Extramedullary or intramedullary fixation for proximal femur fractures?

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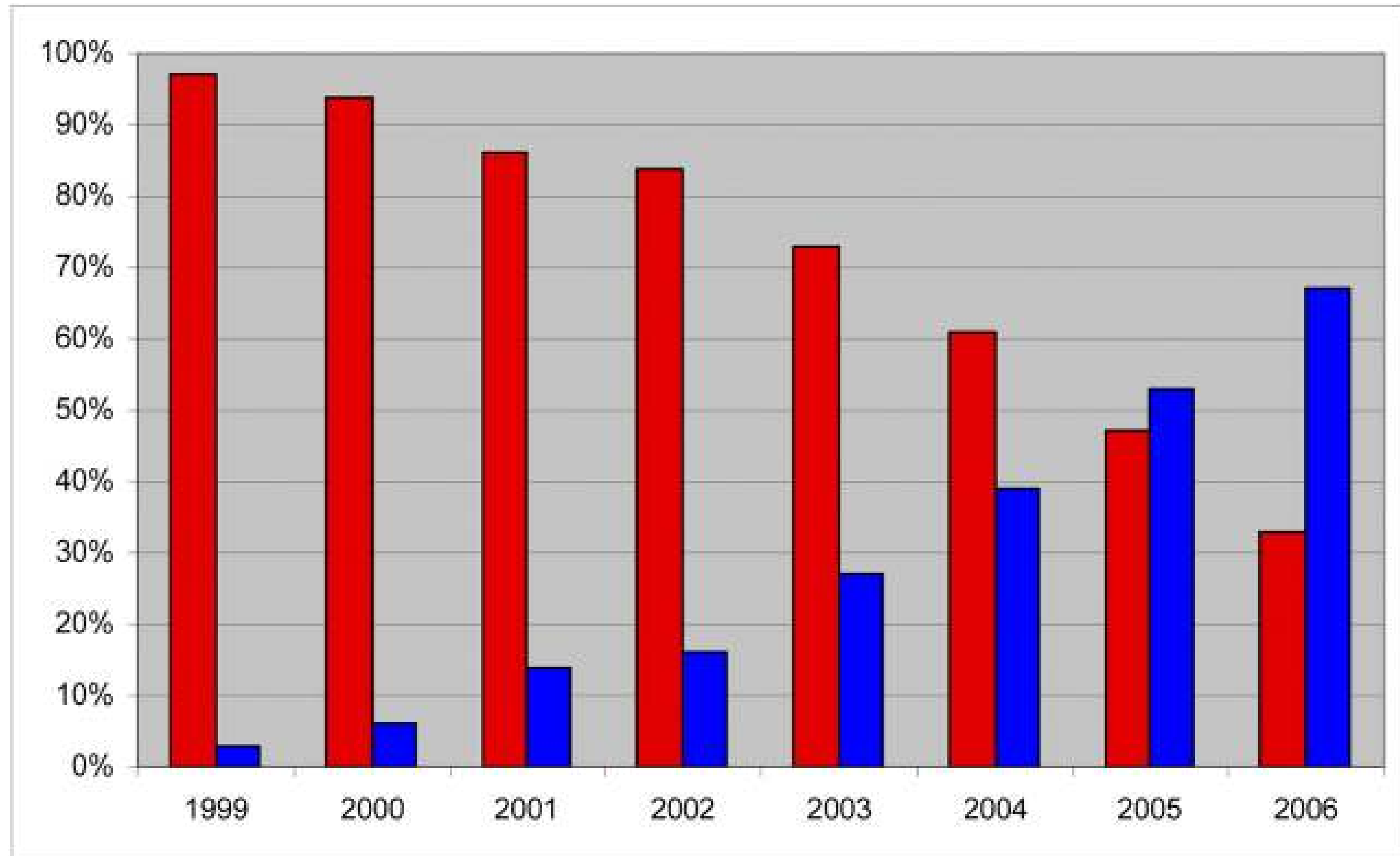
September Fracture Forum

Content

- Introduction
- Evidence
- Intertrochanteric fractures
- Reverse Obliquity fractures
- Subtrochanteric fractures
- Summary
- Conclusions

Fig. 1 Bar graph illustrating the proportion of intertrochanteric fractures fixed with plates (red bars) compared with nails (blue bars).



on Behalf of the American Board of Orthopaedic Surgery Research Committee J Bone Joint Surg 2008:90:700-707

J B&J S

What is the most robust form of evidence?

What is the most robust form of evidence?

Meta- analysis

What meta-analyses are there?

What meta-analyses are there?

Parker MJ, Handoll HHG.

Gamma and other cephalocondylic intramedullary nails versus extramedullary implants for extracapsular hip fractures in adults.

Cochrane Database of Systematic Reviews 2008, Issue 3. Art. No.: CD000093. DOI: 10.1002/14651858.CD000093.pub4

Design

- Cochran review Meta-analysis

Results

- 22 trials (3781 pt) Gamma vs SHS
  - increased risk of operative and later fracture of the femur and an increased reoperation rate
  - No major differences (wound inf, mortality, medical complications)

Results

- 5 trials (623 pt) IMHS vs SHS
  - Fracture fixation complications were more common in the IMHS group
  - all cases of operative and later fracture of the femur occurred in this group.
  - Results for post-operative complications, mortality and functional outcomes were similar

Results

- 3 trials (394 pt) PFN vs SHS
  - no difference in fracture fixation complications, reoperation, wound infection and length of hospital stay

Results

- 2 trials (65 participants with reverse and transverse fractures at the level of the lesser trochanter)
  - intramedullary nails (Gamma nail or PFN) associated with better intra-operative results
  - fewer fracture fixation complications than extramedullary implants (a 90-degree blade plate or dynamic condylar screw)

Authors' conclusions

- lower complication rate of the SHS in comparison with intramedullary nails
- SHS appears superior for trochanteric fractures
- Further studies are required to determine:
  - if different types of intramedullary nail produce similar results
  - if intramedullary nails have advantages for selected fracture types (for example, subtrochanteric fractures)

What else is there?

Systematic review

What else is there?

- ParkerMJ, Handoll HHG

  Condylocephalic nails versus extramedullary implants for extracapsular hip fractures.

  Cochrane Database of Systematic Reviews 1998, Issue 4. Art. No.: CD000338. DOI: 10.1002/14651858.CD000338

What was its bottom line?

- **Authors' conclusions:**
- advantages in intra-operative outcomes of condylocephalic nails are outweighed by
  - increase in fracture healing complications,
  - reoperation rate,
  - residual pain
  - limb deformity.
- The use of condylocephalic nails (in particular Ender nails), for trochanteric fracture is no longer appropriate.

Why?

- Limited no. of publications
- Too many different treatment methods
- Defective methodology for meta-analysis
- Trials did not assess enough numbers of "unstable" fractures

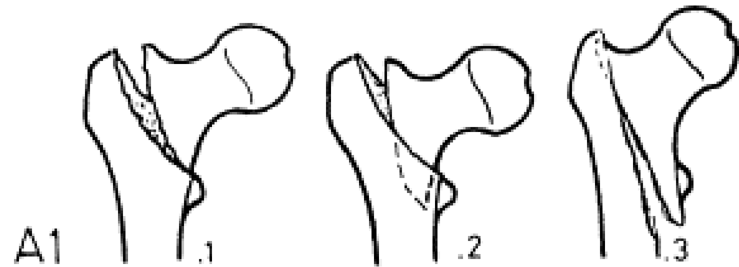
What other evidence is there?

- For unstable fractures intramedullary implants are (biomechanically) superior.
- clinical advantages of both treatment methods are suggested and advocated,
- still remain to be demonstrated on evidence base

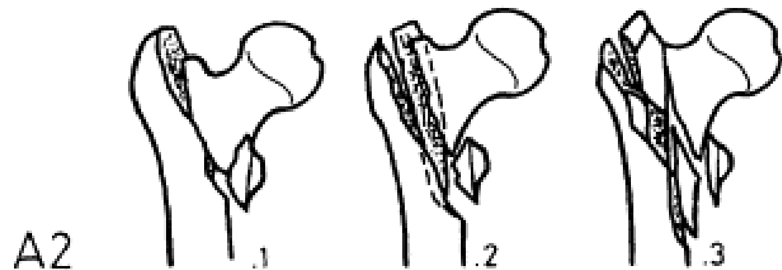
Schipper, I. B., R. K. Marti, and Werken C. van der. "Unstable trochanteric femoral fractures: extramedullary or intramedullary fixation. Review of literature." Injury 35.2 (2004): 142-51.

Classifications

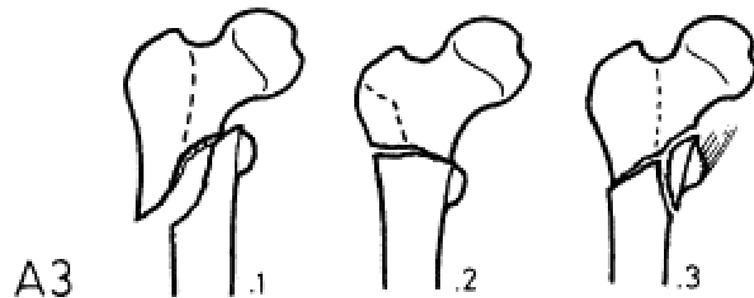
- Simple Intertrochanteric



- Complex intertrochanteric
  - Lesser Troch# +/- Comminution or Gtr troch #



- Reverse Obliquity



Classifications

- Evans, 1949
- Modified by Jensen & Michaelson, 1975

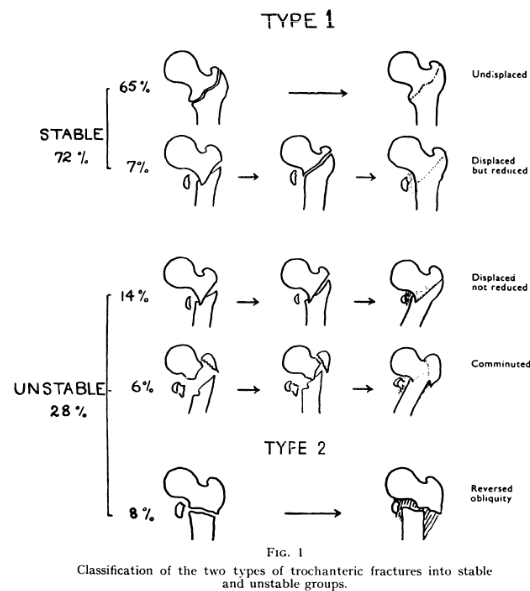


FIG. 1
Classification of the two types of trochanteric fractures into stable and unstable groups.

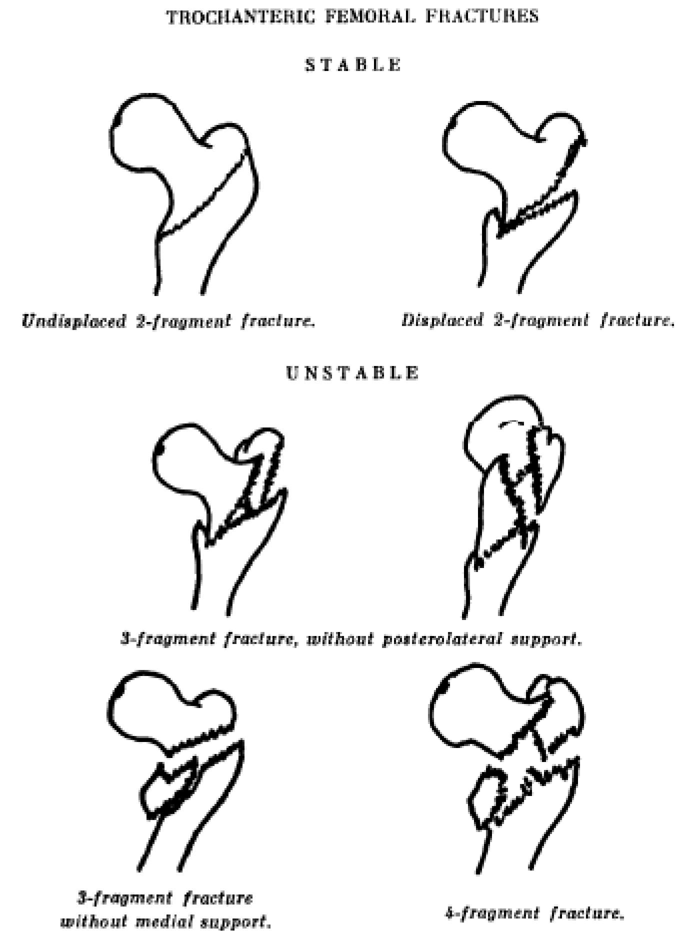
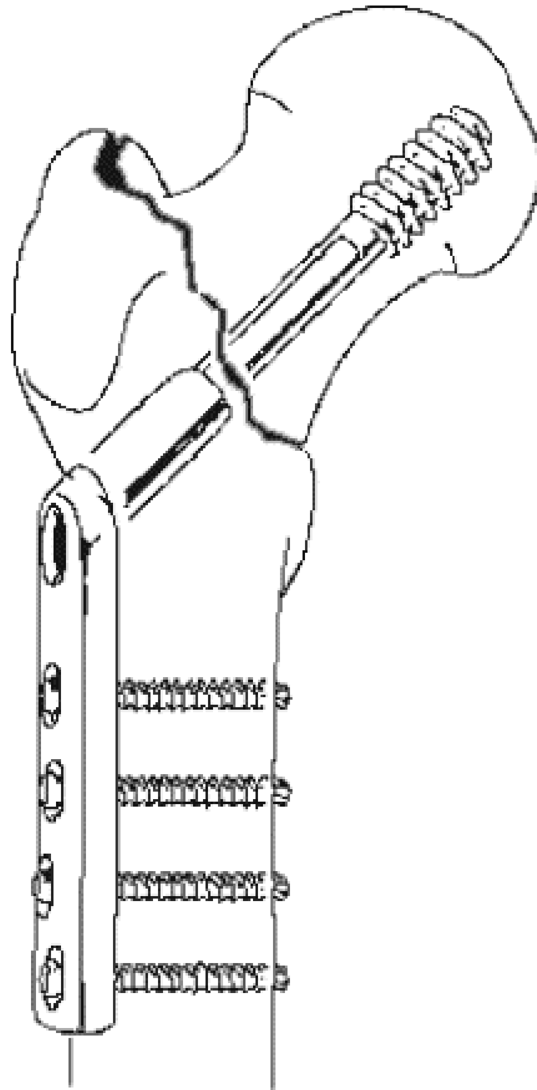
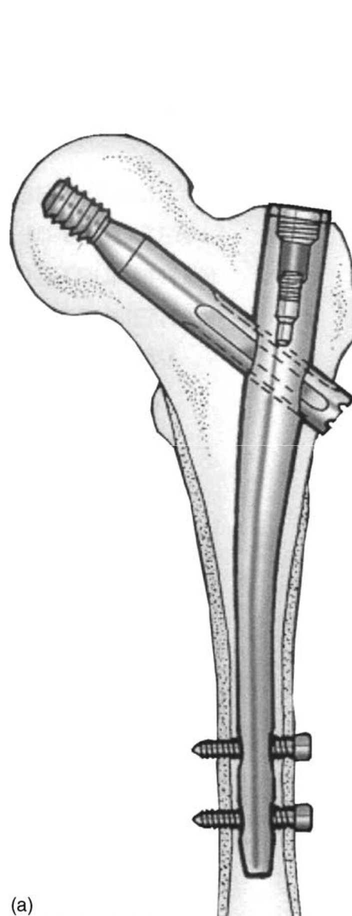


Figure 2. Classification of trochanteric fractures according to Evans.

