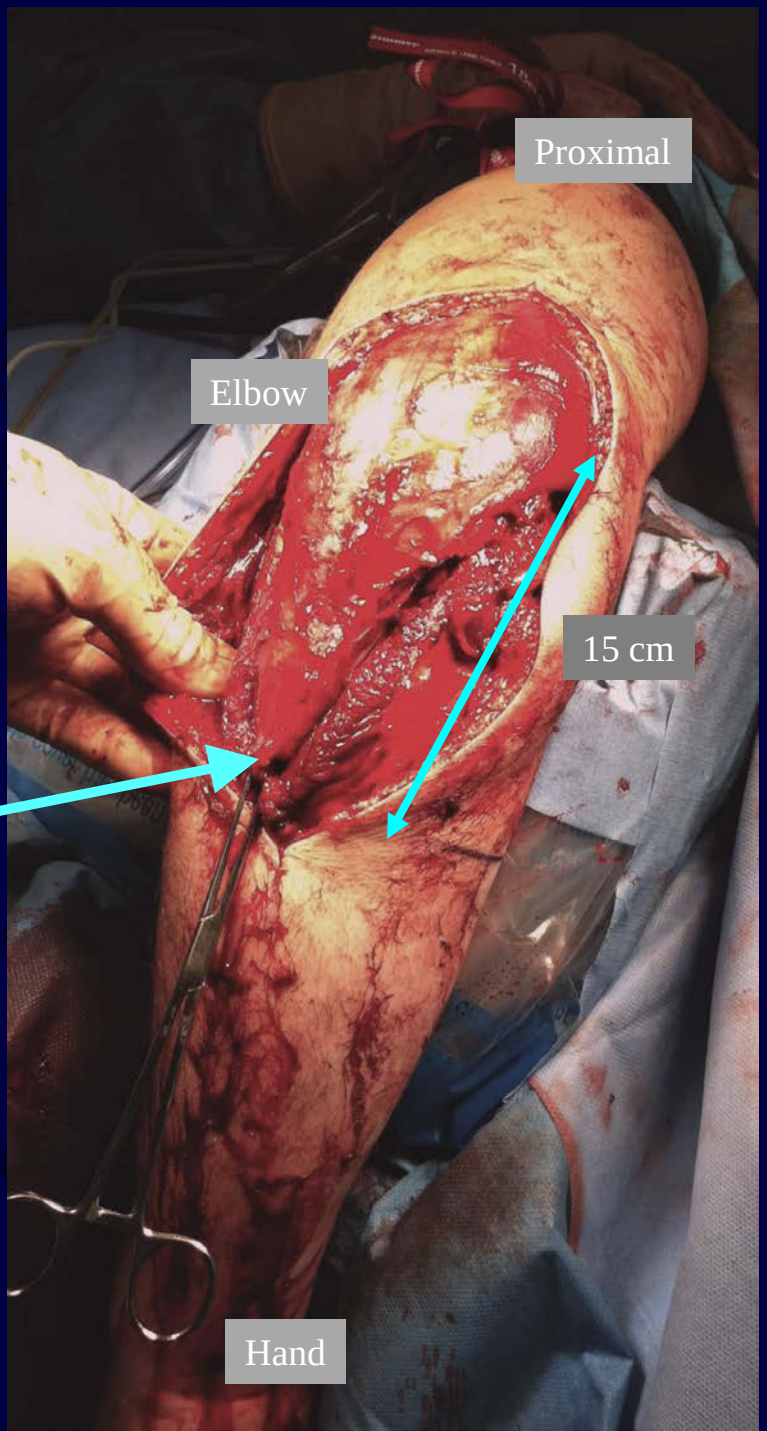
Surgical exposure

- Medial and lateral exposures – triceps sparing
  - Good for extra-articular fractures and some simple intra-articular fractures (OTA type 13-C1 or 13-C2)
  - Resect tip of olecranon to improve visualization without detaching tricep

