PRINCIPLES OF FRACTURES

When there is a Fracture…….

- Why? How?
- Possibility of MULTIPLE INJURIES
- Possibility of MULTIPLE FRACTURES
- ALWAYS RESUSCITATE first
- PROPER TREATMENT…GOOD FUNCTION & LITTLE COMPLICATION

CLASSIFICATION OF FRACTURES

TRAUMATIC

DIRECT FORCE eg.Tapping

INDIRECT FORCE eg.Twisting, compression

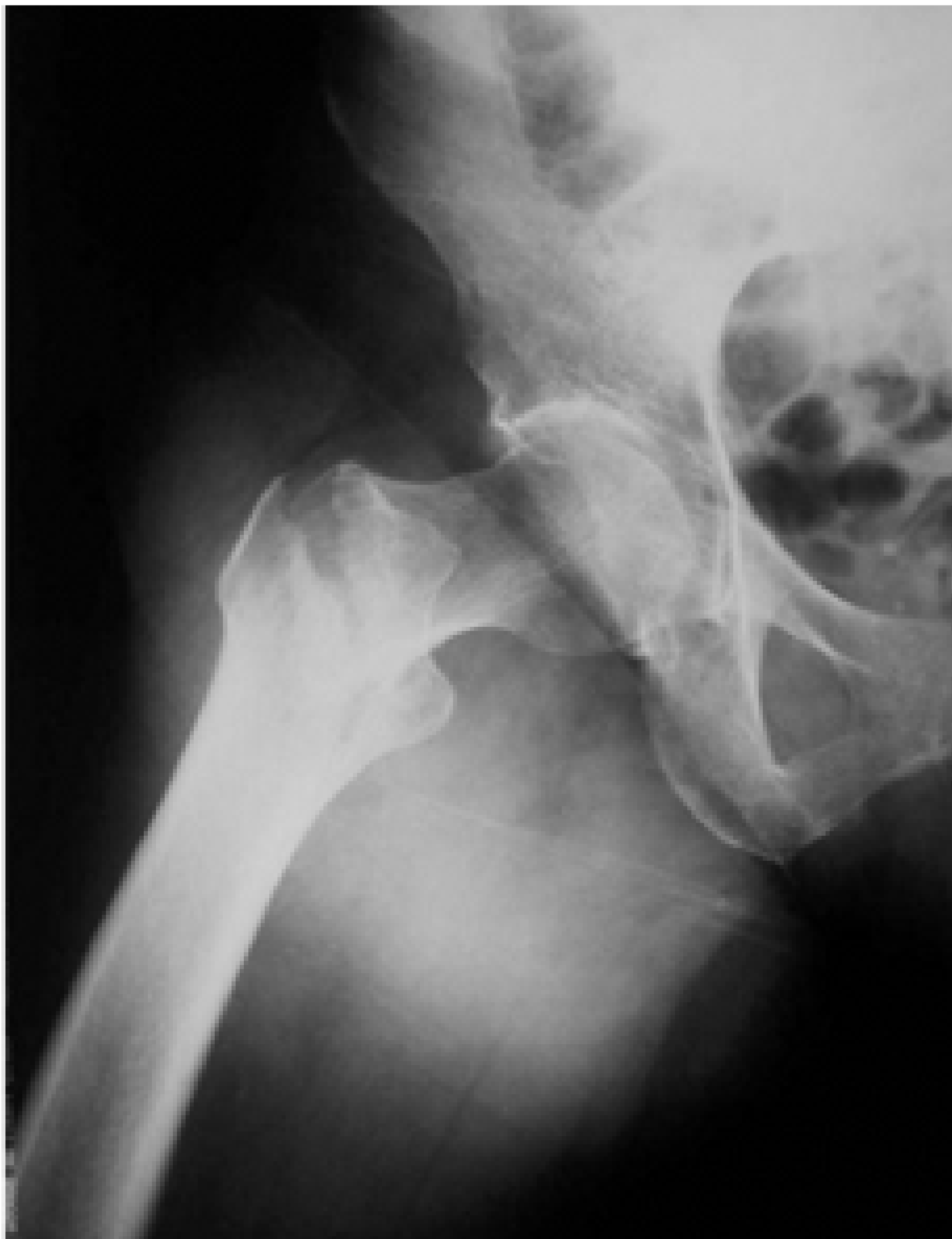
STRESS

PATHOLOGICAL eg.Osteoporosis, metastasis, cyst

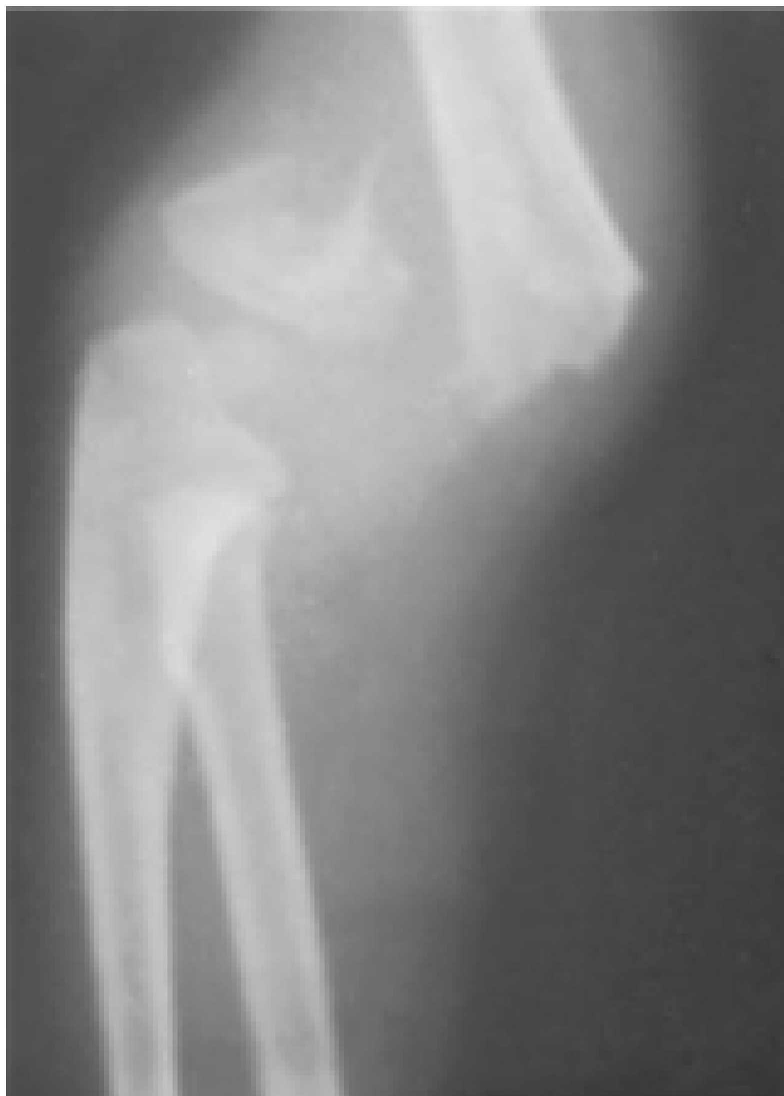
CLASSIFICATION OF FRACTURES

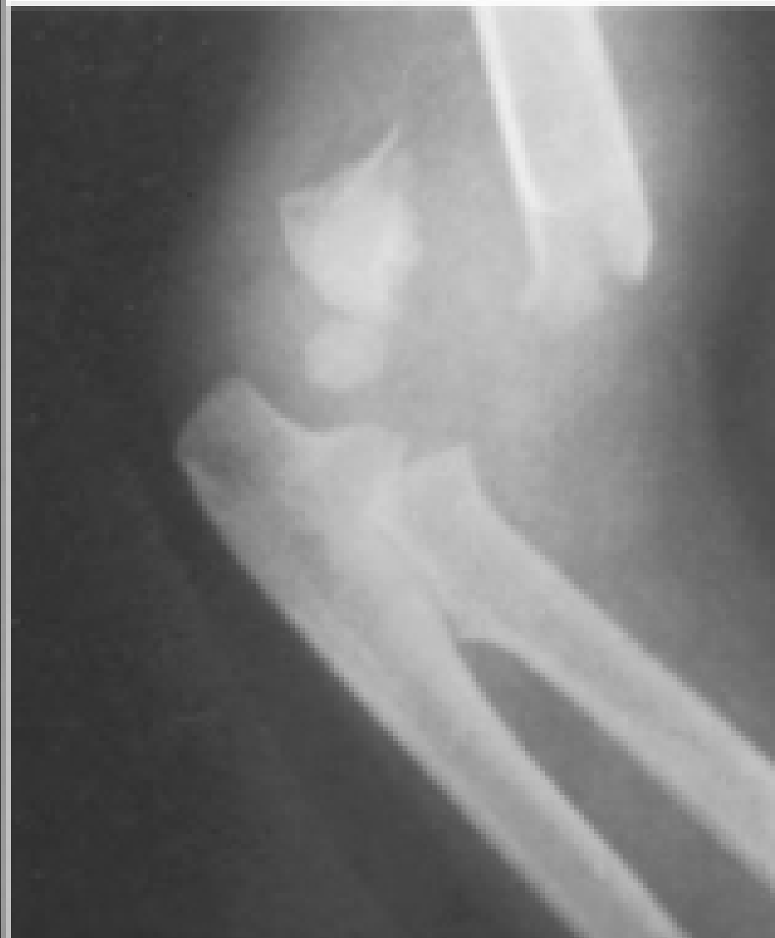
SIMPLE or CLOSED

COMPOUND or OPEN



TROCHANTERIC # R FEMUR





DISCRIPTION of FRACTURES

PATIENT PROFILE
TRAUMATIC or PATHOLOGICAL
OPEN or CLOSED
SITE ie which bone/which part
COMPLETE or CRACK
PATTERN (Transverse, oblique, spiral)
ANY DISPLACEMENT (shift, angulation, *rotation)
SINGLE or MULTIPLE
ANY ASSOCITED INJUIRES eg Nerve,Blood vessel

ALWAYS SOFT TISSUE INJURY

- HIGH VELOCITY…….SEVERE
- LOW VELOCITY…….MODERATE

FRACTURE HEALING

HAEMATOMA ….INFLAMMATION….CALLUS

…..CONSOLIDATION……REMODELLING

- BLOOD SUPPLY is

  BASIS of ALL FRACTURE HEALING

TIME-TABLE of HEALING

	UNION	CONSOLIDATION
UPPER LIMB	3/52	6/52
LOWER LIMB	6/52	12/52

X 2 if TRANSVERSE

Quicker in CHILDREN

*CLINICAL and RADIOLOGICAL EVIDENCE

CLINICAL FEATURES

HISTORY

PAIN ; SWELLING ; BRUISE ; DEFORMITY

*VELOCITY of INJURY

*ASSOCIATED INJURIES

DON’T JUMP TO X-RAYS NOW

- YOU WILL REGRET!!!

CLINICAL FEATURES PHYSICAL EXAMINATION

- GENERAL

- ABC
- ASS. INJURIES
- PREDIPOSING FACTORS

- LOCAL

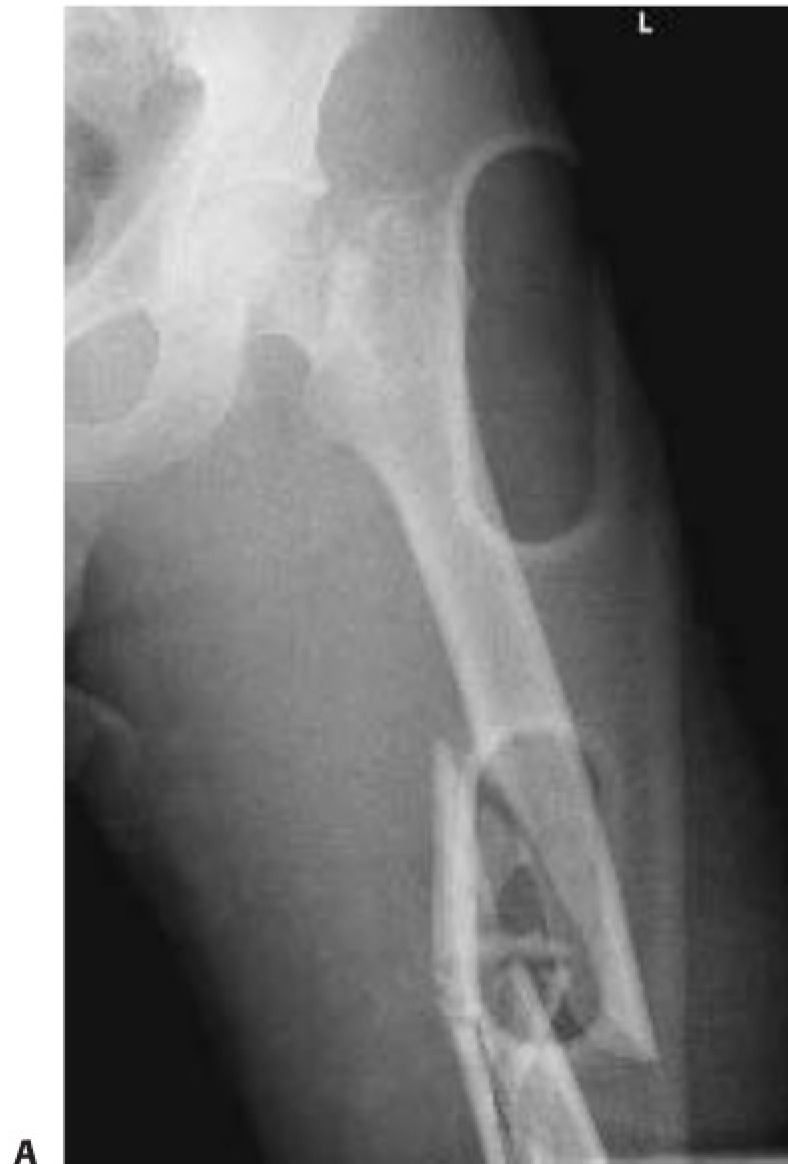
- LOOK
- FEEL
- MOVE

- NERVE/VASCULAR INJUIES
- ASS. INJURIES

INVESTIGATIONS

- X-RAYS
- 2 VIEWS
- 2 JOINTS
- 2 LIMBS
- 2 OCCASIONS
- Other suspicious sites

- SPECIAL IMAGING
- CT.. incl. 3D reconstruction
- MRI
- Bone scan



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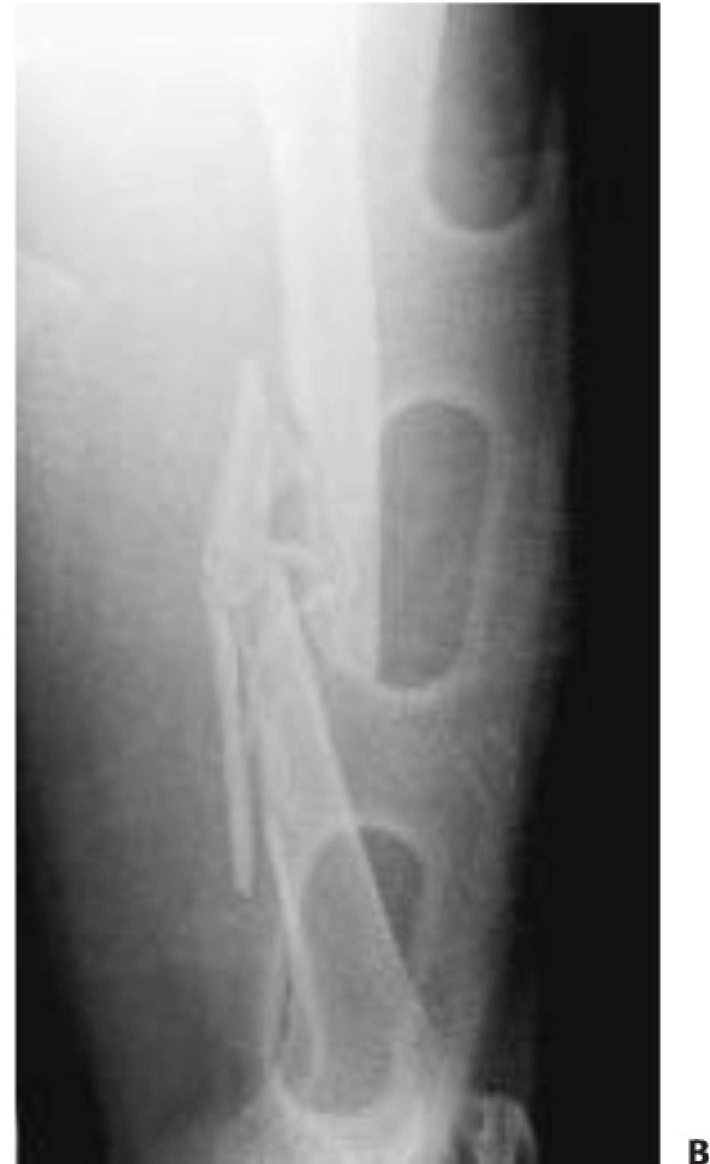

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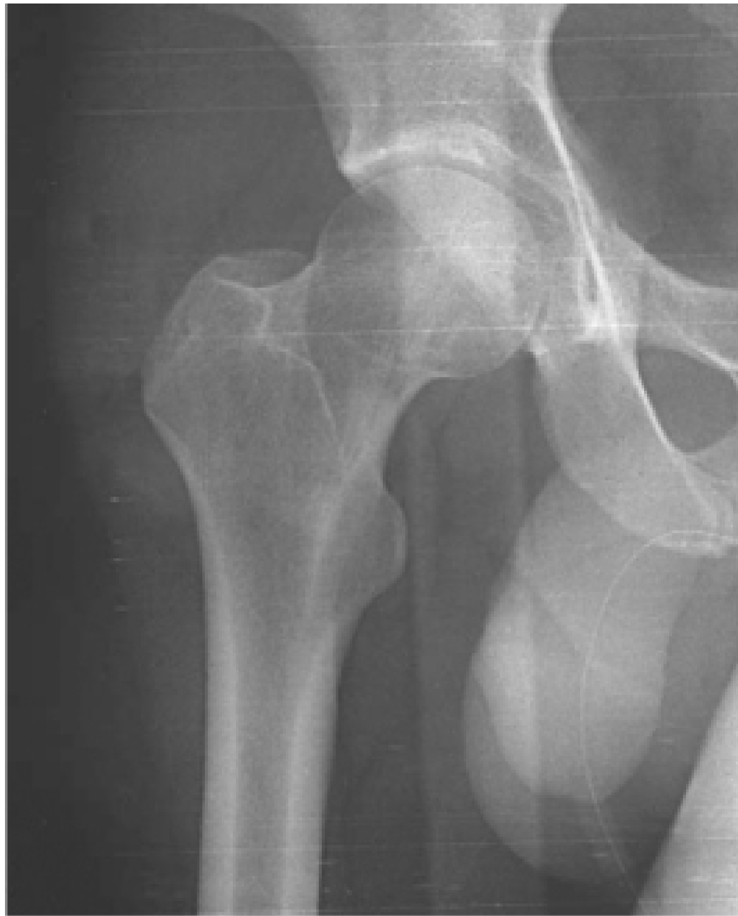

