**Intertrochanteric Fractures:**  
Technical Tips and Tricks for Avoiding Malreductions

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**Disclosure**

- Consultant for Smith & Nephew –  
  - Design team for proximal femoral plates  
- SAB/Investor Anthem Orthopedics VAN  
  - Prox femoral nail

**Goals of Fracture Treatment**

- Restore anatomy  
- Secure fixation to allow immediate walking  
- Prevent complications
Malunion after Prox Femur Fx Surgery is Common

Historically, the implant of choice for all intertrochanteric fractures.

Sliding allows controlled collapse to a stable position and avoids cut out.
The prevention of deformity in intertrochanteric fractures of the femur

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(a) Five representative patients in whom an intertrochanteric fracture associated with avulsion of the lesser trochanter has been reduced and fixed by a nail and plate. All of them illustrate collapse into deformity, but they show that this may take
Pertrochanteric Hip Fractures: Time for Change
Thomas A. Russell, MD* and Roy Sanders, MD

• “Good” outcome no longer a healed fracture in a patient who limps, has occasional pain, and uses a cane.

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Failure Modes

• Malreduction
  – Varus
  • Decreased abductor moment arm
  – Malrotation

• Loss of Reduction
  – Collapse/Shortening
    • Loss of length
    • Loss of Offset
    – Progressive Varus

• Loss of Fixation
  – Screw cut out
  – Pull off
  – Rotational failure
Implant Failure

Excess Collapse is BAD

- Jacobs (1980) - 15.7 mm sliding in unstable IT's treated with DHS.
- Steinberg (1988) - incidence of fixation failure was increased when sliding length > 5 mm.
- Rha (1993) - Excessive sliding major cause of fixation failure.
- Baixauli (1999) - pts with sliding > 15 mm had more pain.

Consequences of Excess Collapse

- Limb shortening
- Abductor dysfunction
Preventing is easier than Treating

Reduction
Implant Choice and Position
Recognize the unstable fractures

Lateral Wall Fracture

Options for Unstable Fractures

- IM Nail
- Trochanteric Buttress
  Plate / SHS
Know How to Reduce the Fracture and Insert the Implant

Intertrochanteric Fractures of the Femur
150-Degree Angle Nail-Plate Fixation and Early Rehabilitation: A Preliminary Report of 100 Cases *

BY AUGUSTO SARMIENTO, M.D., MIAMI, FLORIDA

From the Division of Orthopedics, Department of Surgery, University of Miami School of Medicine, Jackson Memorial Hospital, Miami

Weigh-bearing on the fractured extremity is safe only if the fracture, whether simple or comminuted, has been reduced so that there is an accurate fit of the fragments at the anteromedial cortex of the femur.

Anatomical reduction of the medial and anterior cortices is of great importance since the stability of the fracture and the efficiency of the nail depend on the reduction of this portion of the bone.

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TECHNICAL TRICK

(J Orthop Trauma 2007;21:485-489)
The Anterior and Medial Reduction of Intertrochanteric Fractures: A Simple Method to Obtain a Stable Reduction

James B. Carr, MD
Avoiding varus malreduction during cephalomedullary nailing of intertrochanteric hip fractures

David J. Hui · Christian Bliat
Trochanteric buttress plate

- Limits potential sliding and therefore deformity. Biomechanically comparable to IMHS.
- Becomes a fixed angle device
- Higher failure rate than conventional SHS
- Requires a larger exposure
- Potential for greater trochanteric bursitis
Summary

- Best way to treat an intertrochanteric nonunion or malunion is to prevent it in the first place.
- Understand the typical fracture patterns and their stability.
- Understand the role of IM nails and plates, and how to use each.
Revision Cases of Extracapsular Hip Fractures

Hip Fracture PATIENT Outcome Predictors

- Pre-injury physical & cognitive status
- Ability to visit a friend or go shopping
- Presence of home companion
- Postoperative ambulation
- Postoperative complications
G.R.
75 y.o. male with L subtrochanteric femur fracture
Prevention

- Reduction ("Thou shall not Varus" (and flexion))
  - Occurs with locking plate, nail, and blade plate
- Biology (technique and blood supply)
- Fixation (TAD, unstable fractures)
Screw Position:
Tip-Apex Distance

$\text{TAD} = X_{\text{ap}} + X_{\text{lat}}$
Instability Greater in Young Patients
Keys For Revision

