Intertrochanteric Hip Fractures

Improving Outcomes

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Disclosures

- Epix Orthopaedics, Inc. – Founder, Board, Stock
- PDP Holdings, LLC – Founder, Board, Stock
- Total Connect Spine, LLC – Founder, Stock
- Advanced Biologics, LLC – Unpaid Consultant
- Skeletal Kinetics, LLC – Unpaid Consultant
- Biomineral Holdings, LLC – Stock
- PayMD – Advisory Committee, Stock
- Stryker – Research Support
- Depuy Synthes Spine – Speaker Honorarium
One nail with variable angle lag screw - 120-140 degrees

Dynamic targeting from 120-140 degrees

Patented
FDA Approved
Epidemiology

Worldwide prevalence of hip fractures is approximately 4.5 million

740,000 deaths worldwide

Estimated annual costs of 10 and 15 billion dollars in the United States
Incidence of Extracapsular Hip Fractures per year 2012

Europe – 450,000
Japan – 75,000
USA – 140,000

Lifetime risk of hip fracture in women 1 in 6
Breast cancer is 1 in 9
Despite recent advances in medical and surgical care, the 1-year mortality for hip fractures remains unacceptably high.

Over 320,000 hip fractures occur in North America each year and they are associated with a mortality rate ranging from 14% to 36% within 1 year of surgery.

*Acta Orthopaedica* 2014
Simran Mundi, Bharadwaj Pindiprolu, Nicole Simunovic, and Mohit Bhandari
Results — 70 trials published between 1981 and 2012 were included in the review

Mean 1-year mortality rate:
- 24% in the 1980s
- 23% in the 1990s
- 21% after 1999

1-year mean mortality rates for intertrochanteric fractures diminished from 34% to 23% in studies published before 2000 and after 1999 (p = 0.005).

*Acta Orthopaedica* 2014
Simran Mundi, Bharadwaj Pindiprolu, Nicole Simunovic, and Mohit Bhandari
Up to 50% of patients lose ability to function independently and can’t return to pre-injury ambulatory status.

Strength and power deficit in up to 50% of patients.


Nursing home days

• 80 year old without hip fracture
  – 97 days in nursing home over lifetime

• 80 year old with hip fracture
  – 237 days in nursing home over lifetime
How can the surgeon improve outcomes in extracapsular hip fractures?

- Technical:
  - Tip Apex Distance
  - Stay out of VARUS
  - Stable Fixation
  - Decrease Time to OR
  - WBAT

- Systems Efficiency:
  - Emergency Room
  - Medical optimization
  - Anesthesia
  - Physical Therapy
  - Discharge Planning
Considerations:

Co-management
Provider Volume
Patient Education
Timing of Surgery
Anesthesia
Evidence from four randomized controlled studies comparing the effect of multidisciplinary care with usual care after surgery for hip fracture suggests that multidisciplinary care may facilitate walking recovery and improvement in activities of daily living (ADL). However, results were not statistically significant across studies or time frames.
In a randomized trial of 319 patients admitted to a Spanish university hospital for hip fracture surgery, the patients were either randomized to a multidisciplinary geriatric intervention group or to conventional (usual) care. Those who were randomized to the intervention group had a statistically significantly lower in-hospital mortality rate (0.6%) than the usual care group (6%).
Ninety-Day Mortality After Intertrochanteric Hip Fracture: Does Provider Volume Matter?

Patients managed at lower-volume hospitals had significantly higher (10% to 20%) adjusted risks of inpatient mortality than those managed at the highest-volume hospitals. By sixty days postoperatively, the increased mortality risk persisted only among patients managed at the lowest-volume hospitals (six cases per year or fewer).
Interventions to Improve Osteoporosis Treatment Following Hip Fracture
A PROSPECTIVE, RANDOMIZED TRIAL
MICHAEL J. GARDNER, MD, ROBERT H. BROPHY, MD, MS, DEMETRIS DEMETRAKOPOULOS, BA, JASON KOOB, BA, RICHARD HONG, BA, ADAM RANA, BA, JULIE T. LIN, MD, AND JOSEPH M. LANE, MD

Conclusions: Patients who were provided with information and questions for their primary care physician about osteoporosis were more likely to receive appropriate therapeutic intervention than were patients who had not received the information and questions.

JBJS 2005
In their 2009 meta-analysis of 52 studies involving 291,413 patients, Khan et al. concluded that surgery within 48 hours of admission reduces hospital stay and may also reduce complications and mortality.

Timing

Meta-analysis of 16 studies involving 13,478 patients showing that earlier surgery (1-3 days) was associated with lower risk of death, postoperative pneumonia, and pressure sores among elderly patients with hip fractures.

