Optimizing the treatment of peri-trochanteric fractures

Andreas Panagopoulos
Lecturer in Orthopaedics
University Hospital of Patras
Objectives

• Epidemiology & clinical factors
• Understand classification
• Optimize patient variables
• Optimize fracture fixation
• Recent evidence-based med
• Suggest surgical tips to avoid problems
Epidemiology

70,000/year in UK
Rise to 91,500/2015
and 101,000/2020

252,000/year US
3.5 million hospital days

£2 billion/year in UK
Surgical treatment of hip fractures:

- increase mortality rate,
- reduce independence
- impair walking ability
- seriously impaired ADL-functions
Risk factors for failure to return to the pre-fracture place of residence after hip fracture: a prospective longitudinal study of 444 patients

Anne J. H. Voelteloo · Sabine T. van Vliet-Koppert · Andrea B. Maier · Wim E. Tuinebreijer · Maarten L. Röling · Mark R. de Vries · Rolf M. Bloem · Rob G. H. H. Nefissen · Peter Pilot

Patient factors

Age, Dementia
Lower pre-fracture level of ADL
Presence of home companion

- ASA score
- > 4 days surgery delay
- general anesthesia

Radcliff et al, J Bone Joint Surg Am, 2008
A new algorithm for hip fracture surgery

Reoperation rate reduced from 18% to 12% in 2,000 consecutive patients followed for 1 year

Henrik Palm¹, Michael Krasheninnikoff¹, Kim Holck¹, Tom Lemser¹, Nicolai Bang Foss², Steffen Jacobsen¹, Henrik Kehlet³, and Peter Gebuhr¹

Surgeon factors

Protocol according to type

Quality of reduction
Implant selection
Good surgical technique
Radiological evaluation

Anteroposterior

Lateral

Traction x-ray in ER

CT, MRI
Factors affecting construct strength

**Uncontrolled factors**

- Fracture geometry
- Bone quality

**Controlled factors**

- Quality of reduction
- Implant position
- Implant selection
**Fracture geometry**

*Stability* is the ability to reduce fracture to support physiologic loading

Stability relates not only to the number of fragments but on the fracture *plane* as well.
Classification

stable

unstable
Highly Unstable
Controversies of classification

Which fracture is more unstable?

A2.1  

A2.3
Controversies of classification

total area of fragmentation

A2.2 and A2.3 a lot more unstable than A2.1.

more prone to fragmentation of the lateral wall during reaming (DHS)
Bone quality

Can / Should we strengthen the bone-implant interface?

the PMMA cemented DHS proved to have better outcome than a conventional DHS for unstable intertrochanteric fractures in elderly patients
Failures tended to be more related to delayed union, nonunion and resultant side plate construct failure.
Factors affecting construct strength

Uncontrolled factors
Fracture geometry
Bone quality

Controlled factors
Quality of reduction
Implant position
Implant selection

Need to get these right!!
Quality of reduction

Biplanar, anatomic alignment of proximal & shaft fragments

Fracture table, reduction steps: traction, abduction, internal rotation
TIPS & TECHNIQUES
MODIFIED PATIENT POSITION ON A FRACTURE TABLE FOR HIP FIXATION
Chun-Sheng Wu, MD; Pei-Yu Chen, MD; Kao-Shang Shih, MD; Sheng-Mou Hou, MD, MPH, PhD
Orthopedics July 2007 - Volume 30 · Issue 7
The Anterior and Medial Reduction of Intertrochanteric Fractures: A Simple Method to Obtain a Stable Reduction

James B. Carr, MD

(J Orthop Trauma 2007;21:485–489)
Double density of medial cortex is evidence of intussuscepted neck into shaft seen on lateral
Traction will not reduce this “sag” but a lever into the fracture will reduce it.
The AP view before and after lever reduction: the medial cortex is restored.
Implant position

*Apex of the femoral head*

Defined as the point where a line parallel to, and in the middle of the femoral neck intersects the joint.
Implant position

Screw Position: TAD

Tip-Apex Distance

\[ \text{Tip-Apex Distance} = X_{\text{ap}} \div X_{\text{lat}} \]
Logistic Regression Analysis

Multivariate (dependent variable: Cut Out)

- Reduction Quality $p = 0.6$
- Screw Zone $p = 0.6$
- Unstable Fracture $p = 0.03$
- Increasing Age $p = 0.002$
- Increasing TAD $p = 0.0002$

Baumgaertner, Curtin, Lindskog, Keggi JBJS (A) '95
1. Cut-out was found in 3.4 % (255pt)
2. TAD >25 mm the most important factor for cut-out in stable and unstable fractures
4. Anterior screw placement increases cut-out incidence
Optimal screw placement

Dead Center

and

Very Deep

(TAD<25mm)

- Best bone
- Maximum slide
- Validates reduction
- No moment arm for rotational instability
Implant selection: is there a big deal?
CHS: risk of failure

Implant of choice in stable fractures

Failure rates of the sliding hip screw of up to **12.5%**

Limited ability to resist fracture collapse and medialization of the femoral shaft.