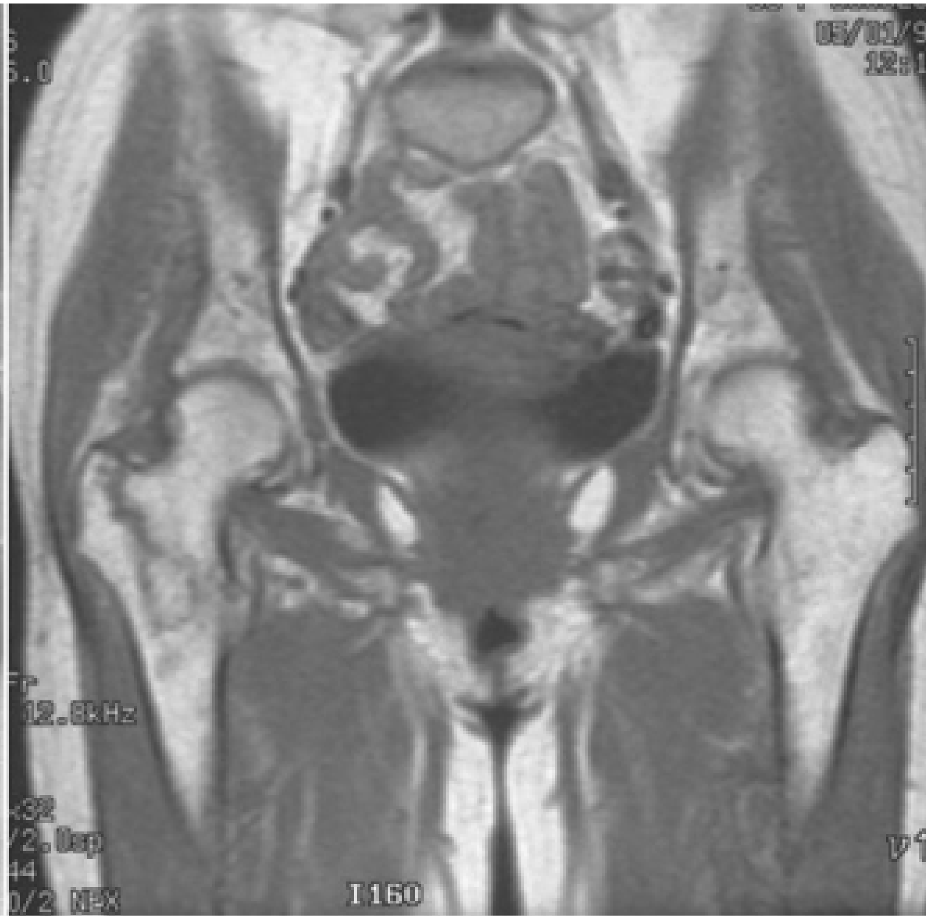
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COMPLICATIONS

- GENERAL VS

BLOOD LOSS

SHOCK

FAT EMBOLISM

CARDIOPULMONARY FAILURE etc

- LOCAL

- EARLY
- LATE

COMLICATIONS..LOCAL..EARLY

URGENT

NERVE Injury
Blood vessel Injury
Visceral Injury
Compartment Syndrome
Infection

LESS URGENT

Fracture Blisters
Plaster sores
Nerve Entrapment
Myositis Ossificans
Joint Stiffness

COMPLICATIONS…LOCAL…LATE

- MALUNION
- DELAYED UNION
- NON-UNION
- AVASCULAR NECROSIS
- OSTEOARTHRITIS
- JOINT STIFFNESS or INSTABILTY
- MUSCLE PROBLEMS

TREATMENT OF FRACTURE

- GOAL:

  UNION of the Fracture

in the *MOST ANATOMICAL position with

*the MAXIMAL FUNCTIONAL RETURN &

*the FEWEST COMPLICATIONS

TREATMENT of FRACTURES

- INDIVIDUALIZED
- NOT a CLEAR-CUT DECISION
  (Each option has its Benefits & potential Complications)

Evaluate the WHOLE PATIENT
(NOT just the Injuried part) &
the NEEDS of the patient.

3 BASIC PRINCIPLES

- 1. REDUCTION
- 2. HOLD
- 3. EXERCISE

REDUCE

- CLOSED REDUCTION

Traction

Disengagement of fragments

Re-position (reverse the force)

*check alignment in different planes

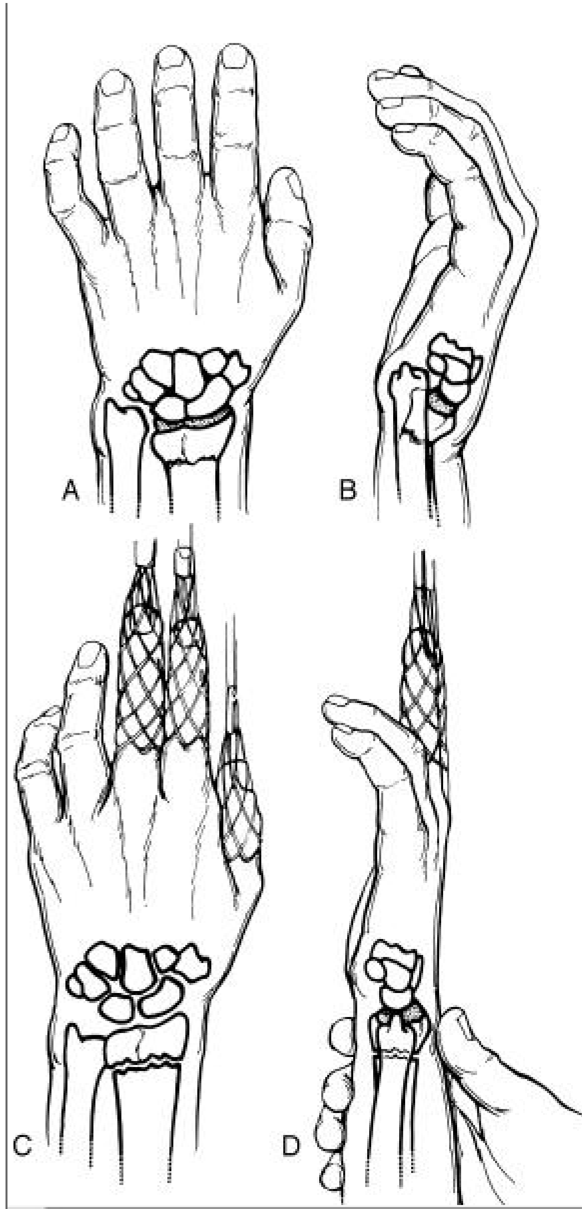
- OPEN REDUCTION

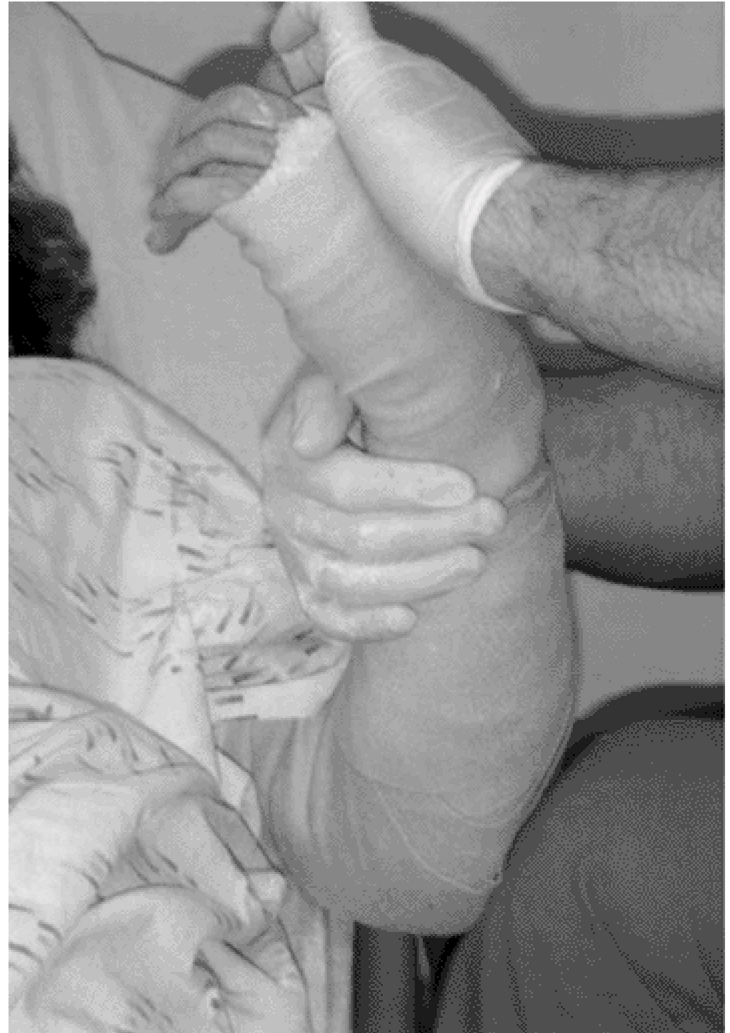
*When Closed Reduction fails

*first step in internal fixation

2. HOLD

- TRACTION…Gravity, skin, skeletal
- CAST (PLASTER of PARIS or POP)
- BRACING
- INTERNAL FIXATION
- EXTERNAL FIXATION


A
B
C
D



POP

- should be FIT;

  too tight.....skin, nerve, vascular

  too loose….lose reduction

. Change when necessary

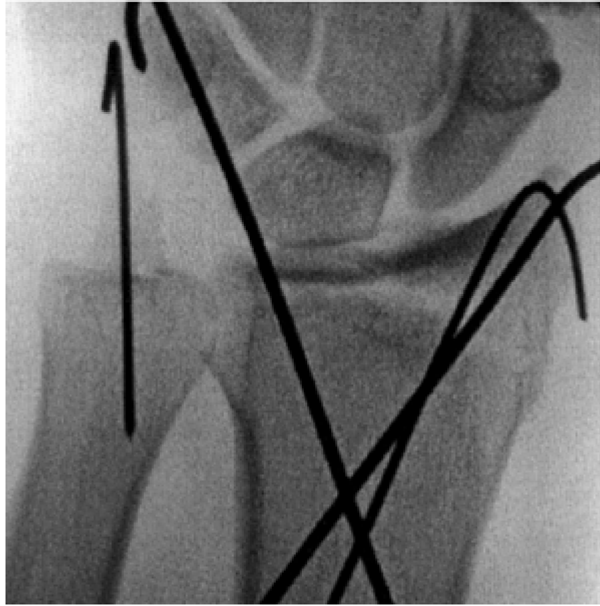
.CHECK ! LISTEN!

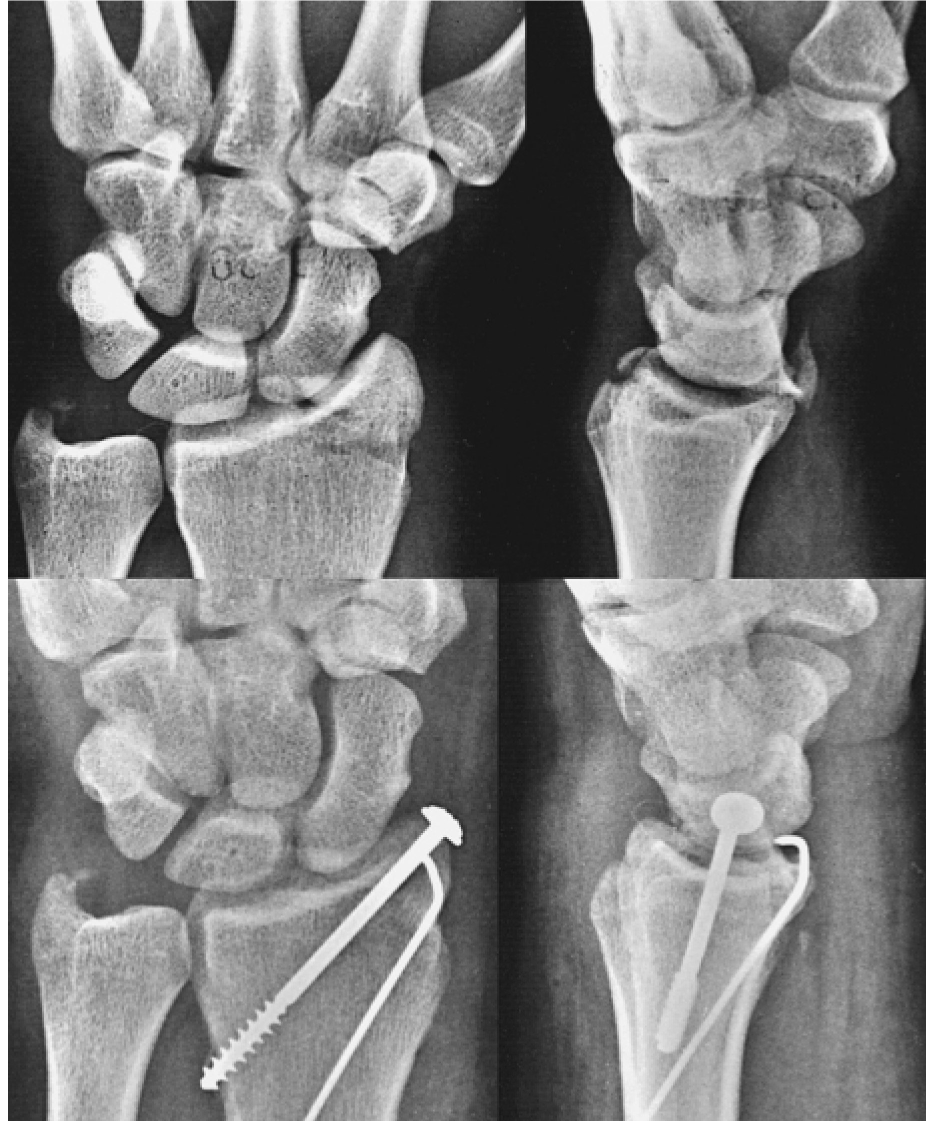
INTERNAL FIXATION; INDICATIONS

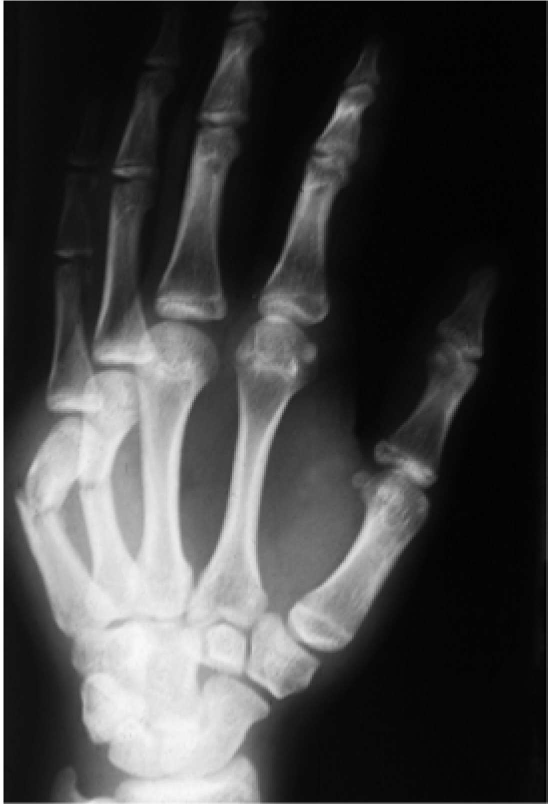
- When closed reduction fails
- Unstable #; prone to displacement
- Multiple #s
- Nursing difficulties (elderly, paraplegic,multiple injuries)

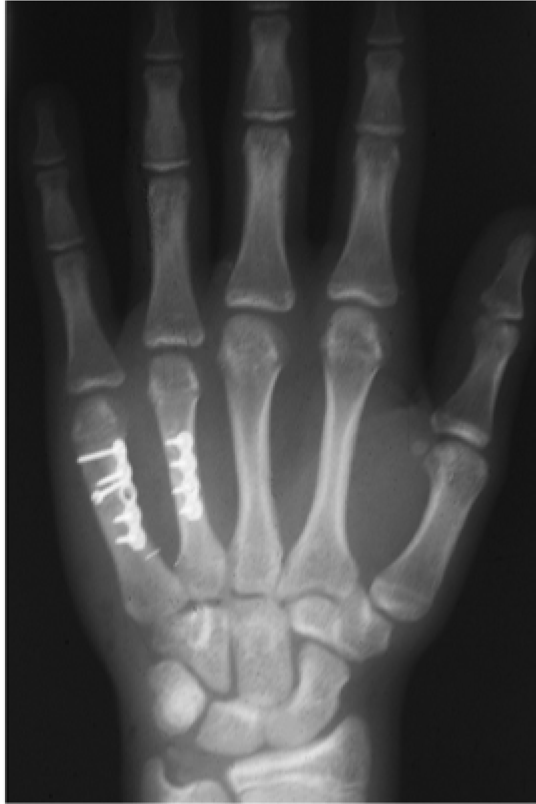
TYPES of INTERNAL FIXATION

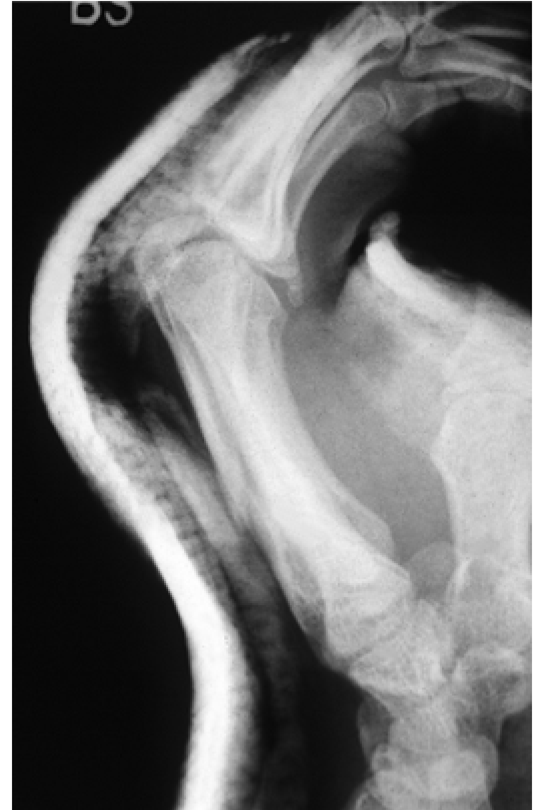
- WIRES
- SCREWS
- PLATES & SCREWS
- INTRAMEDULLARY NAILS (+/- interlocking screws;   ream/unream)

