DISTAL RADIUS FRACTURE: OPERATIVE TREATMENT

Which side was broken?
History & physical

- Hx:
  - Mechanism, Associated Injury & Neurologic complaints
  - Hand dominance, prior injury, & vocation
- Pex:
  - Look —> S.E.A.D.S.
  - Feel —> Tenderness & Neurovascular exam
  - Move —> Joint above & below

Diagnosis

- Clinical
- Radiographic:
  - Joint above and below
  - Images of Wrist:
    » AP
    » LAT
    » Oblique
  - CT —> Select indications
Computed Tomography

• Indications:
  • Intra-articular fractures with complex fragmentation
  • Centrally impacted fragments
  • DRUJ incongruity
  • Cole et al. (1997) —
  • Increased sensitivity for intra-articular fragments
  • 25% change in management

Associated Soft tissue injury

• TFCC – 45%
• DRUJ – 33%
• Scapholunate – 28% (DISI)
• Lunotriquetral – 7% (VISI)
• Median Nerve must be checked

Treatment Goals

• **RESTORE ANATOMIC RELATIONSHIPS**
• **PROVIDE APPROPRIATE FIXATION**
• **PRESERVATION OF BLOOD SUPPLY**

Radiographic REVIEW: ABCs

• **A**
  • Assess *adequacy* of x-ray which includes proper number of views and penetration
  • Assess *alignment* of x-rays
Radiographic REVIEW: ABCs

- **A**
  - Assess adequacy of x-ray which includes proper number of views and penetration
  - Assess alignment of x-rays
- **B**
  - Examine bones throughout entire length for fracture lines and/or distortions
- **C**
  - Examine cartilage (joint spaces) for widening
- **S**
  - Assess soft tissues for swelling/effusions/hemarthrosis

**Language**

- Translation
- Bayonet vs. Apposition (%)
- Angulation (°)
- Apex dorsal vs. Volar
- Length
- Distracted vs. Shortened
- Rotation
- Dislocation or subluxation

**Radiology**

- **Radial Inclination** – 22°
- **Radial Height** – 11 mm
- **Volar Tilt** – 11-14°
- **Ulnar Variance** neutral

**RULE OF 11’s**
Radial Height
Radial inclination
Volar angulation

Radiology
• DRUJ:
  • Widening of DRUJ on AP
  • NEED TRUE LATERAL
  • Volar or Dorsal translation of ulnar head

Treatment Goals
1. ARTICULAR CONGRUITY
2. RADIAL ALIGNMENT AND LENGTH
3. MOTION
4. STABILITY
**LIMITED EVIDENCE AT BEST**

- Nerve decompression
- Casing for adequately reduced unstable #’s
- No specific surgical approach
- For or Against Operative mgmt for pts. >55
- Use of Supplemental bone graft

**INCONCLUSIVE OR WEAK:**
- Post-op Lateral for DRUJ assessment
- Rigid Immobilization vs. Splints for non-op mgmt
- Operative treatment for:
  - Radial Shortening >3mm
  - Tilt > 10º
  - Articular step/displacement

**MODERATE OR STRONG:**

**Operative vs. Non-Op**
- Non-op
  - Acceptably reduction:
    - Radial Height <5mm shortening
    - Radial Inclination = 22º
    - Dorsal Inclination < 5º or w/in 20º of Contralateral wrist
    - Intra-articular steps < 1-2mm (Knirk and Jupiter)
    - Ulnar variance = equal to other wrist or neutral
  - Stable pattern (Extra-articular)
  - Unfit for Surgery

**Non-Op: Judge your Reduction**
- Volar Cortical Buttress (Tornetta et al.)
- Carpal Alignment
- Teardrop Angle
- Radial Length
**Casting Tips**
- Tips?
  - 3 point Mould
  - Direction of reduction
  - Snug not tight (Cast index)
  - Immobilize x 6wks

**Cast Index**
- First described by Chess et al (1994)
- Evaluates index for molding plaster casts for forearm fractures
- Internal Width in sagittal plane compared to in the coronal plane (AT THE FRACTURE SITE)

**Follow-up**
- Follow closely initially (Weekly)
- 5-8 weeks of casting typical based on Xrays
- Transition to removable brace
- Begin exercise ASAP for finger/hand/Elbow ROM…
- If reduction is lost => high failure rate of re-attempt => consider OR

