Intramedullary Nailing of Humeral Shaft Fractures

Antegrade or Retrograde approach?

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Sports Medicine & Knee Fellow, University of Leeds, UK
Shoulder & Elbow Fellow, King’s College University, UK
Epidemiology

- 1-3% of all orthopaedic fractures
- 20% of shoulder fractures
- **bimodal distribution** 30 (m) & 70 (w)

## Surgical anatomy

### Table 16.1. Position of fracture fragments

<table>
<thead>
<tr>
<th>Fracture Location</th>
<th>Proximal Fragment</th>
<th>Distal Fragment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above pectoralis major insertion</td>
<td>Abducted, rotated externally by rotator cuff</td>
<td>Medial, proximal by deltoide and pectoralis major</td>
</tr>
<tr>
<td>Between pectoralis major and deltoide</td>
<td>Medial by pectoralis, teres major, and latissimus dorsi</td>
<td>Lateral, proximal by deltoide</td>
</tr>
<tr>
<td>tuberosity</td>
<td>Abducted by deltoide</td>
<td>Medial, proximal by biceps and triceps</td>
</tr>
<tr>
<td>Distal to deltoide tuberosity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of surgical anatomy](image)
- direct blow to the arm
- twisting injuries
- traffic accidents
- pathologic fractures

<table>
<thead>
<tr>
<th>Injury</th>
<th>Incidence (%)</th>
<th>Age (yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple fall</td>
<td>59.2</td>
<td>65.3</td>
</tr>
<tr>
<td>Fall from a height</td>
<td>7.9</td>
<td>43.2</td>
</tr>
<tr>
<td>Sport</td>
<td>4.6</td>
<td>20.5</td>
</tr>
<tr>
<td>RTA (pedestrian)</td>
<td>4.2</td>
<td>42.2</td>
</tr>
<tr>
<td>RTA (vehicular)</td>
<td>12.9</td>
<td>29.2</td>
</tr>
<tr>
<td>Pathological</td>
<td>6.2</td>
<td>53.4</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>5.1</td>
<td>36.9</td>
</tr>
</tbody>
</table>
Clinical & radiological evaluation

- Pain, swelling, deformity, haematoma, pathologic motion, crepitus, shortening

- assess motor and sensory function of the radial, median and ulnar nerves

Anteroposterior (AP) and lateral radiographs should be obtained first

The shoulder and elbow should be included on each radiograph
Classification

Low vs high energy
Soft tissue injury
Open fracture grading
Associated injuries
Nerve or vascular injury
Co-morbidity

AO classification
Treatment

Conservative
External fixation
Plate fixation
Intramedullary nailing

New fixations techniques and the pressure from patients for faster recovery have lead to increase use of surgical treatment
Statistically significant effect on patient-reported functional outcomes following treatment of humeral shaft fractures, regardless of treatment modality, injury mechanism, and associated fractures.

- patient age,
- history of psychiatric illness,
- insurance type,
- Charlson co-morbidity Index score,
- fracture location
Indications for operative intervention

1. Inability to maintain reduction due to obesity, intolerance of orthosis
2. Specific fracture patterns (segmental, simple transverse, long spiral, Holstein & Lewis)
3. Patients with multiple trauma
4. Bilateral fractures
5. Open fractures
Indications for operative intervention

6. Pathological fractures

7. Ipsilateral injuries (floating elbow or shoulder)

8. Spinal cord and brachial plexus injuries

9. Fractures associated with major vascular injuries

10. **Progressive** or **new onset** of a radial nerve palsy
Fractures of the shaft of the humerus will usually unite, irrespective of the type of the fracture (Sarmiento et al., 2001)

Union rates > 90% are often reported
Acceptable alignment:
- 3 cm of shortening
- 30 of varus / valgus angulation
- 20 of anterior / posterior angulation
Nonoperative treatment of humeral shaft fractures revisited

Erden Ali, MRCSa,c,*, Dylan Griffiths, FRCS (T&O)b, Nnamdi Obi, MRCSa, Graham Tytherleigh-Strong, FRCS (T&O)a, Lee Van Rensburg, FRCS (T&O)a

207 fractures, 138 fractures 5 y follow up (24 nonunions – 15 operative treatment)

Overall union rate 83%
  - Proximal third: 76%
  - Middle third: 88%
  - Distal third: 85%

Comminuted fractures: 89% union rate regardless position
Plate osteosynthesis

Strong indications:
- periprosthetic fractures
- nonunion or delayed union
- ipsilateral arm fractures
- specific fracture patterns?