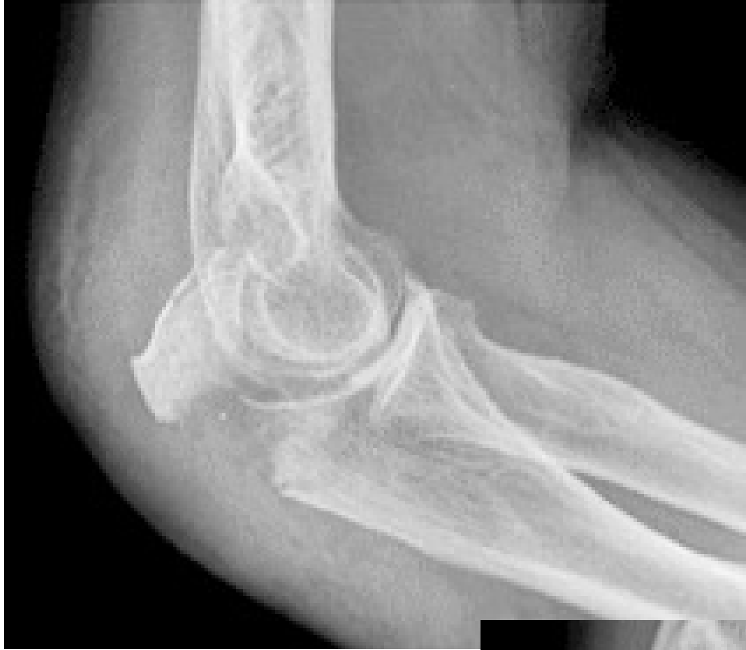
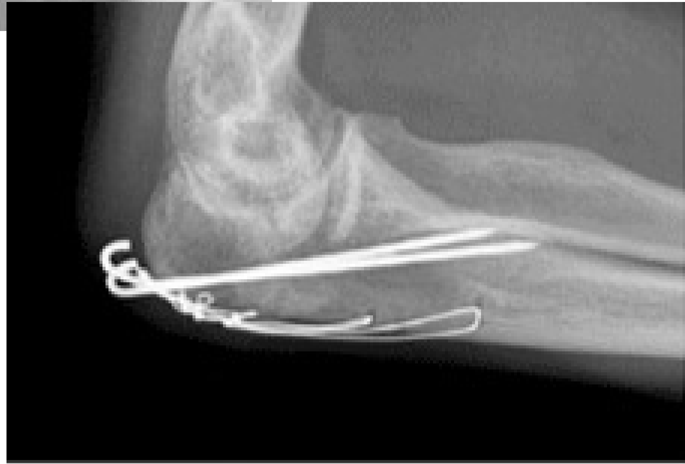
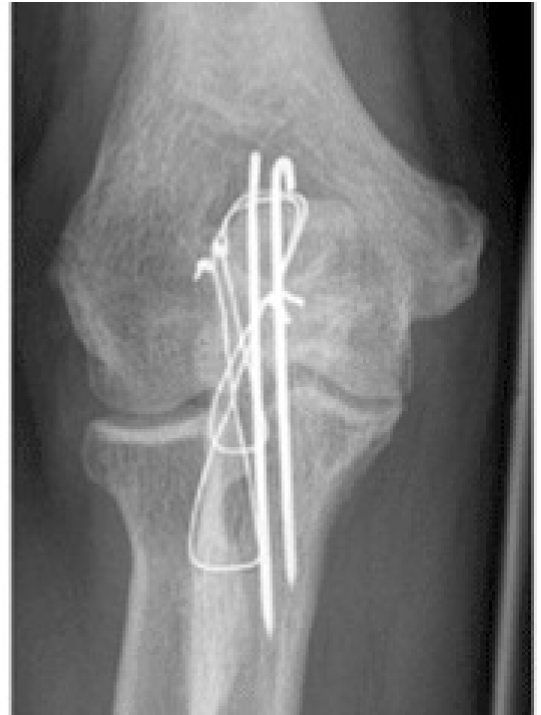


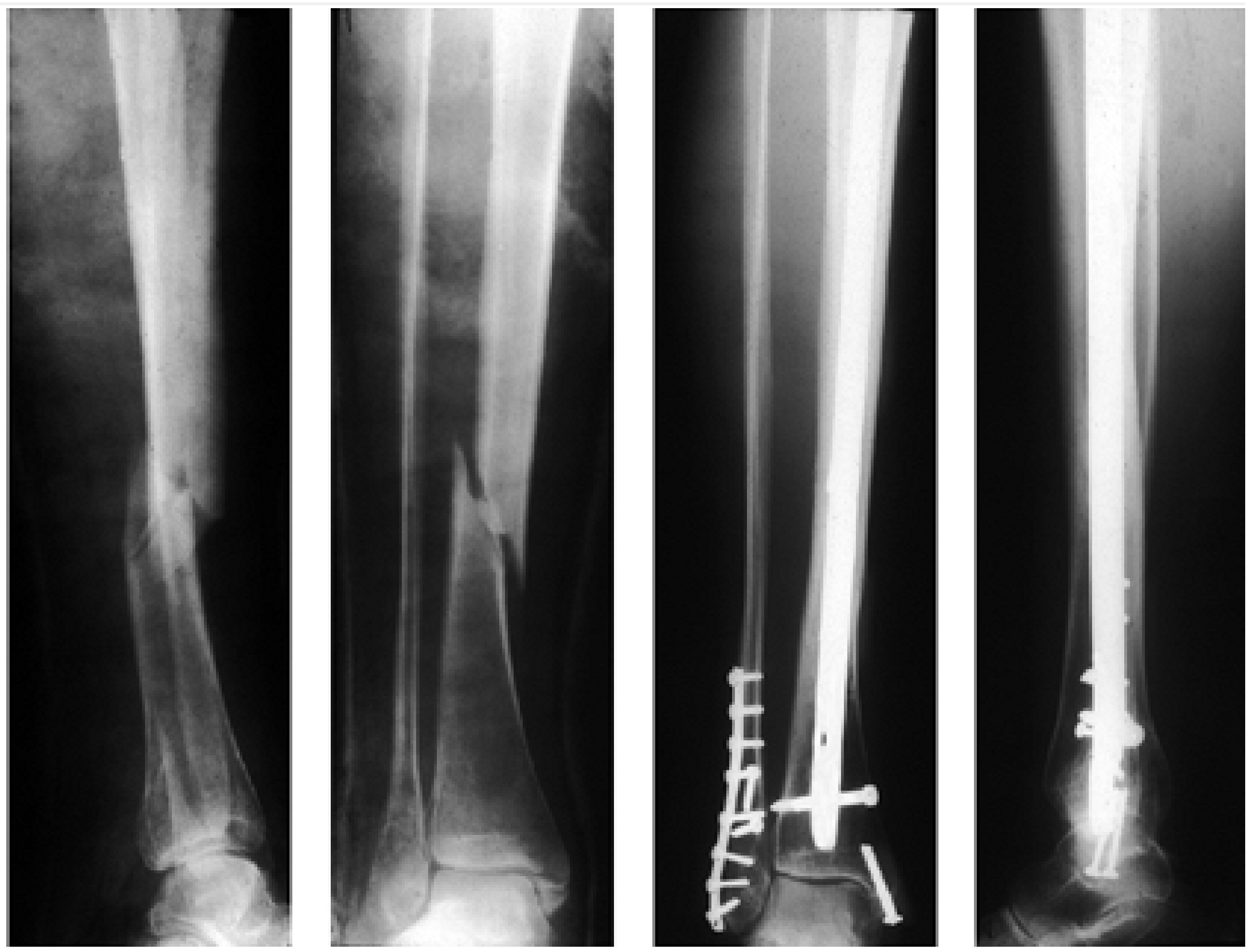


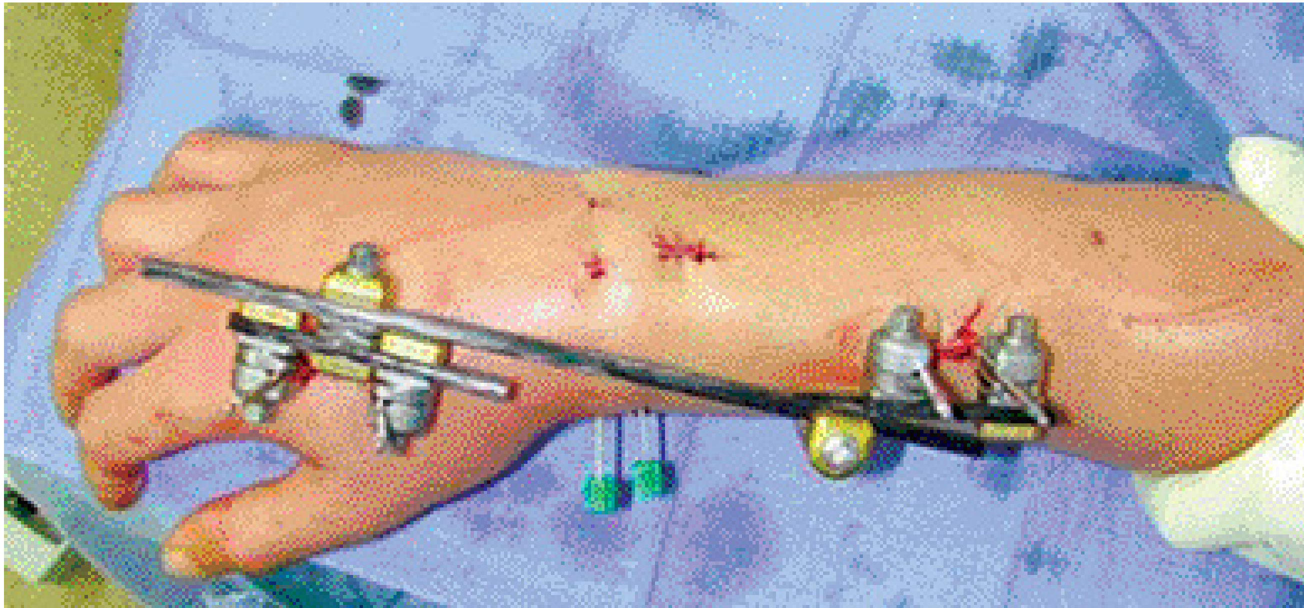








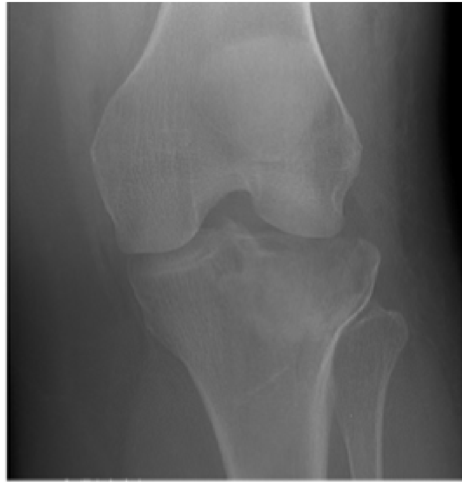
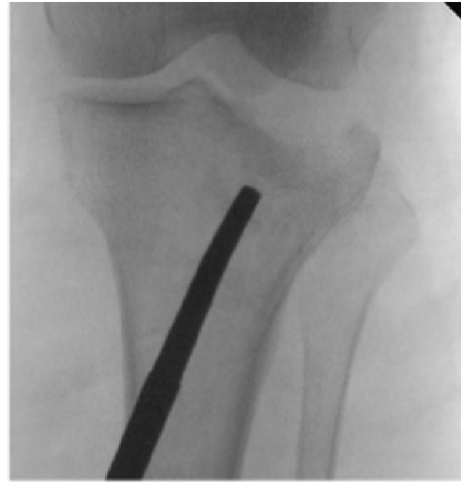
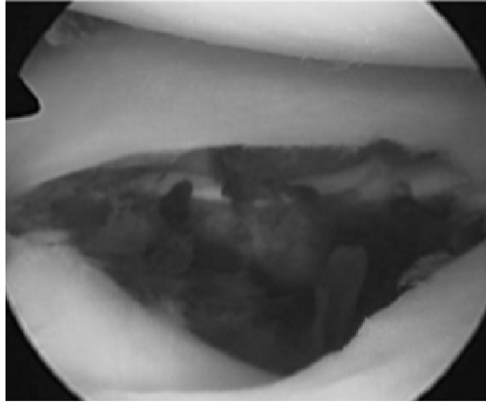
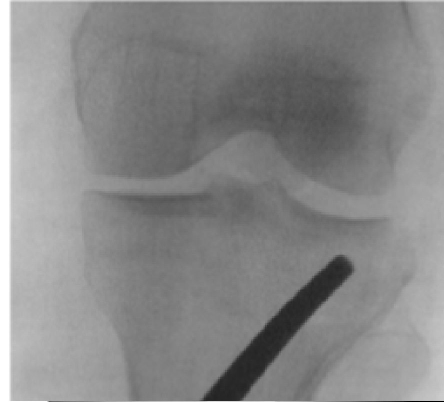
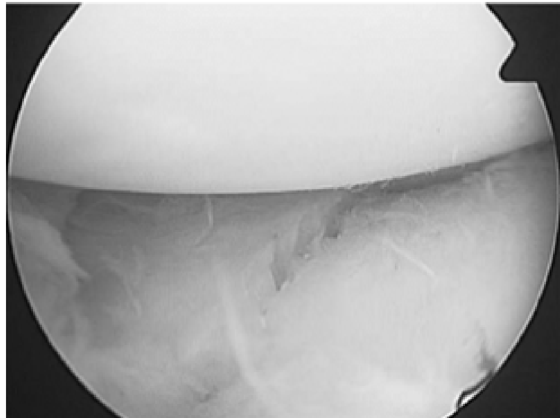
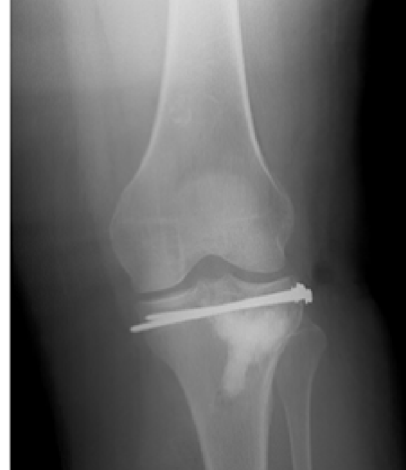


INTERNAL FIXATION

- OPEN vs
- MINAIMAL INVASIVE TECHNIQUE (MIS) ie the fracture haematome is not opened

- MINIMAL INVASIVE TECHNIQUE (MIS)

- Percutaneous K-wires
- IM nail
- External fixation
- Submuscular Plate

COMPLICATIONS of INTERNAL FIXATION

- INFECTION…..DISASTER!!!
- NON-UNION
- MAL-UNION
- IMPLANT FAILURE
- RE-FRACTURE … after implant removal

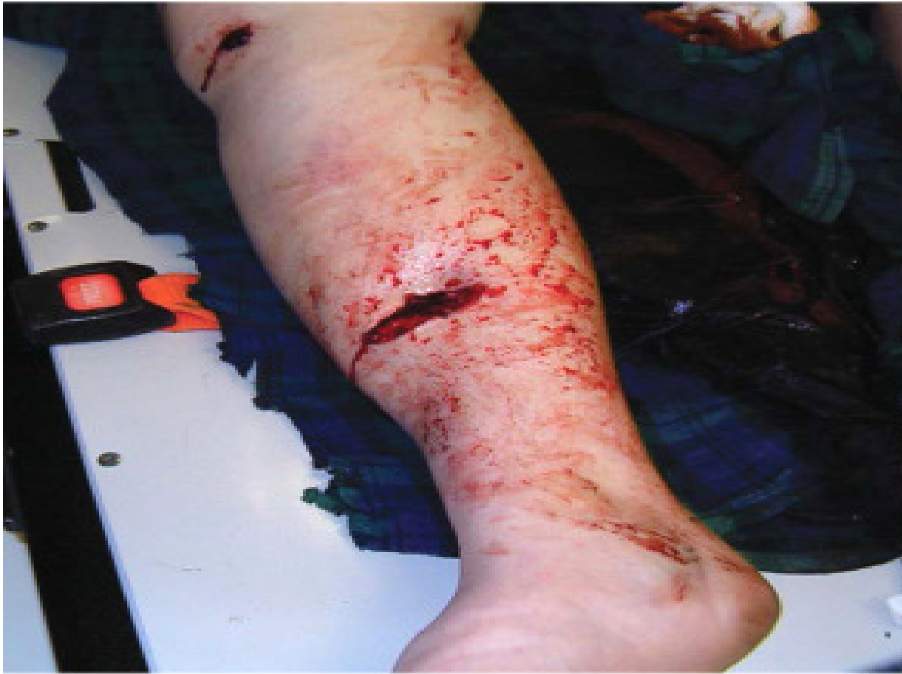
  not too early

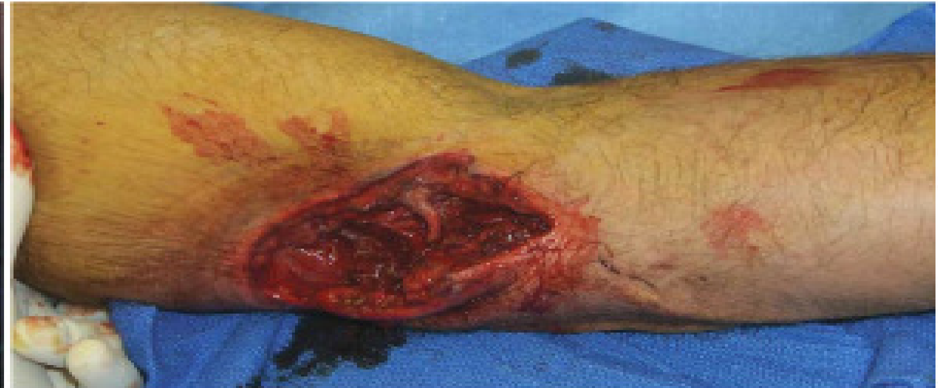
  advice on care and protection

3. EXERCISE

- To RESTORE FUNCTION
- A CONTINUOUS PROCESS
- FOR THE WHOLE PATIENT, NOT JUST THE INJURIED PART

- Reduce edema
- Joint mobility
- Muscle power
- Functional recovery





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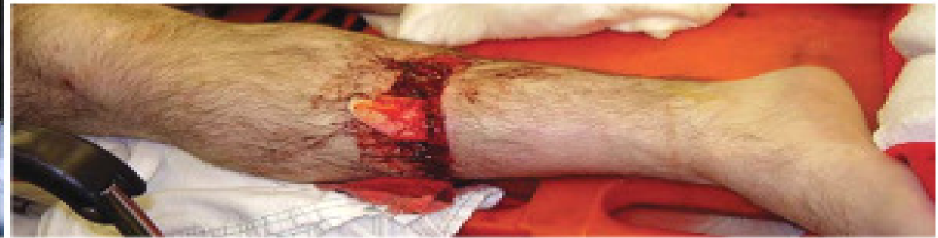

