Minimal Invasive Fixation of Proximal Humeral Fractures

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Epidemiology

Fractures of the proximal humerus:

- Increased overall incidence (17.1% to 47.9% last 15 years)
- Increase annual incidence 13%
- Increased age of presentation (78 ♂ 73 ♂)
Classification

The fracture lines are follow the old epiphyseal plate.

Codman E. A: The shoulder, Boston, T. Todd, 1934
Classification

If any of the part has > 1cm of displacement or > 45° of angulation the fracture will be considered as displaced

Neer C. S.     JBJS A, 1970

JSES,     2001
4-part valgus impacted fracture
Humeral head blood supply

Arcuate a.

Vessels from GTB

Posterior circumflex a (x3 > anterior)

Important anastomoses postero-medial hinge

Gerber C, et al. JBJS Am 1990
Brooks CH, et al. JBJS Br 1993
Valgus impacted proximal humeral fractures and their blood supply after transosseous suturing

preop 6 to 12 hours
Postop 8-10 weeks
Axillary artery
Three images (0°, -45° και +45°)
1 image per second
30 images / patient
Image processing
Image processing

PREOPERATIVELY

Big vessels

Small vessels
Image processing

POSTOPERATIVELY

Big vessels

Small vessels
Ischemia predisposing factors

- a) length of medial metaphyseal head extension (< 8 mm in ischemic heads)
- b) integrity of the medial hinge (43 / 55 ischemic heads > 2 mm)
- c) splitting head component

_Hertel R, et al. JESS 2004_
Lateral or medial displacement of the head relative to the humeral shaft >6 mm or >9 mm, respectively, is an indication of periosteal rupture.

Maintenance of some medial periosteal integrity may provide stability and allow passive reduction of the fracture.
Current Surgical Treatment Options for Complex Proximal Humeral Fractures

George M Kontakis, MD¹, Theodoros Tosounidis, MD², and Kyriakos Kakavelakis, MD³

¹University of Crete, Crete, Greece; ²Leeds General Infirmary, Leeds, UK; and ³University Hospital of Heraklion, Crete, Greece.

What is the fracture pattern?
Does it need to be treated surgically?
Does the medical status of the patient permit operative treatment?
Could the anatomy can be restored by means of stable and durable fixation?
Is the humeral head viable?

Well informed patient about outcome & expectations
Radiological evaluation

AP in the scapular plane

Axillary

Y-view

Velpau axillary
CT scan

- Tuberosities displacement
- Better visualization of the head
- Glenoid pathology


Treatment options

- Conservative
- Internal fixation
- External fixation
- Arthroplasty
- Reverse arthroplasty
Conservative

125 fractures\(^1\) AO type B1.1 *(valgus impacted)*

Constant score 71.8/100 (1 year follow up)

80.6% excellent-very good

1- part → 3-part (CS: 74.5 → 65.6)

507 fractures\(^2\) AO type A

376 patients (1 year follow up)

88% excellent or very good

131 patients lost???

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\(^1\) Court-Brown CM, et al. Impacted valgus fractures (B1.1) of the proximal humerus the results of non-operative treatment. JBJS Br 2002

Conservative
Natural history of complex fractures of the proximal humerus using a three-dimensional classification system

Gordon Edelson, MD, Husam Safuri, MD, Joseph Salami, MD, Fina Vigder, MD, and Daniela Miletich, MD, Tiberias and Haifa, Israel

...“contrary to the common belief – avascular necrosis of the humeral head may be related to the surgical intervention rather than to the lack of it”
Natural history of complex fractures of the proximal humerus using a three-dimensional classification system

Gordon Edelson, MD,a Husam Safuri, MD,a Joseph Salami, MD,a Fina Vigder, MD,b and Daniela Militianu, MD,c Tiberias and Haifa, Israel
Review article

THE OPERATIVE MANAGEMENT OF DISPLACED FRACTURES OF THE PROXIMAL HUMERUS

P. Hoffmeyer

From the University Hospital, Geneva, Switzerland

(Printed with permission of EFORT. The original version of this article appears in European Instructional Course Lectures Vol 5, 2001.)