**Outcomes of Non-op**
- 89% risk of secondary displacement in pts. Older than 65y.o.
- Several studies:
  - Anatomic position at healing ≠ functional outcome
Operative

- Indications:
  - Instability or irreducible
  - Intra-articular step or rim fractures (>2m)
  - Open Injuries (grade 2 & 3)

- Options:
  - CRPP
  - Ext. Fixation
  - ORIF

Pins & External Fixator

- Recent interest
- Indications:
  - Patient not suitable for percutaneous pins
  - High Energy & ++ Comminuted
  - Harbour view - Washington USA
ORIF

- Plates:
  - Many, many —> "Personality of the Fracture"
  - Consider functional requirements of plates:

Should you Fix the Ulnar styloid?

- Souer et al. 2009
- Prospective trial looking at unrepaired vs. Repairs ulnar styloid base #s
- No influence on function or outcome after Distal Radius # fixation

Complications

- Neuropathy / Compartment Syndrome
- FPL /EPL (2-5%) / EDC Rupture (Mckay et al.)
- CRPS (VitC?)
- Malunion
- Non-union
- Radiocarpal arthrosis

Case 1
THE PROXIMAL ULNAR FRACTURE: OLECRANON

- 21% of proximal forearm fractures involve the proximal ulna
- Often associated with other injuries
- Current classification systems have limited ability to direct treatment or predict outcome
ANATOMY
• Complex anatomy with variable morphology
• Angulation in multiple planes

FRACTURE OF NECESSITY
• Elbow Function dictated by Olecranon competency & Triceps Attachment
• Unless triceps function intact MOST need fixation

Fixation Options
• Tension Band Wiring
• Plate and Screws
• Intramedullary Screw or Nail
• Suture Only

DISTAL HUMERUS FRACTURES
**DISTAL HUMERUS**

**WHAT YOU NEED TO KNOW**
- 3 things...
  - The Triangle
  - 3 Joints
  - 3 Nerves

**FUNCTIONAL ANATOMY**
- Column Theory

**DISTAL HUMERUS**

**EVALUATION**
- Soft tissue?
- Vascular status
- Neurologic status

**EVALUATION**
- Neurologic status
  - Radial nerve - most commonly injured
    - 14 cm proximal to the lateral epicondyle
  - Median nerve - rarely injured
  - Ulnar nerve

- 20 cm proximal to the medial epicondyle
DISTAL HUMERUS

RADIOGRAPHIC EVALUATION
- AP & LAT
- Traction views helpful
  - Evaluate intra-articular extension & for pre-operative planning (partial reduction via ligamentotaxis)
- CT scan helpful in most cases

Two and three-dimensional computed tomography for the classification and management of distal humeral fractures

DISTAL HUMERUS

TREATMENT PRINCIPLES (WITH LARGE SURFACE OR CARTILAGE DEFECTS)
1. Anatomic articular reduction 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

COMMINUTED CAPITELLM OR TROCHLEA
- Orientation of CT cut planes can be confusing
- 3D CT is probably best for evaluation and planning
FIXATION IN ELDERLY PATIENTS

- 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

ORIF VS. ELBOW ARTHROPLASTY

- 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

POST-OPERATIVE CARE

- SPLINT
  - NO EVIDENCE for positions:
    - Extension is harder to recover than flexion
- PROM Immediately
- NSAIDs x 6wks or single-dose RADx if at high risk for Heterotopic ossification
  - Recent report documents dramatically-increased complication risk of olecranon osteotomy after radiation therapy
OUTCOMES

- ALL Lose 10-25 degs AT TERMINAL MOTION
- Supination / Pronation usually NORMAL
- Decrease in muscle strength = depends on approach
- Overall:
  - Good/excellent 75%
- Factors most likely to affect outcome
  - Severity of injury
  - Occurrence of a complication

SUMMARY

- ORIF indicated for most
- 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

HUMERAL SHAFT FRACTURES:
TREATMENT OPTIONS

- AP / Lateral radiographs
- Move patient – not arm

Imaging Studies
**NONSURGICAL TREATMENT**

Most humeral fractures…
- Rigid immobilization is not necessary for healing
- Perfect alignment is not essential