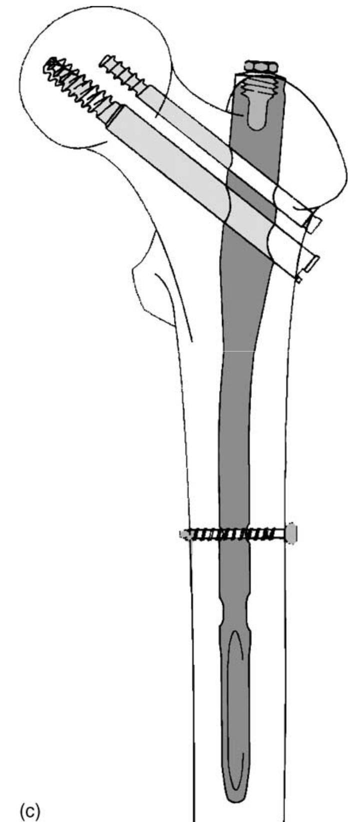
What about Biomechanics then?





(a)

(b)



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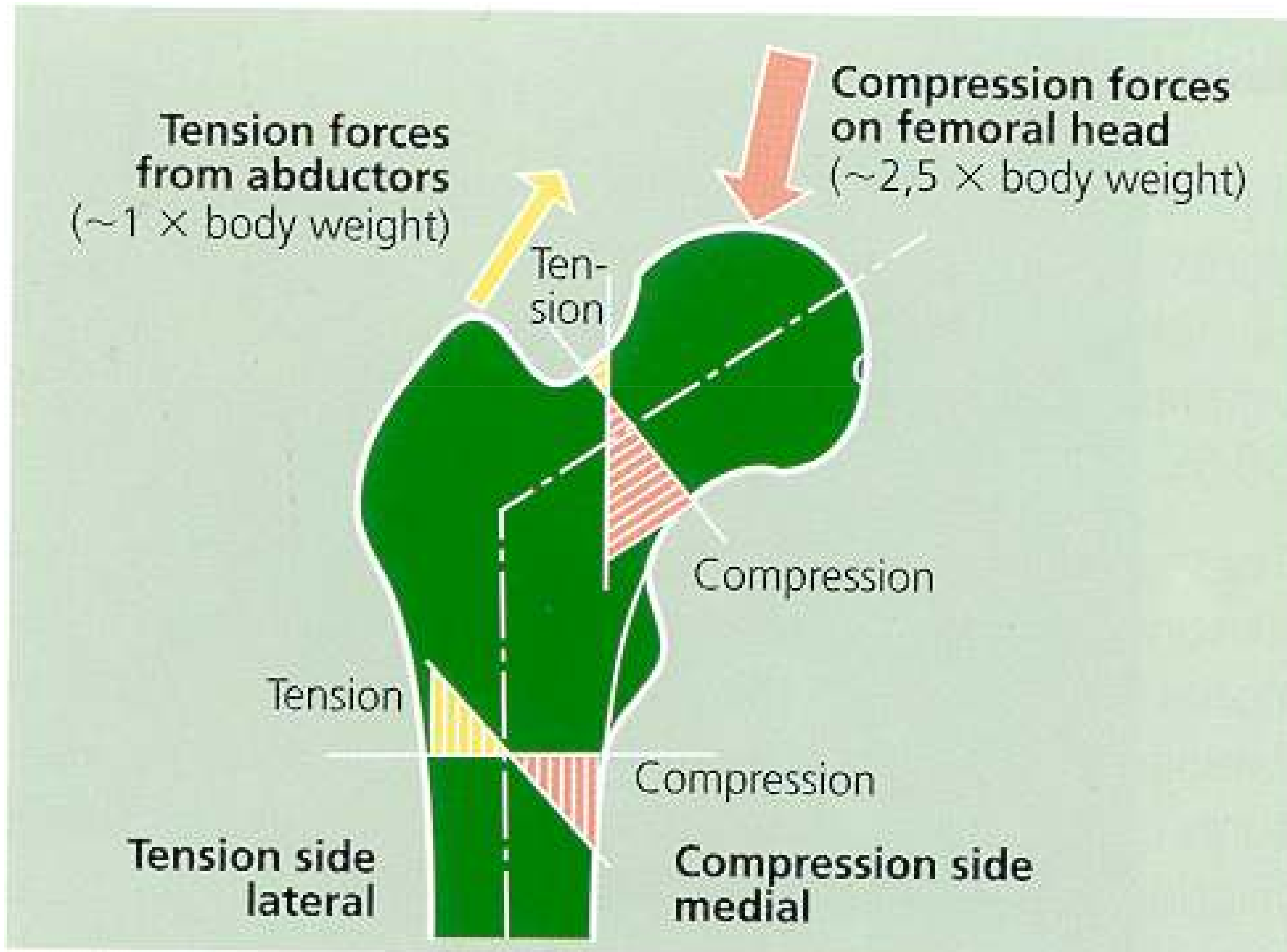
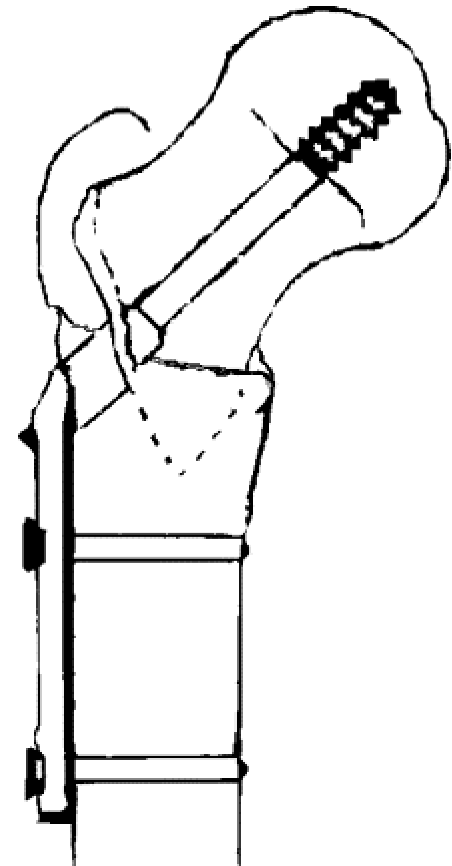
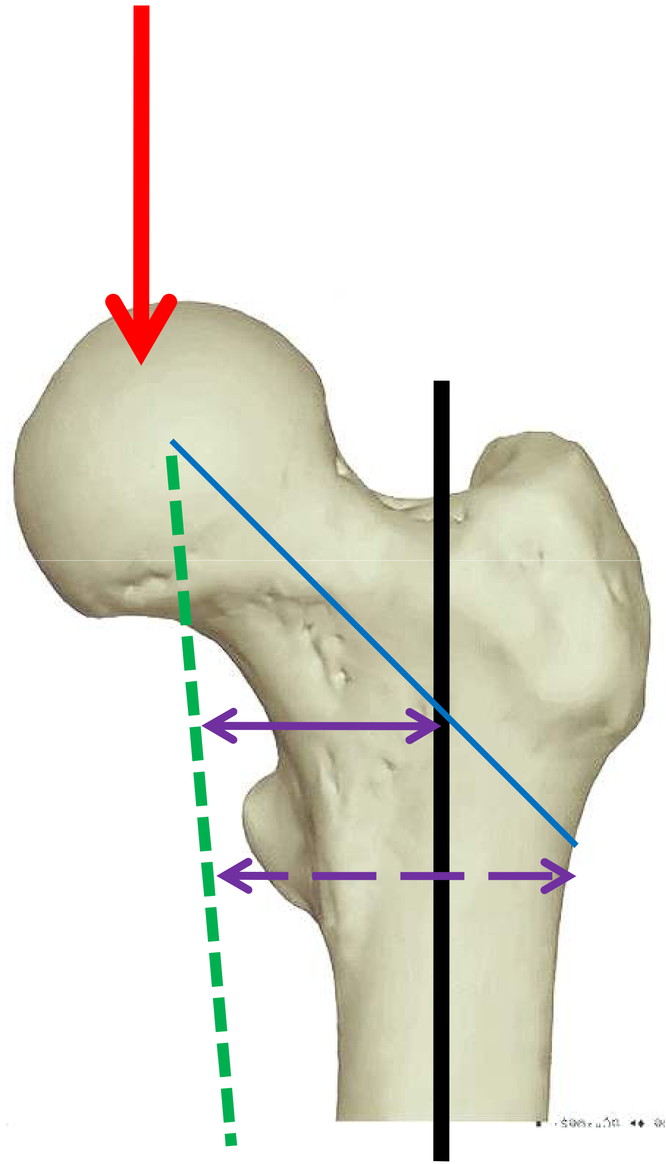

Compression forces
on femoral head
(~2,5 × body weight)
Tension forces
from abductors
(~1 × body weight)
Ten-
sion
Compression
Tension
Compression
Tension side
lateral
Compression side
medial

Medialising the Femur

- Reduces the bending moment on the cephalic screw
- Enables compression at the fracture site by resecting comminution
- Assoc with shortening, malrotation, gluteal weakness
- Longer procedure, more blood loss, higher incidence of wound problems, not translated into a better clinical outcome

A. Desjardins, A. Roy, G. Paiement *et al.*, Unstable intertrochanteric fracture of the femur. A prospective randomised study comparing anatomical reduction and medial displacement osteotomy. *J. Bone Joint Surg. Br.* **75** (1993), pp. 445–447





Advantages

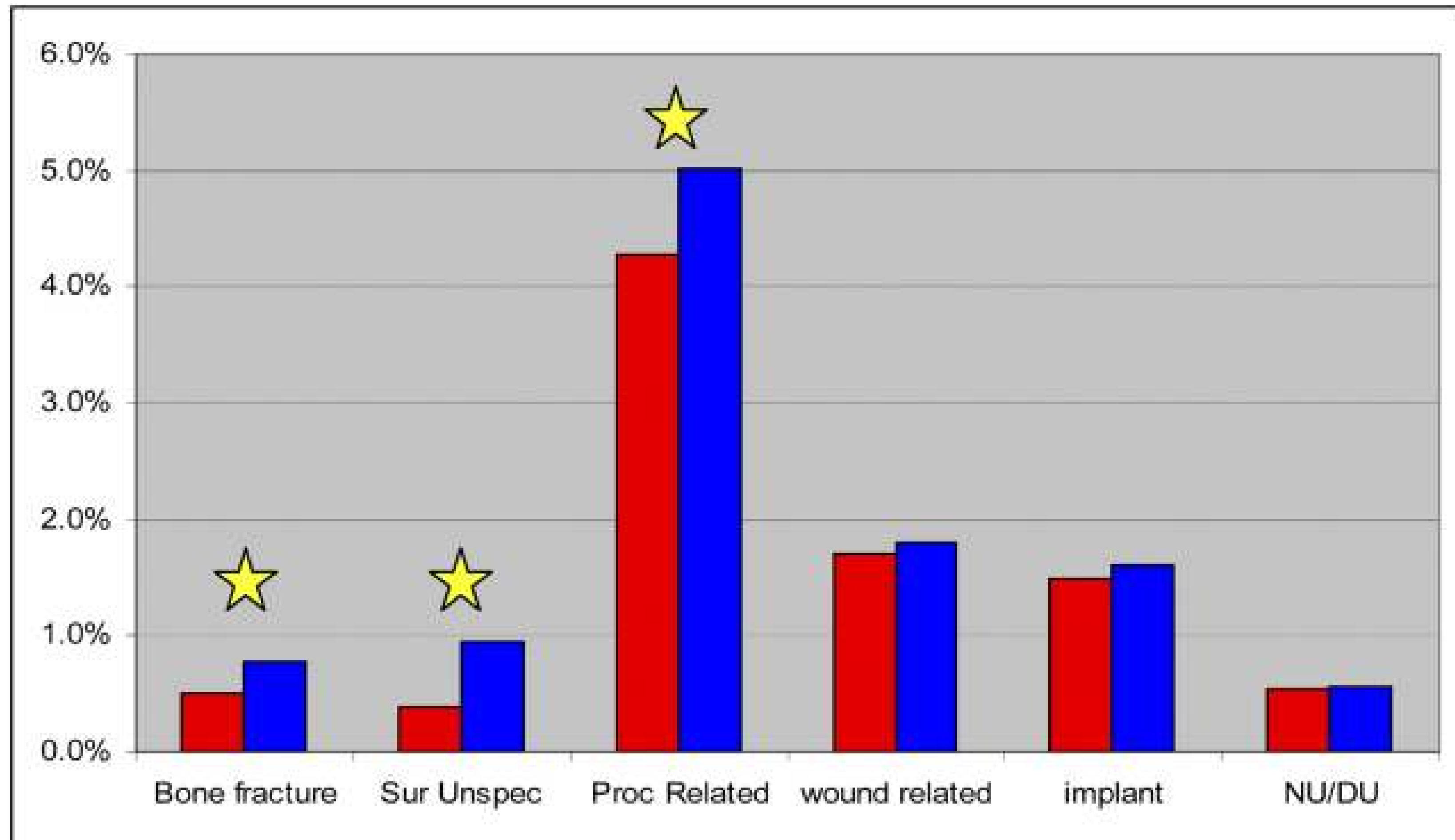
- shifts the moment of inertia medially
- greater calcar load sharing
- short lever arm decreases the bending moment
- sliding screw allows for controlled compression
- Decreased fracture exposure may contribute to healing
- “minimally invasive”
- Treatment of choice for reverse obliquity

Disadvantages

- ? Technically more difficult
- Learning curve
- Higher incidence of distal fracture with short nails may offset advantage of jigged distal locking
- Only minimally invasive if adequate closed reduction can be achieved
- Not translated into real world clinical benefit
- Cost

- in vitro weight bearing capacity and implant stability of the DHS, Gamma Nail and the PFN tested
  - in unstable trochanteric fractures,
  - using static and dynamic loading.
- when perfectly inserted, intramedullary implants
  - enable immediate postoperative and uncompromised mobilisation
  - full weight bearing conditions

Fig. 3 Bar graph illustrating the complication rates for patients managed with a compression hip screw device (red bars) and patients managed with an intramedullary nail (blue bars)