- reverse obliquity fractures
- extended fracture at lateral cortex (8 times risk of collapse)

Not for A3 fractures
Trochanteric Stabilizing Plate (TSP)

adjunct to limit shaft medialization

≥20mm screw slide collapse
op time, blood loss
? complications
length of rehab
IM nailing: biological advantages

- Percutaneous Procedure
- Maintenance of tissue sleeve
- Rehabilitation time
- Less blood loss?
IM nailing: mechanical advantages
Key point

It is not only the reduced lever arm that offers the clinically significant mechanical advantage,

but the intramedullary buttress that the nail provides to resist excessive fracture collapse*

* Reduced collapse has been reported in almost all randomized studies
The nail substitutes for the incompetent lateral cortex
The nail substitutes for the incompetent posteromedial cortex.
Gamma initial clinical results

Advantages : +/-
Complications :+++  

Bridle, JBJS (Br), 1991
Boriani, Orthopaedics, 1991
Lindsey, Trauma, 1991
Halder, JBJS (Br), 1992
Williams, Injury, 1992
Leung, JBJS (Br), 1992
Aune, Acta Scand, 1994
Gamma vs CHS

1996 Meta-analysis of ten randomized trials

Shaft fractures: Gamma 3 \times CHS (p < 0.001)

Required Re-ops: Gamma 2 \times CHS (p < 0.01)

IM fixation may be superior for inter/subtroch extension & reverse obliquity fractures

\textit{CHS is a forgiving implant when used by inexperienced surgeons, the Gamma nail is not}”

\textit{Parker, International Orthopaedics '96}
120 patients all above 60 years
AO Type 31-A2 & 31-A3.
Comparable results in all groups
More technical complications (PFN)
Cut-out the primary subject of analysis

Seventeen randomized control trials

No significant difference in the frequency of implant-related complications between the two types of devices
Critical factors in cut-out complication after gamma nail treatment of proximal femoral fractures

Alicja J Bojan¹, Claudia Beimer², Gilbert Taglang³, David Collin¹, Carl Ekholm¹ and Anders Jönsson¹

primary **cut-out rate** 1.85% (57/3066)
- unstable fracture
- non-anatomical reduction
- non-optimal screw position
Gamma nail revisited

...risk of shaft fracture

Meta-analysis of RC trials

Lower risk of shaft fracture due to
- improved design
- increasing learning curve

Bhandari, Schemitsch et al. JOT 2009
Review
Occurrence of secondary fracture around intramedullary nails used for trochanteric hip fractures: A systematic review of 13,568 patients

Rory Norris*, Dhritiman Bhattacharjee, Martyn J. Parker

Overall incidence 1.7%.
Reduced from 2.6%
Lower in other short nails (0.7%)

Long nails had a slight tendency towards a lower risk
CHS is still the device of choice for stable fractures (A1 AO-OTA).

IMN are more appropriate for A3 fractures.

Regarding the A2 group nails seem to do better
- gross comminution
- small lateral wall remnant
- no medial support
Best IMN indications

Reverse Oblique Fractures
Unstable Intertroch + subtrochanteric fractures
Inadequate ‘three-point’ proximal fixation predicts failure of the Gamma nail
Proximal diameter?
Nail Length?
Distal interlocking?
Proximal screw? , Sleeve or no sleeve? , One or two needed?
Blade instead of screw?
Nobody knows
Stable/unstable: **Gnail-3** = 18/43, **ACE** = 20/31
Same mean postop hip scores
Same walking ability (80%)

Table II. — Postoperative complications

<table>
<thead>
<tr>
<th></th>
<th>Gamma 3 (61)</th>
<th>ACE (51)</th>
</tr>
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<tbody>
<tr>
<td>Non-union</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Deep vein thrombosis</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Peripheral nerve injury</td>
<td>1 (1.6%)</td>
<td>0</td>
</tr>
<tr>
<td>Failure of internal fixation</td>
<td>2 (3.2%)</td>
<td>2 (3.9%)</td>
</tr>
<tr>
<td>Wound infection</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Implant failure</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Death (non surgery-related)</td>
<td>14 (22.9%)</td>
<td>12 (23.5%)</td>
</tr>
</tbody>
</table>
Proximal femoral nail antirotation and third-generation Gamma nail: which is a better device for the treatment of intertrochanteric fractures?