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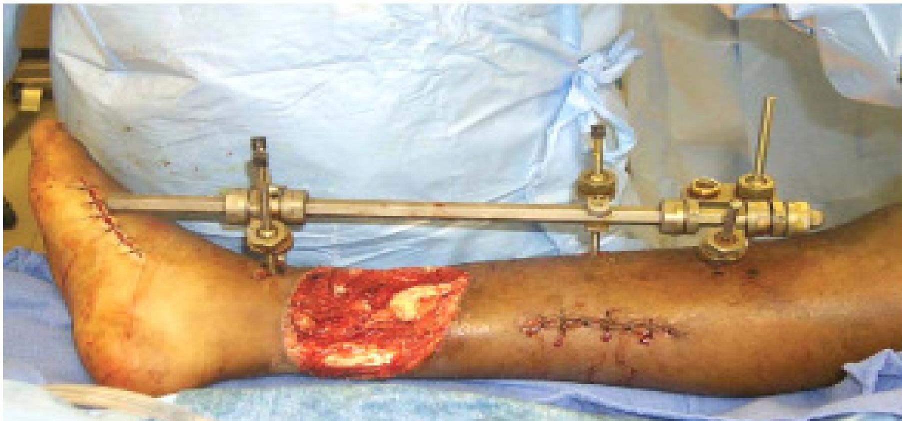
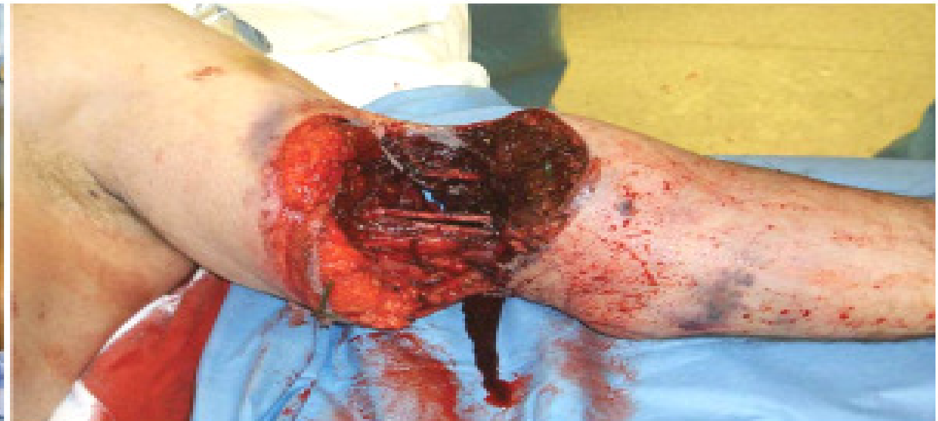




E

OPEN FRACTURES

PROBLEMS

*INFECTION

- SKIN and SOFT TISSUE DAMAGE
- NERVE and VASCULAR INJURIES

- BONES… dead bone; non-union

- JOINT STIFFNESS

OPEN FRACTURE

PRINCIPLES of TREATMENT

1. WOUND DEBRIDEMENT
2. ANTIBIOTIC
3. STABILIZATION of the FRACTURE
4. EARLY WOUND COVER

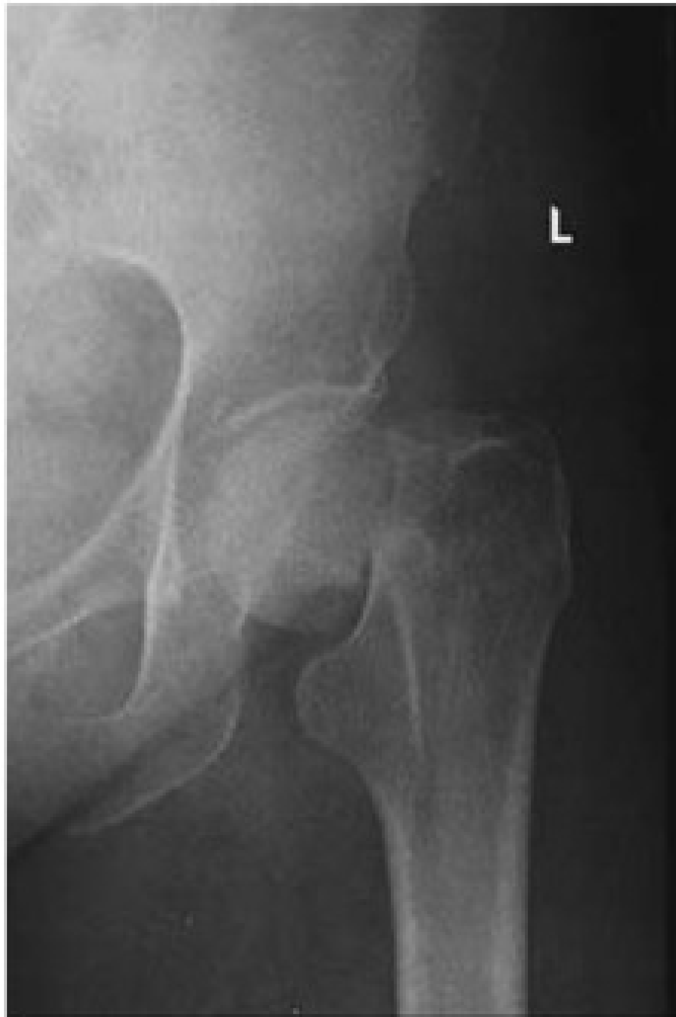
Fracture Neck of Femur

- Age
- Difficulty to HEAL esp DISPLACED

- HEAD SAVING problems of non-union

  AVN, OA

- HEAD SACRIFICE



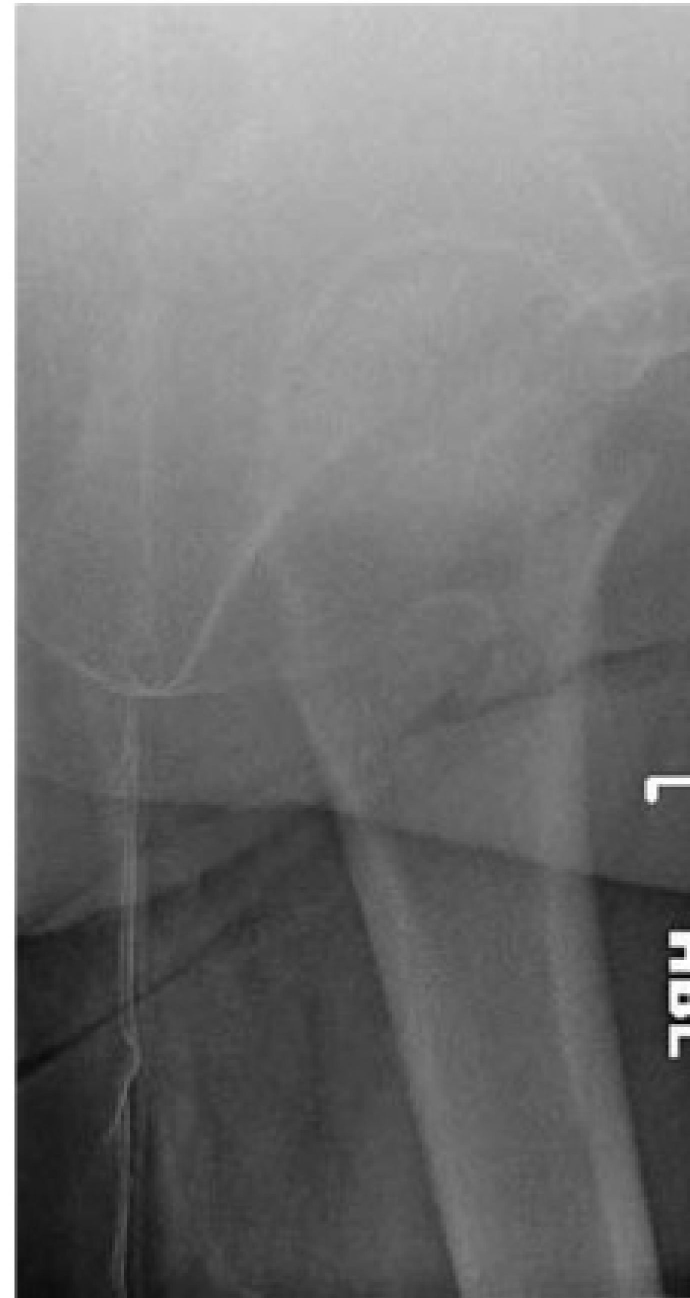
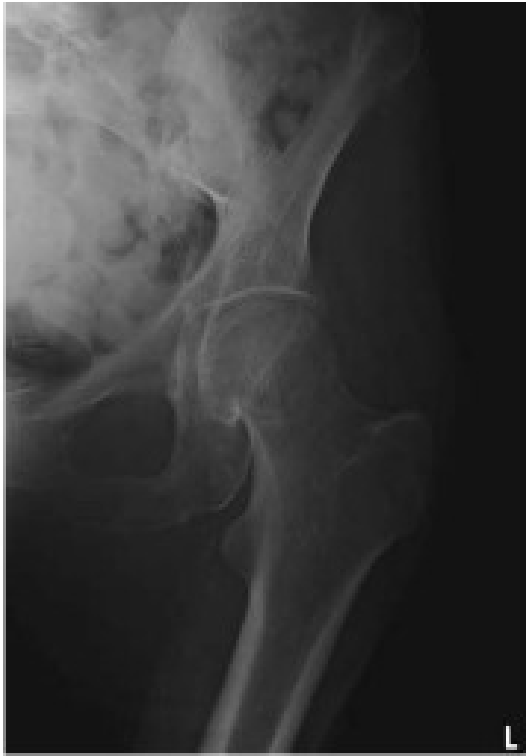


FIGURE 47-1 AP and lateral radiographs of a displaced femoral neck fracture.

A



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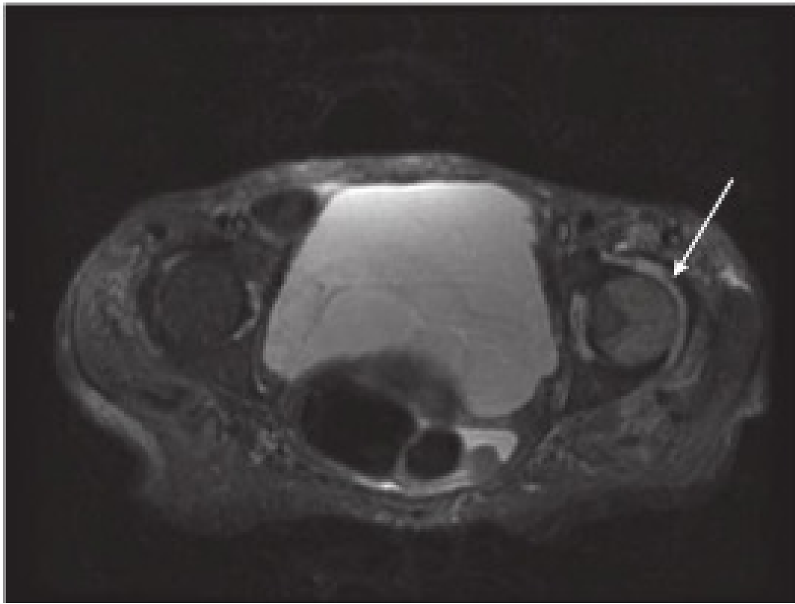
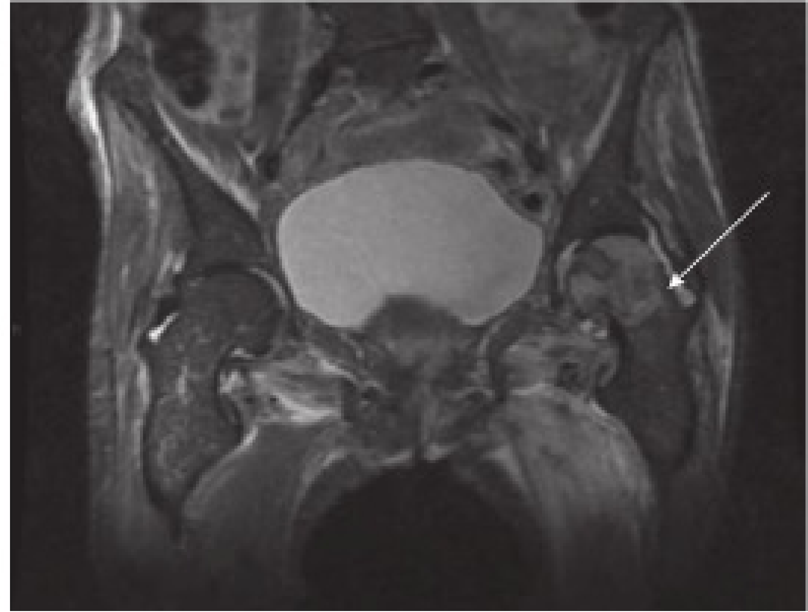




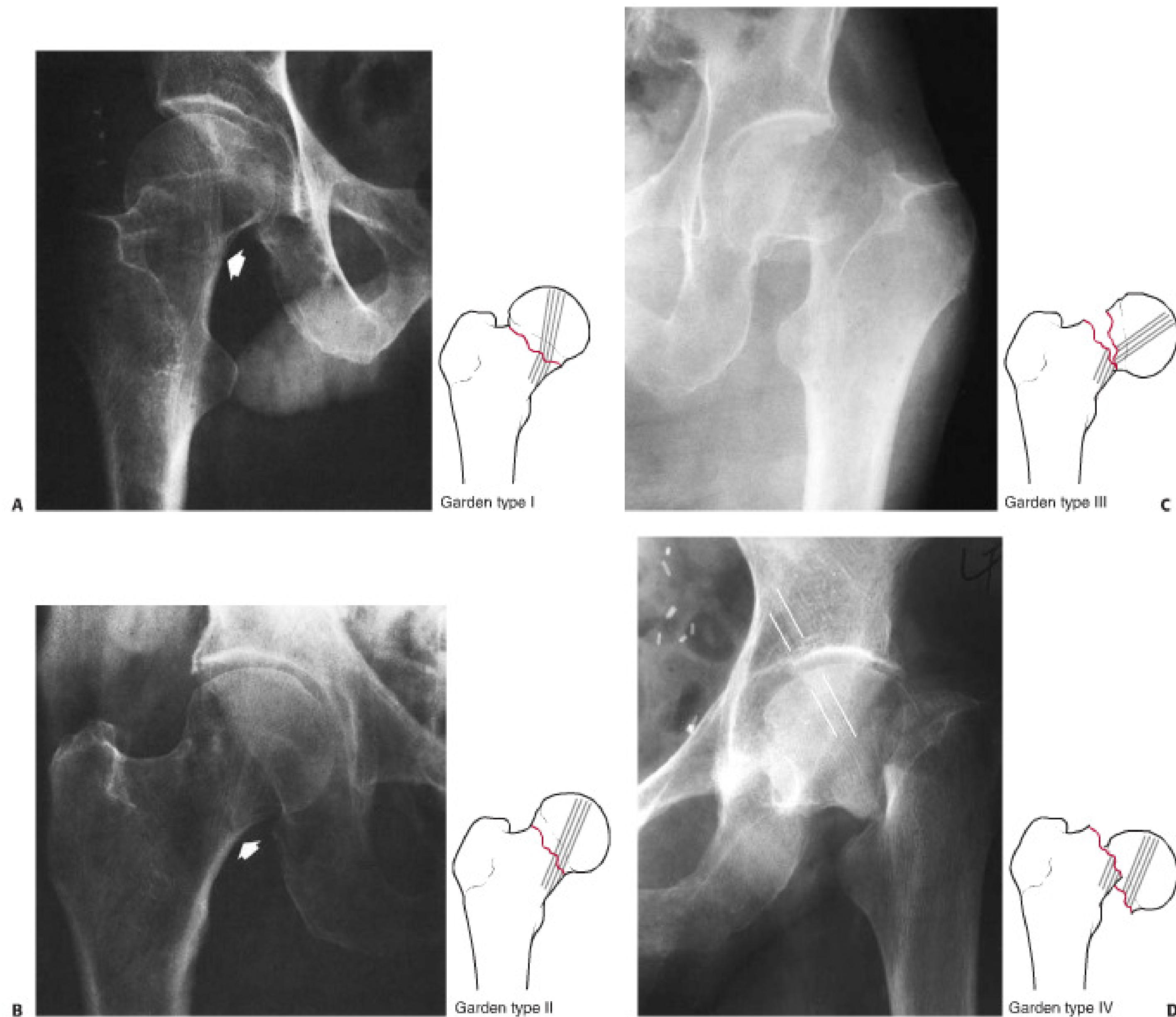


FIGURE 47-3 The Garden classification of femoral neck fractures. Type I fractures can be incomplete, but much more typically they are impacted into valgus, and retroversion **(A)**. Type II fractures are complete, but undisplaced. These rare fractures have a break in the trabeculations, but no shift in alignment **(B)**. Type III fractures have marked angulation, but usually minimal to no proximal translation of the shaft **(C)**. In the Garden type IV fracture, there is complete displacement between fragments and the shaft translates proximally **(D)**. The head is free to realign itself within the acetabulum, and the primary compressive trabeculae of the head and acetabulum realign (*white lines*).