- Make sure no infection
- Correct the deformity
- Enhance the biology
- Preop plan (need to know how to use a blade plate)
1 ½ year

[Scans of x-rays showing bone structures with labels such as "WB" and "RT table"]
Problem

- Reamed in a poorly reduced position
- Difficult to revise with a nail – better fixation with a plate
NAIL DOES NOT REDUCE FRACTURE

- Prevent varus and apex anteriorly
- Schanz pin laterally in head controls varus/valgus
- Ball spike anteriorly for flexion of proximal femur
- Must hold reduction throughout reaming and fixation
Options

- Girdlestone?
- Arthrodesis?
- THA?
- Fresh allograft proximal femur replacement?
- Revision ORIF?
Keys For Revision

• Make sure no infection
• Correct the deformity
• Enhance the biology
• Preop plan (need to know how to use a blade plate)
Is there an “IDEAL” Approach?

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A public health care crisis

• 130,000 IT Fractures / year in U.S.
  & will double by 2050…
• 4-12% fixation failure

Peritrochanteric Fractures

• Intertrochanteric fractures occur in a more aged population than femoral neck fractures
• Incidence of more unstable, comminuted fracture is increasing which parallels the increased longevity of the world population
Intertrochanteric Femur
Anatomic Considerations

- Capsule inserts on IT line anteriorly, but at midcervical level posteriorly
- Neck – Shaft Angle
- Muscle attachments determine deformity

Deforming Forces: Proximal Femur

#1 = Varus

Radiographs

Plain Films
- AP pelvis
- Cross-table lateral

ER Traction view when in any doubt!!
AO/ASIF OTA Classification Scheme

**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*
Fracture geometry

“STABILITY”

The ability of the reduced fracture to support physiologic loading

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

Stable Unstable

AO/OTA31A3: The highly unstable “pertrochanteric” fractures!
Treatment Options

Non Surgical

• Nonambulatory or demented patients with little evidence of pain
• Septic patient
• Significant skin breakdown over the proposed surgical site
• End stages of terminal disease
• Unstable medical conditions

Closed Treatment

• Early mobilization with no attempt to preserve normal anatomy
• Balanced skeletal traction which maintains alignment and prevents varus angulation
• Traction is maintained for 8-12 weeks followed by partial weightbearing mobilization until complete bony healing

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)

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……
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

Hybrid Locking Plates

Fixed angle stability and initial compression
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!

More IT fractures were nailed by 2006
67% nailed in 2006

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

Recovery room control X-ray shows loss of medial support, but nail prevents excessive collapse
Gamma nails revisited
(risk of shaft fracture….)
Bhandari, Schemitsch et al. JOT 2009

CONCLUSIONS
Our meta-analysis of randomized trials suggests that previous concerns about increased femoral shaft fracture risk with Gamma nails have been resolved with improved implant design and improved learning curves with the device. Earlier meta-analyses and randomized trials should be interpreted with caution in light of more recent evidence.

No more increased risk with nails

External Fixation

RCT n=40 Ex fix +HA vs. DHS
Faster ops, fewer transfusions, no comps
Moroni, et al. JBJS(A) 4/05

• Patients
  – 65 y/o+ walking women with osteoporosis

• Results
  – Faster operations with fewer transfusions
  – Less post op pain, similar final function (Harris hip scores - 62)
  – No pin site infections, no increased post op care
  – Increased pin torque on removal @ 12 wks.
  – One nonunion
  – Lower rate of varus collapse
    (2 vs. 6 degrees for CHS)
Arthroplasty

- Hemiarthroplasty or total hip arthroplasty
- Calcar replacement type
- Rarely indicated…. Better salvage operation

Indications…..
Neoplastic
Severe osteoporosis
Renal dialysis patients
Pre-existing hip arthritis

Conclusions

Remember
Kaufer's Variables

Uncontrolled factors
Fracture Geometry
Bone Quality

Surgeon controlled factors
Quality of Reduction
Implant Placement
Implant Selection
Consider

Conclusions

- Healing is no longer “success”
- Deformity & function matter
- Perioperative insult counts
Outcomes and Societal Burden of Failed Peritrochanteric Fracture Fixation

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  - Epix Orthopaedics
  - MBM holdings

Epidemiology – number of IT fx/year

- USA 170,000
- Europe 450,000
- Japan 75,000
Total 695,000 per year
Numbers projected to more than double in 15 years

- Lifetime risk of hip fx in women – 1 in 6
  - Breast cancer is 1 in 9
Mortality at 80 year old

- Hip fracture
  - Decrease in life expectancy of 25% relative to no hip fracture
- Cohort life expectancy
  - 7.2 years
- With hip fracture
  - 5.6 years
  - Of the 5.6 years, the majority are within 1 year

Morbidity – life in a nursing home

- 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

Medicare Spending on post acute care

- Increased 9% per year since 2,000
- 15% of all medicare spending
Medicare – new york times 8/19/08

- Will not pay for
  - the extra costs of treating in-hospitals
  - preventable
    - Errors
    - Injuries
    - Decubiti
    - Infections
    - Early reoperations

Where do patients go?