Risk of mortality at 1 year postoperatively was reduced by 45%.

Choice of Anesthesia

Findings showed that spinal anesthesia is associated with
- significantly reduced early mortality
- lower incidence of deep vein thrombosis
- less delirium
- tendency to fewer myocardial infarctions
- fewer cases of pneumonia, fatal pulmonary embolism, and postoperative hypoxia

Decision making

• Patient factors
• Fracture geometry
• Surgeon experience
• Cost
Factors Influencing Construct Strength

**Uncontrolled factors**
- Bone Quality
- Fracture Geometry

**Controlled factors**
- Quality of Reduction
- Implant Placement
- Implant Selection

*Kaufer, CORR 1980*
Radiographs

Plain Films
- AP pelvis
- Cross-table lateral

ER Traction view when in any doubt!!
Classification – Stable/Unstable

- A1
- A2
- A3

AO/OTA 31
Fracture geometry

“STABILITY”

The ability of the reduced fracture to support physiologic loading

Fracture Stability relates not only to the # and size of fragments but the fracture plane as well
Classifications

**Stable** vs. Unstable

- **Definition 1**
  - Resists medial & compressive loads with anatomic reduction and fixation
- **Definition 2**
  - The implant **shares** load with bone
  - Does not matter which implant
Classifications
Stable vs. **Unstable**

- **Definition 1**
  - Collapses into varus or shaft medializes despite anatomic reduction with fixation

- **Definition 2**
  - The implant **bears** all the load
  - May need intramedullary implant
More IT fractures were nailed by 2006
67% nailed in 2006

Fig. 1
Bar graph illustrating the proportion of intertrochanteric fractures fixed with plates (red bars) compared with nails (blue bars).
Type of implant actually used for extracapsular hip fractures in 2014

80-90% = nails

10-20% = hip screw
Fracture geometry

Stable

Unstable
AO/OTA31A3: The highly unstable “pertrochanteric” fractures!
Goal of Fixation

- Maintain an anatomic relationship between the femoral head, neck and shaft fragments
Operative Treatment

- Plate and screw constructs
  (nail or screws for head)
- Nail constructs
  (nail or screws for head)
- External fixation
- Arthroplasty
Plate Constructs

- Fixed angle nail plate (blade plate)
- Dynamic compression (standard sliding hip screw)
- Linear compression (Gotfried PCCP, multiple head fixation components, controls rotation and translation)
- Hybrid locking (multiple fixation components with compression for fracture reduction and locking screws to prevent axial compression, proximal femoral locking plate)
Fixed angle nail plate (blade plate)

One of the more widely used nails for extracapsular hip fractures was designed by E.L. Jewett of Orlando, Florida. The one-piece nail plate combination was originally made by welding a cannulated, trilanged nail to the side plate, but because the nail frequently broke at this level, the nails now are made on one piece for extra strength. (Jewett, E.L.: One-Piece Angle Nail for Trochanteric Fractures. J. Bone Joint Surg. 23:903, 1941.)

Compared to standard sliding hip screw
Cutout 13%
Nonunion 2%
Implant breakage 14%

Chinoy et al. 1999 meta-analysis

Jewett, JBJS Am, 1941
Dynamic compression
(standard sliding hip screw)

- Parker et al. meta-analysis studies still useful in most IT fractures
- Still useful for “stable” A1 type fractures, however......
Sliding hip screw failures

Normal Obliquity
- Lateral wall fractured
- Medial comminution

Reverse Obliquity
- No lateral Buttress
Reverse Oblique Fractures

Retrospective review of 49 consecutive R/ob. fractures @ Mayo:

**Overall 30% failure rate**

- **Poor Implant Position:** 80% failure
- **Implant Type:**
  - Compression Hip Screw: 56% failure (9/16)
  - 95° blade / DCS: 20% failure (5/25)
  - IM Hip Screw: 0% failure (0/3)

Haidukewych, JBJS(A) 2001
Implant Failure

Injury

Post op

12 week

8 mon
Cephalomedullary Devices

Trochanteric or piriformis technique

Russell has divided into 4 classes

1. Impaction class – TFN
2. Dynamic compression class – Gamma
3. Reconstruction class – smaller diameter nail / 2 screws
4. Integrated class – nail design / integrated 2 screw construct with linear compression - InterTAN
Which nail design is best??

Proximal diameter?
Proximal bend?
Nail Length?
Distal interlocking?

Proximal screw ?
One or two needed ?

Nobody knows!

