CHALLENGES OF PROXIMAL HUMERUS FRACTURES

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DISCLOSURES

• Spouse employee Zimmer
• Honoraria AO speaker Residents Course
82 year old female hx afib, hypothyroid. Lives independently.
45 year old male s/p jump 3rd floor balcony
Severe CHI s/p bilateral craniectomies

Cleared for proximal humerus 3 weeks post injury
CHALLENGES

• Who needs surgery (ORIF)?
• How to achieve reduction?
• How to optimize fixation?
• How to avoid complications?
• When is a hemiarthroplasty indicated?
• 5-9% of all fractures
• Challenging
  – Osteoporosis in elderly
  – Comminution in young
  – Deforming forces of surrounding muscles
TREATMENT

• 80%: Non or minimally displaced/ non-op
• 20%: Displaced/ require surgery
• Goal is to return patient to pain-free function
WHO NEEDS SURGERY?

• Historically based on radiographs and fracture classification
• Poor intra-observer reliability and poor correlation with outcome led to more complex decision making
• Indications continue to evolve
• Patient specific
PATIENT FACTORS

- Physiologic age
- Lifestyle
- Expectations
OTHER CONSIDERATIONS....

- Risk of AVN
- Extent of osteoporosis
- Pre-existing OA
- Pre-existing rotator cuff tear
Assess risk of AVN
• **Posterior humeral circumflex** artery provides **64% of the blood supply** to the humeral head
• Possible explanation for relatively low rates of AVN with displaced proximal humerus fractures
• Important to protect the posterior humeral circumflex artery

Hettrich et al *JBJS* 2010
CALCAR SEGMENT

Less than 8 mm of bone

0.84 accuracy predicting ischemia

Hertel et al J Shoulder Elbow Surg 2004
MEDIAL HINGE

Disruption

0.79 accuracy predicting ischemia

Hertel et al. J Shoulder Elbow Surg 2004
FRACTURE PATTERN

Anatomic Neck Fracture

0.7 accuracy predicting ischemia

Hertel et al J Shoulder Elbow Surg 2004
Assess severity of osteoporosis

Combined cortical thickness < 4 mm significantly lower BMD of the proximal humerus (p < 0.01)

Tingart et al. *JBJB Br* 2003
Assess pre-existing OA and rotator cuff
ABSOLUTE INDICATIONS

- Open fractures
- Vascular injury
- Fracture/ dislocations (young)
RELATIVE INDICATIONS

- Greater tuberosity > 3-5 mm displacement
- >20° deviation from normal neck/shaft angle
- > 50% head to shaft displacement
TREATMENT OPTIONS

• CRPP
• IMN
• ORIF
  – Locking plate
LOCKING PLATES

- Improved fracture stability
- Shorter period of immobilization
- Earlier rehabilitation
- Ability to treat more fractures with ORIF vs hemi or nonop
- Technical factors *critical*
• Locked plates thought to be the answer
• Still a very challenging problem
• Still significant complication rate
HOW TO ACHIEVE REDUCTION?
• Identify tuberosities and place holding sutures suprapinatus/ IS and TM/ subscap
• Nonabsorbable sutures placed at tendon/bone junction to prevent cutting through tendons
• Done for tuberosity avulsion fractures as well as two-part neck fractures

Badman et al JAAOS 2008
Sutures used to reduce tuberosities as well as control varus/valgus (superior suture) and rotation (anterior and posterior sutures)
REDUCTION TECHNIQUES

1. Use plate to assist with reduction
2. Sutures in tuberosities
3. Joy sticks
4. Elevators
Use plate to achieve reduction

– Affix plate to proximal humerus and use nonlocking screw through plate to reduce the shaft
OR:
- Affix with nonlocking screw to shaft (to lateralize)
- Align head to plate, then secure with proximal screws
REDUCTION

• Tuberosity reduction is critical
• Establish “egg cup” to support head segment

Hertel R, Osteoporosis Int 2005
“Joystick”
2.5 mm Schanz pin
Elevator to dis-impact the head

DO NOT LEAVE IN VARUS

GREATER TUBEROSITY DISTAL TO HEAD

Restore calcar (Shenton) line; support medial head
HOW TO OPTIMIZE FIXATION?
HARDWARE PLACEMENT

- Plate 5-8 mm distal to greater tuberosity

  - Too proximal – Impingement
HARDWARE PLACEMENT

– Too distal – inadequate fixation

Agudelo et al  JOT 2007
HARDWARE PLACEMENT

- 2-4 mm posterior to bicipital groove
  - Too anterior – ascending branch/biceps tendon
SCREW INSERTION

• Screw may not follow drill path
• Penetration of articular surface increases risk of screw cut out
• Use fluoro
  – Move image of drill/ depth gauge to contralateral screen
  – Confirm correct screw trajectory
Screws should be within 5-10 mm subchondral bone

Confirm all screws are contained on numerous views
Secure sutures through holes in plate
**CaPO_{4} AUGMENTATION**

- Kwon et al *JBJS* 2002
  - 18 paired cadaveric limbs
  - Surgical neck and GT osteotomy
  - Manual impaction cancellous bone recreate medullary void
  - Half with CaPO_{4}
  - + CaPO_{4}
    - decreased interfragmentary motion
    - increase in torque to failure
    - increase torsional stiffness
CaPO$_4$ AUGMENTATION

Egol et al *J Shoulder Elbow Surg* 2011

- Retrospective study 92 patients > 1 year f/u
- 29 (32%) augmentation with allograft chips
- 27 (29%) augmentation w CaPO$_4$
- 36 (39%) no augmentation