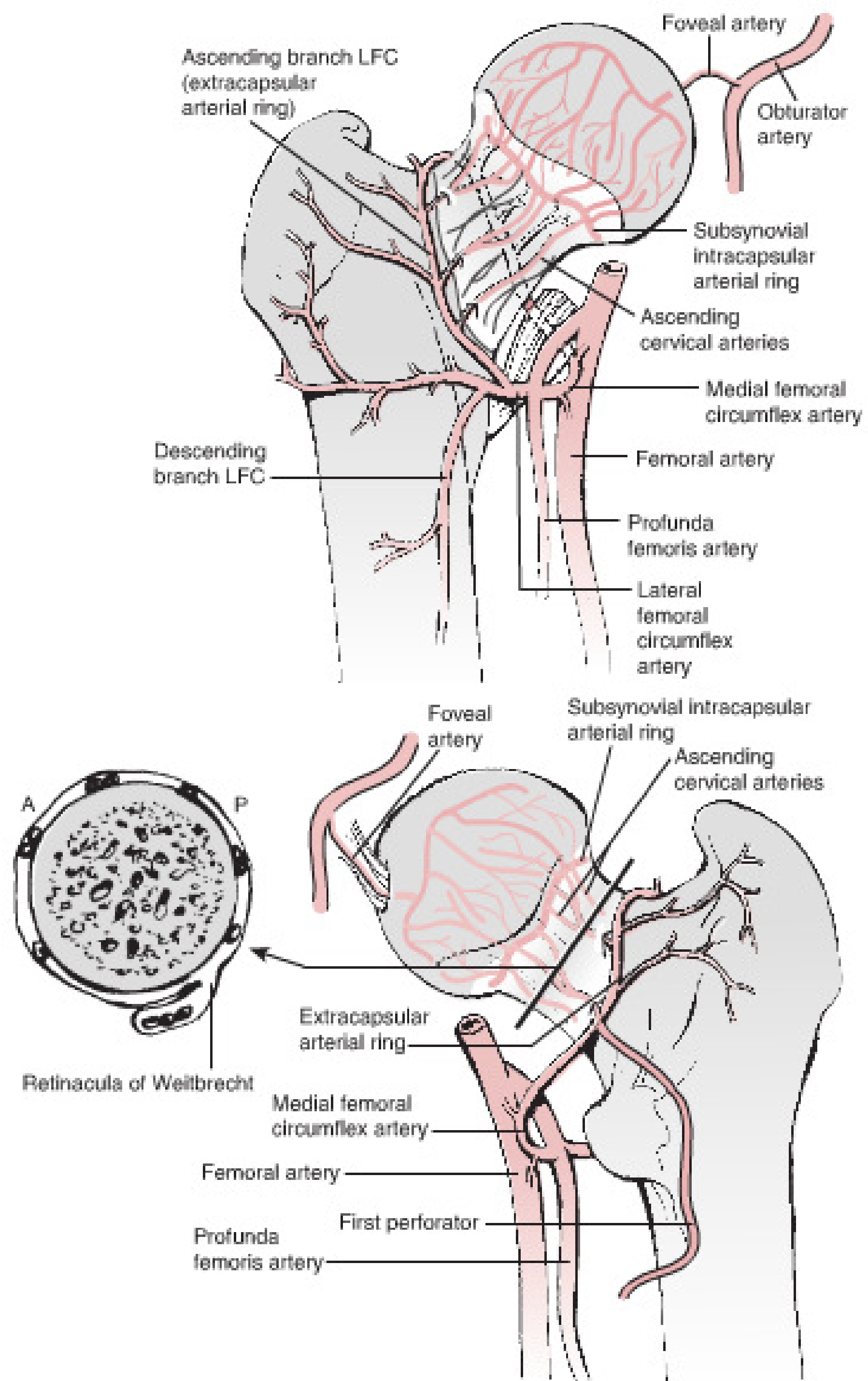
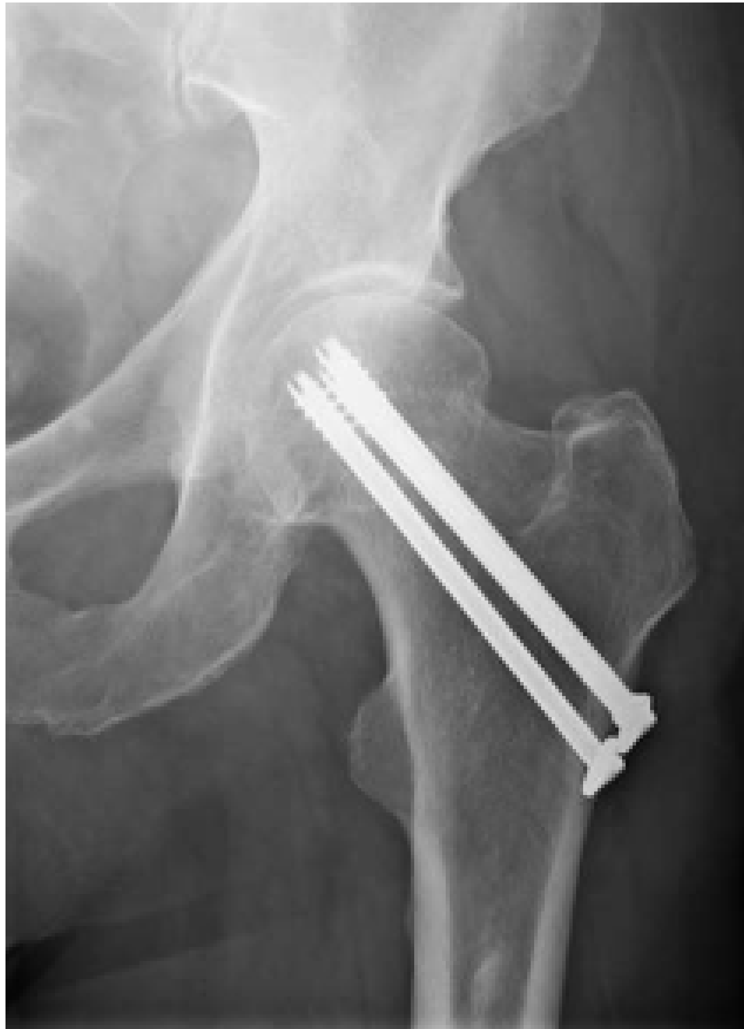


FIGURE 47-8 Vascular anatomy of the femoral head and neck. **(Top)** Anterior aspect. **(Bottom)** Posterior aspect. LFC, lateral femoral circumflex artery.

Cannulated Screw Fixation



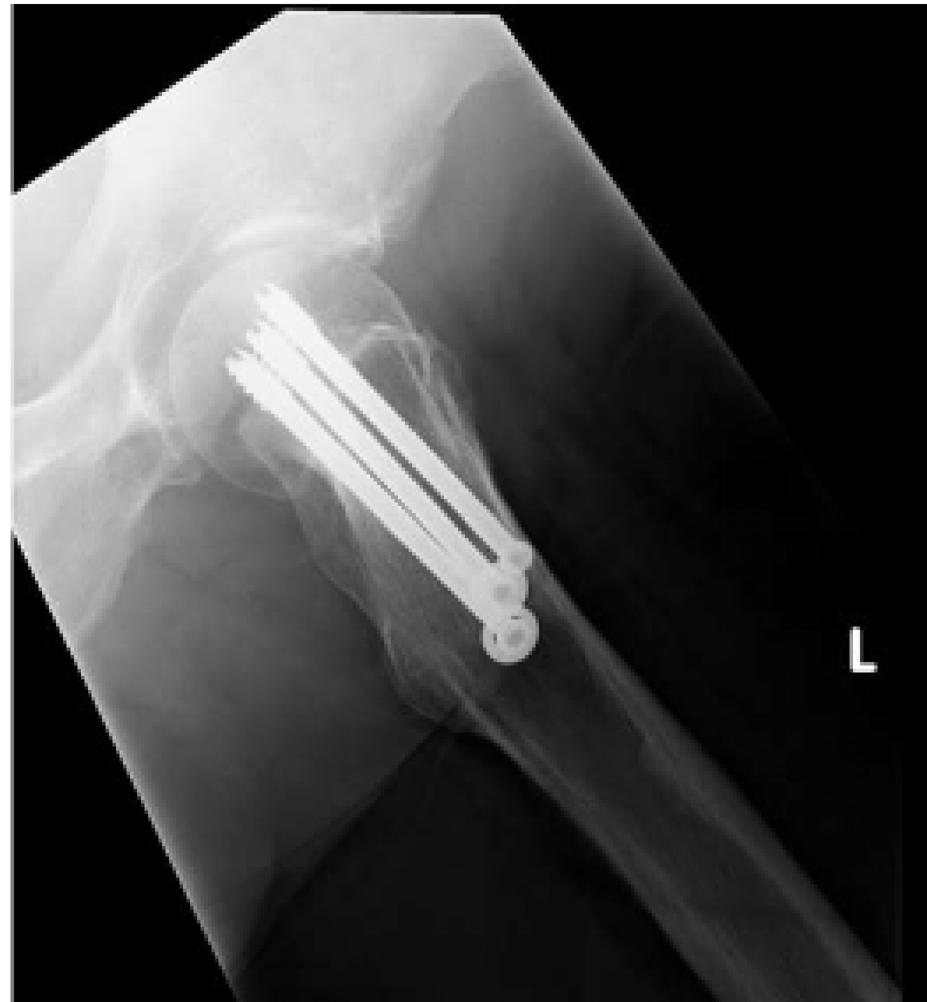
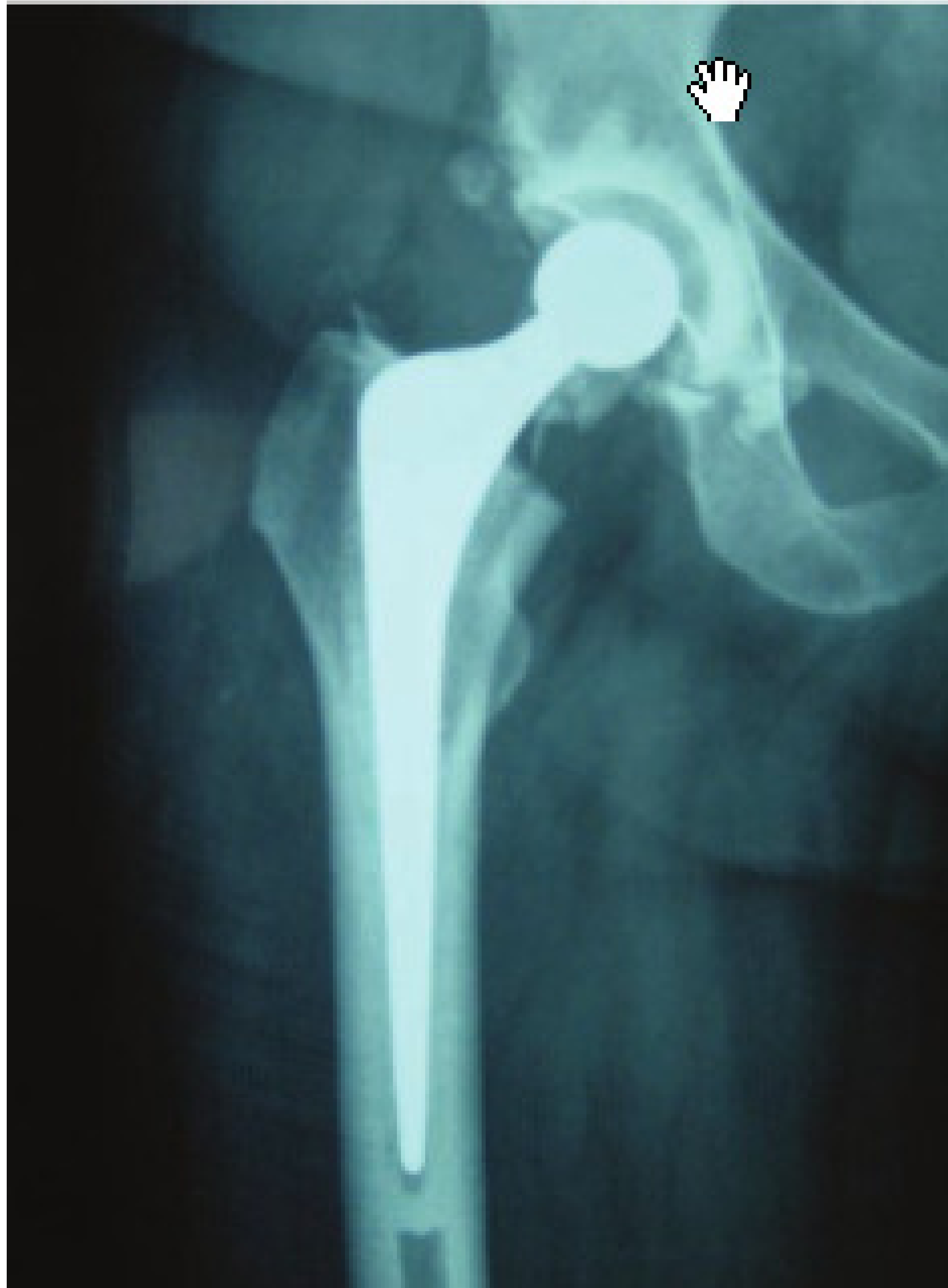
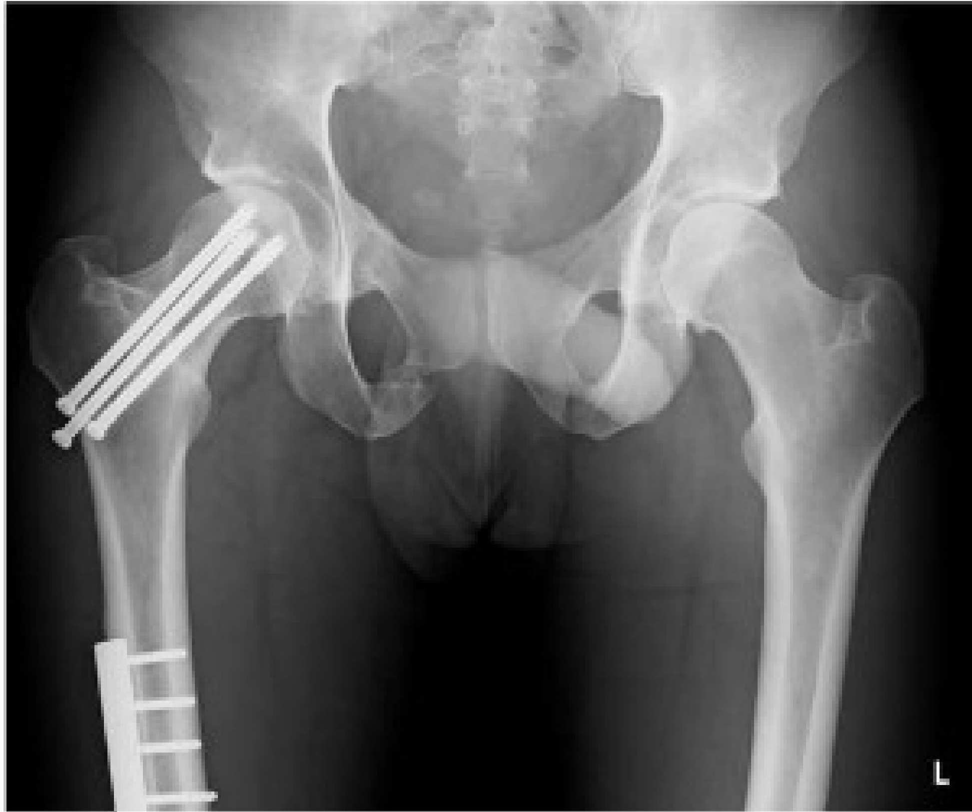
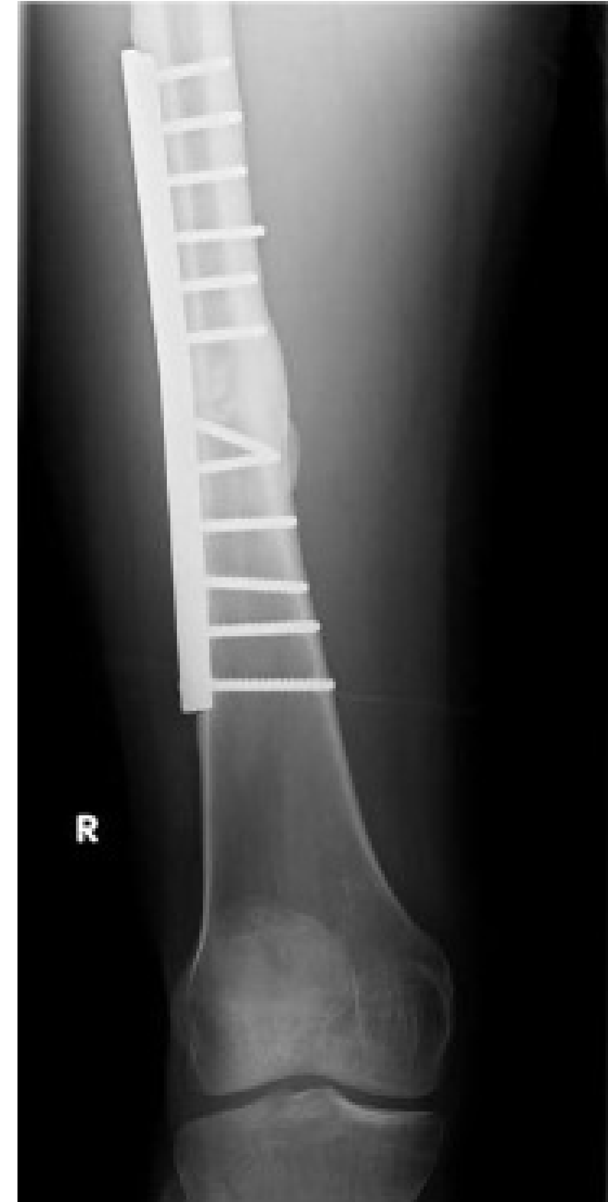


FIGURE 47-13 An Austin Moore prosthesis.