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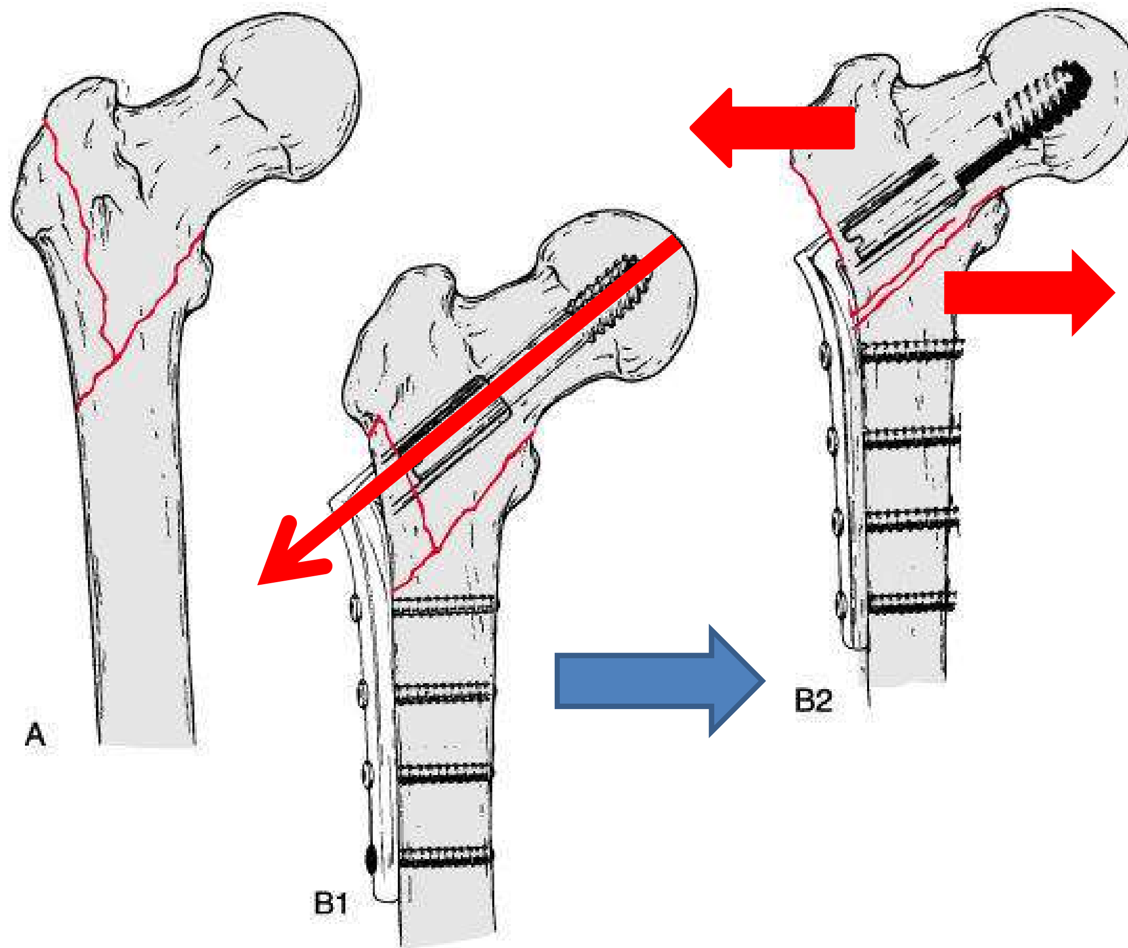
Procedure-Related Complication Subgroup	Wound-Related Complication Subgroup
Hemorrhage	Hemorrhage
Infection	Infection
Wound dehiscence	Dehiscence
Bone fracture	
Implant failure/fracture	
Nonunion/delayed union	
Surgical procedure intervention	
Surgical unspecified	

Reverse Obliquity fractures

- Unique set of problems
- Sliding hip screw do not compress the fracture predictably
- Biology of the fracture is different

What happens with a sliding hip screw?



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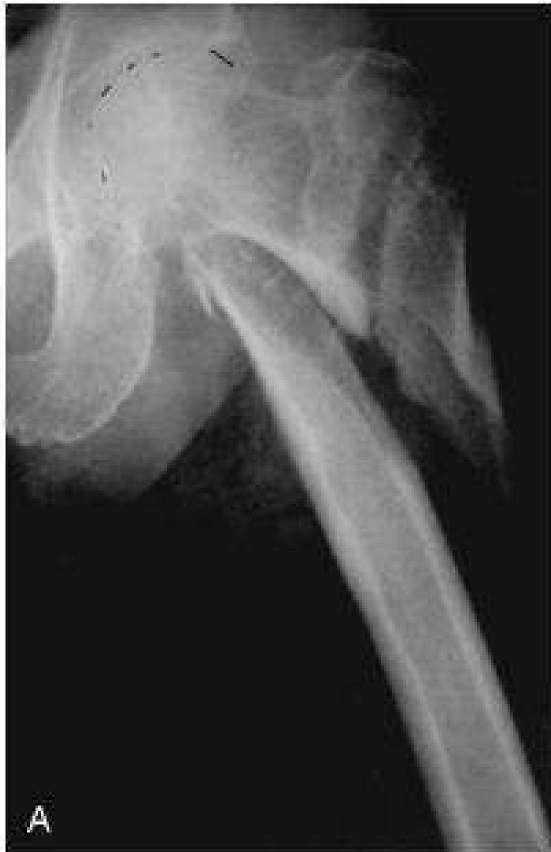

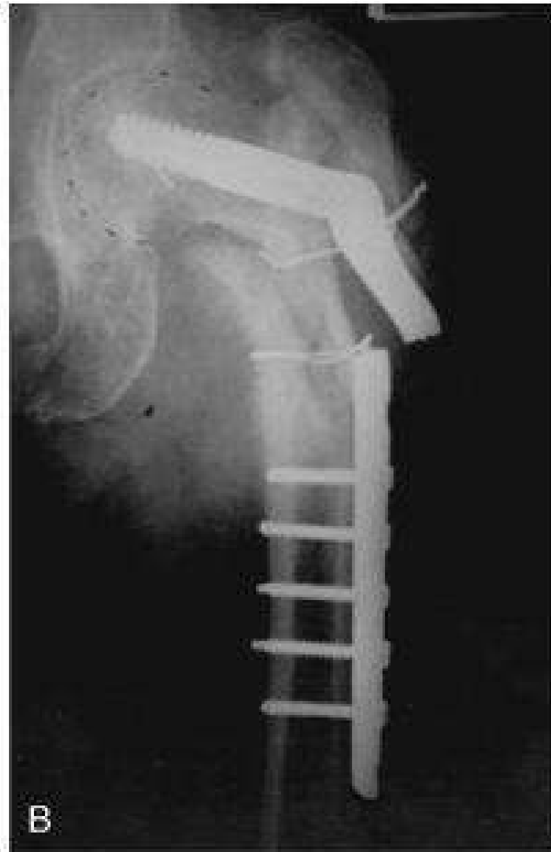

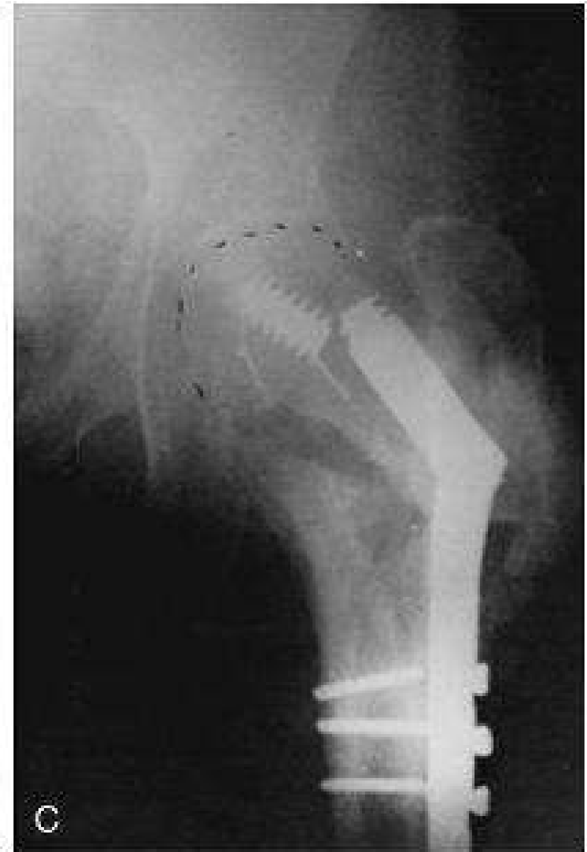

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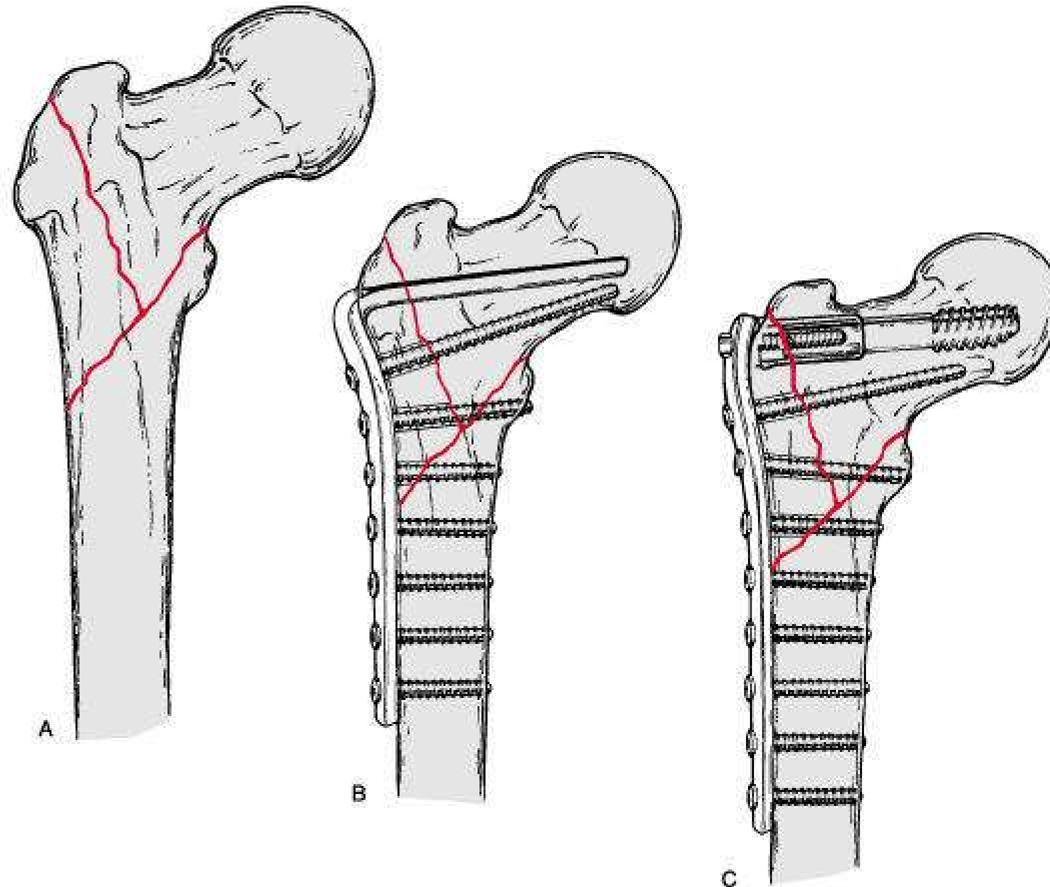
Extramedullary options for reverse obliquity



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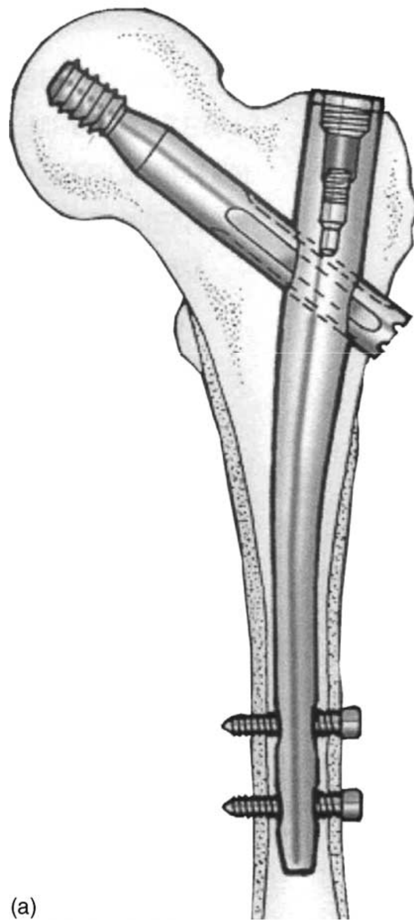
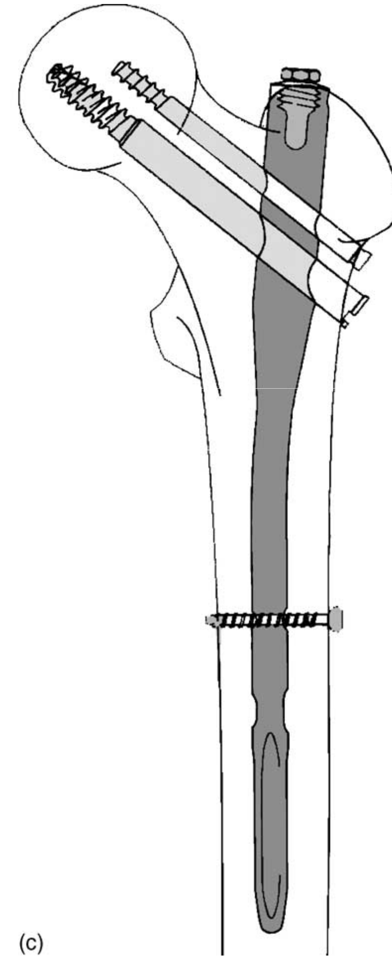
Intramedullary options


(a)

(b)


(c)

The Journal of TRAUMA® Injury, Infection, and Critical Care

Proximal Femoral Nail for the Treatment of Reverse Obliquity Intertrochanteric Fractures Compared With Gamma Nail

Woo-Kie Min, MD, Shin-Yoon Kim, MD, Tae-Kong Kim, MD, Kyu-Bong Lee, MD, Myung-Rae Cho, MD, Yong-Chan Ha, MD, and Kyung-Hoi Koo, MD

Table 2 Comparison of Various Factors

	PFN Group	GN Group	*p*
Age (yr)	67 (46–79)	65 (37–70)	>0.05
Male:female	5:6	6:5	>0.05
Presurgical stay (d)	3 (1–7)	3 (1–7)	>0.05
Operation time (min)	55 (45–75)	60 (40–82)	>0.05
Blood transfusion (No)	3	5	>0.05
TAD (mm)	27.2	29.6	>0.05
Union time (wk)	16.5 (12–40)	17.9 (12–43)	>0.05
Sliding of lag screw (mm)	2.5 (0–11)	3.1 (1–15)	0.046
Change of NSA (degrees)	2.45 (0–13)	3.75 (1–15)	0.032
BMI (kg/m^2)	25.2 ± 3	24.6 ± 2.9	>0.05
BMD (g/cm^2)	0.54 ± 0.09	0.58 ± 0.14	>0.05
Hospital stay (d)	13 ± 4	18 ± 7	0.028
Charlson score	26.4	24.9	>0.05
SWS (No. excellent + good, preoperative)	0	0	>0.05
SWS (No. excellent + good, follow-up)	8	8	>0.05
No. complication	1	3	>0.05