"Augmentation with CaPO$_4$ decreased fracture settling and significantly decreased the incidence of intra-articular screw penetration"
ALLOGRAFT STRUT AUGMENTATION

• Matasi et al *Injury* 2012
  – No collapse > 2 mm
  – No AVN
  – No screw penetration
  – “Safe and promising technique to augment proximal humerus fractures with medial comminution”
HOW TO AVOID COMPLICATIONS?
COMPLICATIONS

• Screw penetration (13-23%)
• Varus malalignment
  • Hardware failure
• AVN (3-16%)
• Nonunion
SCREW PENETRATION

• Intraoperative error
  – Avoidable by not drilling through subchondral bone and confirming placement on numerous views

• Post operative collapse
  – Minimize risk by avoiding varus and achieving stable reduction and fixation
Brunner et al JOT 2009

- Prospective case series
- 158 fractures
- Mean age 65
- 46% patients at least one complication
- 25% unplanned surgeries
- 22% screw penetration
Sudkamp et al JBJS 2009

- 178 patients mean age 63
- 34% complications at 1 yr
  - 48% incorrect surgical technique
- 19% unplanned 2\textsuperscript{nd} surgery by one year
- 14% screw penetration
Owsley et al JBJS 2008

- 53 patients mean age 52
- 36% complication rate
  - 23% cut out
  - 25% varus (>10°)
  - 4% AVN
- Radiographic complications 57% people > age 60 vs 22% < 60
35 patients treated with PHLP
Average age 62
Xrays analyzed
Adequate medial support if
- Medial cortex anatomically reduced
- Shaft medialized and impacted into head
- Screws within 5 mm inferomedial cortex
<table>
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<th></th>
<th>+MS</th>
<th>−MS</th>
<th>( P ) Value</th>
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<td>Average age (yr)</td>
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<td>Fracture distribution</td>
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<tr>
<td>2 Part</td>
<td>4</td>
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<tr>
<td>3 Part</td>
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<td>CaP cement augmentation</td>
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<td>Change in humeral head</td>
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<tr>
<td>Mean</td>
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<tr>
<td>SD</td>
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<tr>
<td>Max</td>
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<tr>
<td>&gt;5 mm Loss of reduction</td>
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<td>(&lt;0.001)</td>
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<tr>
<td>N</td>
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<tr>
<td>%</td>
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<td>Screw penetration</td>
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<td>Screw loosening</td>
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<td>Post op</td>
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• Restoration and support of medial cortex important in preventing collapse, varus malalignment, and screw cut out

Gardner et al. JOT 2007
ARTHROPLASTY

• Role of arthroplasty also evolving

• Indications:
  – unreconstructable humeral head
  – shell-like head
  – avascular humeral head
  – delayed presentation or salvage after failed ORIF
• Function in elderly worse than expected
• Relies on tuberosity healing for good outcome
• 35% of patient FF > 90 degrees
  Pijls J Orthop Trauma 2011

• < 50% satisfactory outcome at 10 years
  Antuña J Shoulder Elbow Surg 2008

• Optimal treatment for displaced fractures in elderly remains unclear
HEMI vs NON-OP

- RCT hemi vs nonop 4 part fractures
- 55 patients mean age 77
- Hemi:
  - Less pain
  - Better QOL
  - Same ROM

Olerud et al J Shoulder Elbow Surg 2011
ORIF vs NON-OP

- RCT ORIF vs nonop 3 part fractures
- 60 patients mean age 74
- ORIF:
  - Better ROM
  - Better function
  - Better QOL
  - 30% reoperation

Olerud et al. J Shoulder Elbow Surg 2011
ORIF vs HEMI

- Retrospective review
- 57 patients mean age 56.9 years
- 3 and 4 part fractures
- ORIF:
  - Better functional outcome
  - Better UCLA shoulder score
  - Better Constant score
  - Better patient satisfaction
  - Better ROM

Wild et al Orthopedics 2011
ORIF vs HEMI

- Retrospective review
- 122 patients > 55 years old
- 38 locked plate, 48 hemi
- ORIF:
  - Better Constant score (3 pt > 4 pt)
  - More complications
- Initial varus displacement worse outcomes

Solberg et al JBJS 2009
82 year old female hx afib, hypothyroid. Lives independently
12 days post injury
3 weeks post injury
3 months post injury
9 months post op
FF 150
SUMMARY

• Who needs surgery (ORIF)?
• How to achieve reduction?
• How to optimize fixation?
• How to avoid complications?
• When is a hemiarthroplasty indicated?
SUMMARY

• Who needs surgery (ORIF)?
  
Patient specific
Greater tuberosity >3-5 mm
20° variation varus/ valgus
> 50% shaft translation
SUMMARY

• How to achieve reduction?

Sutures bone/tendon interface
Use plate to help achieve reduction
Adjuncts: sutures, kwires, joy sticks
Tuberosities critical
NO VARUS
SUMMARY

• How to optimize fixation?

  Plate not too high or too low
  Plate posterior to bicepital groove
  Screws within 5-10 mm subchondral bone
  Sutures through plate
  Adjunts: CaPO4, fibular strut
SUMMARY

• How to avoid complications?

  Avoid intra-articular screws
  No varus
  Restore medial buttress
  Screw within 5 mm medial buttress
SUMMARY

• When is a hemiarthroplasty indicated?

- Unreconstructable or shell-like head
- Avascular head
- Salvage
- Relies on tuberosity healing
- Less-than-ideal function
Thank you!