TRAP Flap

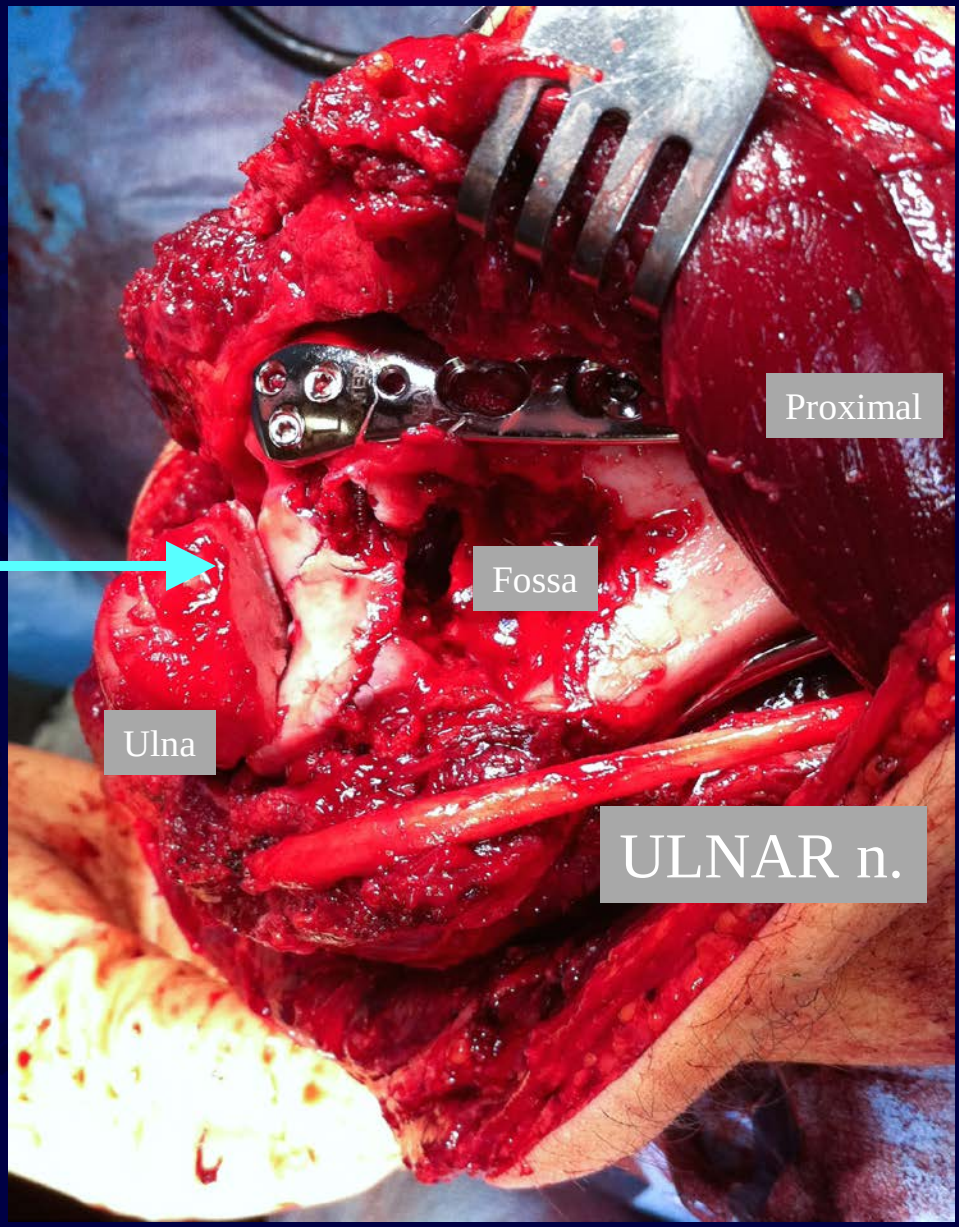
- Posterior approach

- Flap lifted off ulna to about 15 cm distal to joint
- Repaired through ulna with FibreWire™ at end of procedure