The rates of non-union and hardware failure requiring revision range from 2.5 to 16%

The most common complications are iatrogenic nerve palsy (0–5%) and infection (0–6%)
Holstein-Lewis with radial nerve palsy
Intramedullary nailing

UHN

Garnavos nail

Synthes nail

Targon H

Uniflex® Humeral Nail System
virtually simulate (CT)
76 Thai cadaveric humeri
Russell-Taylor HN (8 mm 220 mm)

(1) the diameter of the medullary canal averaged 7.9–13.8 mm

(2) Retrograde nailing requires excessive reaming at the distal part of the humerus to accommodate nail insertion
Intramedullary nailing

Success rate as high as that for other methods:

(Ingman and Waters, 1994; Rodriguez-Merchan, 1995; Rommens et al., 1995; Shazar et al., 1998; Sims and Smith, 1995; Brumback, 1996; Redmondet al., 1996; Achecar and Whittle, 1997; Lin et al., 1997; Crates and Whittle, 1998; Tome et al., 1998).

non-union 6%

infection 2%

radial nerve palsies 3%
Intramedullary nailing

Advantages:

shorter operating time, no need of external support, reduced blood loss, low infection rate, and early recovery of function

Problems:

Antegrade: proximal migration, RC integrity, interlocking, extension of the fracture, diastasis, radial nerve palsy

Retrograde: Eccentric nail insertion, proximal interlocking, axillary nerve, fracture extension
The biomechanical stability appears to be similar in the fixation of humerus shaft fractures with medial butterfly fragment.
111 patients (105 antegrade)
52 intraoperative complications in 40 pt (36%)
Distraction 4.5%
Wrong screws 8.1%
Additional fracture 6.3%
Nail protrusion 7.2%

36 secondary surgeries (32.5%)
Complications of Locked Nailing in Humeral Shaft Fractures
Jinn Lin, MD, PhD, Po-Wen Shen, MD, and Sheng-Mou Hou, MD, PhD

Antegrade nailing: 87 fractures (proximal)
Retrograde nailing: 74 (distal)

Significantly higher in risk of operative comminution with retrograde nailing

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Postoperative Complications of Humeral Locked Nailing in 159 Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complications</td>
<td>No. of Patients</td>
</tr>
<tr>
<td>Nonunion</td>
<td>9</td>
</tr>
<tr>
<td>Protruded proximal screw</td>
<td>2</td>
</tr>
<tr>
<td>Shoulder joint impairment</td>
<td>7</td>
</tr>
<tr>
<td>Elbow joint impairment</td>
<td>3</td>
</tr>
<tr>
<td>Operative comminution (with fracture union)</td>
<td>2</td>
</tr>
<tr>
<td>Fracture gap (with fracture union)</td>
<td>3</td>
</tr>
<tr>
<td>Transient postnailing radial nerve palsy</td>
<td>3*</td>
</tr>
<tr>
<td>Angular malunion</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
</tr>
</tbody>
</table>

* One patient had nonunion simultaneously.
Diaphyseal humeral fractures and intramedullary nailing: Can we improve outcomes?

Christos Garnavos

<table>
<thead>
<tr>
<th>Antegrade nailing</th>
<th>Retrogade nailing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Violation of RC</td>
<td>Eccentric nail insertion</td>
</tr>
<tr>
<td>Distal interlocking</td>
<td>Proximal interlocking</td>
</tr>
<tr>
<td>Soft tissues around shoulder</td>
<td>Soft tissue around shoulder</td>
</tr>
<tr>
<td>Soft tissues around elbow</td>
<td></td>
</tr>
</tbody>
</table>

Ream/undreamed, antegrade/retrograde, solid/flexible, locking/unlocked?
34 patients were treated with the flexible nail. The mean duration for fracture consolidation was 10 weeks. Constant score was 93 points.
Modified extra rotator-cuff entry point in antegrade humeral nailing
Panayiotis Dimakopoulos · Andreas X. Papadopoulos · Michalis Papas · Andreas Panagopoulos · Elias Lambiris

**Modified extra rotator-cuff entry point in antegrade humeral nailing**
2 nonunions / 63 fractures

Constant score, at a minimum of 2-year follow-up, was excellent or very good in 93.7% of the patients.
New Technique for Humerus Shaft Fracture Retrograde Intramedullary Nailing