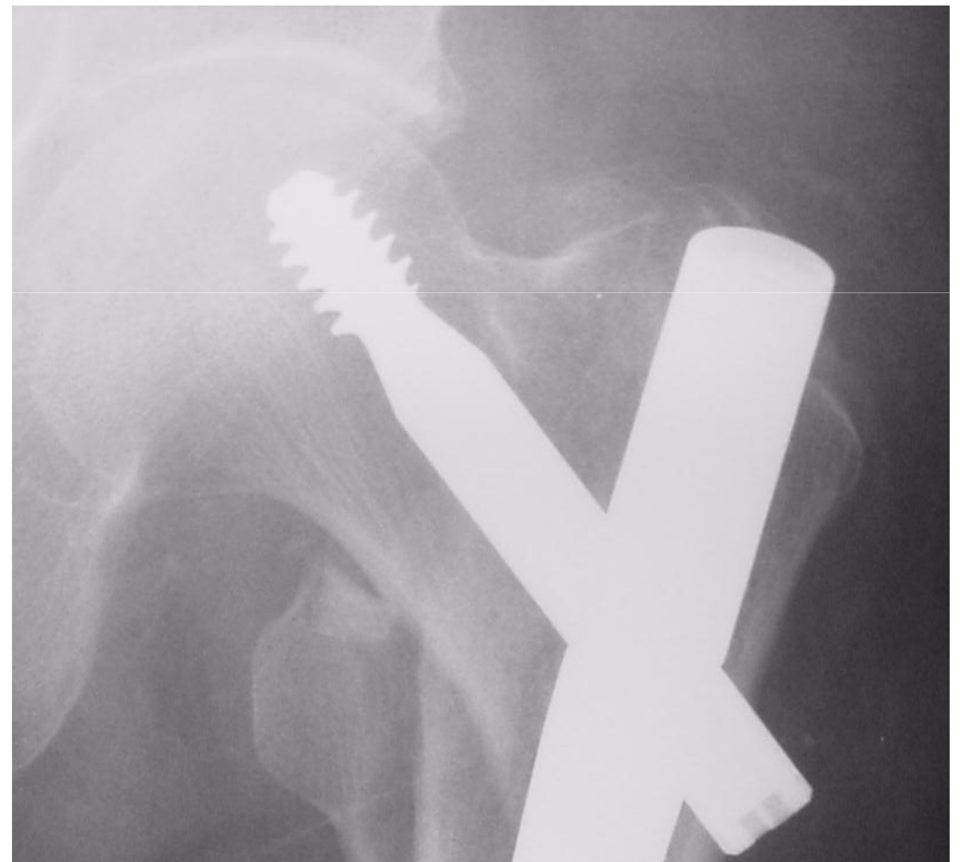
PFN, proximal femoral nail; GN, gamma nail; TAD, Tip apex distance; NSA, neck-shaft angle; BMD, bone mineral density; SWS, Salvati and Wilson score system; BMI, body mass index.

Min: J Trauma, Volume 63(5).November 2007.1054-1060

Complications

Intraoperative:

- Reduction
- hip screw position
- blood loss
- shaft fracture
- surgical time



Complications

Postoperative:

- hip screw cutout
- infection
- femoral shaft #
- deformity

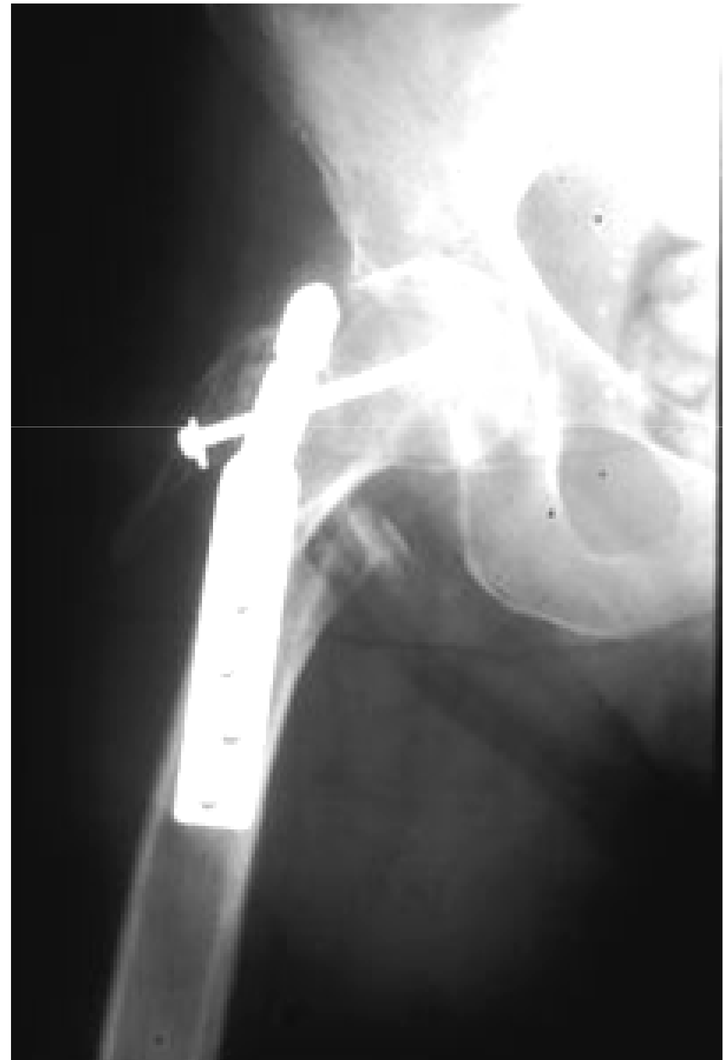
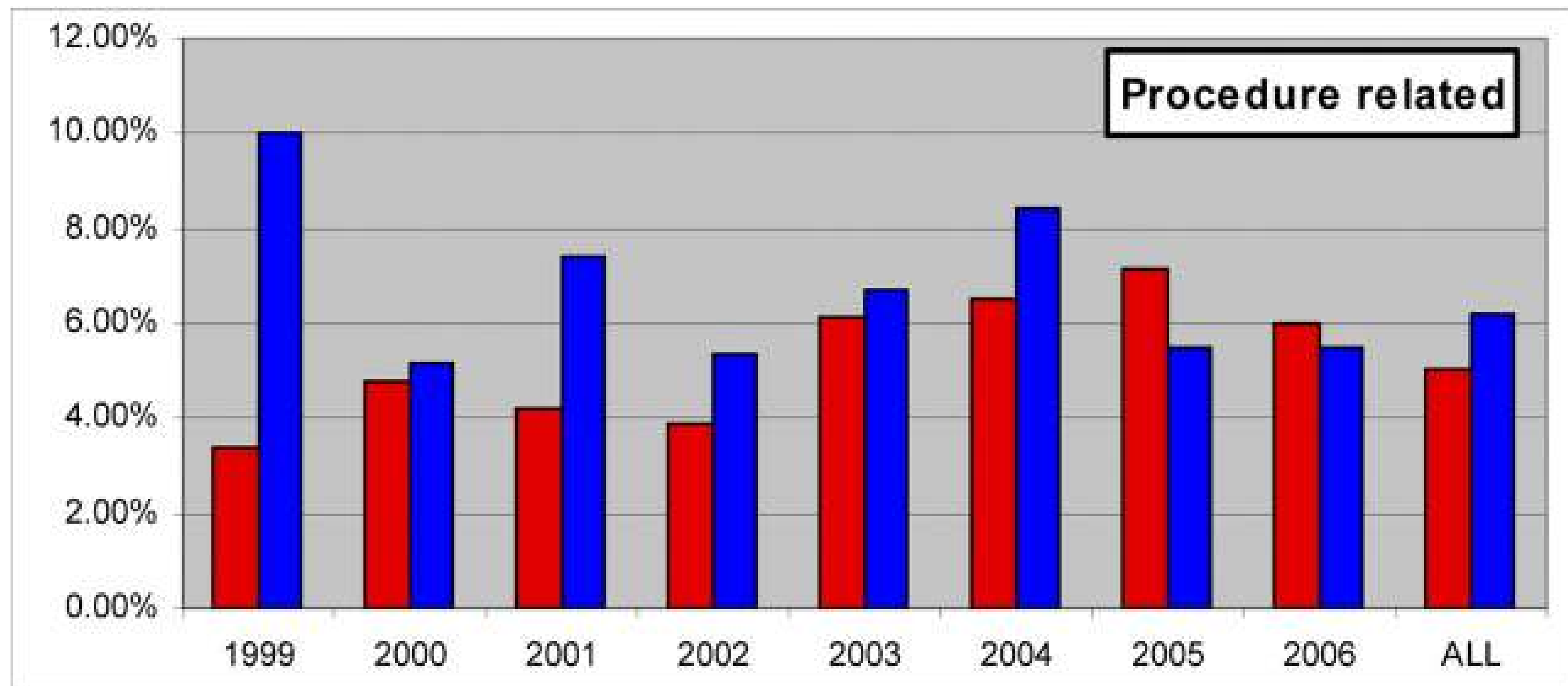


Fig. 4-A Fig. 4-B Bar graphs illustrating the time-course of the rates of bone fracture (Fig. 4-A) and procedure-related complications (Fig. 4-B) over the period of 1999 to 2006 for patients managed with a plate (red bars) and patients managed with an intramedullary nail (blue bars).



on Behalf of the American Board of Orthopaedic Surgery Research Committee J Bone Joint Surg 2008;90:700-707

JB&JS

INTERTROCHANTERIC FEMORAL FRACTURES

MECHANICAL FAILURE AFTER INTERNAL FIXATION

T. R. C. DAVIS, J. L. SHER, A. HORSMAN, M. SIMPSON, B. B. PORTER, R. G. CHECKETTS

From Dryburn Hospital, Durham, Sunderland District General Hospital and The General Infirmary, Leeds

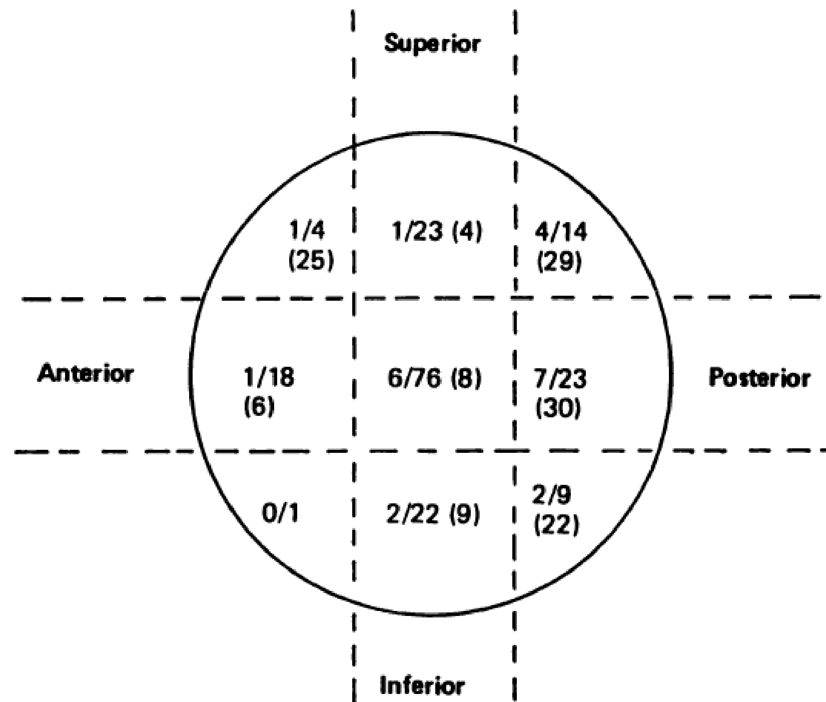


Fig. 6

The frequency of cutting-out in relation to the position of the implant in the femoral head, excluding 2-part fractures. Percentages are given in parentheses.