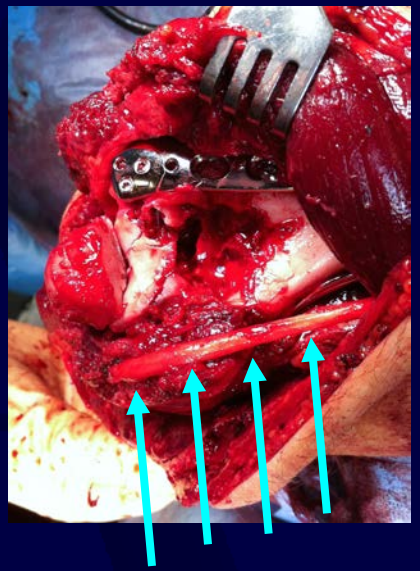
TRAP

- Good Exposure
- Osteotomy of 25% olecranon
- With flexion to 120 can see 95% of joint surface



To transpose or not to transpose?

- Identification and mobilization of the ulnar nerve is often required
- Ulnar nerve palsy may be related to injury, surgical exposure/mobilization/stripping, compression by implant, or scar formation



To transpose or not to transpose?

- Wang et al (1994) *J Trauma 36:770*
  - consecutive series of distal humeral fractures treated with ORIF and anterior ulnar nerve transposition
    - no post-operative ulnar nerve compression sx
  - overall results:
    - Excellent/Good 75%, Fair 10%, and Poor 15%
  - Conclusion
    - routine anterior transposition indicated

To transpose or not to transpose?

- Chen et al (2010) *J Orthop Trauma* 24:391
  - Retrospective cohort comparison
  - 89 patients transposition; 48 patients did not
  - 4x greater incidence of ulnar neuritis in patients with transposition
  - Conclusion:
    - routine ulnar nerve transposition not recommended during ORIF of distal humerus fractures

To transpose or not to transpose?

- No real answer
  - COTS currently running prospective study

Post-operative care

- Elbow position
  - 90 degrees of flexion or extension?
  - Authors support either and proponents strongly argue that their position is the best
    - Extension is harder to recover than flexion
    - Final arc of motion recovered is more functional if centered on 90 degrees of flexion
- Personally use extension
  - early ROM day 10-14 at suture removal

Post-operative care

- AROM / AAROM (PROM may be used but might promote heterotopic ossification)
- Anti-inflammatory for 6 weeks or single-dose radiation therapy used occasionally if at high risk for heterotopic ossification
  - Recent report documents dramatically-increased complication risk of olecranon osteotomy after radiation therapy
    - (Hamid et al (2010) JBJS-A 92:2232)

Outcomes

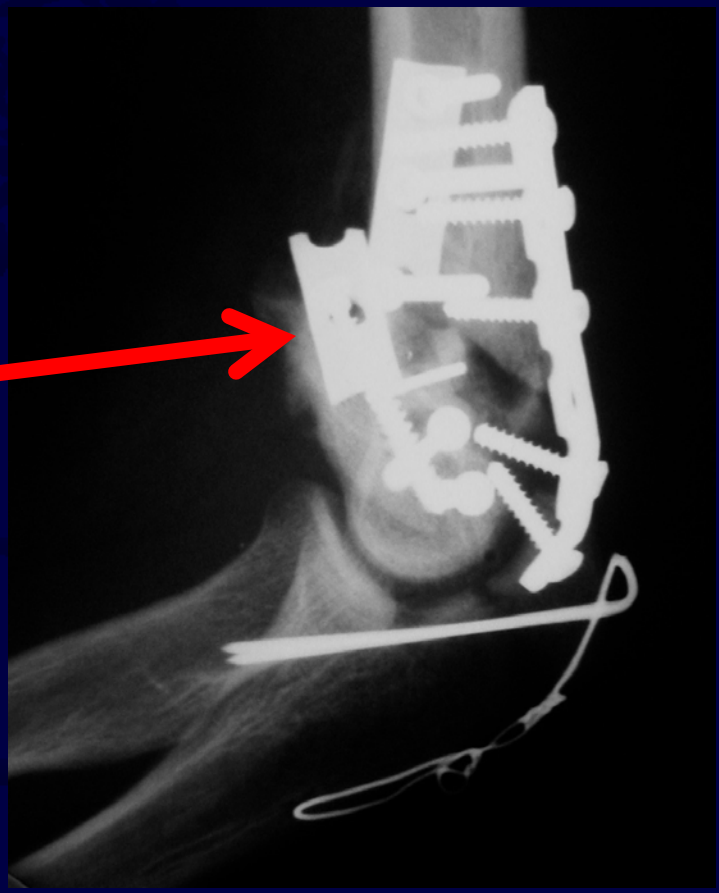
- Most daily activities can be accomplished with the following final motion arcs:
  - 30 –130 degrees extension-flexion
  - 45– 45 degrees pronation-supination
- Outcomes based on pain and function
- Patients not necessarily satisfied with above motion arcs (need the 130 for sure)