Yue-Hua Yang¹, MD, Yu-Ren Wang¹, MD, Sheng-Dan Jiang¹, MD, PhD, Lei-Sheng Jiang¹, MD, PhD

Table VI. Comparison of postoperative complications at the final follow-up.

<table>
<thead>
<tr>
<th>Complication</th>
<th>No. of patients (%)</th>
<th>p-value</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>PFNA (n = 103)</td>
<td>Gamma 3 (n = 107)</td>
</tr>
<tr>
<td>Cutout</td>
<td>1 (1.0)</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td>Reoperation</td>
<td>1 (1.0)</td>
<td>1 (0.9)</td>
</tr>
</tbody>
</table>

Slightly better quality of reduction with Gamma-nail, but same rate of complications and clinical outcome
Overall risk for local complication after PFNA fixation was 45% (40% for Gamma-3)

- fracture impaction (5 cases)
- delayed healing (5 cases).
- 3 cases of nonunion,
- 3 cases of blade migration
- one case of implant loosening,
41.3% technical complications
2 cut-outs
5 "Z effects"
1 case with reverse "Z-effect"
2 implant failures,
Overall rate of re-operation 28.8%. 
fracture fixation in varus position,
severe medial comminution,
inappropriate entry point of the nail
poor bone quality.
combination of rotational stability and initial linear compression:

preventing uncontrolled shortening and varus collapse

Promising results first 100 pt
Summary of technical tips

Intertrochanteric Fractures: Ten Tips to Improve Results

By George J. Haidukewych, MD

An Instructional Course Lecture, American Academy of Orthopaedic Surgeons
technical tip 1

Use the Tip-to-Apex Distance

deep and central in the femoral head within 10 mm of the subchondral bone
technical tip 2

“No Lateral Wall, No Hip Screw”

reverse obliquity fractures
transtrochanteric fractures
technical tip 3

Know the Unstable Intertrochanteric Fracture Patterns, and Nail Them

- reverse obliquity fractures,
- transtrochanteric fractures,
- fractures with loss of the calcar buttress,
- fractures with subtrochanteric extension
technical tip 4

Beware of the Anterior Bow of the Femoral Shaft

Most available IMN have a radius of curvature of between 1.5 and 2.2 m.

If resistance is encountered during insertion of a long IMN do not hammer (take a true lateral x-ray)
technical tip 5

Start Slightly Medial to the Exact Tip of the GT

The patient’s soft-tissue mass, the operative drapes, the trajectory of the reamer, the nail insertion can gradually enlarge the pilot hole
technical tip 6

Do Not Ream an Unreduced Fracture

Good positioning
Gentle traction
Unrestricted C-arm control

Percutaneous or open techniques of reduction
technical tip 7

Be Cautious About the Nail Insertion Trajectory, and Do Not Use a Hammer to Seat the Nail

The femoral shaft may need to be reamed further or

there may be impingement on the anterior femoral cortex
technical tip 8

Avoid Varus Angulation of the Proximal Fragment

Varus angulation increases the lever arm on the fixation

Use a 130° nail, check for the neck-shaft angle

Look the relationship between the tip of the greater trochanter and the center of the femoral head
technical tip 9

Lock the Nail Distally if the Fracture Is Axially or Rotationally Unstable

Most unstable fractures of the proximal part of the femur require a long intramedullary nail

Especially in osteoporotic bone
technical tip 10

Avoid Fracture Distraction When Nailing

Fractures that are internally fixed in distraction are at risk for nonunion and eventual hardware failure.

To eliminate distraction, the traction on the lower limb should be released prior to insertion of the distal locking screws.
Did the surgeon do a good job?

• Yes
• No
Now, consider specifically:

A. The reduction is satisfactory
B. The TAD (screw position) is OK
C. Both are satisfactory
D. Neither are satisfactory

…Choose Best Answer
Post op
The TAD was acceptable but the reduction was grossly short.
Did the surgeon do a good job?

- Yes
- No
Conclusions

Uncontrolled factors

Fracture geometry
Bone quality

Controlled factors

Quality of reduction
Implant position
Implant selection
Conclusions

Implants have different traits-choose wisely

Position screw centrally and very deep (TAD≤20mm)

Long nails in very comminuted fractures

Healing is no longer “success”

Deformity & function matter