JBJS Br 1990 Jan;72(1):26-31

CUTTING-OUT OF THE DYNAMIC HIP SCREW RELATED TO ITS POSITION

MARTYN J. PARKER

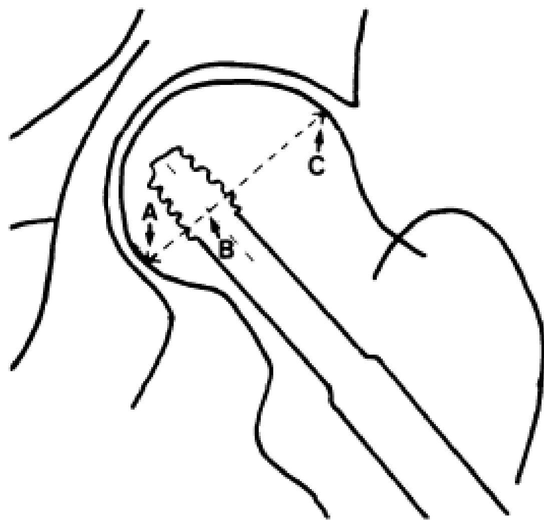


Fig. 1

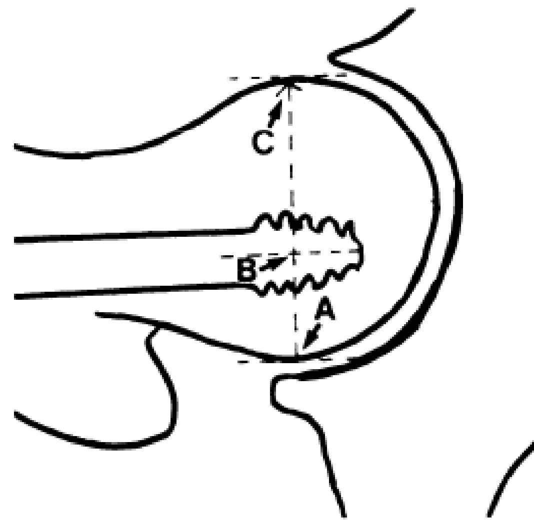


Fig. 2

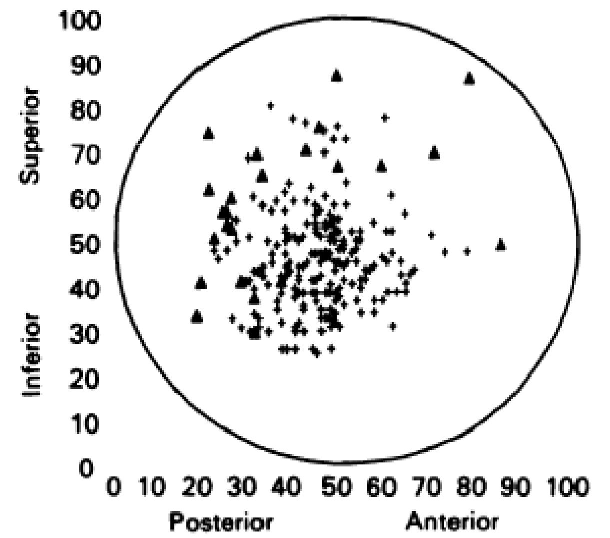
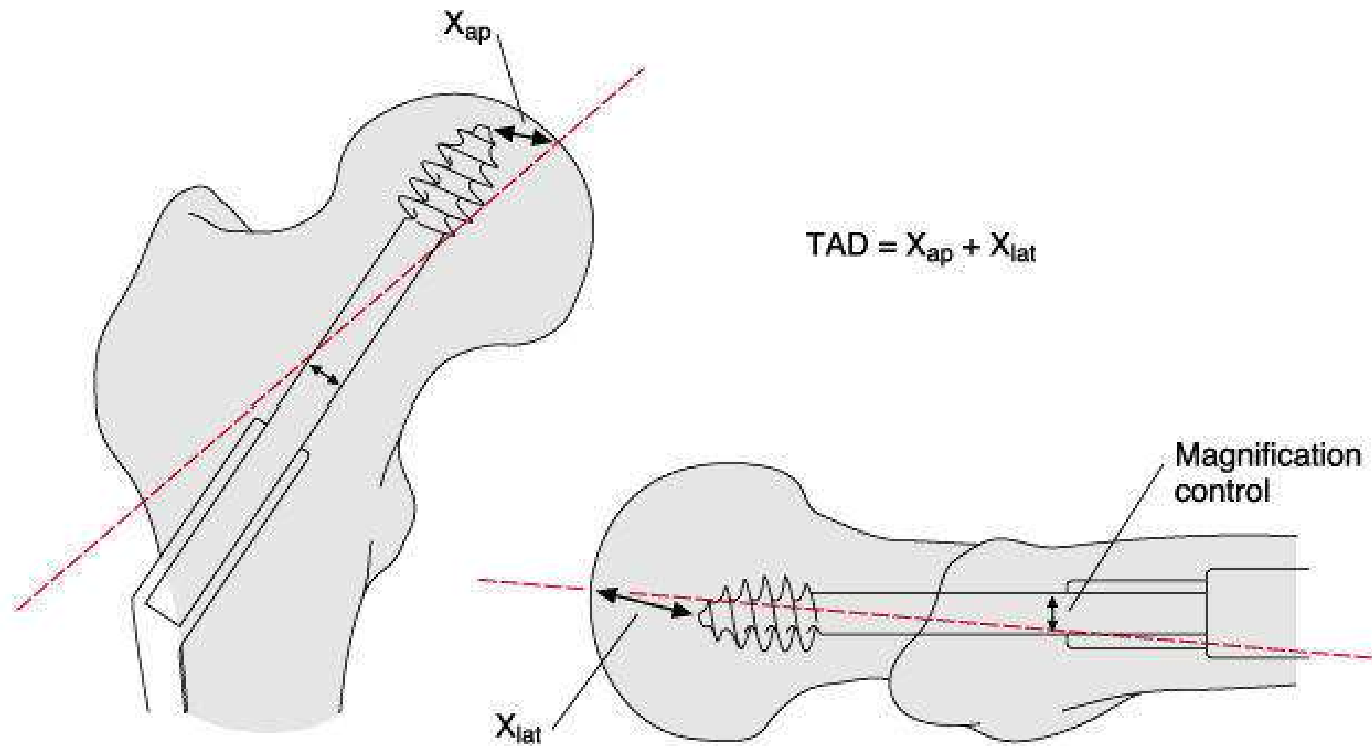


Fig. 3

J Bone Joint Surg Br. 1992 Jul;74(4):625

Tip-Apex Distance



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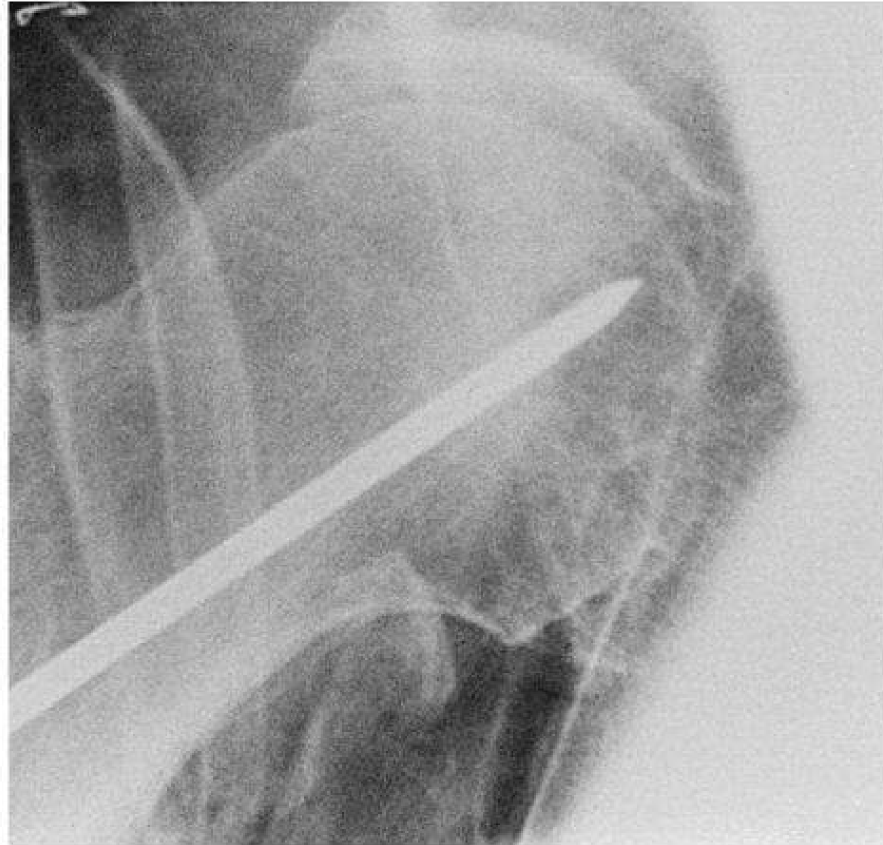
Baumgaertner, M.R.; Solberg, B.D. Awareness of tip-apex distance reduces failure of fixation of trochanteric fractures of the hip. J Bone Joint Surg Am 79:969–971, 1997



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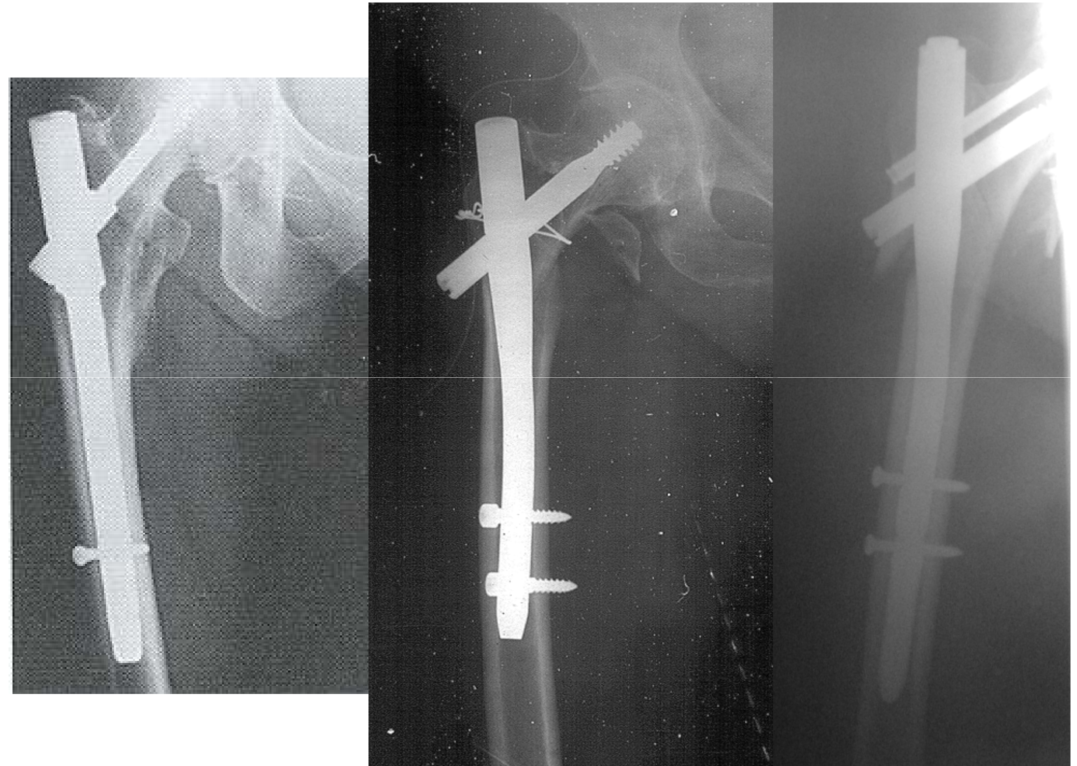
Preventing Cut-Out

- Cut out rates were similar for nails and sliding hip screws
- Quality of reduction was the most important factor in being able to position the screw in the centre

Preventing Distal fracture

- Most common in Gamma nail
- Lateral entry point with point loading distally and laterally leading to a stress riser
- More recent modifications have not been taken into account in previous reviews



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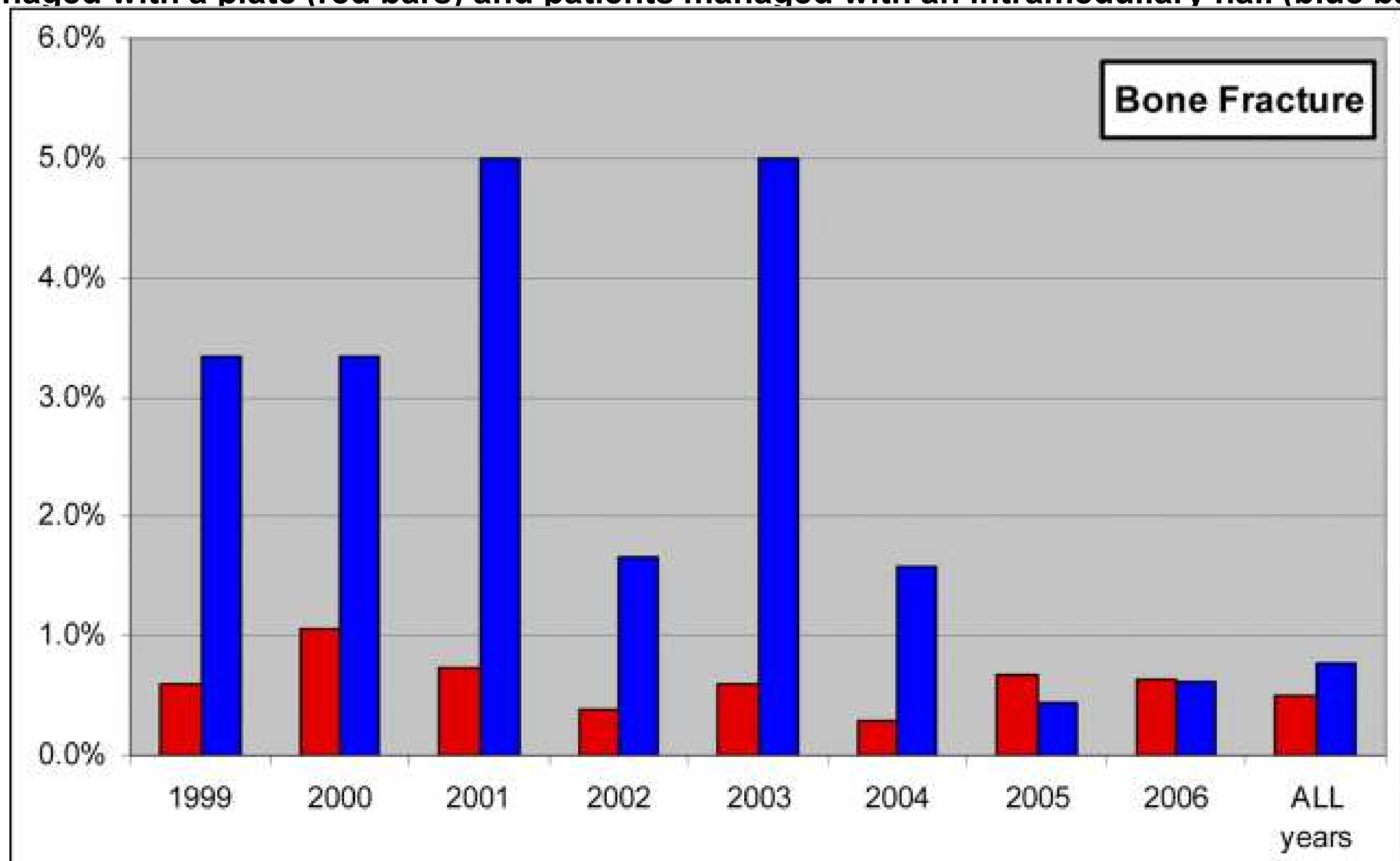

