Femoral Neck Fractures in Young Adults: What is the Standard?

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We accept....

Femoral neck fracture in young adults
• Difficult injuries
• Early, skilled treatment essential
• Complications are potentially catastrophic
• Salvage Rx are common

This Lecture

• Describe injury pattern
• What is the standard?
• Optimal care
• Expectations
Early Surgical Rx


• 22 patients aged 20-40 (Army)
• Mostly CRIF

• 59% nonunions
• 86% AVN

Who Risks Failure?

What is likely to affect union?
• Host factors (hormones, smoking, etc.)
• Intra-articular injury (synovial fluid)
• Vascularity
• Fracture configuration
  • Reduction
  • Fixation

Who Risks Failure?

• Fracture orientation: vertical
Friedrich Pauwels (1920’s)

• Biomechanical view of hip fractures
• Compressive vs. shearing forces

Modern Treatment

Liporace et al. Results of internal fixation of Pauwels’ III vertical femoral neck fractures. JBJS Am, 2008.

• 56 patients young patients with Pauwels’ III
• Mostly CRIF

– 17% nonunion
– 12% AVN

30% failure rate

Modern Treatment

• I have failed
Disclosure

• Failure is costly for the young patient

Modern Treatment

• Ignored injury
• Swiontkowski et al.

Results


"IF of femoral neck fractures and femoral neck shortening affect patient VAS scores and functional outcomes."

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total No. (%)</th>
<th>12R or N/PAD (No. (%)</th>
<th>Modern PAD (No. (%)</th>
<th>Senior PAD (No. (%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femoral neck shortening (cm)</td>
<td>1.2 (0.5 to 2.7)</td>
<td>7.9 (5.8 to 9.9)</td>
<td>7.7 (6.0 to 9.5)</td>
<td>7.8 (5.5 to 9.9)</td>
<td>0.001</td>
</tr>
<tr>
<td>VAS at discharge</td>
<td>5.0 (3.0 to 7.2)</td>
<td>7.3 (5.0 to 7.8)</td>
<td>7.9 (6.0 to 9.8)</td>
<td>7.8 (6.0 to 9.8)</td>
<td>0.001</td>
</tr>
<tr>
<td>VAS at 12R</td>
<td>7.3 (5.5 to 8.7)</td>
<td>7.0 (5.5 to 9.0)</td>
<td>7.1 (5.5 to 9.1)</td>
<td>7.3 (5.5 to 9.0)</td>
<td>0.001</td>
</tr>
<tr>
<td>VAS at 6M</td>
<td>7.8 (6.0 to 9.3)</td>
<td>8.0 (6.0 to 9.8)</td>
<td>8.0 (6.0 to 9.8)</td>
<td>8.0 (6.0 to 9.8)</td>
<td>0.001</td>
</tr>
<tr>
<td>VAS at 1Y</td>
<td>8.0 (6.0 to 9.3)</td>
<td>8.0 (6.0 to 9.8)</td>
<td>8.0 (6.0 to 9.8)</td>
<td>8.0 (6.0 to 9.8)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Outcomes


• Results

"Displaced fractures and Pauwels 3 fractures shorten the most."

<table>
<thead>
<tr>
<th>Patient and Fracture Characteristics</th>
<th>Mean (In.)</th>
<th>Little Te Pou (In.)</th>
<th>Median Chin (In.)</th>
<th>Spence’s (In.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male Sex (%)</td>
<td>40 (34.5)</td>
<td>18 (15.8)</td>
<td>18 (15.8)</td>
<td>18 (15.8)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>80 (14.6)</td>
<td>85 (14.6)</td>
<td>85 (14.6)</td>
<td>85 (14.6)</td>
</tr>
<tr>
<td>BMI kg/m²</td>
<td>25 (8)</td>
<td>28 (11.5)</td>
<td>28 (11.5)</td>
<td>28 (11.5)</td>
</tr>
</tbody>
</table>
| Treatment Decisions

• Algorithms (e.g. MacCauley et al, JAAOS, 2006)

Treatment Decisions

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Treatment Decisions

- Algorithm provided

TAMARID

TAMARID

TAMARID

- ICL Example

ICL Example

ICL Example

ICL Example
Treatment Decisions

• What might have been done differently?