Outcomes

- What patients may expect, for example:
  - Lose 10-25 degs of flexion and extension
  - Maintain most of supination and pronation
  - Decrease in muscle strength
  - Overall:
    - Good/excellent 75%
  - Factors most likely to affect outcome
    - Severity of injury
    - Occurrence of a complication

Complications

- Failure of fixation
  - Associated with stability of operative fixation
  - K-wire fixation alone is inadequate
  - 1/3 tubular plates no good
  - If diagnosed early, revision fixation indicated
  - Late fixation failure must be tailored to radiographic healing and patient symptoms



Complications

- Nonunion

- Uncommon
  - Usually a failure of fixation
  - Symptomatic treatment
  - Bone graft with revision plating

Complications

- Non-union of olecranon osteotomy
  - Rates as high as 30% or more
  - Chevron osteotomy has a lower rate
  - Treated with bone graft occasionally and revision fixation
  - Excision of proximal fragment is salvage
    - 50% of olecranon must remain for joint stability

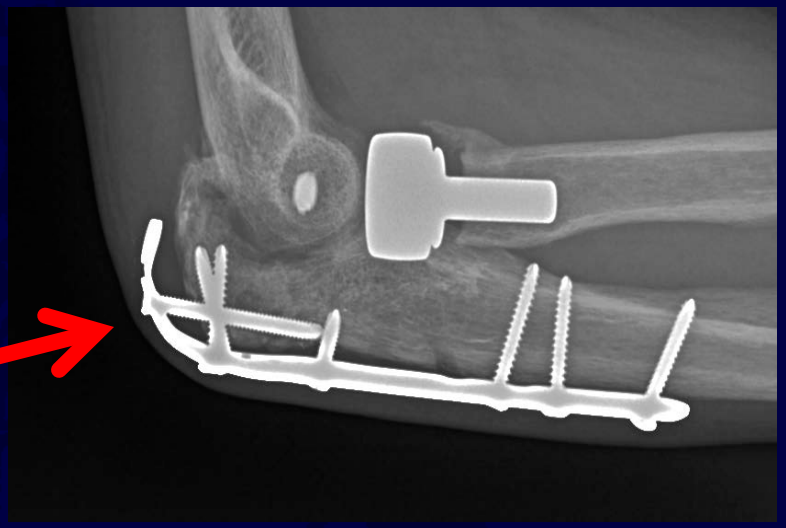
Complications

- Infection
  - Range 0-6%
  - Highest for open fractures
  - No style of fixation has a higher rate than any other
    - So early definitive management is most desired treatment

Complications

- Ulnar nerve palsy
  - 8-20% incidence
  - Reasons: operative manipulation, hardware prominence, inadequate release
  - Results of neurolysis (McKee, et al)
    - 1 excellent result
    - 17 good results
    - 2 poor results (secondary to failure of reconstruction)
  - Prevention best treatment (although routine transposition is of unknown importance)