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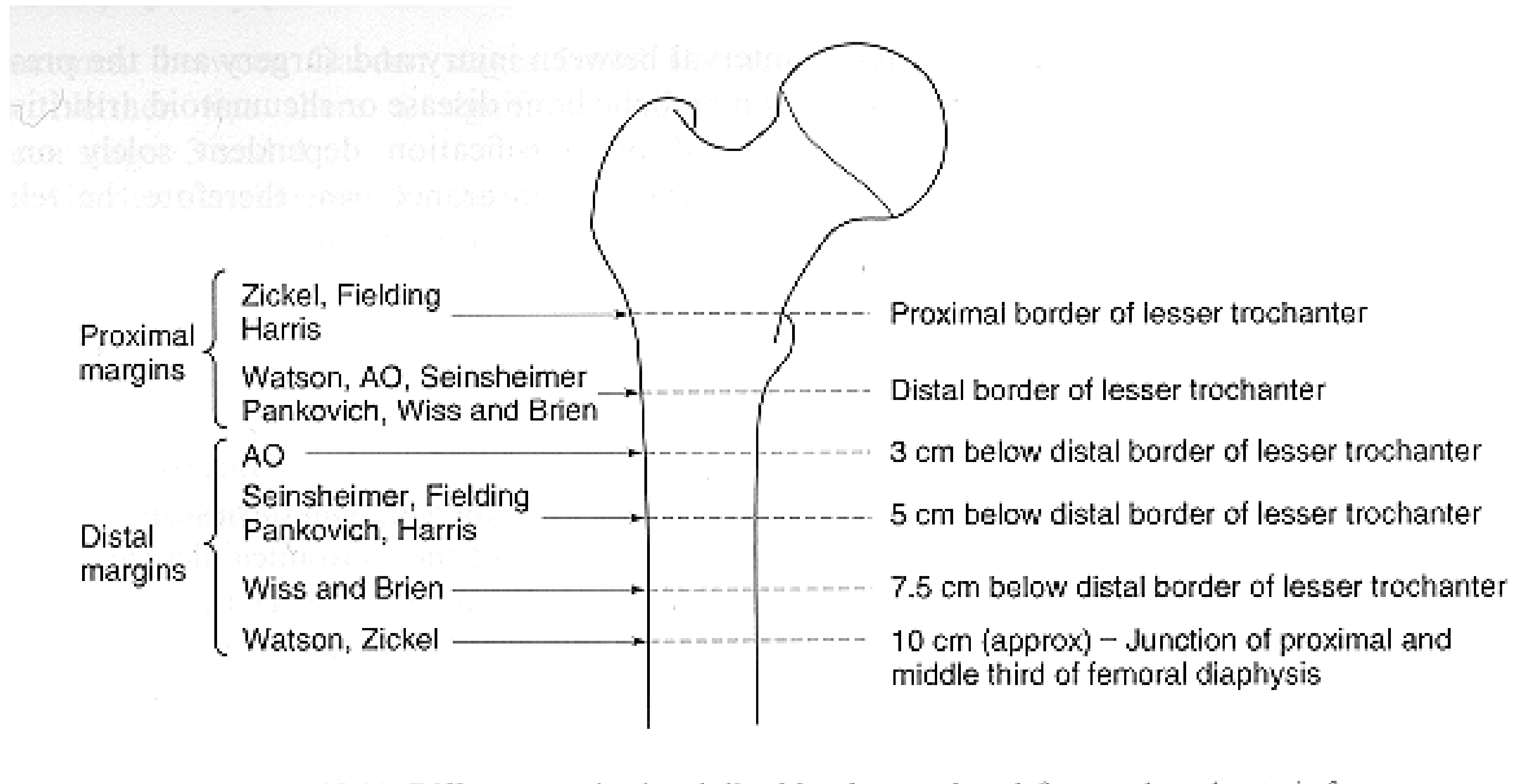
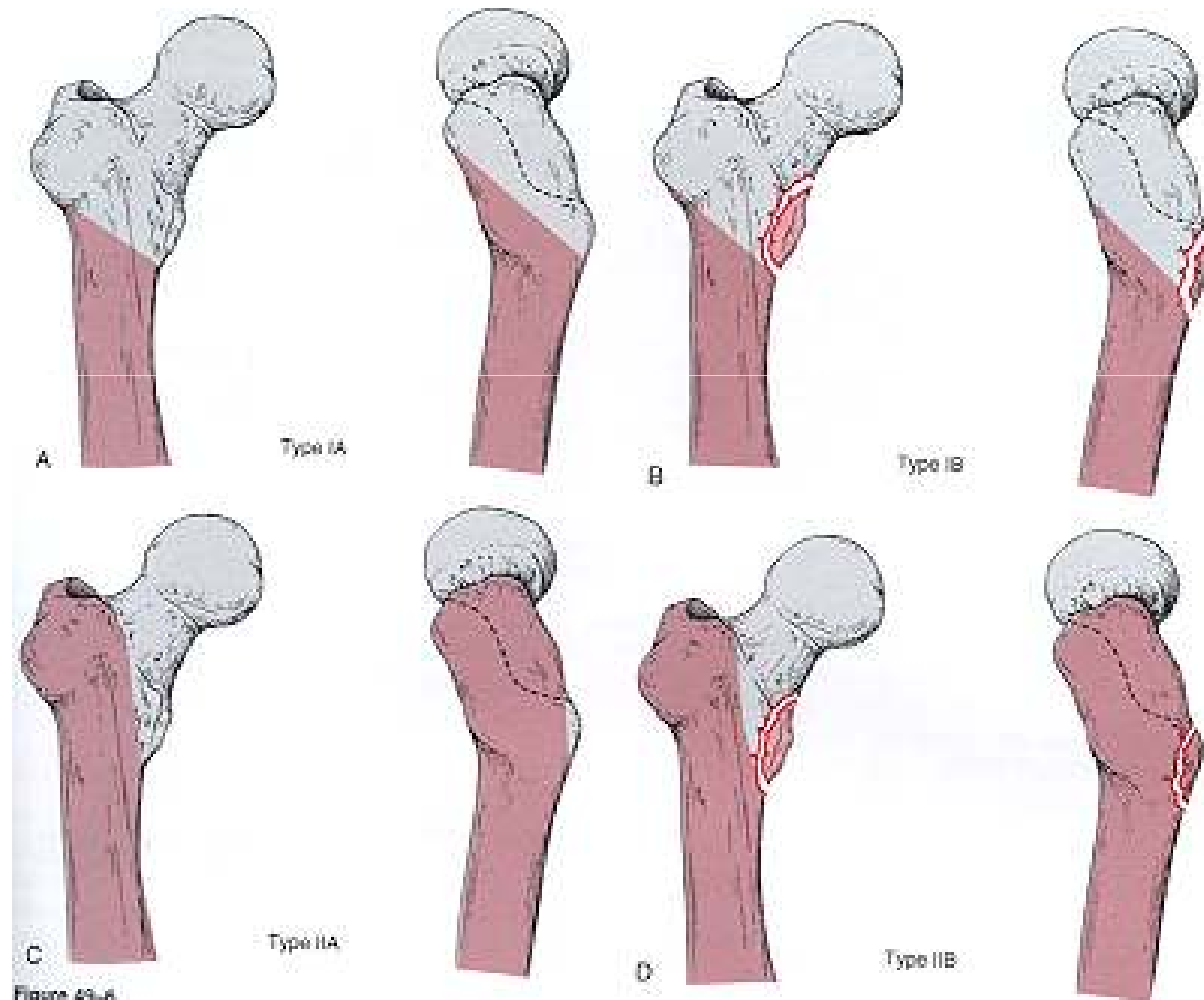
The Subtrochanteric region



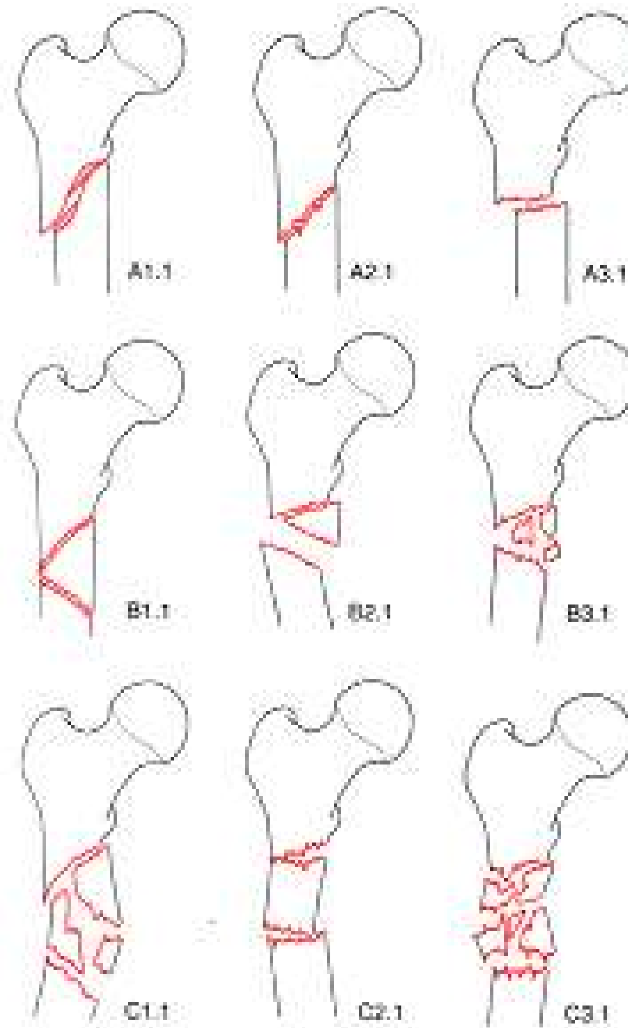
Classification

- Boyd & Griffin, 1949
- Fielding, 1966 Historical
- Zickel, 1976
- Seinsheimer, 1978
- Russell Taylor, 1986 Guide for nailing
- AO (Müller), 1990

Russell-Taylor Classification



AO Classification



CLOSED SUBTROCHANTERIC FRACTURES
OPERATIVE CANDIDATE
NO PREEXISTING DEFORMITY
(HIP OR SHAFT)

RADIOGRAPHIC STUDIES
LATERAL RADIOGRAPH:
CORONAL FRACTURE LINE
INTO PIRIFORMIS FOSSA?

NO

AP radiograph:
lesser trochanter intact
(no medial comminution)

YES

Type IA
Subtrochanteric Fracture

Static-interlocked IM nail.
Screws proximal to fracture.
Cephalomedullary nail OK.

NO

Type IB
Subtrochanteric Fracture

Static-interlocked
cephalomedullary
(reconstruction) nail.

YES

AP radiograph:
lesser trochanter intact
(no medial comminution)

NO

Type IIA
Subtrochanteric Fracture

Special plate or
static-interlocked
trochanteric-entry IM nail;
indirect reduction.

YES

Type IIB
Subtrochanteric Fracture

95° screw or blade-plate,
other special plate (Medoff,
trochanteric extension, etc.),
or static-interlocked
trochanteric-entry
cephalomedullary (reconstruction)
IM nail; indirect reduction.

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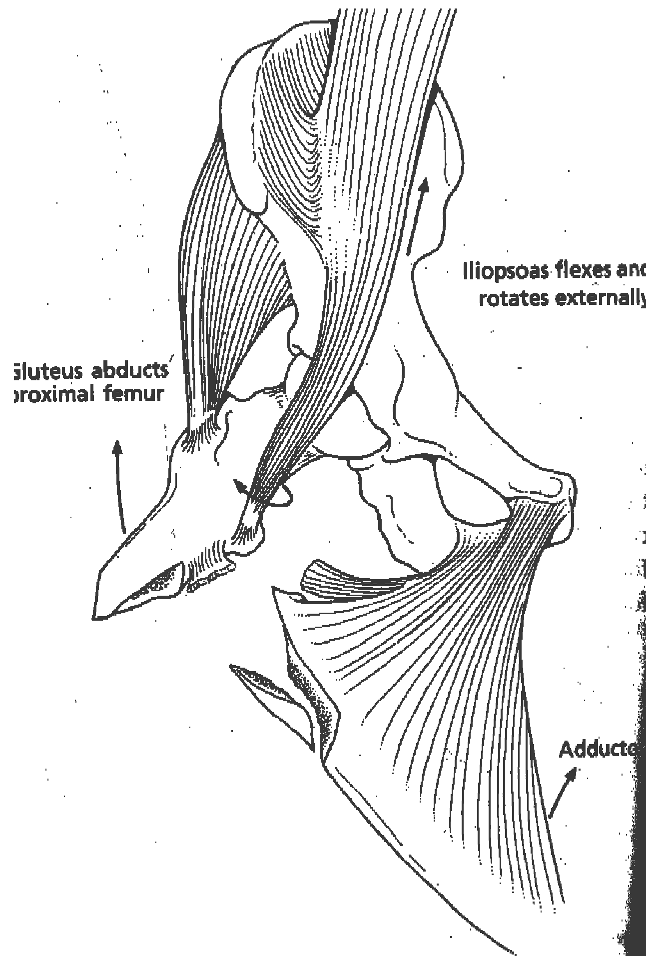
Incidence

- 10-34% of all hip fractures
- Bimodal distribution
- About 2/3 in pt > 50
- Old- low energy
- Young- High energy
- 10% assoc with GSW in US
- Tumours

Subtrochanteric biomechanics



- Proximal fragment
  - Abductors: gluteus
  - Flexors: psoas
  - External rotators: quadratus, obturators
- Distal fragment
  - Adductors
  - Shortening: hamstrings, quads
  - Froimson 1970

Functional consequences

- Shortening
- Varus femoral neck
- Abductor shortenting
- Abductor lurch

Goals

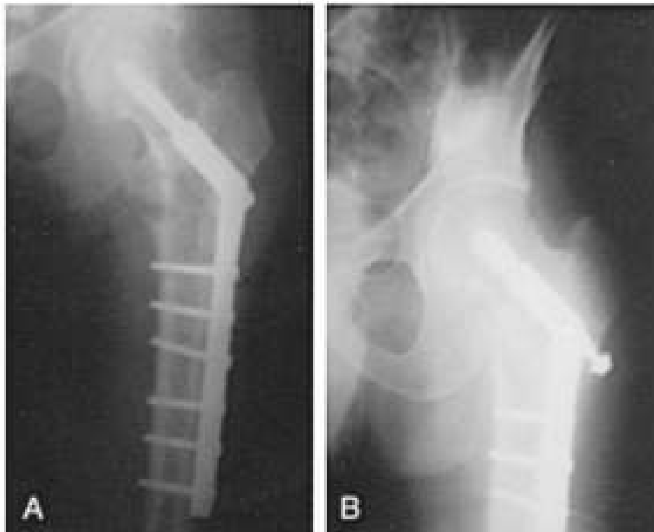
- Restore:
  - Length
  - Rotation
  - Alignment
- Correct varus (most common difficulty/mistake)

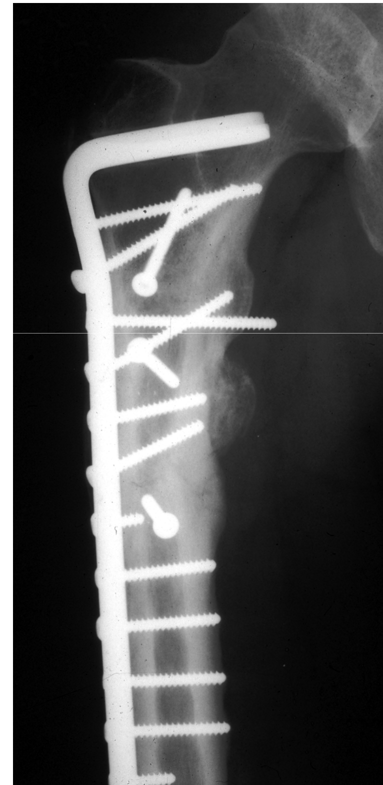
Treatment options

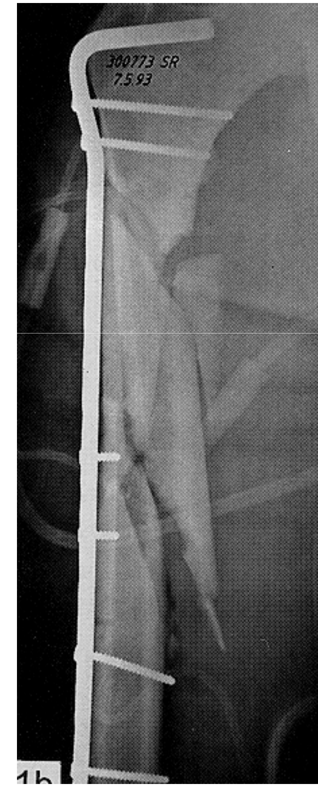
- Conservative
  - 90°/90° traction
- Plates
- Nails