Treatment Decisions

• What about pre-operative planning?

Treatment Decisions

• Is evaluating this in surgery OK?
Treatment Decisions

What sort of evaluation is being done?

• 3 trauma centers
• 65 Pauwels’ III vertical neck fractures in patients <50 yo undergoing repair
• Exclusion:
  – Acetabular or femoral shaft fx
  – Arthroplasty

Collinge, Beltran, Reddix, and Mir. J Ortho Trauma submitted

Finding: Half went to OR with this radiographic work-up

Collinge, Beltran, Reddix, and Mir. J Ortho Trauma submitted
Fracture Morphology

- Confirmed vertical fracture

Fracture Morphology

- External rotation deformity
- Fracture rarely transverse

Fracture Morphology

- Comminution
  - Young 95%
- Apex inferiorly on calcar
Fracture Morphology

- Loss of the calcar buttress: 50%

Fracture Morphology

So now what?
- Better idea of obtaining reduction
- Not everyone gets the same construct (?)
  - Buttress plating the neck?
  - Fixed angled devices with rotational control ?
- Modelling for Lab studies
Reduction

• Must overcome deformity and muscle forces

External rotation

Reduction

• Leadbetter Technique
  – Flex the hip to 90°, slight adduction
  – In-line traction with the femur
  – While maintaining traction, IR to 45°
  – Slowly move into slight abduction and full extension, while maintaining traction and internal rotation

• Lots of others

Reduction

Karanicolas et al. Interoobserver Reliability of Classification Systems to Rate the Quality of Femoral Neck Fracture Reduction. JBJS-Am 2004

• Assessed inter-rater reliability of surgeons using reduction grading systems
• Reviewed series of femoral neck ORIF’s
• 5 scales used vs. “clinical impression”
  
  e.g.
Reduction

Open (vs. closed)
- Higher quality
- Low threshold
- Smith-Pete

Open Reduction

Heuter/ Mini Smith-Pete
- Excellent neck exposure

Open Reduction

- Traction (or not)
Open Reduction

- Joy stick(s)
  - Rotate
  - Push/pull(?)
  - Provisional fixation

- Bone hook
  - pull (rotate)

Clamps

Small or mini-frag plates

Fixation

- Mechanical Fixation in Vertical Neck Fx

Bainer et al, Clin Orthop, 1999
Fixation

• Mechanical Fixation in Vertical Neck Fx

Grossman et al., OTA, 2001

Fixation

• Cadaveric study, multiplanar cyclic loading

Aminian et al, JBJS, 2007

Fixation


• Clinical study
• 41 patients
• Mean age 47 (21-65)

- 2 nonunions (5%), 2 AVN requiring surgery (5%)
- 63% excellent and 20% good results (Harris hip)

Fixation

What do the “Experts” say?
Fixation

Luttrell et al. J Ortho Trauma, May, 2014

• OTA Members- Construct of Choice?

Implant Preferences

- Parallel Cannulated Screws
- Parallel Noncannulated
- Locking Proximal Femur Plate
- Cephalomedullary Nail
- Condylar Hip Screw
- Arthroplasty
- Blade Plate
- Condylar Hip Screw with or without Derotation Screw

Reason for Implant Choice

- Biomechanically Most Stable
- Less Invasive
- Technically Easier
- Fewer Complications
- Improved Mobilization

Summary: Case 2
Summary: Case 2

Conclusions
Femoral neckFx in young adult
• Assessment
• Pre-op planning
• Reduction
• Fixation
• Complication management
Final Thoughts

Pauwels III femoral neckFx in young adult
- We need to understand the injury better
- Requires a thoughtful solution

Conclusions

Thank You
A Rational Approach?