Anne M. Hollister, MD,* Carla Saulsbery, OTR, CHT,† Jennifer L. Odom, PA-C,* Lucas Anissian, MD, PhD,* Mark Tyson Garon, MD,* and Jenee’ Jordan†

TABLE 1. Literature Results

<table>
<thead>
<tr>
<th>References</th>
<th>No. Patients in Study</th>
<th>% Radial Nerve Palsies</th>
<th>% Iatrogenic Fractures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blum et al¹</td>
<td>57</td>
<td>15%</td>
<td>14%</td>
</tr>
<tr>
<td>Cheng and Lin²</td>
<td>43</td>
<td>4%</td>
<td>Not reported</td>
</tr>
<tr>
<td>Rommens et al³</td>
<td>190</td>
<td>4.2%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Loitz et al⁴</td>
<td>120</td>
<td>Not reported</td>
<td>5.8%</td>
</tr>
<tr>
<td>Martinez et al⁵</td>
<td>21</td>
<td>Not reported</td>
<td>5%</td>
</tr>
<tr>
<td>Muckley et al⁶</td>
<td>36</td>
<td>Not reported</td>
<td>5.5%</td>
</tr>
<tr>
<td>Rommens et al⁷</td>
<td>99</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>Wang et al⁸</td>
<td>707</td>
<td>4.2%</td>
<td>Not reported</td>
</tr>
</tbody>
</table>

Incidence of perioperative fractures and radial nerve palsy reported in the literature.
New Technique for Humerus Shaft Fracture Retrograde Intramedullary Nailing

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Special design for Targon nail, no intraoperative fracture in 41 cases
Antegrade 27 patients (midshaft to distal)

retrograde 16 patients (midshaft to proximal)

union rate
   antegrade (93%)
   retrograde (69%)

No significant difference in shoulder and elbow pain or range of motion
Functional Outcome after Intramedullary Nailing of Humeral Shaft Fractures: Comparison between Retrograde Marchetti-Vicenzi and Unreamed AO Antegrade Nailing

Thierry Schoerinck, MD, and Frank Hendelberg, MD

The retrograde approach to the humeral medullary cavity using a MVN resulted in better shoulder function and similar elbow function compared with the antegrade approach using an AO-UHN.
similar treatment results, including healing rate and eventual functional recovery for middle humeral fractures
25 patients in each group
mean age 37 years
Road traffic accident

Significant difference:
duration of hospital stay,
operative time and blood loss

No difference in terms of union or complications.

Functional outcome similar at 1 year
10 studies (1990-2012)
459 cases,
231 plating & 228 nailing

No difference:
- nonunion
- infection
- radial nerve palsy
- other complications

Delayed healing rate lower with plate
## Implant selection

<table>
<thead>
<tr>
<th>Antegrade</th>
<th>Retrograde</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher nailing linearity</td>
<td>Less shoulder injury</td>
</tr>
<tr>
<td>Easier technique</td>
<td>Fracture compression</td>
</tr>
<tr>
<td>Less elbow injury</td>
<td>Less nailing linearity</td>
</tr>
<tr>
<td>Small medullary canal</td>
<td></td>
</tr>
<tr>
<td>Avoid shoulders with preexisting problems</td>
<td>Insert nail from upper edge of olecranon fossa</td>
</tr>
<tr>
<td>Countersink nail and screw during insertion</td>
<td>Avoid small medullary canal</td>
</tr>
<tr>
<td>Meticulously repair rotator cuff and bursa</td>
<td>Create long enough entry portal</td>
</tr>
<tr>
<td>Avoid too long nails</td>
<td>Adequately ream and use trial nailing</td>
</tr>
<tr>
<td>Compress fracture or use back strike technique</td>
<td>Manually insert nail</td>
</tr>
<tr>
<td>Bluntly dissect soft tissue during screw insertion</td>
<td>Avoid elbow with extension contracture</td>
</tr>
</tbody>
</table>
Extended Neviaser Portal Approach to Antegrade Humeral Nailing

MATTHEW F. DILISIO, MD; RYAN E. FITZGERALD, MD; ERIC T. MILLER, MD
Conclusions

- Functional bracing/nonoperative care is still the mainstay of treatment

Surgery can give a better XRay and potentially quicker recovery but with the inherent risks of surgery... choose wisely

- Careful patient selection
- Meticulous surgical technique
- Preservation of rotator cuff tendons
- Avoid iatrogenic elbow fracture in RHN