**INITIAL TREATMENT**

Coaptation Splint or Hanging Arm Cast
Functional Brace

**Contraindications to Functional Brace**
- Massive soft tissue/osseous loss
- Unreliable/uncooperative patient
- Absence of Contractile musculature
- Inability to obtain/maintain acceptable Fx alignment

**Indications for Operative Management**
- Open Fx
- Vascular injury
- Floating elbow
- Segmental Fx
- Pathologic Fx
- Bilateral Fxs
- Poly-trauma
- Intra-articular Fx
- Unacceptable alignment
  - > 20° AP angulation
  - > 30° Varus angulation
  - > 3 cm shortening
Radial Nerve Injury

- Incidence varies from 1.8% to 24% of shaft fractures
- Primary - occurs @ injury
- Secondary - occurs later during closed or open management
- Management controversial

Radial Nerve Injury

- Transverse fractures of the middle 1/3 are most commonly associated with neuropraxia
- Spiral fractures of the distal 1/3, the Holstein-Lewis fracture = a higher risk of laceration or entrapment of the radial nerve

Radial Nerve Injury

- Spontaneous recovery >70% of reported cases
- Even secondary palsies, those associated with fracture manipulation, have a high rate of recovery
- 90% will resolve in 3 to 4 months
- EMG and nerve conduction studies can help to determine the degree of nerve injury and monitor the rate of nerve regeneration

Nonunion

- Rate for humeral shaft fractures ranges from 0% to 15%
- Proximal and distal aspects of the humerus are at greatest risk for nonunion
- Biologic & Mechanical factors:
  - Significant bone gaps secondary to fracture distraction or bone loss
  - Soft-tissue interposition
  - Uncontrolled fracture motion
  - Impaired soft-tissue envelope and blood supply
  - Infection
  - Host Biology
Nonunion: Predisposing Factors

• Other factors:
  • transverse fracture pattern
  • older age
  • poor nutritional status
  • osteoporosis
  • endocrine abnormality affecting calcium balance
  • use of steroids
  • anticoagulation
  • previous RT

Summary

• MOST Humeral Shaft fracture - Will do VERY WELL with non-operative management
• Coaptation Bracing is KEY
• Minimize Non-union risk factors:
  • Smoking
  • Poor Diet
  • Vit D Levels
• SELECT Humeral Fractures = Operative

Current Evidence: Proximal Humerus Fractures
Epidemiology

- Incidence
  - Most common humerus Fracture (5% of all #s)
  - Age 65 & older = 250 per 100,000
  - 2:1 (F : M)
  - 87% caused by Low-energy trauma
  - Younger patients --> D/L, NV injury

Spectrum of Injury

- Shaft Fractures
- Neck & Head Fractures
- Younger Patient Higher Energy
- Older Patient Lower Energy
Radiography

- Trauma series of shoulder (ESSENTIAL)
  - True GH AP, Scapular Y, Axillary
  - Velpeau or Trauma axillary prn
- CT
  - Articular fractures
  - More complex injuries
- MRI
  - ? RTC injury (rare to do acutely)

CT

- Articular fractures
- More complex injuries
- MRI
- ? RTC injury (rare to do acutely)

History

- Codman’s Segment Theory - 1934
- Neer - Displacement theory
- AO/OTA Classification - 27 subtypes
- Hertel - Binary description

How to Treat?

Non-operative vs. Operative
Non-Operative

- Indications —>
  - Min-Displaced, Elderly 3/4 part #s

- Outcomes
  - Fjelde et al. 2010 —> Regardless of displacement (Pt > 60yo equal functional outcomes for Op vs. non-op) —> Constant = 74pts
  - Foruria et al. JBJS (Br) 2011 —> Valgus & Postero-medial impaction & Inferior displacement associated with poor outcomes

- Complications

Operative Indications

- Head-shaft displacement > 50% of diaphyseal diameter
- Varus or Valgus deviation >20° from typical 130°
  - Biomechanically > 45° varus = significant supraspinatus tendon efficiency loss [Voigt et al. JOT 2011]
- GT displacement > 0.5mm [Platzner et al. J trauma 2006 & Yin et al. Ortho 2012 (RCT)]