Pre-operative Assessment
Fixation

• Plate-screw with anti-rotation
  — DHS + AR screw

Discussion

“Schizophrenic” Thinking

• schiz-o-phere-ni-a [skit-suh-free-nee-uh, -freen-yuh]
• noun
• 1. Psychiatry. Also called dementia praecox. A mental disorder characterized by some, but not necessarily all of the following features: emotional blunting, intellectual deterioration, social isolation, disorganized thought and behavior, delusions, and hallucinations.
• 2. a state characterized by the coexistence of contradictory or incompatible elements.
• Vertical Shear Fractures of the Femoral Neck A Biomechanical Study.
  Baitner, Avi C. MD; Maurer, Stephen G. MD; Hickey, Derrick G. MD; Jazrawi, Laith M. MD; Kummer, Frederick J. PhD; Jamal, Joseph BS; Goldman, Sara BS; Koval, Kenneth J. MD

• December 2002Volume 33, Supplement 3, Pages 24–32
  Analysis of fracture gap changes, dynamic and static stability of different osteosynthetic procedures in the femoral neck
  F.A. Bonnaire, A.T. Weber

• Internal Fixation of Femoral Neck Fractures With Posterior Comminution: A Biomechanical Study
  Kauffman, Jeffrey I.; Simon, Jordan A.; Kummer, Frederick J.; Pearlman, Charles J.; Zuckerman, Joseph D.; Koval, Kenneth J.
Relationship of Mechanical Factors to the Strength of Proximal Femur Fractures Fixed with Cancellous Screws

Stankewich, C. J.; Chapman, Jens; Muthusamy, Raman; Quaid, Gina; Schemitsch, Emil; Tencer, Allan F.; Ching, Randy P.
• Displaced Femoral Neck Fractures in Young Adults Treated With Closed Reduction and Internal Fixation
  • Hui-Kuang Huang, MD; Yu-Ping Su, MD; Chuan-Mu Chen, MD; Fang-Yao Chiu, MD; Chien-Lin Liu, MD
  • Orthopedics
  • December 2010 - Volume 33 · Issue 12

• Injury
  • Volume 28, Issue 2, March 1997, Pages 135–139
  • Paper
  • Percutaneous cannulated screw fixation of femoral neck fractures: the three point principle
  • C.A. Bout, D.M. Cannegieter, J.W. Juttmann

• Journal of Orthopaedic Trauma:
  • February 2000 - Volume 14 - Issue 2 - p 131
  • Abstracts From The 15Th Annual Meeting Of The Orthopaedic Trauma Association
  • †A biomechanical analysis of fixation constructs in high angle femoral neck fractures
  • Sirkin, Michael; Grossman, Mark G.; Renard, Regis L.; Sabatino, Christopher T.; Doumas, Christopher; Reilly, Mark C.; Behrens, Fred F.
The effect of moment arm length on high angled femoral neck fractures (Pauwels’ III)

MS LePine, WR Barfield, JD DesJardins... - Journal of Biomedical ..., 2010 - file.scirp.org

Journal of Trauma Injury Infection & Critical Care:

September 2011 - Volume 71 - Issue 3 - pp 625-634

doi: 10.1097/TA.0b013e31820e86e6

Original Article
A Comparative Biomechanical Analysis of Fixation Devices for Unstable Femoral Neck Fractures: The Intertan Versus Cannulated Screws or a Dynamic Hip Screw

Rupprecht, Martin MD; Grossterlinden, Lars MD; Ruecker; Andreas H. MD; de Oliveira, Alexander Novo MD; Sellenschloß, Kay Dipl Ing; Nüchtern, Jakob MD; Püscher, Klaus MD; Morlock, Michael MD; Rueger, Johannes Maria MD; Lehmann, Wolfgang MD
Vertically Oriented Femoral Neck Fractures: Mechanical Analysis of Four Fixation Techniques

Aminian, Arash; Gao, Fan; Fedoriw, Wasyl W; Zhang, Li-Qun; Kalainov, David M; Merk, Bradley R

doi: 10.1097/BOT.0b013e31814b822e

Augmentation

Buttress plate for a shearing injury

Koval, Clin Orthop, 1999
Fixation

Mechanical Fixation in Vertical Neck Fx

Grossman et al., OTA, 2001

Fixation

• Cadaveric study, multiplanar cyclic loading

Merk, JBJ, 2007

Disclosure

• I have failed.