Complications



- Painful implants
  - The most common complaint
  - Common location
    - Olecranon
    - Medial implants (over medial epicondyle)
    - Lateral implants (some plates prominent over posterior-lateral aspect of lateral condyle)
  - Implant removal
    - After fracture union
    - Patient may need to restrict activity for 6-12 weeks

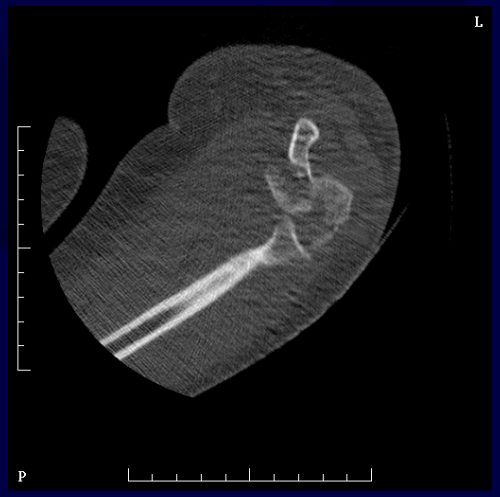
Summary

- ORIF indicated for most displaced patterns
- Total elbow arthroplasty excellent alternative in patient with poor bone quality and low functional demands
- Chevron osteotomy is preferred type of olecranon osteotomy when needed
- Routine transposition of ulnar nerve has not been demonstrated to be beneficial

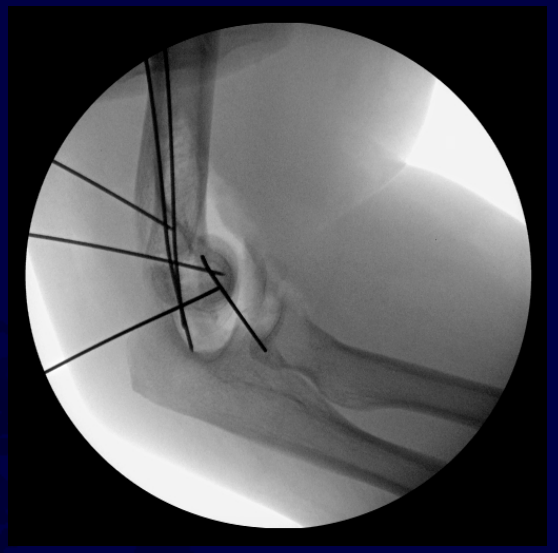
Case Examples

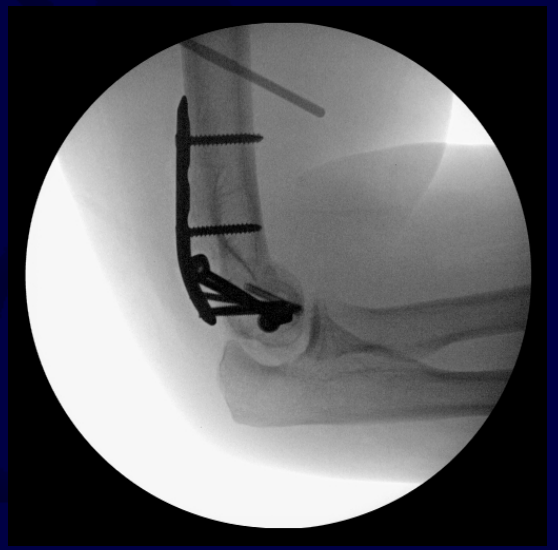
1. Lateral column fracture
2. Capitellar fracture
3. Intra-articular distal humeral fracture
4. Low articular distal humeral fracture
5. Intra-articular plus TTriad
6. Failure of inadequate ORIF

Case 1: 44y/o s/p fall
Lateral epicondyle and capitellum Fx's



Lateral approach
Capitellum: Post to Ant lag screws
Epicondyle: Screw + buttress plate
Healed
Loss of 20 degs ext