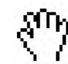
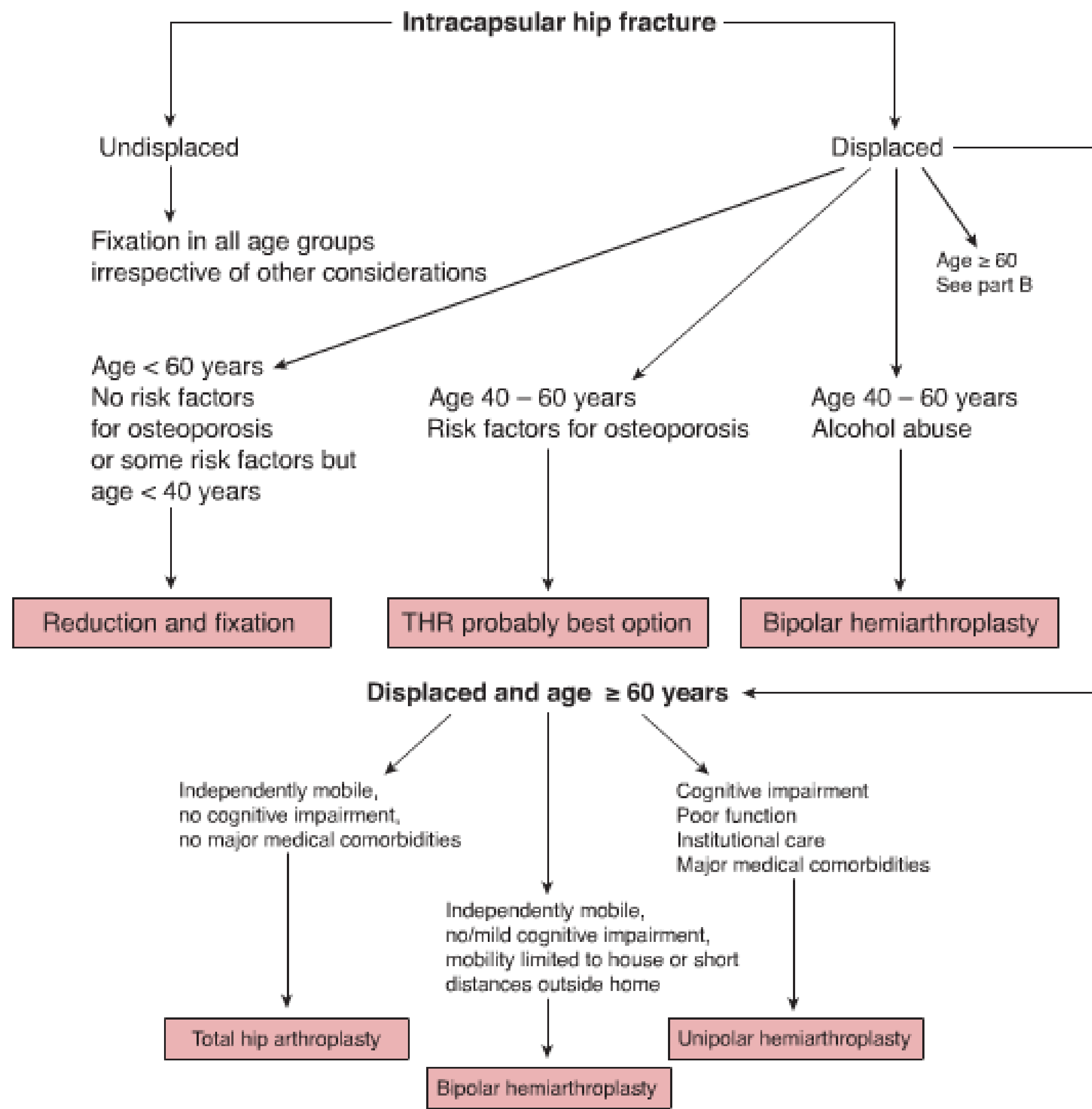


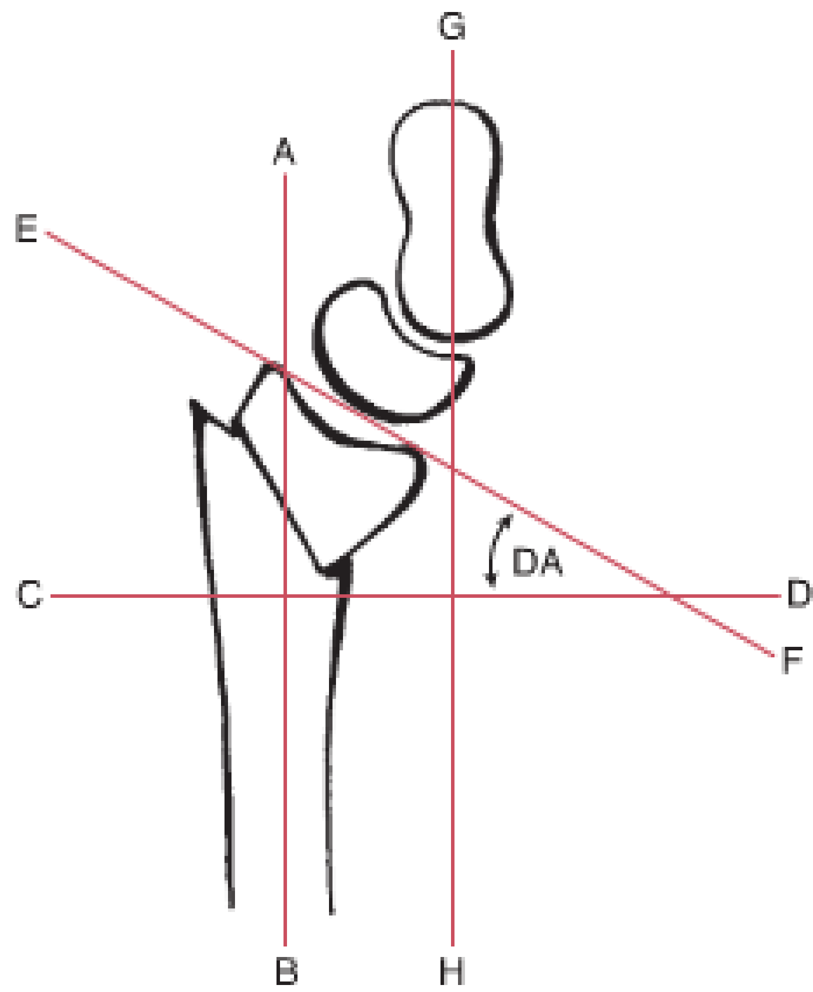
FIGURE 47-17 Ipsilateral femoral neck **(A)** and femoral shaft **(B)** fractures treated by plating and screw fixation.



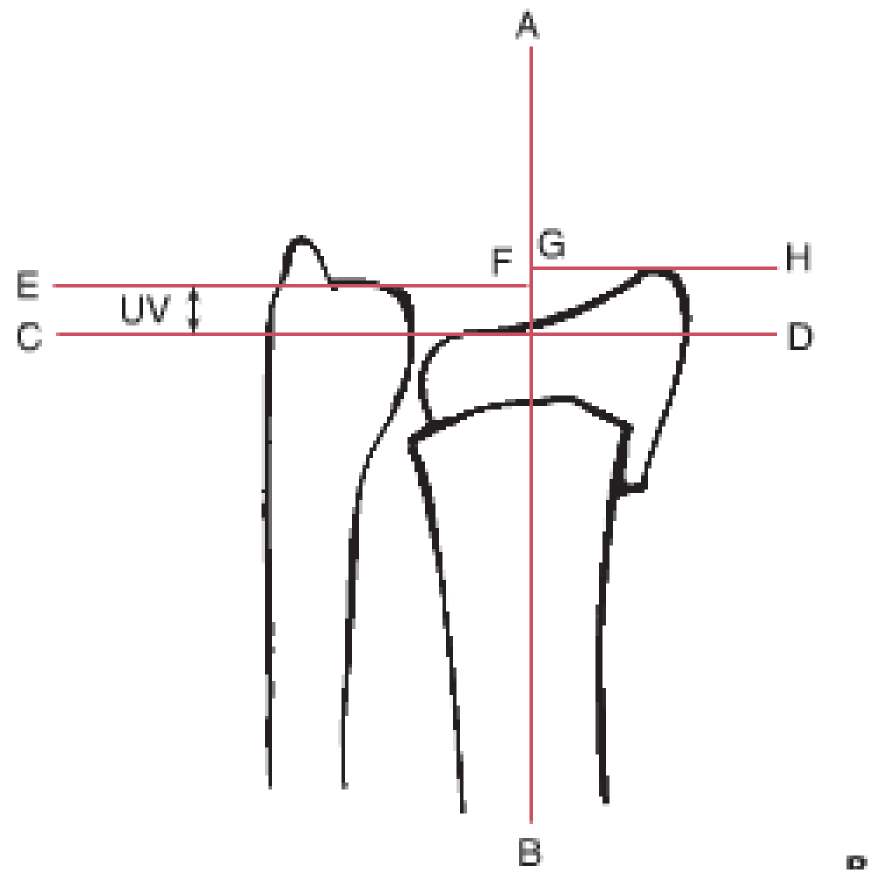
Intracapsular hip fracture
Undisplaced
Displaced
Fixation in all age groups
irrespective of other considerations
Age ≥ 60
See part B
Age < 60 years
No risk factors
for osteoporosis
or some risk factors but
age < 40 years
Age 40 – 60 years
Risk factors for osteoporosis
Age 40 – 60 years
Alcohol abuse
Reduction and fixation
THR probably best option
Bipolar hemiarthroplasty
Displaced and age ≥ 60 years
Independently mobile,
no cognitive impairment,
no major medical comorbidities
Cognitive impairment
Poor function
Institutional care
Major medical comorbidities
Independently mobile,
no/mild cognitive impairment,
mobility limited to house or short
distances outside home
Total hip arthroplasty
Unipolar hemiarthroplasty
Bipolar hemiarthroplasty

Fracture DISTAL RADIUS

- RX ….INDIVIDUALIZED
- PATIENT PROFILE & DEMAND

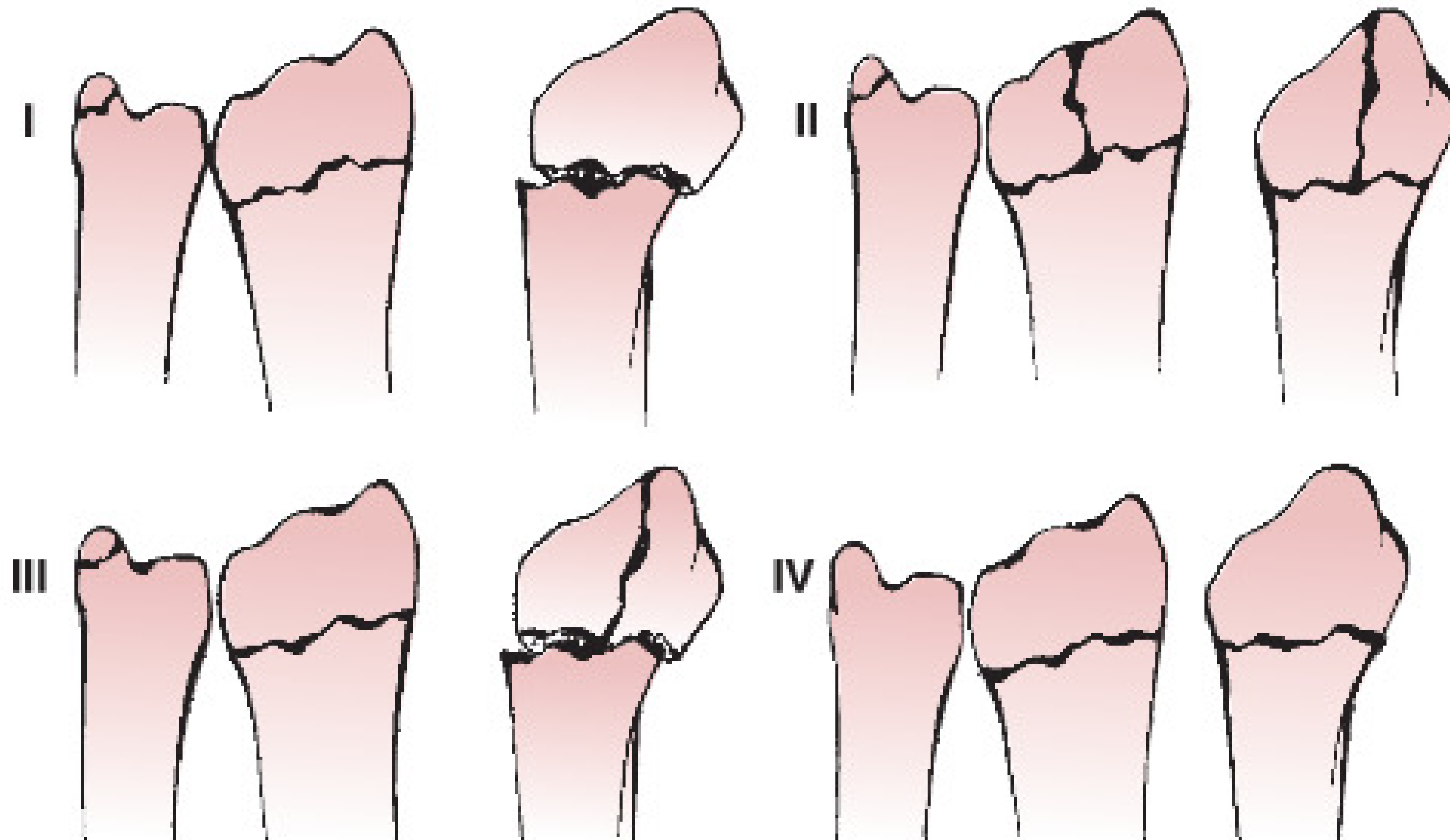


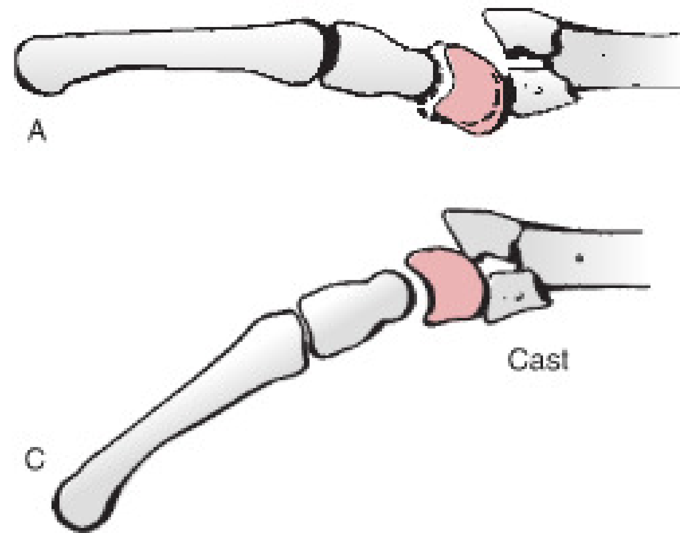
G
A
E
DA
C
D
F
B
H



A
G
F
H
E
UV
C
D
B

*DISPLACED VS UNDISPLACED
*EXTRA-ARTICULAR VS INTR-ARTICULAR





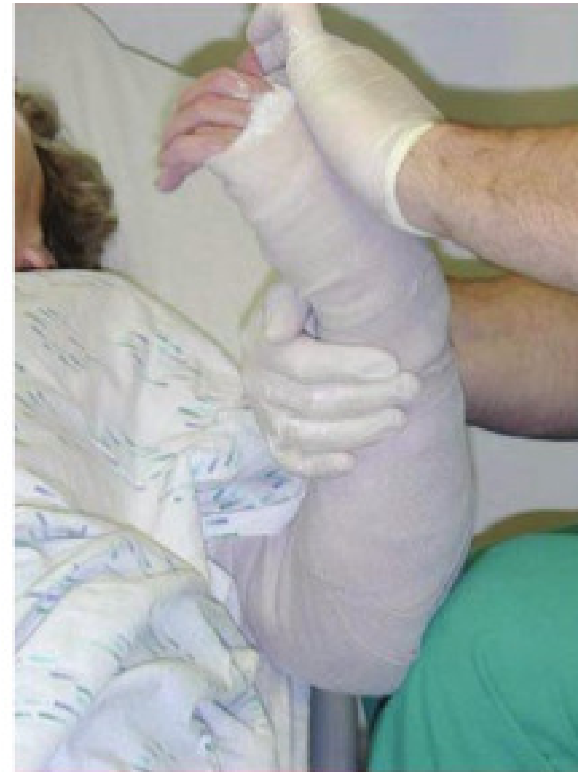
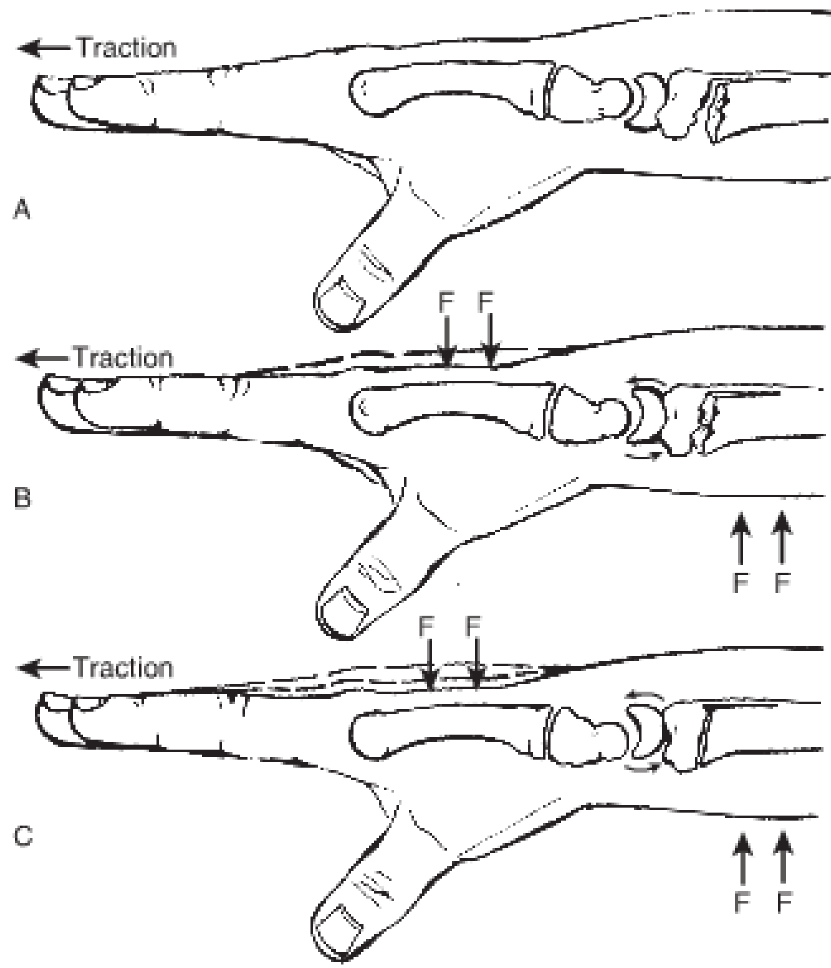
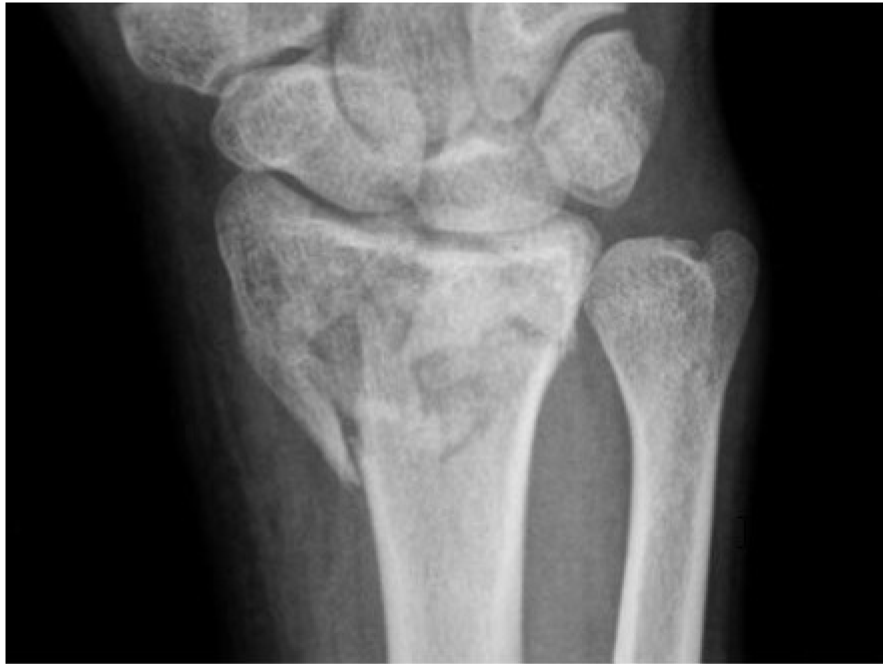
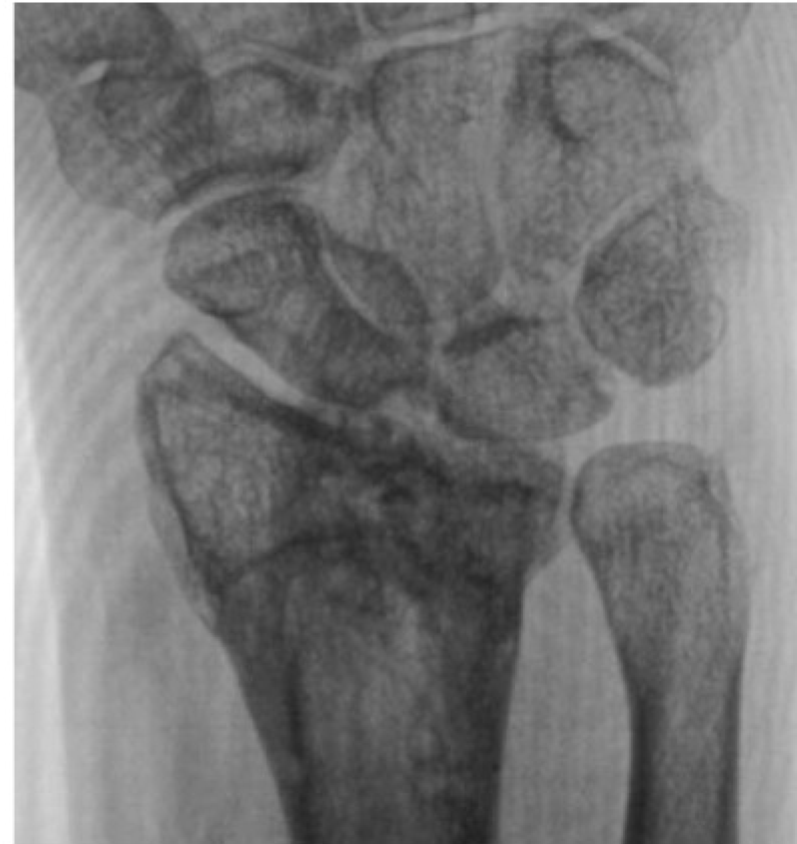