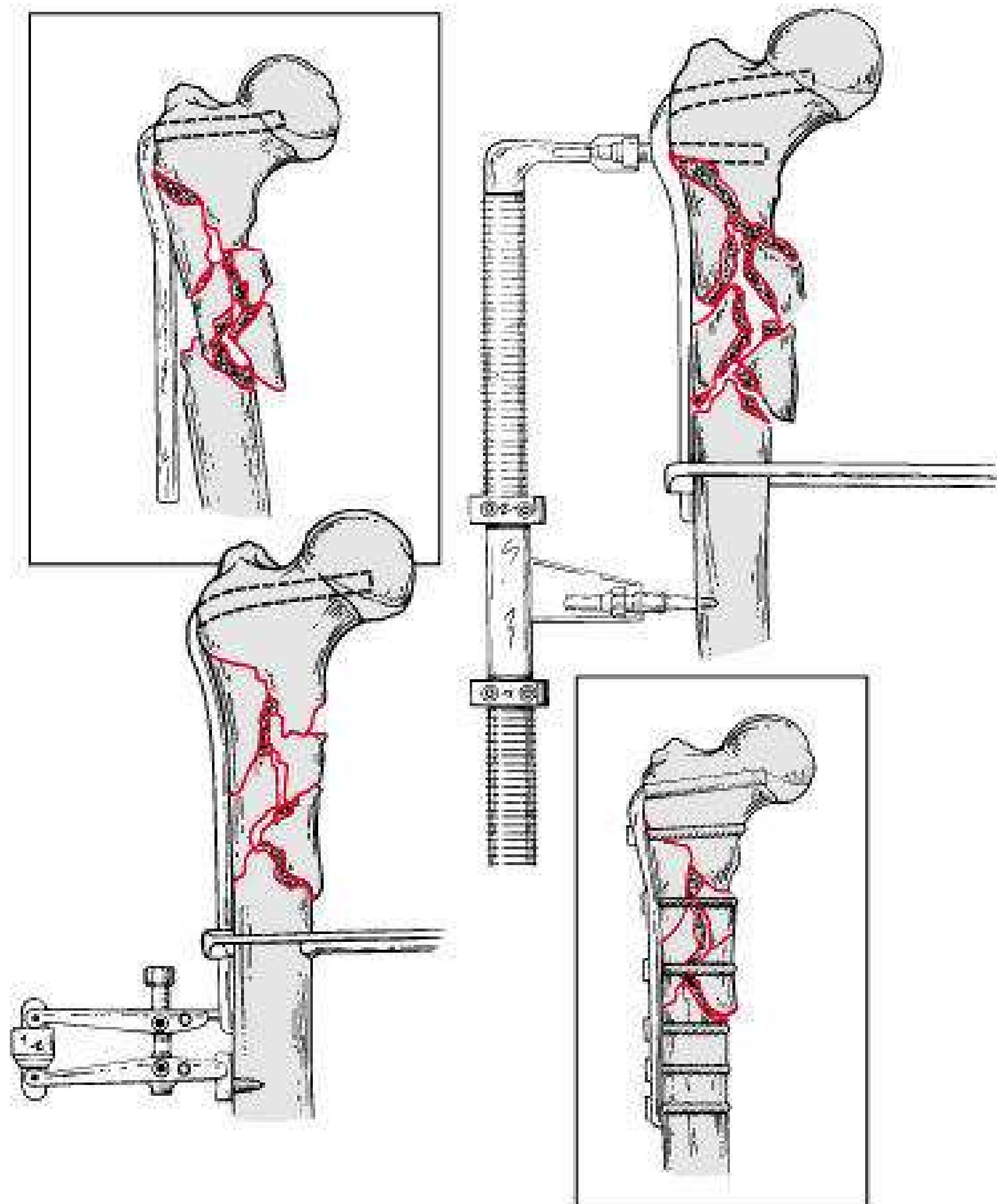
Plate Techniques

- MIPO possible
- Blade or DCS:
  - Direct vision
  - extensive incision
  - rotation/length easier









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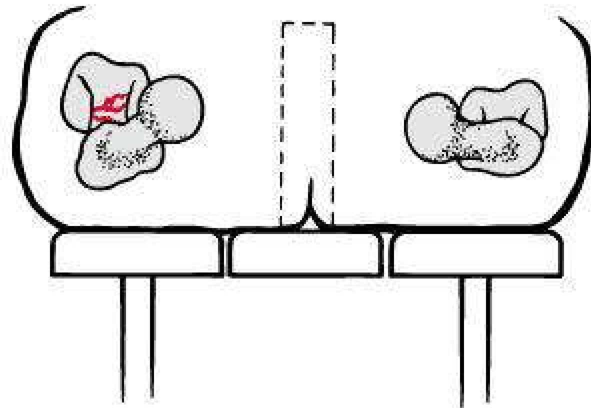
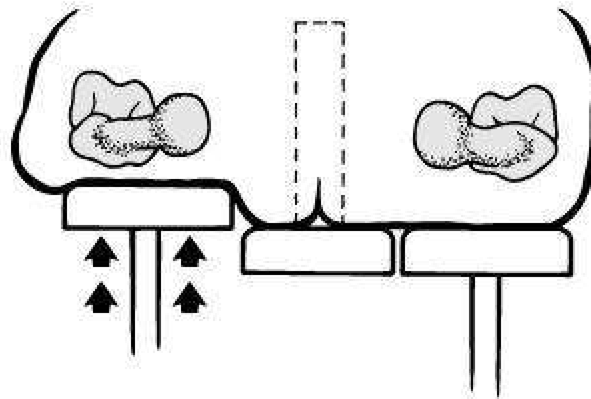
Nail Techniques

- Closed reduction
- Difficult
- Adjuncts needed to get reduction
- 21% complication rate





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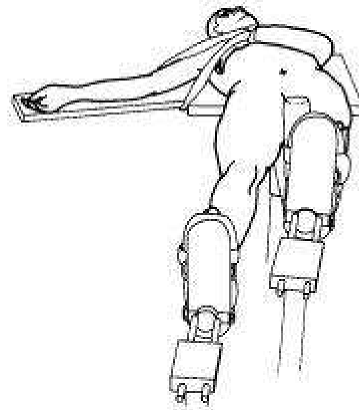

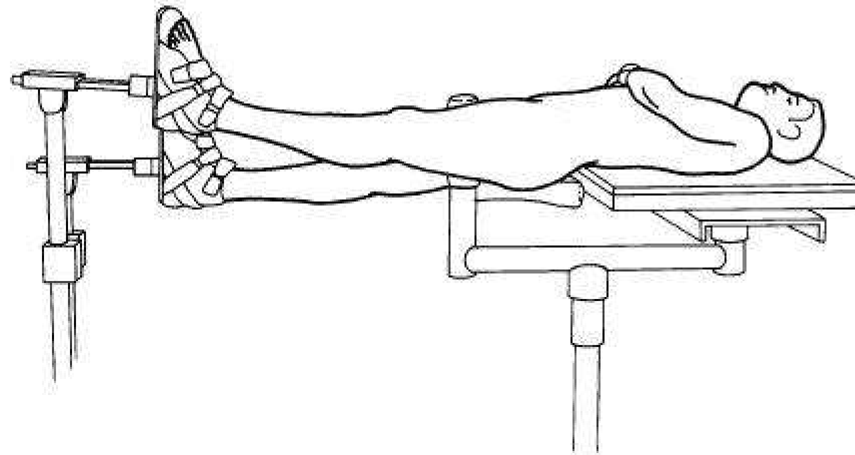

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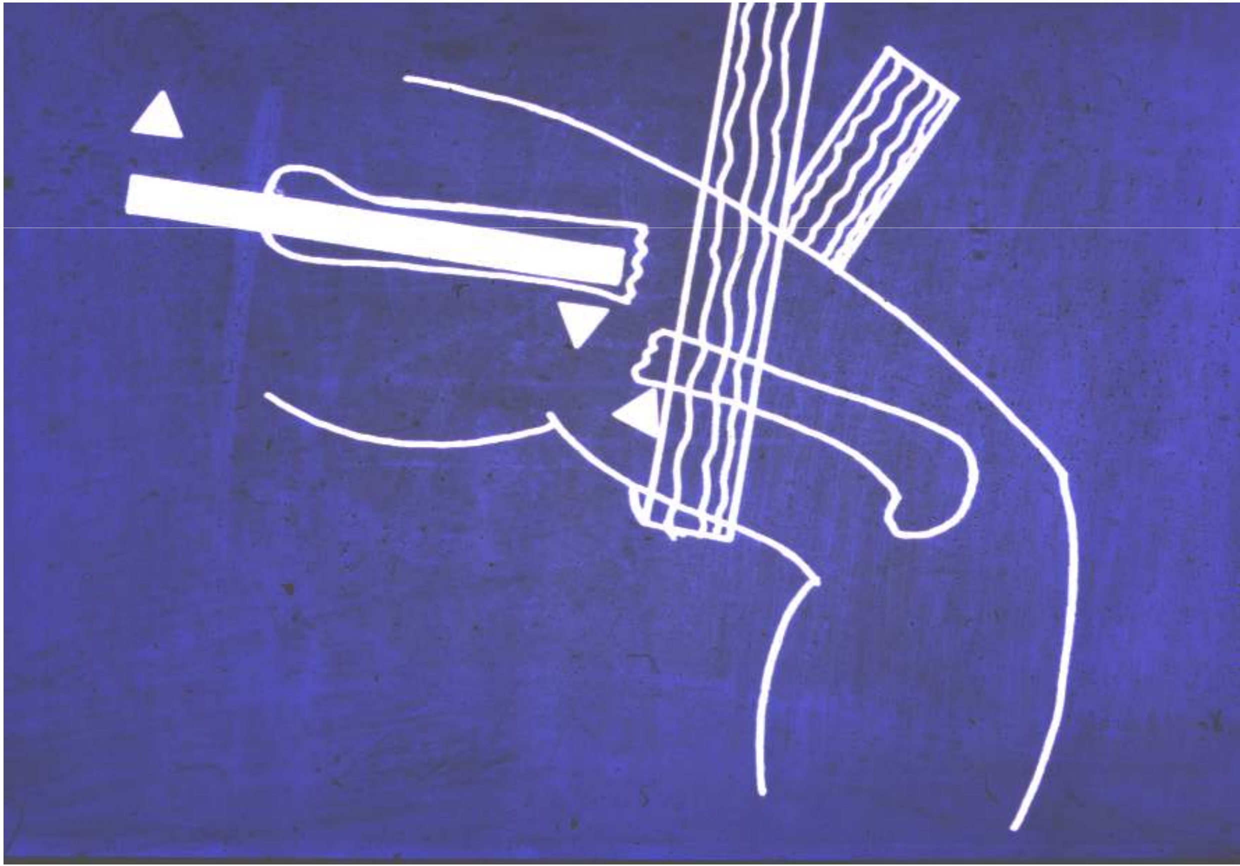
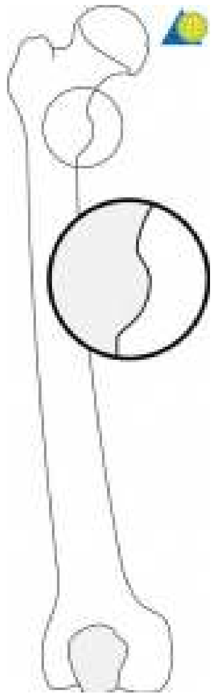
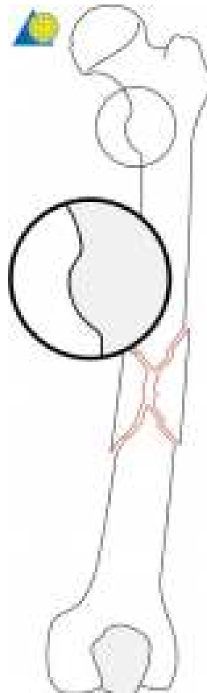
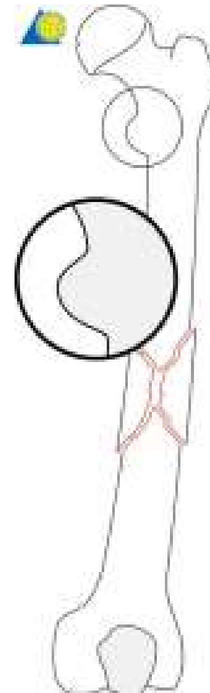
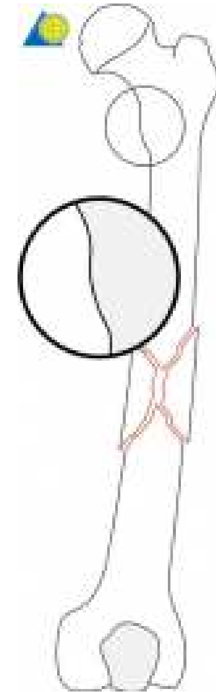
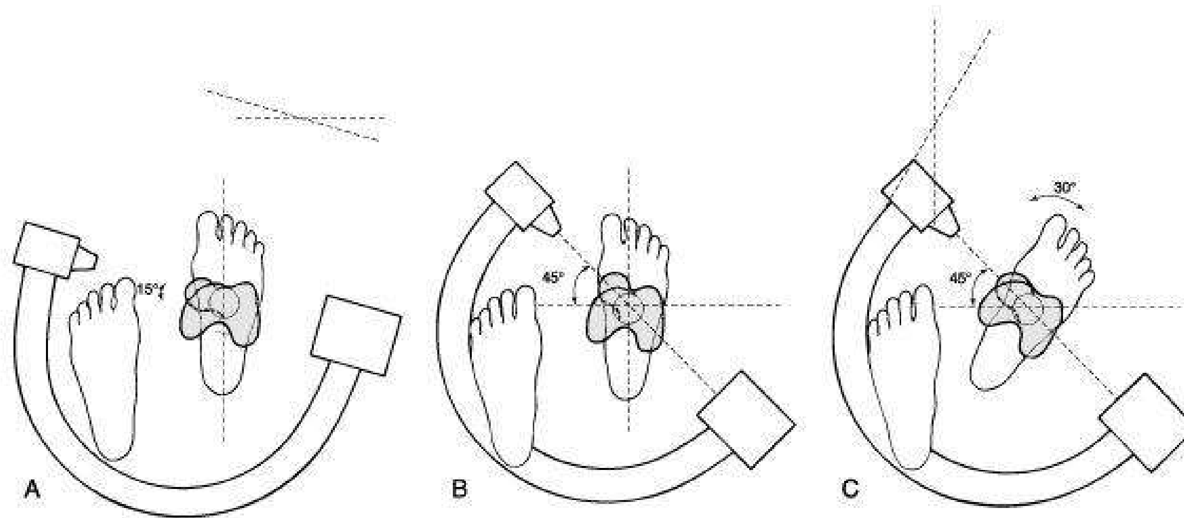