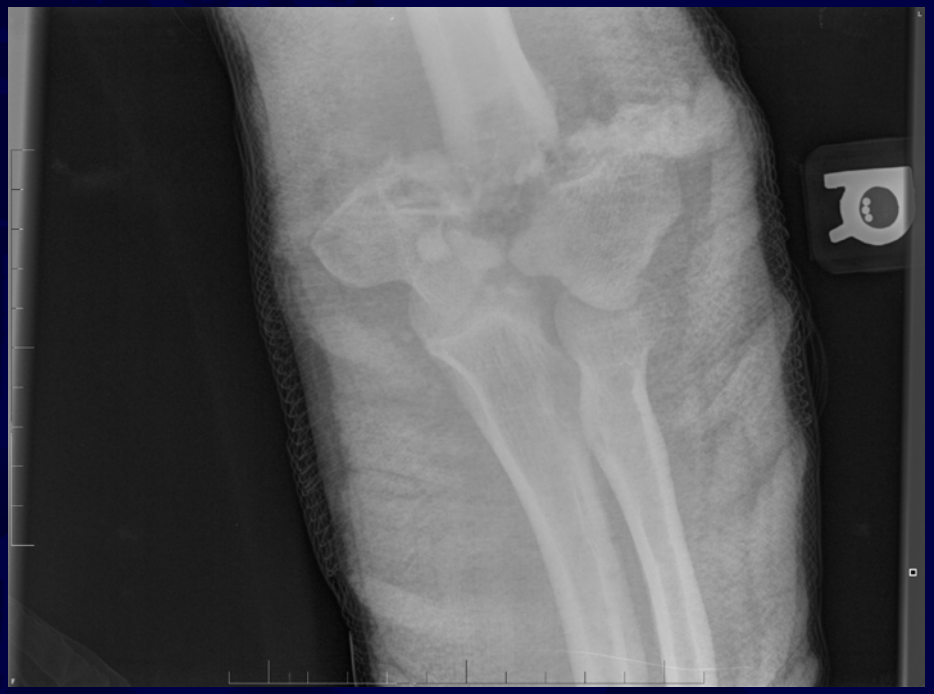




Case 2:
43 y/o female fell from steps
--Hard to see on AP

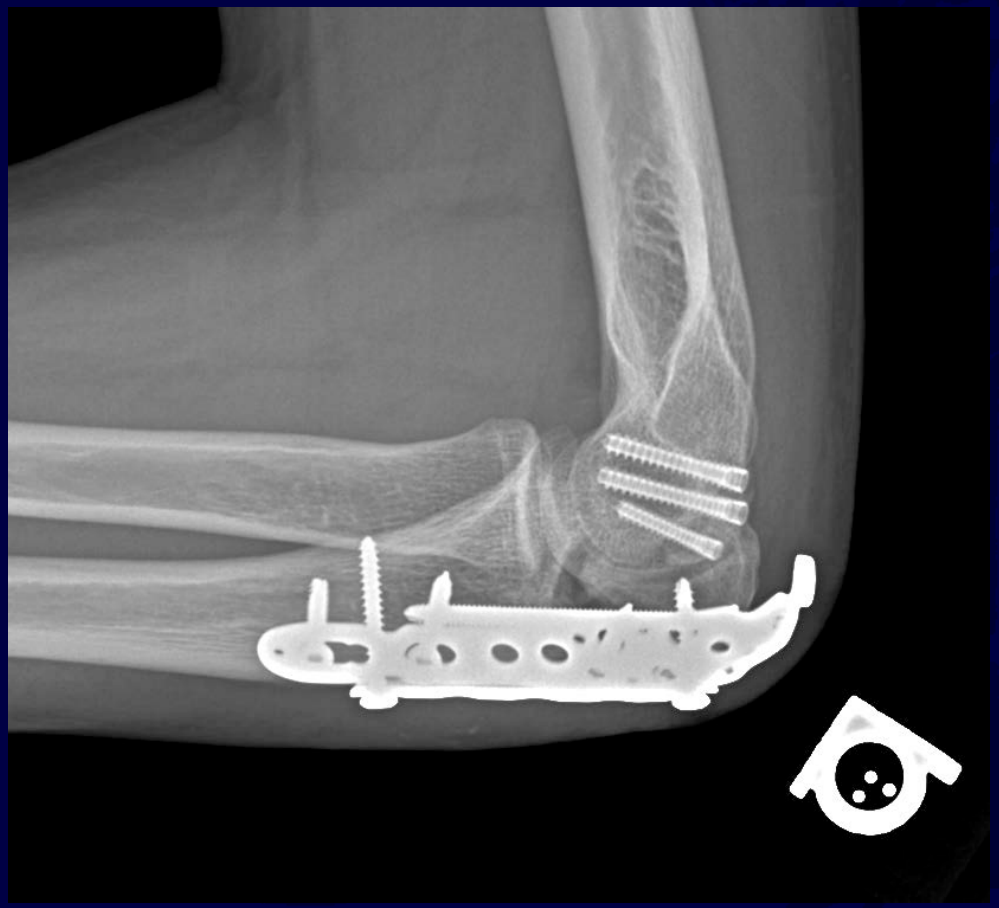
- Lateral approach only
- Front and back visualization
- Direct clamping