FIGURE 30-15 The fate of the lunate facet with attempted closed treatment of an intra-articular fracture **(A)**. Palmar flexion **(B)**, which is used to restore palmar tilt, results in depression of the volar lunate facet **(C)**.


Traction
A
F F
Traction
B
F F
F F
Traction
C
F F





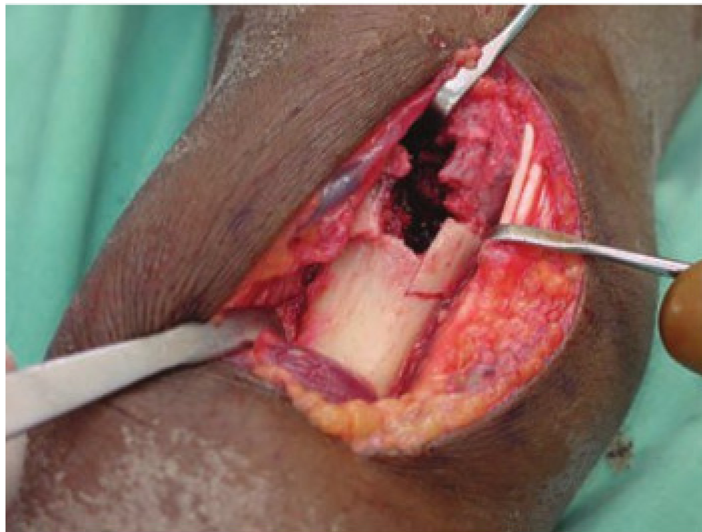


FIGURE 30-19 A,B. A large metaphyseal defect is seen in a young adult with a comminuted fracture. The defect was filled with cancellous autograft and the fracture was stabilized with a dorsal plate. Note the appearance of the metaphysi after healing and plate removal **(C)**.

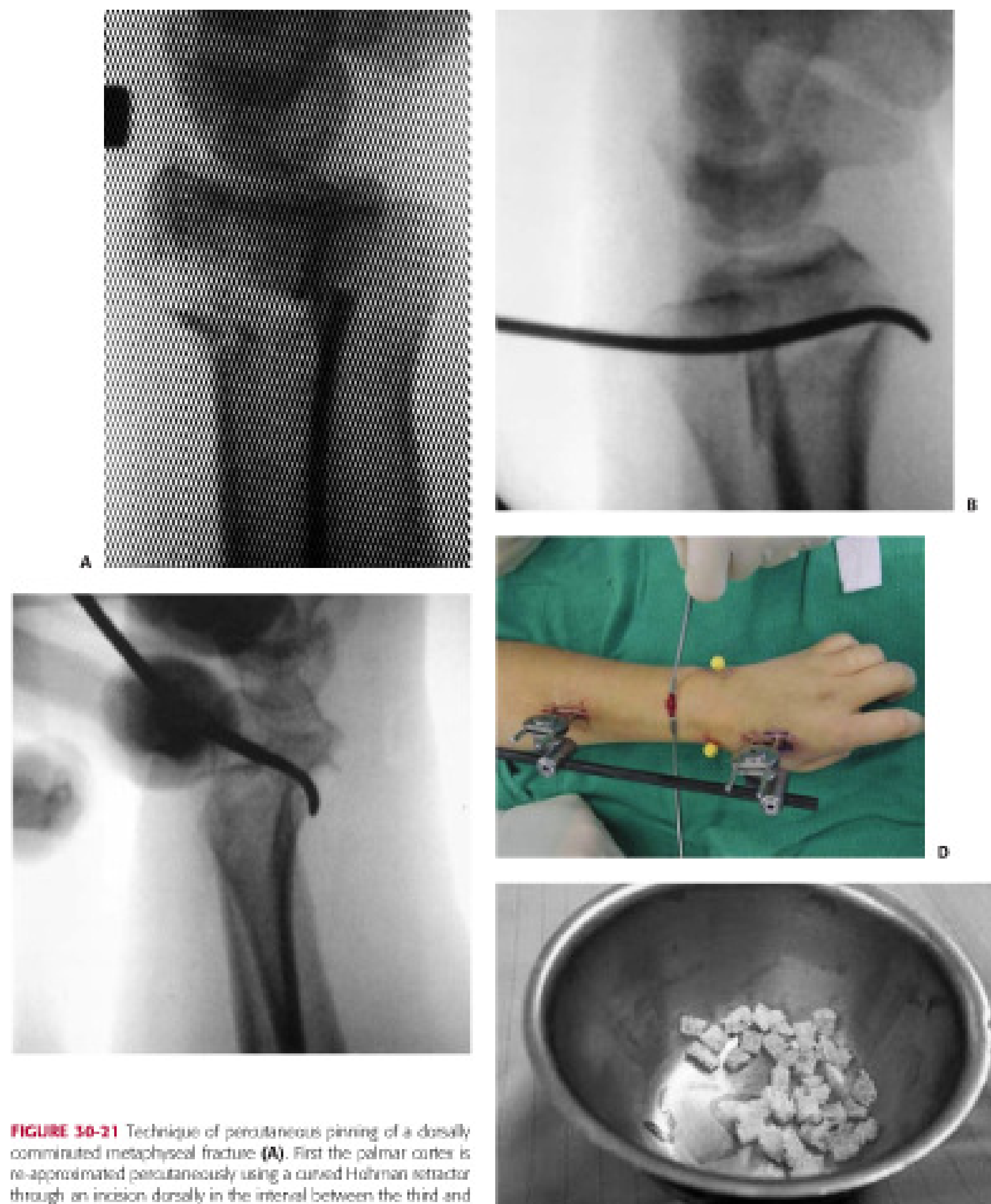
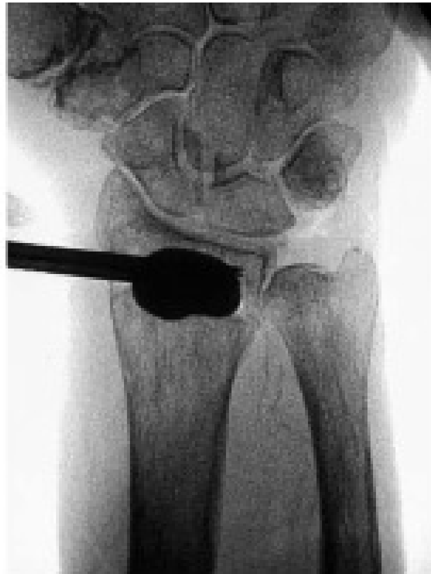


FIGURE 30-21 Technique of percutaneous pinning of a dorsally comminuted metaphyseal fracture **(A)**. First the palmar cortex is re-approximated percutaneously using a curved Hohman retractor through an incision dorsally in the interval between the third and



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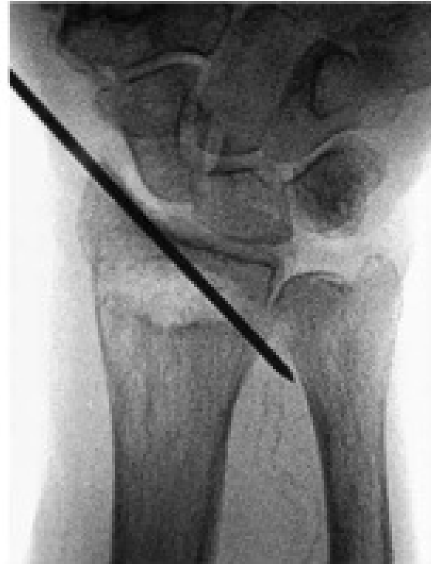

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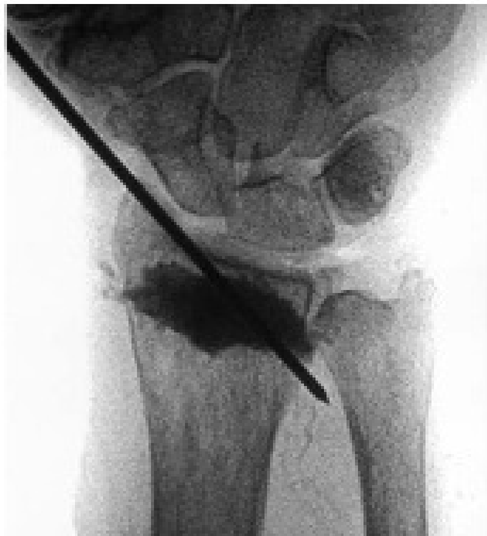

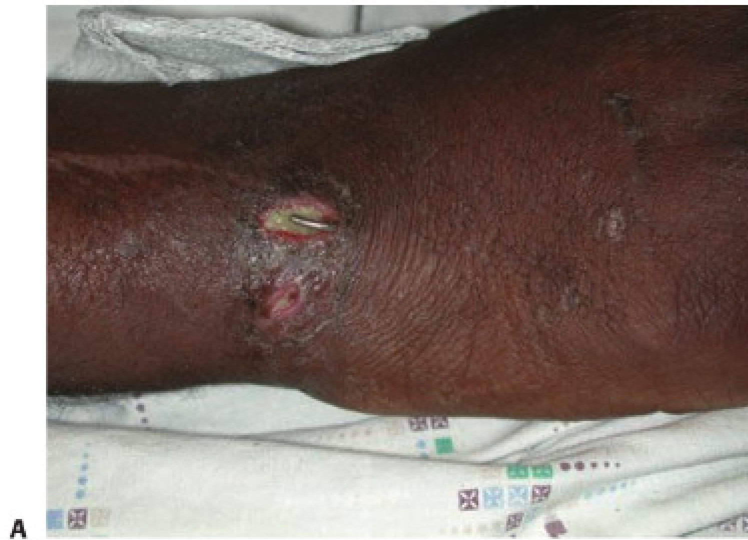

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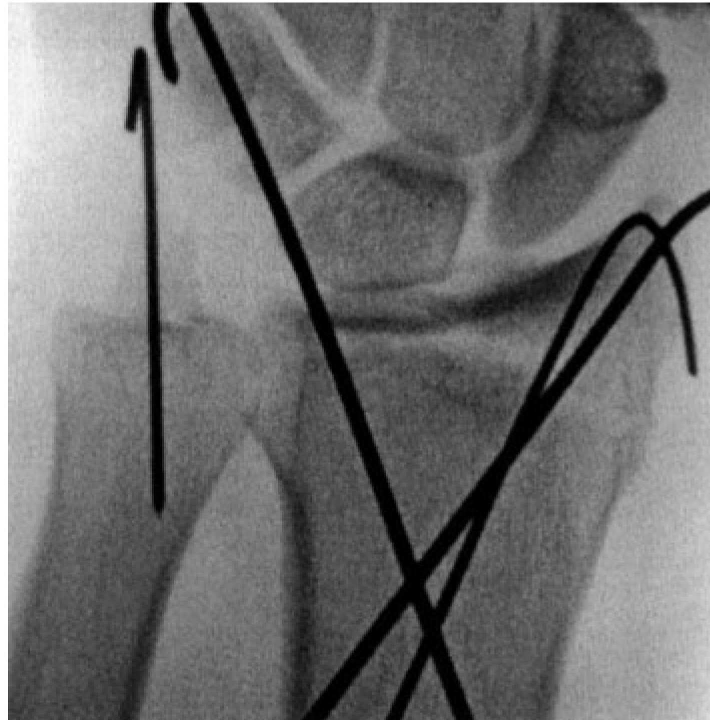

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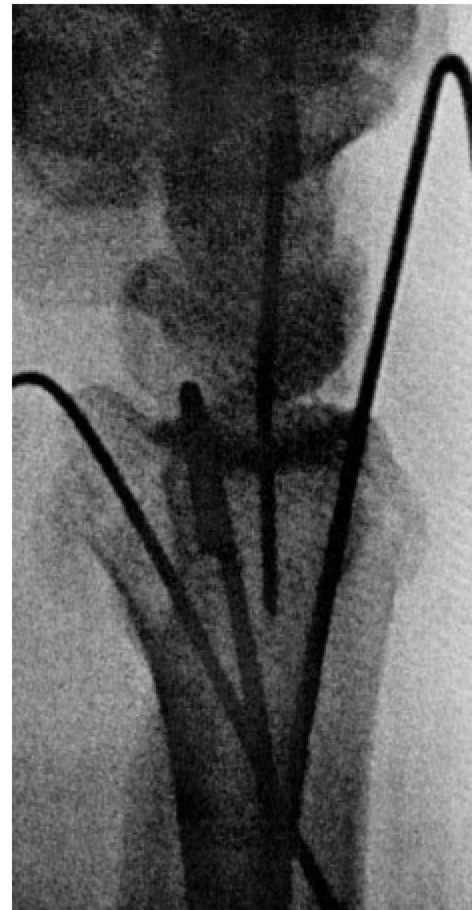


C

FIGURE 30-17 A–C. Comminuted radius fracture in a poly trauma patient treated with percutaneous pinning technique.

Fracture SHAFT of FEMUR

- RESUSCITATE!
- High Velocity
- MULTIPLE INJURIES
- MULTIPLE FRACTURES

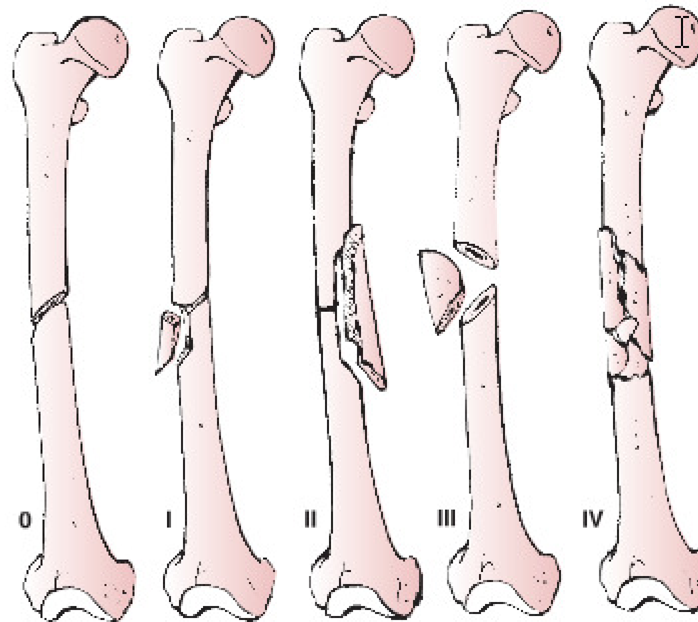


FIGURE 50-2 The Winquist-Hansen classification for diaphyseal femoral comminution. See text and Table 50-1 for explanation.