- Hip fractures –
  - 26% go to in-hospital rehab
  - 64% go to Short Term Nursing Facility
  - 65% who got home use home health care

Epidemiology

- 300,000 hip fractures per year
- Lifetime cost $81,000
- Days in hospital
  - 1981 – 21 days
  - 2001 – 5.8 days

Some of the major costs

- Initial Hospital: $8,900.00
- Nursing Facility: $35,400.00
- Home Care: $30,800.00
- Other: $5,900.00
Medicare 120 day Spending on post acute care

- Home - $6012 (± $10,000)
- In-hospital Rehab $23,344 (± $17,500)
- SNF $16,911 (± $16,800)
- Acute readmissions - $3,000 (± $8,000)

Factors that are out of our control

- IN-hospital factors
  - Can be in more in our control
  - Osteoporotic fracture service
- Pre-injury mobility
- Nutritional status
- Co-morbidities
- Fracture Pattern
- Osteoporosis

Outcomes linked to 5 fracture related factors

- Bone quality
- Fracture geometry
- Reduction achieved
- Implant selected
- Position of implant

{ } No Surgeon Control
{ } Surgeon Control
Leading causes of Failure

- Varus
- Increased TAD > 25mm should be avoided
  - ‘poor reductions tended to be associated with increased TAD measurements’
  - fractures with poor reductions were more than three times as likely to progress to cutout than fractures with good reductions
  - Cutout was significantly higher in patients with a poor reduction relative to patients that had a good reduction (P = 0.04)

Outcomes

- Varus Collapse and Cutout
  - 4-20%
  - Occurs usually within 4 months of fixation
  - Dependent on
    - Fracture reduction
    - Position of lag screw
    - Fracture pattern
    - Osteoporosis
  - Revision = THA

Functional problems with hip fractures today

- Strength and power deficit in up to 50% of patients
- Up to 50% of patients lose ability to function independently and can’t return to pre-injury ambulatory status
- Why?
  - One large factor is altered hip biomechanics
  - Varus of the hip causes abductor muscle weakness
Downstream Problems

- Fracture fixation failure
- Nail Breakage
- Need for hip replacement
  - Cost is huge
    - Operative time
    - Blood loss
    - Complications
  - Surgical costs – implants, operating theatre and hospital

Costs to the Healthcare system with 10% fixation failure rate (69,500/year USA, EU, JP)

- Simple Calculation of Hospital Utilization costs for primary Total Hip Arthroplasty
  - $24,170 for simple THA
  - $31,341 for revision THA
  - So, conservative estimation of total possible cost of simple THA for cases in the USA
  - $124,170 x 69,500 = $1,679,815,000 per yr
  - Does not include post discharge services

Outcomes after THA from Failed IT fx

- Major Problem –
  - Trochanteric fracture nonunion
    - Need cables and plate to hold troch
  - So, the cost is actually higher than primary THA
Conversely
What happens when you get an accurate reduction?

- Very good outcomes
- Near normal function
  - Cost to outpatient services decrease
- Reoperation rates 1%
  - The cost of THA drops to $170 million/year

Mortality

- Related to pre-op factors
- BUT - Despite improvements in
  - Medicine, Surgery and rehabilitation
  - 7-27% within 3 month of injury
- One Year Mortality = 30%

What can we do to decrease mortality?

- One thing that has been shown to consistently decrease mortality rates is
  - Multidisciplinary approach
    • Patient in hospital flow
    • Algorithmic treatment protocols
    • Buy in from
      - Ortho, anesthesia, emergency room, internal medicine, PT, Social work
What can we do?

1. Create an elderly fracture multidisciplinary team approach
2. Pay attention to the fracture reduction
   - varus mal-alignment before and after implant placement
3. Choose correct implant for fracture pattern
4. Place lag screw in the center-center position of the femoral head

Thank You