Non-op

- Protocol
  - Immobilization and early ROM
  - Immediate hand and elbow ROM
  - Close f/u, x-rays
  - Cuff and collar, Gilchrist bandage, Desault bandage

Tuberosity Fragments

- Greater tuberosity
  - Displacement poorly tolerated (> 3 - 5mm risk of impingement)
  - RTC bar equivalent
  - ORIF (Open or Arthroscopic)
  - Screws, tension band, or suture anchor
- Lesser tuberosity
  - Rare in isolation
  - Nonoperative unless displacement blocks internal rotation
  - Screw fixation
  - Excision & SSC advancement
Operative Treatment of Isolated Greater Tuberosity Fractures: Retrospective Review of Clinical and Functional Outcomes

Tuberosity Fragments

Nail Fixation

Reverse Total Shoulder Arthroplasty

3/4 Part Fractures

Surgical Treatment of Three and Four-Part Proximal Humeral Fractures

By Brian D. Solberg, MD, Charles N. Moon, MD, Dante P. Frances, MD, and Gay D. Palermo, MD

Indications
- Un-reconstructable tuberosities
- RTC deficiency
- Salvage for failed 1st line treatment
Reverse Total Shoulder Arthroplasty

- Outcomes
  - Lacking long term studies
  - Low level evidence
  - High complications
  - Scapular notching 25% - 90%

Evidence: Treatment Options

- Non-operative
  - Majority of fractures especially pt. > 65yo
- ORIF
  - Young pt., 2-4 part fractures, GT if's, non-union
- Hemi
  - Failed ORIF in young patient (< 65)
- Reverse
  - Over 75: unreconstructible 4 part, fracture-dislocation, non-union

Reverse Total Shoulder Arthroplasty

- Outcomes
  - High complications
  - 10% revision
  - 12% complication rate

Reverse Total Shoulder Arthroplasty

- Outcomes
  - 1º & 2º reverses appear to have same outcomes
  - AVG. ROM 104º FE, 11-15º ER
  - 67% age matched Constant score
Indications?
- 250 patients, displaced proximal humerus fx
  - RCT – op vs non-op
  - 2 & 5 years – no difference
  - BUT...
    - "Displacement" defined by surgeon
    - 66 surgeons – median 1 patient per surgeon
    - Reduction quality not assessed

Evidence
- Multiple Studies... Treatment Modality ≠ Success
- ~ 20% need operative treatment
  - Neer 1970; Neer 1970; Slobogean et al. 2011
- Limited evidence that newer technology improves outcome
  - Koukakis et al. 2006; Boldin et al. 2005; Moondt et al. 2007; Weinstein et al. 2006; Walsh et al. 2006; Björnström et al. 2009

Evidence
- No global difference in outcome with any treatment modality
  - Poor Classification system
  - Poor Outcome Measures
  - Poor Stratification of patients

Evidence
- Only evidence based indication for ORIF/Operative
  - 3/4 part fracture-dislocation
  - Head Split
  - Varus surgical neck #'s
  - GT # displaced > 5-7mm
MANAGEMENT OF CLAVICLE FRACTURES

Incidence

- 1/20 fractures
- 44% of shoulder girdle injuries

68% males (15-24yo 21%)
Fall on same level or off bicycles
43% midshaft
17% had ORIF within 30 days

Conservatively at least 19% of fractures are undergoing surgery

Traditional Thoughts

All fractures heal and do reasonably well
"as long as they are in the same room the bones will heal"
BUT... recent reports

**All types**

15% nonunion rate with nonoperative/displaced fractures*

...difficult to define displacement

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**Surgical Indications – Still...**

**Definitive**
- Open and neurovascular compromise

**Relative**
- Shortening greater than 2 cm
- Displacement greater than 100%
- Skin compromise
- Floating shoulder
- Severe angulation, comminution
- Symptomatic nonunion / malunion

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**Summary**

- Identify fractures at risk for a poor outcome...
- Individualized
- Displacement, Shortening, Rotation
- Patient Factors (Age, function, Habits (Smoking etc.)
- ORIF may improve outcomes in high Risk or high functioning patients
- ORIF - High complication rate (up to 30% re-op rate)

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**Displaced Midshaft Clavicle Fracture Union Can Be Accurately Predicted with a Delayed Assessment at 6 Weeks Following Injury**

A Prospective Cohort Study