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

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Early Surgical Rx


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

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

Who Risks Failure?

• Reduction
• Fixation

- Affected by surgeon
Who Risks Failure?

• Fracture orientation: vertical

Friedrich Pauwels (1920’s)

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

Modern Treatment


• 56 patients young patients with Pauwels’ III
• Mostly CRIF
  - 17% nonunion
  - 12% AVN
  - 30% failure rate
Disclosure
• I have failed

Modern Treatment
• Failure is costly for the young patient

Modern Treatment
• Pauwels
• ........
• ........
• ........
• Swiontkowski et al.
• ........
• ........
• ?
Outcomes


• Results

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

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total (n= 35)</th>
<th>Mean ± SD</th>
<th>p &lt;0.01</th>
<th>p &lt;0.05</th>
<th>p &lt;0.10</th>
<th>p &lt;0.20</th>
<th>p &lt;0.30</th>
<th>p &lt;0.40</th>
<th>p &lt;0.50</th>
<th>p &lt;0.60</th>
<th>p &lt;0.70</th>
<th>p &lt;0.80</th>
<th>p &lt;0.90</th>
<th>p &lt;0.95</th>
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<tbody>
<tr>
<td>Displaced fractures</td>
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<td>Pauwels 3 fractures</td>
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</table>

Outcomes


• Results

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

Treatment Decisions

• Algorithms (e.g. MacCauley et al, AAOS, 2006)
Treatment Decisions

- Algorithms (e.g., MacCusky et al., JAAOS, 2006)

Treatment of Femoral Neck Fractures in Young Adults

- Algorithm provided

An axially loaded, high-energy force applied to an addicted hip results in a femoral neck fracture. The fracture pattern is typically linear and, thus, biomechanically more unstable. These characteristics have important implications with regard to selecting and maintaining reduction methods, both of which are necessary for healing to occur.

Treatment of Femoral Neck Fractures in Young Adults

- Algorithm provided

Imaging, a Weber clamp or 3.5 mm K-wire, and sliding hip screw can provisionally hold the reduction. Definitive fixation can be obtained with lag screws or intramedullary nailing. A single- or double-column fracture pattern is common. An anterior approach, with use of a modified Smith-Peterson incision, allows access to the acetabular capital and neck articular surfaces. The femoral neck is fixed with a lag screw or sliding hip screw.

The preoperative regimen that
Treatment Decisions

• 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?

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

What sort of evaluation is being done?
• “AP and ‘lateral’” Xrays 65/65
  – Vertical pattern apparent 30/65 (55%)

• “Advanced” imaging
  – 2% had dynamic/ traction views
  – 55% had CT scan (25/30 trauma scans)
Understand: Take Home Point #1

Treatment Decisions

• Radiography: 52 yo rancher

Understanding fracture morphology
• 55% of patients had CT
• CT provides great information
  – Axial cuts good
  – 2D recons very good
  – 3D recons excellent
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

Collinge, Reddix, and Mir. J Ortho Trauma, 2014

Fracture Morphology

• Loss of the calcar buttress: 50%

Collinge, Reddix, and Mir. J Ortho Trauma, 2014

Fracture Morphology

• Erosion

Collinge, Reddix, and Mir. J Ortho Trauma, April 2014
Fracture Morphology

What else does CT offer?

Quantitative CT
- Yields data similar to DEXA
- Quantifies “osteoporosis”
- Software $11,000 (Siemens)

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

Reduction

Ideal reduction is ANATOMIC
– Restores muscle lengths, levers
– Restores fracture stability
  • Optimizes fractures mechanics
  • Interdigitates bony interstices

• Acceptable?: ≤15° valgus, ≤10° AP
• NO varus is acceptable

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
Open Reduction
Heuter/ Mini Smith-Pete

- Excellent neck exposure

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Open Reduction

- Traction (or not)

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Open Reduction

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

- Bone hook
  - pull (rotate)
FIGURE 4. A, A 16-year-old female involved in a high-speed motor vehicle accident. The patient sustained a left external iliac artery injury requiring emergent repair. The reduction was then temporarily held with a 3.5-mm pelvic reconstruction plate (D and E). Definitive fixation was placed percutaneously using small incisions (F and G). The bone hook prevents subluxation through the acetabular fracture.

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Open Reduction of Intracapsular Hip Fractures Using a Modified Smith-Petersen Surgical Exposure

Molnar, Robert B; Routt, M L Jr

doi: 10.1097/BOT.0b013e31804a7f7f

- Clamps
- Small or mini-frag plates

Fixation: Take Home Point #3

- Mechanical Fixation in Vertical Neck Fx
• Mechanical Fixation in Vertical Neck Fx

• Cadaveric study, multiplanar cyclic loading

• Clinical series, 56 patients
ProxFem Locking Plate

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

Fixation


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

63% All
20%
Conclusions

Femoral neck Fx in young adult
• Assessment
• Pre-op planning
• Reduction
• Fixation
• Complication management

Conclusions

Pauwels III femoral neck Fx in young adult
• We need to understand the injury better
• Requires a thoughtful solution

Thank You
ORIF w/ Std. Implant + Anti-glide Plate

Common mode of failure

Buttress plate for a shearing injury

ORIF w/ Std. Implant: Common mode of failure
Radiographic W/U

- Collinge, Reddix, and Mir. J Ortho Trauma, Submitted.

90% 85%

Radiographic W/U

- Collinge, Reddix, and Mir. J Ortho Trauma, Submitted.

52% 38%

Radiographic W/U

- Collinge, Reddix, and Mir. J Ortho Trauma, Submitted.

2%
Injury Xrays

- Radiography: 52 yo rancher

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A Rational Approach?

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Pre-operative Assessment
Fixation

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

Double Engine Medical, China
**Schizophrenic** Thinking

• **schiz-o-phe-ri-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 2002 Volume 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.
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

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

†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 (Pauwells' 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.0b013e31820e8e6e
• 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; Sellenschloh, Kay Upling; Nüchtern, Jakob MD; Püschel, Klaus MD; Morlock, Michael MD; Rueger, Johannes Maria MD; Lehmann, Wolfgang MD
**Conclusions**

"The following conclusions are notable.

- Internal fixation of femoral neck fractures results in permanent physical limitations.
- Median femoral neck shortening was 1.1 cm.
- Femoral neck shortening decreased gait velocity and seemed to impair gait symmetry and physical functioning.
- Age, weight, and Pauwels classification were risk factors for femoral neck shortening."

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**Fixation**

- Mechanical Fixation in Vertical Neck Fx

Koval, Clin Orthop, 1999

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**Fixation**

- Mechanical Fixation in Vertical Neck Fx

Grossman et al., OTA, 2001
Fixation

• Cadaveric study, multiplanar cyclic loading

Merk, JBJS, 2007

Disclosure

• I have failed.