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL
Intramedullary fixation of intertrochanteric hip fractures
A comparison of two implant designs
A prospective randomised clinical trial

Gamma 3 nail vs the ACE nail

No Difference in functional outcome, complications or failure rate

Philip Winnock de Grave, Thomas Tampere Pieter Byn, John VAn Overeshielde, Christophe Pattyn, René Verdonk

Acta Orthop. Belg., 2012
Unstable Pertroch Fractures *(OTA31A.3)*

347 articles reviewed: 10 relevant; 5 RCTs*

“Evidence-based bottom line:”

- Unacceptable failure rates with CHS
- Better results with 95° devices
- Best results with IM devices*
- Best “functional outcome” not known

Kregor, et al (Evidence Based Working Group) JOT ‘05
Intramedullary Nail Indications

- Reverse obliquity
  - Improved outcome over DHS
  - 56% failure with DHS
Intramedullary Nail

- Decreased bending moment on screw
- Provides intramedullary buttress to prevent shaft medialization
- Can span fragmentation
Problems with current hip fracture fixation

• Failure to achieve optimal outcomes
• Common 20,000/year in USA

• Need for 3-4 implants to accommodate anatomic variable neck shaft angles
Problems

Normal Variability of Neck-Shaft Angles

120 deg

140 deg
Unstable trochanteric femoral fractures: extramedullary or intramedullary fixation. A literature review
Schipper et al, Injury, 2004

<table>
<thead>
<tr>
<th>Reference</th>
<th>Method</th>
<th>Number of patients</th>
<th>Average age (years)</th>
<th>Unstable TF (%)</th>
<th>Operation time (min)</th>
<th>Blood loss (ml)</th>
<th>Fixation failure (%)</th>
<th>Cut-out/varus (%)</th>
<th>Femoral fracture (%)</th>
<th>Wound problems/ infections (%)</th>
<th>Re-operation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desjardins et al.</td>
<td>Anatomical reduction Medial displacement osteotomy</td>
<td>57, 52</td>
<td>81</td>
<td>100</td>
<td>83</td>
<td>340</td>
<td>0</td>
<td>9</td>
<td>10</td>
<td>0</td>
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<td>Bucico et al.</td>
<td>CHS, RAB-plate</td>
<td>122, 111</td>
<td>81</td>
<td>100</td>
<td>63</td>
<td>400</td>
<td>2</td>
<td>15</td>
<td>?</td>
<td>?</td>
<td>11</td>
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<td>Baumgaertner et al.</td>
<td>DHS, IMHS</td>
<td>68, 67</td>
<td>79</td>
<td>49</td>
<td>80</td>
<td>340</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td>?</td>
<td>7</td>
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<tr>
<td>Hardy et al.</td>
<td>DHS, IMHS</td>
<td>50, 50</td>
<td>80</td>
<td>68</td>
<td>57</td>
<td>144</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>?</td>
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<td>Fritz et al.</td>
<td>Gliding Nail®</td>
<td>40, 40</td>
<td>79</td>
<td>100</td>
<td>62</td>
<td>296</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>5</td>
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<td>Adams et al.</td>
<td>GN, SHS</td>
<td>203, 197</td>
<td>81</td>
<td>53</td>
<td>55</td>
<td>244</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>6</td>
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<td>Pelet et al.</td>
<td>GN, AB-plate</td>
<td>13, 13</td>
<td>70</td>
<td>100</td>
<td>86</td>
<td>550</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>0</td>
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<td>Sadowski et al.</td>
<td>PFN, DCS</td>
<td>20, 19</td>
<td>?</td>
<td>100</td>
<td>82</td>
<td>?</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>5</td>
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</tbody>
</table>

Table 2: Randomised trials comparing treatment results of unstable trochanteric fractures

Significant difference: P ≤ 0.05
Tip – Apex Distance

$$TAD = X_{ap} + X_{lat}$$

- $X_{ap}$: Apex Distance
- $X_{lat}$: Latitudinal Distance

Magnification control
Probability of Cutout
TAD

68 y M

Orthopaedic Trauma Institute
UCSF + San Francisco General Hospital
TAD = 26 mm
Which of the following is a problem in the operating room with unstable extracapsular hip fractures?

<table>
<thead>
<tr>
<th>Option</th>
<th>Percentage</th>
<th>Votes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varus malreduction</td>
<td>92.1%</td>
<td>106</td>
</tr>
<tr>
<td>Tip apex distance</td>
<td>1.74%</td>
<td>2</td>
</tr>
<tr>
<td>Valgus reduction</td>
<td>1.74%</td>
<td>2</td>
</tr>
<tr>
<td>Implant choice</td>
<td>4.35%</td>
<td>5</td>
</tr>
<tr>
<td>No Vote</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
How common is VARUS?