Case 3: 30 y/o male MCC
Distal, two column Fx
NV intact



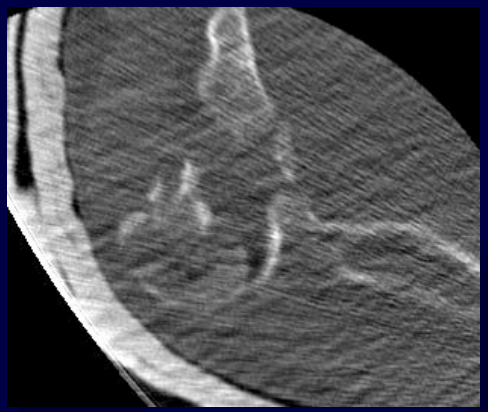
TRAP Flap intra-articular approach
Lag screw and bi-column plating
No osteotomy needed
Large missing bone segment-
bridged with locking plates

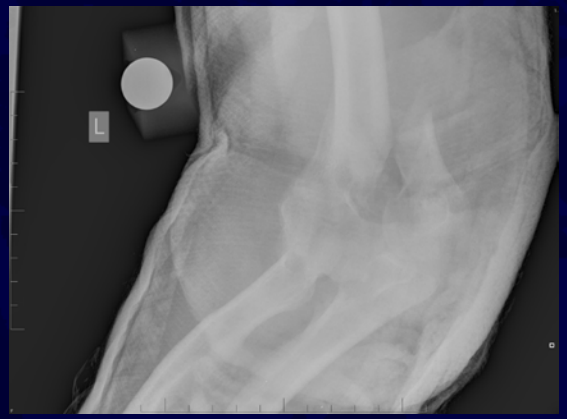
Case 4 – Open Fx olecranon and Low humerus fracture 30yo

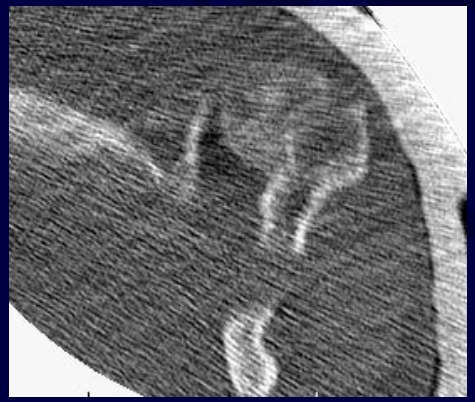



L

Case 5 young patient with fracture dislocation
Elbow terrible triad – and humerus







Provisional k-wire fixation –
After intra-articular splits and radial head are fixed
Then plate application as buttress
Then screw fixation – locked
Soft tissue repair

5 year follow-up

Case 6
63 yo Female
Seen elsewhere – Fx Elbow…

3 weeks later
In your clinic

H
L

References

- Hamid et al. Radiation therapy for heterotopic ossification prophylaxis acutely after elbow trauma. JBJS-A (2010) 92:2032.
- Vazquez et al. Fate of the ulnar nerve after operative fixation of distal humerus fractures. *J Orthop Trauma* (2010) 24:395.
- Chen et al. Is ulnar nerve transposition beneficial during open reduction internal fixation of distal humerus fractures? *J Orthop Trauma* (2010) 24:391.