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The image depicts a flowchart outlining the operative management of displaced fractures of the proximal humerus. The chart categorizes fractures based on the status of the head of the humerus and whether the bone is vascular or avascular. Depending on these factors, different treatments are proposed:

- **Vascular Status**:
  - Strong bone: Osteosynthesis
  - Soft bone: Osteosuture

- **Avascular Status**:
  - Strong bone: Osteosynthesis (Arthroplasty)
  - Soft bone: Arthroplasty
What kind of osteosynthesis?
How much minimal ...?

Severe infection
Options for internal fixation

- Plate-screws
  (T, L, 90° blade, cloverleaf, 1/3 tubular, Plantan, Philos)

- Percutaneous KW or cannulated screws

- Intramedullary KW or rods
  (Kapandji, Rush, Ender, Prevot, Zifko, Evans, Jig etc)

- Antegrade or retrograde intramedullary nailing
  (Polarous, Halder, PHN-T, PHN-S, Targon etc)

- Osteosuture
  (wiring, cross screw osteosynthesis, sutures, dacron tapes etc)

- Combined techniques ± grafting, cement, Norian
Options for minimal invasive fixation

- Percutaneous KW or cannulated screws
- Intramedullary KW or rods
  (Kapandji, Rush, Ender, Prevot, Zifko, Evans, Jig etc)
- External fixation
- Osteosuture
  (wiring, cross screw osteosynthesis, sutures, dacron tapes etc)
The Humerusblock NG: a new concept for stabilization of proximal humeral fractures and its biomechanical evaluation

Alexander Brunner · Herbert Resch · Reto Babst · Susanne Kathrein · Johann Fierlbeck · Alfred Niederberger · Werner Schmöld
Current strategies for the treatment of proximal humeral fractures: an analysis of a survey carried out at 348 hospitals in Germany, Austria, and Switzerland

Alexander Tepass, MD\textsuperscript{a}, Gunnar Blumenstock, MD\textsuperscript{b}, Kuno Weise, MD\textsuperscript{a}, Bernd Rolaufls, MD\textsuperscript{a}, Christian Bahrs, MD\textsuperscript{a,*}
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<table>
<thead>
<tr>
<th>Complications</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implant Failure</td>
<td>2.9%</td>
</tr>
<tr>
<td>Vascular/ Nerval Damage</td>
<td>3.4%</td>
</tr>
<tr>
<td>Nonunion</td>
<td>9.2%</td>
</tr>
<tr>
<td>Infection</td>
<td>9.8%</td>
</tr>
<tr>
<td>Sub-/ Luxation Hemiarthroplasty</td>
<td>11.5%</td>
</tr>
<tr>
<td>Posttraumatic Oarthrosis</td>
<td>16.4%</td>
</tr>
<tr>
<td>Implant Migration</td>
<td>25.6%</td>
</tr>
<tr>
<td>Rotator Cuff Lesion</td>
<td>32.5%</td>
</tr>
<tr>
<td>Incorrect Implant Position</td>
<td>35.6%</td>
</tr>
<tr>
<td>Impingement</td>
<td></td>
</tr>
<tr>
<td>Humeral Head Necrosis</td>
<td>58.9%</td>
</tr>
<tr>
<td>Secondary Fracture Displacement</td>
<td>67.0%</td>
</tr>
<tr>
<td>Implant perforation of the Humer Head</td>
<td>71.0%</td>
</tr>
<tr>
<td>Non-Anatomic Reduction</td>
<td>73.0%</td>
</tr>
</tbody>
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A systematic review of locking plate fixation of proximal humerus fractures

Robert C. Sproul, Jaicharan J. Iyengar, Zlatko Devcic, Brian T. Feeley

University of California, San Francisco, Department of Orthopaedic Surgery, Sports Medicine and Shoulder Surgery Service, 1500 Owens Street, San Francisco, CA 94158, United States