10%-15% Rate published from “Academic” settings
20-25,000 cases/year

<table>
<thead>
<tr>
<th>Year</th>
<th>Journal</th>
<th>Author</th>
<th>Description</th>
<th>N</th>
<th>Varus %</th>
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</thead>
<tbody>
<tr>
<td>2009</td>
<td>JOT</td>
<td>Rueker</td>
<td>IT fx using InterTan</td>
<td>48</td>
<td>4</td>
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<tr>
<td>2008</td>
<td>Injury</td>
<td>Simmermacher</td>
<td>IT fx using PFN</td>
<td>315</td>
<td>6.5</td>
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<tr>
<td>2007</td>
<td>Injury</td>
<td>Shukla</td>
<td>Subtrochs with Cephalomedullary nails</td>
<td>101</td>
<td>19</td>
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<tr>
<td>1998</td>
<td>JOT</td>
<td>Madsen</td>
<td>Gamma vs DHS IT fx</td>
<td>170</td>
<td>12</td>
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<tr>
<td>1994</td>
<td>IJOT</td>
<td>Ahrengart</td>
<td>Gamma vs DHS IT fx</td>
<td>426</td>
<td>7</td>
</tr>
</tbody>
</table>
Why Do You get Varus?
Mistaken Imaging
Looks more valgus than it is
Neutral rotation

Neutral rotation

Neutral rotation

Reduced

Short

Varus

50º EXT rotation

50º EXT rotation

50º EXT rotation
Technical Issues
Nail-Anatomy Mismatch
Variable proximal bend and thickness changes correct entry site
Many Intra-operative technical issues

The Dreaded Oval

Nail Neck Impingement
If you are in varus, a small Tip-Apex Distance is hard to achieve
Does it matter if fracture is in varus?

- Mechanical Study
  - Is there a difference regarding implant strain with varus or valgus loading when treating intertrochanteric fractures
    - Dynamic Hip Screw
    - Intramedullary hip nail
Methods

• 12 matched paired cadaveric proximal femurs with gap osteotomy
• DEXA performed on all specimens
  – 6 fixed with Compression Hip Screw and Side Plate (CHSP)
  – 6 fixed with Intramedullary Hip Screw (IMHS)
Methods

- Implants were instrumented with strain gages at area of maximal force and historical location of failure
  - This allowed assessment of implant load bearing
Specimens were loaded via the MTS Machine

• Non-destructive compressive loading
• Single-leg-stance phase of gait
  – 15° of adduction, 0° of flexion, and 0° of internal rotation

**Loading angles relative to single-leg-stance**
• Anatomic neck-shaft angle
• 5°, 10°, 15° Varus
• 5°, 10°, 15° valgus
This study supports the use of intramedullary devices for unstable fracture types and also avoiding varus malreductions.
Discussion

- Proximal femur fractures loaded in varus lead to significantly increased load on the implant

- Valgus decreases the load on the implant

- Compression hip screws seem to be more affected by varus/valgus mal-alignment than intramedullary hip screws
What about clinically?
Abductor muscle short and weak
Altered hip biomechanics

Up to 50% of patients lose strength, power, and function can’t return to pre-injury ambulatory status

Varus of the hip causes abductor muscle weakness

What happens when you accurately reduce a hip fracture?

- Excellent outcomes
- Near normal function
- Reoperation rates <1%

Omesh Paul, Joseph U Barker, Joseph M Lane, David L Helfet, Dean G Lorich
Systems Efficiency
Principles of Geriatric Hip Fracture Care

Almost all patients benefit from surgical stabilization
The sooner they have surgery, the less time they have to develop iatrogenic illnesses
Co-management with frequent communication avoids iatrogenesis
Standardized protocols decrease unwarranted variability
Discharge planning begins at admission
Emergency department fast-track

Preprinted orders
Insure medical stability
Admit to combined service
Reduce ED time
Early pain control
• Medicine/Geriatrician
  – Fluid management
  – Comorbidity management
  – Urinary catheter management
  – Nutritional supplementation
  – Constipation management
• Physical Therapy
  – OOB to Chair day 0
  – OOB with walker/gait training day 1
  – OOB with walker/gait training and abductor strengthening day 2

• Social Services
  – Discharge planning continues from ED
  – Safe home environment, SNF placement
  – Family services as needed
GOAL

- Efficient patient care
- Minimize variability
- D/C to rehab unit POD #3
Conclusion

- Problem is big and getting bigger
- The surgeon HAS control over
  - Functional Outcomes
    - Reduction
    - Implant choice
    - Implant position
    - Leg Length
    - Abductor strength
    - Cutout
- Avoid
  - Varus
  - Tip Apex Distance >25mm
- Create a multidisciplinary geriatric team
Conclusions

Consider

- Healing is no longer “success”
- Deformity & function matter
- Perioperative insult counts