References

- Coles et al. The olecranon osteotomy: a six-year experience in the treatment of intraarticular fractures of the distal humerus. *J Orthop Trauma* (2006) 20:164.
- Tejwani et al. Posterior olecranon plating: biomechanical and clinical evaluation of a new operative technique. *Bull Hosp Jt Dis* (2002) 61:27.
- Gainor et al. Healing rate of transverse osteotomies of the olecranon used in reconstruction of distal humerus fractures *J South Orthop Assoc* (1995) 4:263.

References

- John, H, Rosso R, Neff U, Bodoky A, Regazzoni P, Harder F: Operative treatment of distal humeral fractures in the elderly. JBJS 76B: 793-796, 1994.
- Pereles TR, Koval KJ, Gallagher M, Rosen H: Open reduction and internal fixation of the distal humerus: Functional outcome in the elderly. *J Trauma* 43: 578-584, 1997
- Hewins et al. Plate fixation of olecranon osteotomies. *J Orthop Trauma* (2007) 21:58.

References

- Cobb TK, Morrey BF: Total elbow arthroplasty as primary treatment for distal humeral fractures in elderly patients. JBJS 79A: 826-832, 1997
- Frankle MA, Herscovici D, DiPasuale TG et al: A comparison of ORIF and Primary TEA in the treatment of intraarticular distal humerus fractures in women older than age 65. *J Orthop Trauma* 17(7):473-480, 2003.
- Mullett et al. K-wire position in tension band wiring of the olecranon: a comparison of two techniques. *Injury* (2000) 31:427.

References

- Schemitsch EH, Tencer AF, Henley MB: Biomechanical evaluation of methods of internal fixation of the distal humerus. *J Orthop Trauma* 8: 468-475, 1994
- Korner J, Diederichs G, Arzdorf M, et al: A Biomechanical evaluation of methods of distal humerus fracture fixation using locking compression versus conventional reconstruction plates. *J Orthop Trauma* 18(5):286-293, 2004.
- Prayson et al. Biomechanical comparison of fixation methods in transverse olecranon fractures: a cadaveric study. *J Orthop Trauma* (1997) 11:565.

References

- Cheung EV, Steinmann SP. Surgical approaches to the elbow. J Am Acad Orthop Surg. 2009 May;17(5):325-33.
- Galano GJ, Ahmad CS, Levine WN. Current treatment strategies for bicolumnar distal humerus fractures. J Am Acad Orthop Surg. 2010 Jan;18(1):20-30.

References

- Jacobson SR, Gilsson RR, Urbaniak JR: Comparison of distal humerus fracture fixation: A biomechanical study. *J South Orthop Assoc* 6: 241-249, 1997
- Voor, MJ, Sugita, S, Seligson, D: Traditional versus alternative olecranon osteotomy. Historical review and biomechanical analysis of several techniques. *Am J Orthop* 24: Suppl, 17-26, 1995

References

- Wang KC, Shih, HN, Hsu KY, Shih CH: Intercondylar fractures of the distal humerus: Routine anterior subcutaneous transposition of the ulnar nerve in a posterior operative approach. *J Trauma* 36: 770-773, 1994
- McKee MD, Jupiter JB, Bosse G, Hines L: The results of ulnar neurolysis for ulnar neuropathy during post-traumatic elbow reconstruction. Orthopaedic Proceedings JBJS-B 77 (Suppl):75, 1995

- For questions or comments, please send to ota@ota.org