• Proximal humerus fractures due to trauma (excluding pathologic fractures).
• Patients greater than 18 years of age.
• More than 15 patients in the study or subgroup of interest.
• At least eighteen months follow-up.
• At least one relevant functional outcome score such as range of motion, pain, patient satisfaction, or complications.
• Quality outcome score of at least a 5/10 according to a previously published scoring system.¹⁴,²⁰

Complications

varus malunion 16%,
AVN 10%,
screw perforation 8%,
subacromial impingement 6%,
infection 4%

12 studies/ 514 patients
Constant score 74
DASH score 27
Percutaneous KW or cannulated screws

19%-55%

- Perforation
- Superficial infection
- Inadequate reduction
- Migration - breakage
- Nerve damage

Soete PJ, et al. JSES 1999
Darder A, et al. Orthop Trauma 1993
Resch H, et al. JSES 1995
Resch H, et al. JBJS Br 1997
Percutaneous KW or cannulated screws

Rowles DJ, McGrory JE. Percutaneous pinning of the proximal part of the humerus: an anatomic study. JBJS 2001
105 patients (9 A-fractures, 36 B, 60 C) median follow-up 79.7 months 70–75% excellent or good Constant and UCLA scores.
74% good or satisfactory quality of initial reduction

21% secondary displacement
27% humeral head necrosis
22% had implant related problems
27 patients
mean age 61 years
7 two-part, 8 three-part, 12 VI
mean follow-up 35 months
All fractures healed
mean Constant 73.9
4 malunion
4 osteoarthritis

Fracture type, age, malunion, or osteoarthritis had no significance influence on measured outcomes.
Percutaneous fixation of displaced proximal humeral fractures: Indications based on the correlation between clinical and radiographic results

Emilio Calvo, MD, a Ignacio de Miguel, MD, a Juan J. de la Cruz, PhD, b and Néstor López-Martín, MD, a Madrid, Spain

(J Shoulder Elbow Surg 2007;16:774–781.)
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The impacted varus (A2.2) proximal humeral fracture in elderly patients: Is minimal fixation justified?
A case control study

Davide Blonna, MD*, Roberto Rossi, MD, Gianluca Fantino, MD, Alessio Maiello, MD, Marco Assom, MD, Filippo Castoldi, MD
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<table>
<thead>
<tr>
<th>Table I</th>
<th>Baseline data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group</td>
</tr>
<tr>
<td></td>
<td>Surgery</td>
</tr>
<tr>
<td></td>
<td>Control</td>
</tr>
</tbody>
</table>

CS, constant score; SD, standard deviation, M, male; F, female; R/L, right-handed/left-handed; Pts, patients.
Number of sessions P < .05.

K-wires ■ Conservative Treatment

Reacr. ACT.: recreational activities
Elev: elevation
Abd: abduction
ER: external rotation
IR: internal rotation
*: p<0.05
Patients> 65 years

1 superficial and 1 deep infection

KW migration in 3 cases

Good fracture reduction and clinical outcome
Parallel pin fixation should be applied whenever possible, and a specially designed parallel drill sleeve with a 1-cm pin-to-pin distance is recommended during clinical application.
90 patients
“Palm-tree” wiring
21 (2 part), 44 (3 part), 25 (4 part)
Mean Constant score 77
15 patients (17%) complications
most frequent AVN (4%)
3 pt migration
Percutaneous surgery requires

(1) careful selection of cases, with conditions such as good bone quality and very little comminution of the tubercles; (2) preservation of the medial cortex with its periosteum; (3) that a stable, closed reduction be achieved; and (4) that the patient be cooperative.
Intramedullary KW or rods, nails, helix wires etc

- head perforation
- infection
- loss of reduction
- migration
- Impingement

41 unstable 2-part fractures
mean age of 65 years
mean follow-up 29 months
excellent 25, satisfactory 12,
unsatisfactory 3, failure 1