Rotational control

- Contralateral saved on II
- Check Lesser Troch

Rotational control



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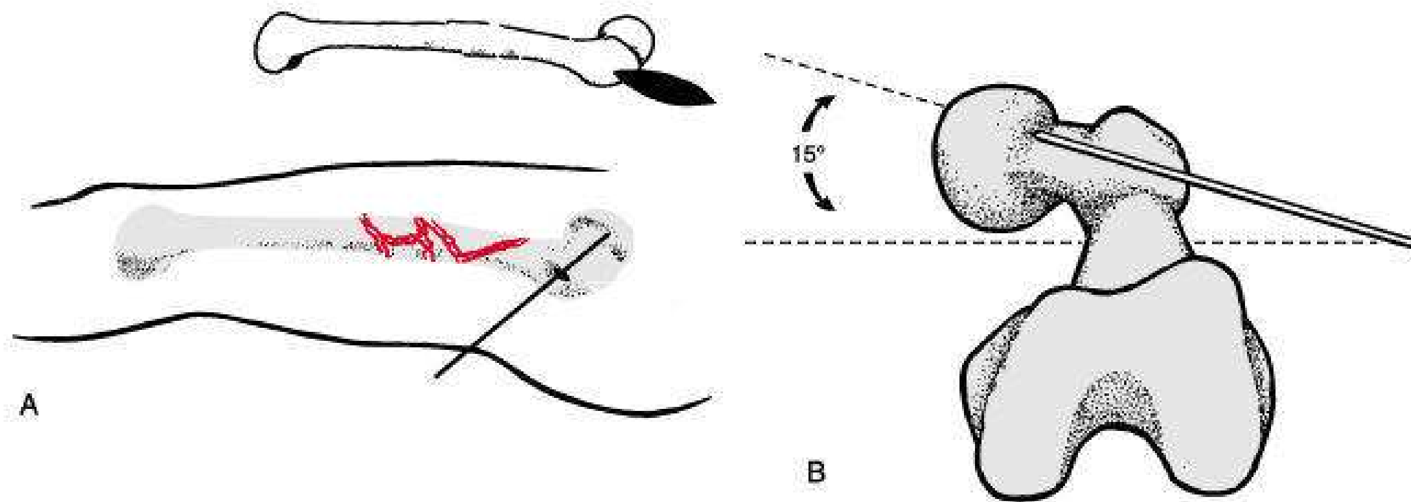
Rotational control



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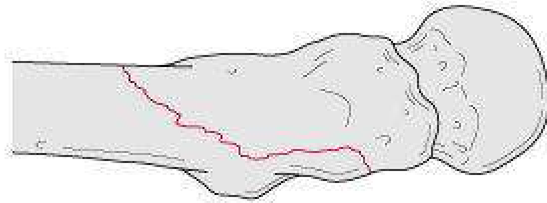
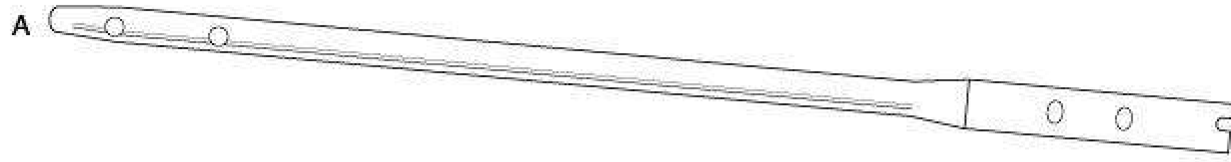
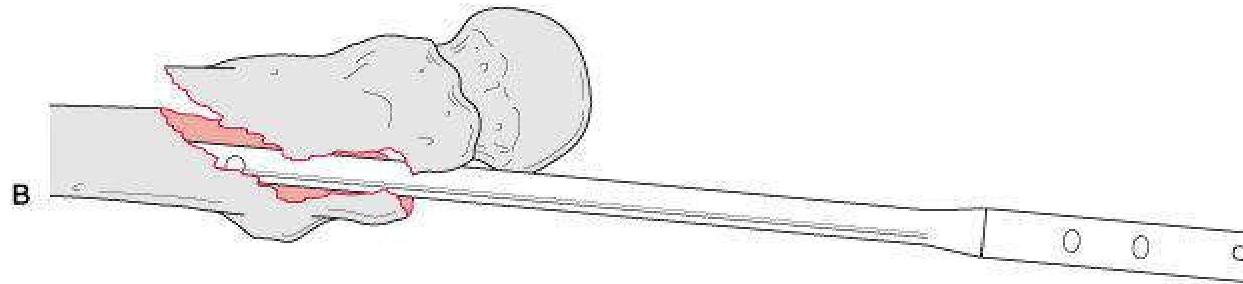
Maintain reduction







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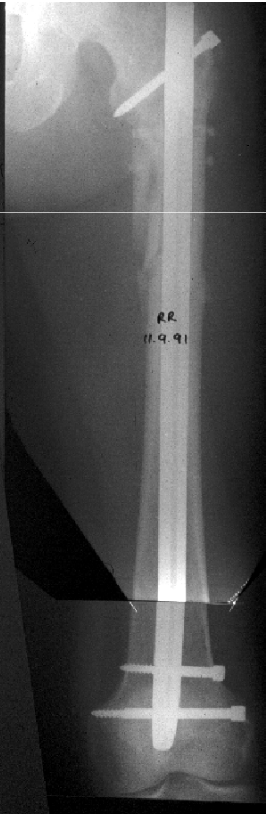
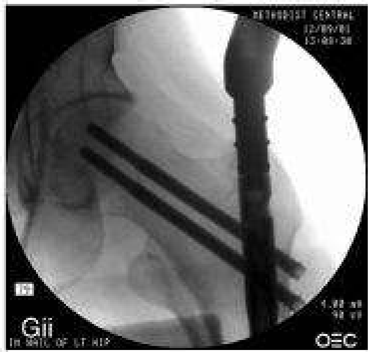
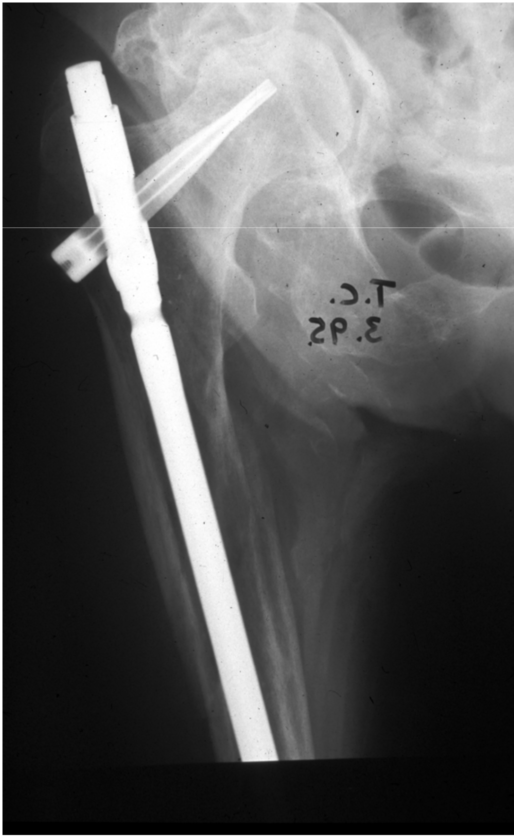
Nail options

Conventional / recon mode





UFN Spiral Blade



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2:297–305, Raven Press, New York
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A Biomechanical Comparison of Various Methods of Stabilization of Subtrochanteric Fractures of the Femur

*A. F. Tencer, †K. D. Johnson, †D. W. C. Johnston, and †K. Gill

*Biomedical Engineering Program, The University of Texas at Arlington, Arlington; and †Division of Orthopedic Surgery, Department of Surgery, Southwestern Medical School, The University of Texas Health Science Center at Dallas, Dallas, Texas

- Torsional stiffness:
  - Nails ~5% of intact femora
  - Plates ~ 50%
- Bending
  - All ~80%
- Combined Bending and compression to failure
  - Locked IM nails ~300-400% Body weight
  - Plates ~ 100%

- R-T nail:
- Closed section
- Cloverleaf
- Interlocking
- Also with cephalomedullary screws as reconstruction nail

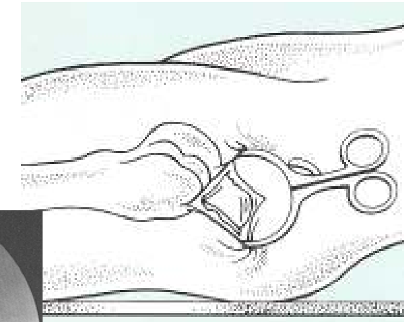
- 106% bending stiffness cf femur (15mm), 96% (13mm)
- 58% torsional stiffness
- 450% body weight load to failure in axial loading

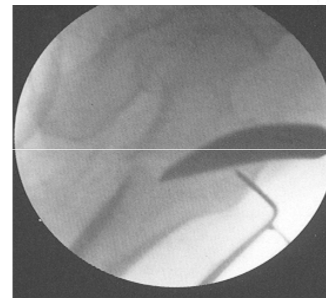
Tencer, A.F.; Calhoun, J.; Miller, B.B. Stiffness of subtrochanteric fracture of the femur stabilized using a Richards interlocking intramedullary rod or Richards AMBI. Orthop Biomech Lab Report #002. Memphis, Richards Medical Co., 1985.

Operative technique

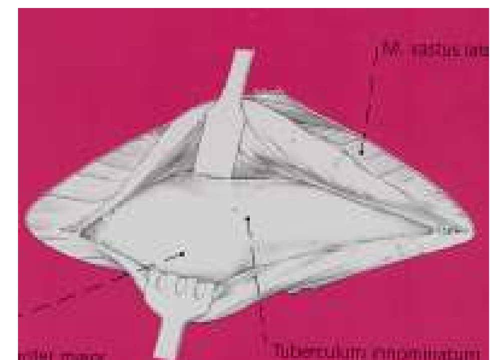
Surgical Exposure

- Intramedullary: minimal





- Extramedullary: for complex # extensive.



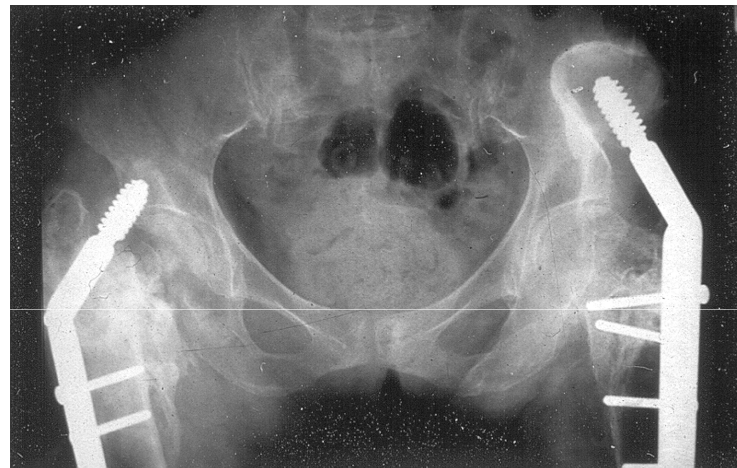
Complications

- NSS:
  - Blood loss
  - Operative time
  - Late cut out
  - Infection
  - Mobility
- Greater shortening with extramedullary
- More femoral shaft # with intramedullary (short)

Complications

<u>Lethal:</u>

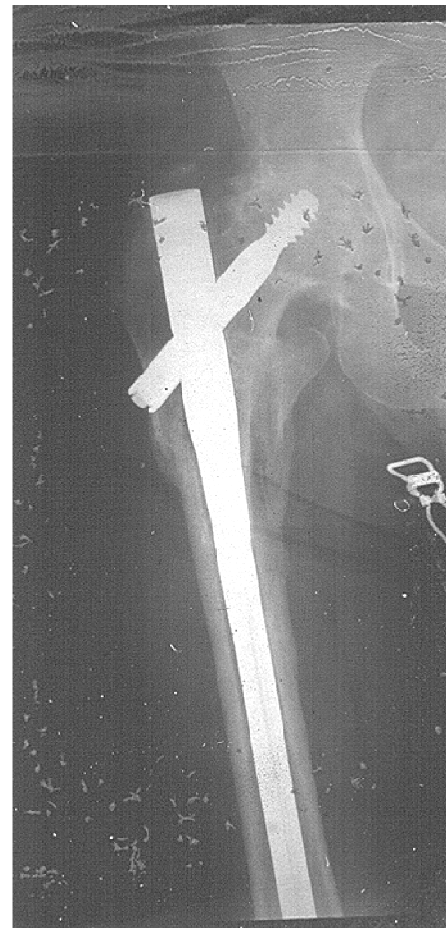
- hip nail cut out
- plate cut out
- deep infection



Complications

<u>Salvageable</u>

- shaft fracture
- superficial infection



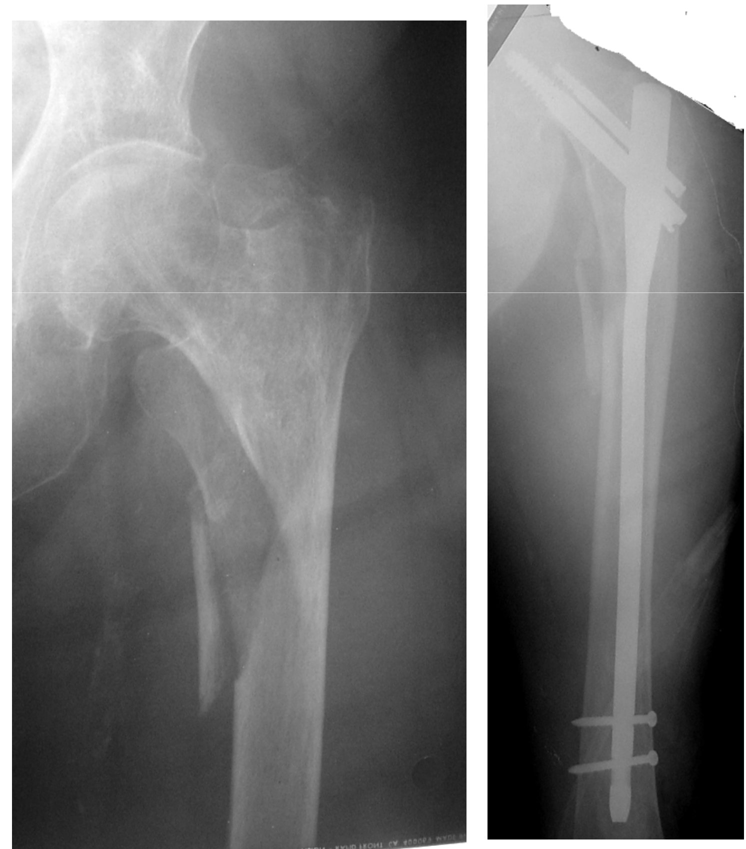
Summary

- “Intertrochanteric femur fractures:
  - The sliding hip screw is the implant of choice
  - Gamma nails provide some advantages
    - The intramedullary location shifts the moment of inertia medially, allowing greater calcar load sharing.
    - A short lever arm decreases the bending moment.
    - A sliding screw allows for compression of the fracture in a controlled manner.
    - Decreased fracture exposure may contribute to healing when this device is used.”

    Motley GS et al, Adult Trauma, *in* Review of Orthopaedics, *Miller MD, (Ed)*
- “Secondary # at the distal end…. is the most common complication”……NOT ANY MORE!

Conclusion

- little difference between implants and complications
- tip fractures easily salvaged
- IM nail biomechanically more suited to unstable fractures.
- long IM shows promise.



Any Questions?