Especially indicated for unstable
two-part subcapital fractures

2.4 K-Wires
24 patients (3-part & 4-part)
40% excellent results
45% satisfactory
15% unsatisfactory
12 patients
2 years follow-up
union in 3 months
7 pt excellent
3 good
2 satisfactory
1 case of impingement
10 female patients
mean age 73.0 years
mean follow-up 20.6 months.
Constant score, 80.8
32 patients
mean age 56 years
mean fup 18 months
Mean union time 13 weeks.
Mean Neer score 83.2
2 pt pin loosening
1 patient AVN
no infection or impingement
The hybrid technique: Potential reduction in complications related to pins mobilization in the treatment of proximal humeral fractures

Davide Blonna, MD*, Filippo Castoldi, MD, Michele Scelsi, MD, Roberto Rossi, MD, Giuseppe Falcone, MD, Marco Assom, MD

51 patients percutaneous fixation
55 patients Hybrid technique
Open reduction and osteosutures
Complications 16 patients/ 6 patients
Revision rate 19% /4%
Pins migration 8 /1 case
MCS at 12-months 77/ 89
Considerations for hybrid ex-fix

Not all fractures can be fixed
Risk of infection
Stability in osteoporotic bone
Patient discomfort

If the fracture is opened maybe is better to use a plate?
- since no hardware is left in the shoulder, some complications such as deep infection, nonunion, or avascular necrosis are potentially easier to treat
Transsosseous suturing, wiring etc

Cuomo et al (1992)
22 patients 2-, 3-part fractures
82% excellent or very good results

27 patients, 13 GTB, 9 surgical neck,
6 3-part 89% excellent or very good result

Branco et al (2001)
13 patients, Dacron sutures, small fup
Skin incision

Deltoid splitting and bursa removal
Recognition of fracture pattern

Transosseous suturing of the tuberosities
Sutures through the humeral head and diaphysis

Cross-manner fixation with tension band effect

Minimal intraoperative reduction of the head fragment
Final assessment of reduction and knotting -
11-year period
165 patients (94 f, 71 m)
mean age, 54 years
27% valgus impacted fractures
39% three-part fractures
34% two-part fractures

No 5 Ethibond sutures
All fractures united except 2
mean Constant score 91 points
Complications

Malunion nine patients (5%)

AVN eleven (7%)

Impingement syndrome 4

Arthritis 2
INDICATIONS:

- 2-part GT fractures with or without dislocation
- 3-part fractures or 3-part fracture-dislocations
- 4-part valgus impacted fractures
  (no more than 45° of rotational deformity and <6 to 7 mm of lateral displacement)

CONTRAINDICATIONS:

- Complex 4-part or 4-part fracture-dislocations
- 2-part surgical neck fractures
- Head-splitting or anatomical neck fractures
Proximal Humerus Fractures: Pin, Plate, or Replace?

Charles M. Jobin, MD, and Leesa M. Galatz, MD

Key factors

- fracture type
- bone quality
- integrity of the medial calcar
- tuberosity comminution
- risk of AVN
- joint congruity
- functional demands
## Proximal Humerus Fractures: Pin, Plate, or Replace?

Charles M. Jobin, MD, and Leesa M. Galatz, MD

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<th>Percutaneous fixation</th>
<th>ORIF (plates-sutures)</th>
<th>Arthroplasty</th>
</tr>
</thead>
<tbody>
<tr>
<td>good bone stock</td>
<td>good-quality bone</td>
<td>head-splitting fractures, or significant head impaction fractures or in osteoporotic nonreconstructable 4-part fractures and fracture dislocations, or when the head is devoid of vascularity</td>
</tr>
<tr>
<td>preserved medial calcar</td>
<td>displaced 2-, 3-, 4- part fractures</td>
<td></td>
</tr>
<tr>
<td>2-part surgical neck fractures</td>
<td>2-part surgical neck fractures with comminuted medial calcar</td>
<td></td>
</tr>
<tr>
<td>some 3-part fractures</td>
<td>head-splitting fractures in young patients &gt;45 years old in an attempt at head salvage</td>
<td></td>
</tr>
<tr>
<td>4-part VI fractures</td>
<td></td>
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