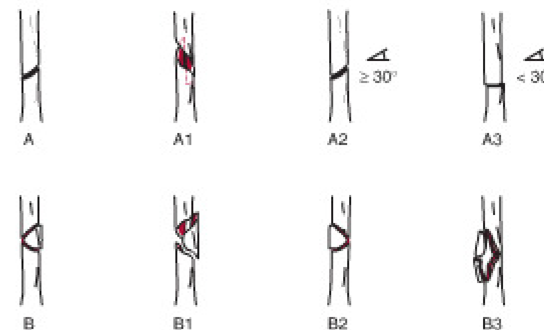
femoral shaft at the fracture site (Fig. 50-2). Grade 0 fractures have no associated comminution. Grade I fractures have a small chip or fragment of comminution. Grade II fractures have a small butterfly fragment, but at least 50% of the cortex remains intact. Grade III fractures have a larger butterfly fragment with minimal cortical abutment predicted. Grade IV fractures have no predicted cortical contact between the fracture fragments and are often referred to as segmentally comminuted. This was originally used to determine whether a locking nail should be used and if so, whether it should be locked statically or dynamically. Grade 0 and I fractures are stable in length and can theoretically be treated without interlocking; grade II fractures are at risk for rotational abnormalities and interlocking is recommended; fractures that are grade III and IV require interlocking to prevent shortening and rotational malunion. However, because of the possibility of unrecognized comminution and the predictable performance of statically locked nails, it is unusual to consider using an unlocked implant with currently available nailing systems and techniques.

The AO–Orthopedic Trauma Association classification is based largely on the fracture morphology and includes the fracture location as well as the degree and type of comminution (Fig. 50-3). Type A fractures are considered simple and include

be useful for documenting and categorizing large numbers of femoral fractures.

Biomechanics of Fracture and Nailing

The femur is subjected to significant bending, axial, and torsional forces that can exceed three to four times body weight during normal activities. The commonly observed fracture pat-



shaft fractures has limited indications. However, temporary external fixation is used with increasing frequency in some valuable circumstances. External fixation is most easily accomplished with a unilateral frame (Fig. 50-8) but circular frames are designed specifically for the femur. Unfortunately, these devices are poorly tolerated by the patient over the extensive time necessary to ensure adequate healing of the femur.

External fixation has several advantages, especially as a temporizing measure for the initial stabilization of a fractured femur. The procedure is rapid, and a temporary external fixator can be reliably applied in less than 30 minutes. This is particularly important in the critically ill patient.[4,34,199,212,245] The vascular supply to the femur is not damaged to a significant degree during the application of an external fixator, and this may be important in high-energy and open injuries with significant damage to the extraosseous and intraosseous blood supply. No additional foreign material is introduced in the region of the fracture, which may be particularly advantageous in open fracture infections occur commonly and are related to the time the fixator is in place, the amount of soft tissues that the pins must traverse, and the sterility at the time of the initial application.[117] Loss of knee motion occurs commonly. Angular malunion and femoral shortening occur more frequently than with other methods. There are still concerns about the potential increased infection risk associated with conversion of an external fixator to another definitive treatment methods. Finally, unilateral external fixation has limited ability to adequately stabilize the femoral shaft. This is largely because of the large weight of the leg combined with the distance between the femoral shaft and the bar of the external fixator.

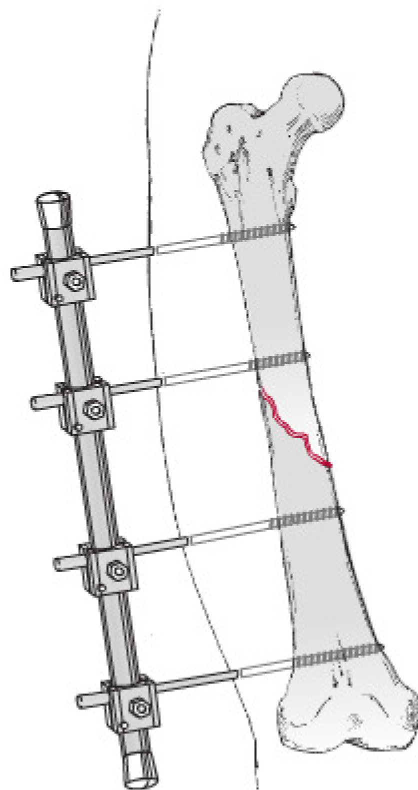


FIGURE 50-8 Association for the Study of Internal Fixation external half pin fixator used for temporary stabilization of a shaft fracture.

Indications

The indications for external fixation (Table 50-2) are continuing to evolve.* Initially, extensive comminution and open fractures were considered to be relative indications for the use of femoral external fixation as a definitive treatment for femoral shaft fractures. However, as other treatment methods such as intramedullary nailing have continued to improve and low complication rates have been demonstrated with nails even in the most complex injuries, the indications for the use of external fixation have become more limited. Currently, the primary indications include use as a temporary bridge to intramedullary nailing (Fig. 50-9), use in the severely injured patient who cannot tolerate reaming and/or placement of a medullary implant as a form of damage control orthopaedics, use in a patient with an ipsilateral arterial injury that require repair, and in patients with severe soft tissue contamination in whom a second debridement would be limited by other devices. Which patients are more suitable for initial placement of an external fixator followed by secondary conversion to a medullary implant continues to be better defined but includes patients with a severe head injury, elevated Injury Severity Score (ISS), associated thoracic trauma, or multiple extremity injuries. In patients with an accompanying ipsilateral arterial injury, an external fixator can be rapidly applied, produces temporary stability of the limb, and can easily be converted to another form of stabilization.[127]

*References 4,34,68,127,185,199,212–214,235,245.

TABLE 50-2 Indications for External Fixation

Severe soft tissue injuries with extensive contamination
Evolving muscular crush that requires an extensive secondary debridement
Medullary contamination
Associated vascular injury requiring stabilization prior to repair
Polytrauma or injuries that prevent other treatments; as a temporary bridge to femoral nailing (damage-control orthopaedics)

However, in this circumstance the rate of nonunion is likely increased by the combination of the injury and surgical exposure. One should consider that any salvage procedures in this scenario will require a repeat surgical exposure through a scarred medial approach around a vascular repair.

Technique

The patient can be positioned supine or lateral on a completely radiolucent table to allow unimpeded fluoroscopic imaging of the femur from the hip to the knee. Lateral positioning eases the retraction of the vastus lateralis in open techniques but may not be applicable in the polytraumatized patient. In addition, proximal imaging can be more difficult with the patient positioned laterally. For supine positioning, the entire limb should be prepped in the surgical field, including the groin to allow access to femoral vessels if necessary. A small bump beneath the ipsilateral hip helps to internally rotate the limb to neutral, simplifying the surgical approach and making the intraoperative assessment of rotation easier. A radiolucent ramp or several folded blankets placed beneath the thigh and leg improves the lateral fluoroscopic imaging by elevating the leg relative to the contralateral extremity.

Depending on the fracture configuration, an open or a submuscular technique may be applicable. For simple fracture patterns that allow an accurate cortical reduction of the majority of the femoral shaft, an open technique with compression plating using AO principles is advisable. However, in fracture patterns that have near circumferential or segmental comminution, bridge plating techniques are applicable. This can be accomplished with submuscular plate placement or an open technique that leaves all the intercalary comminuted segments undisturbed. No matter what technique is chosen, the vascularity to the femoral shaft and the associated fracture segments should be preserved.

For open compression plating of simple fracture patterns, a lateral incision is used. The length of the incision should be of adequate size to allow placement of a long plate directly on the lateral femur without traumatic retraction of the muscular envelope. The iliotibial band is sharply incised along the length of the incision. The vastus lateralis is then atraumatically elevated from the posterior limb of its fascia, from distal to proximal. The perforating vessels should be sequentially identified, isolated, and ligated. The muscle can then be elevated off the periosteum at the lateral femur. No periosteal stripping is necessary, and no deep retractors placed over the anterior femur

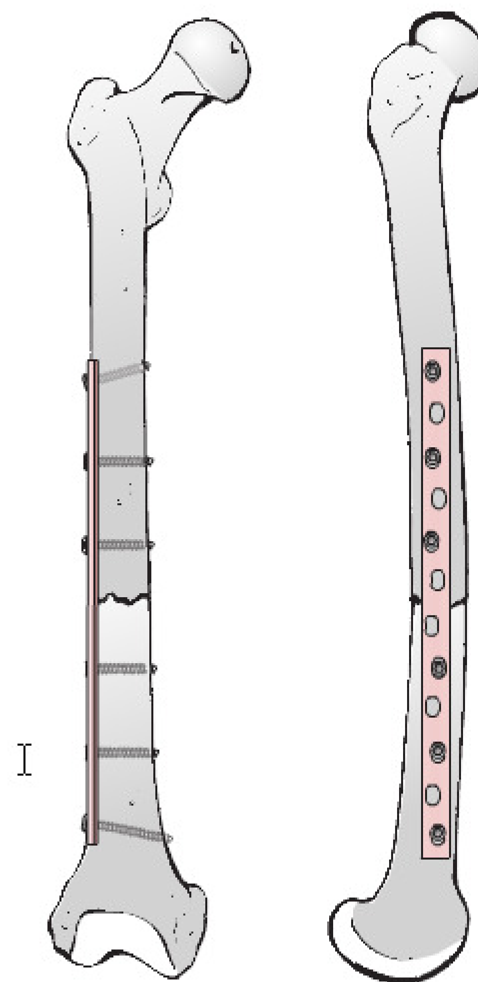
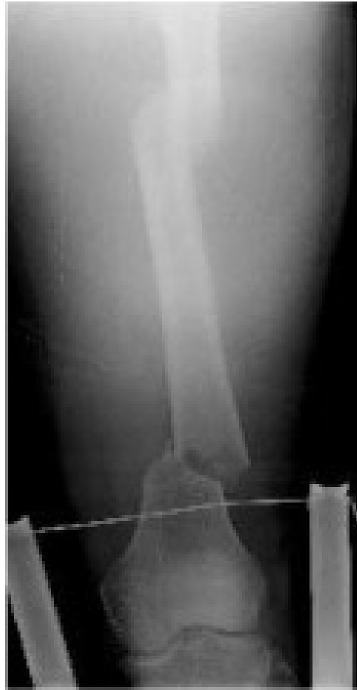


FIGURE 50-10 Femoral plating for a simple fracture pattern. Plate length and screw position are more important than screw number.

considered a minimum length. The choice of a broad or a narrow plate depends on the femoral diameter and the size of the patient. As the fracture comminution increases, so should the plate length such that at least five screw holes of plate length are present on each side of the fracture (Fig. 50-10). For transverse fractures, appropriate over-contouring of the plate should be performed, and the fracture should be appropriately compressed. This can be accomplished with a pull screw, the articu-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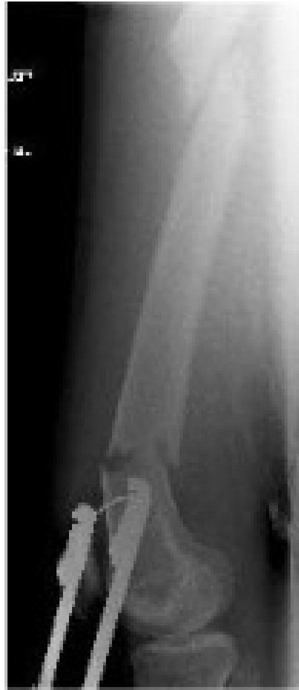
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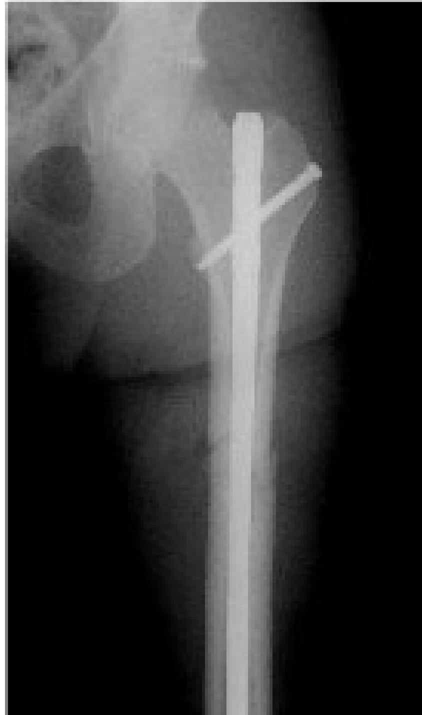
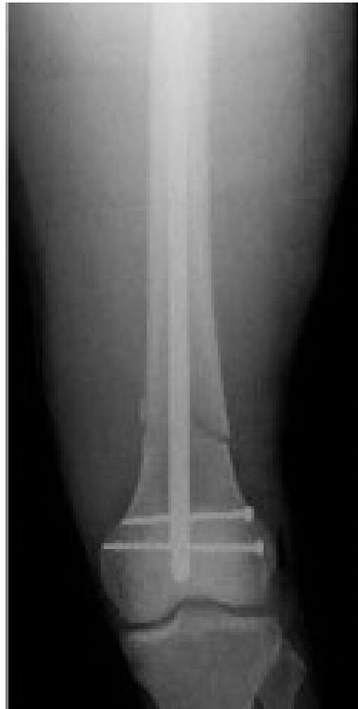
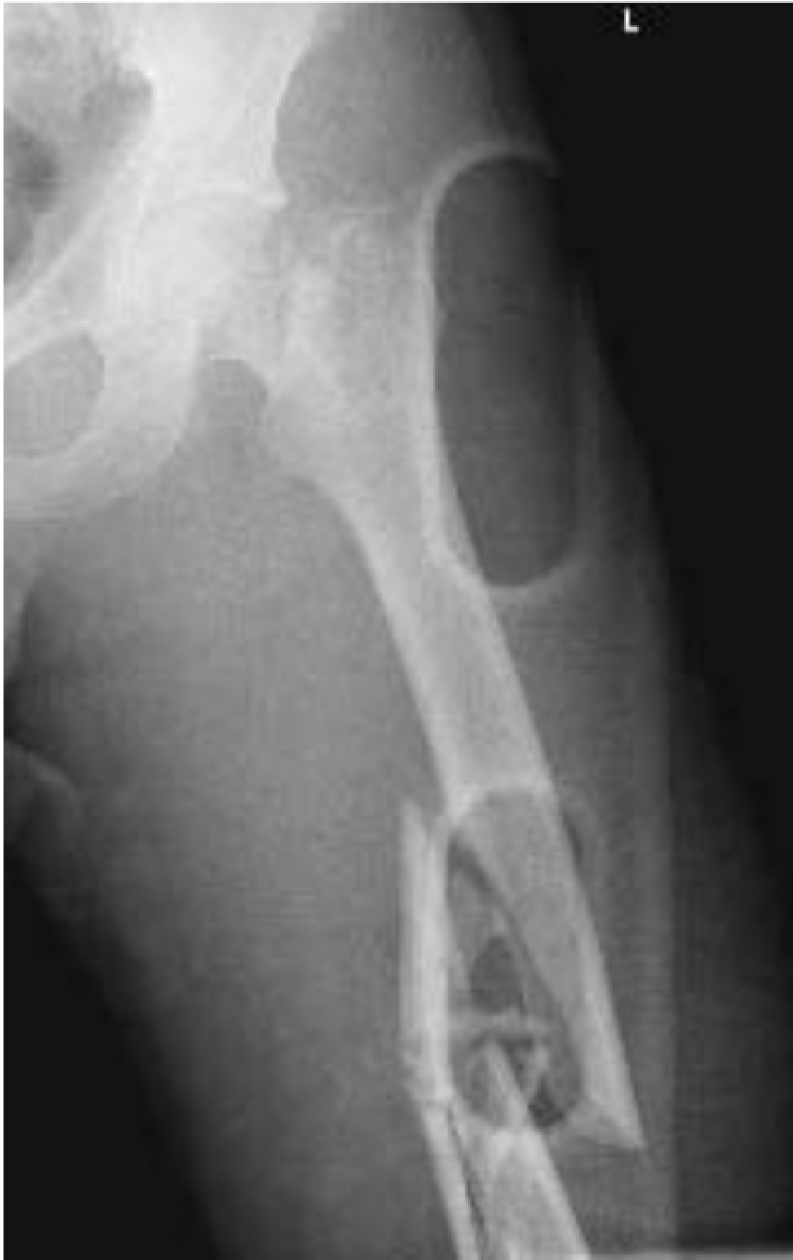




NEXT SLIDE….REMEMBER!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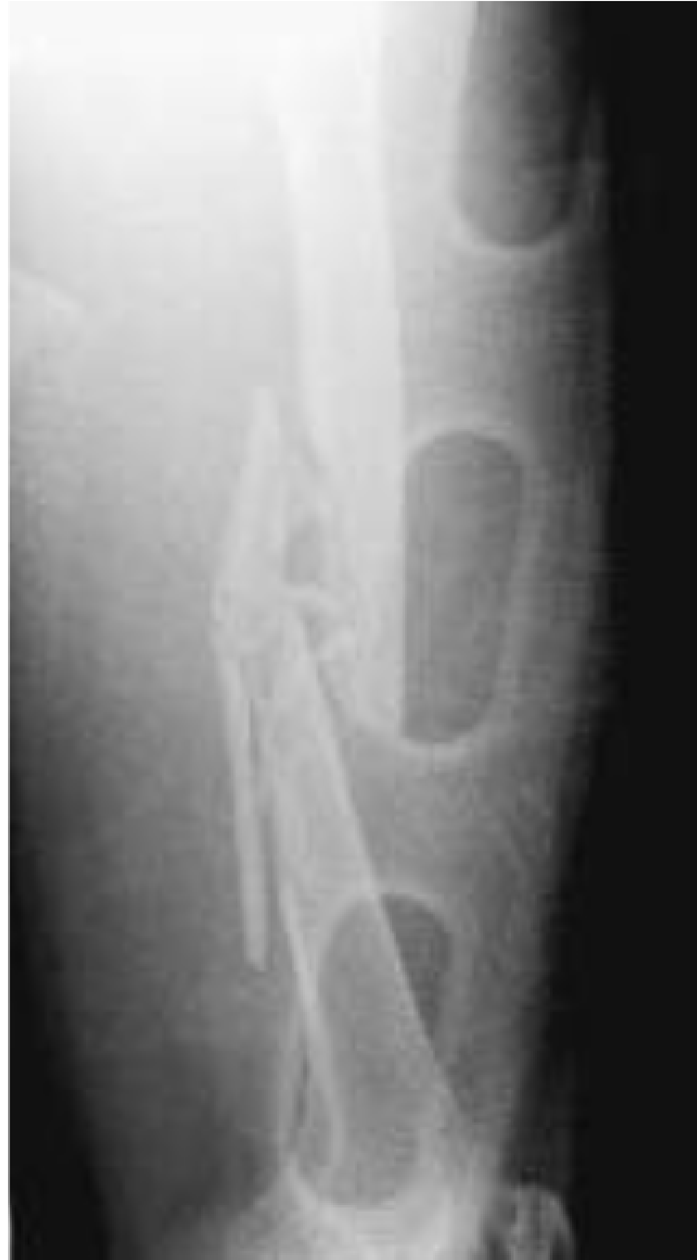
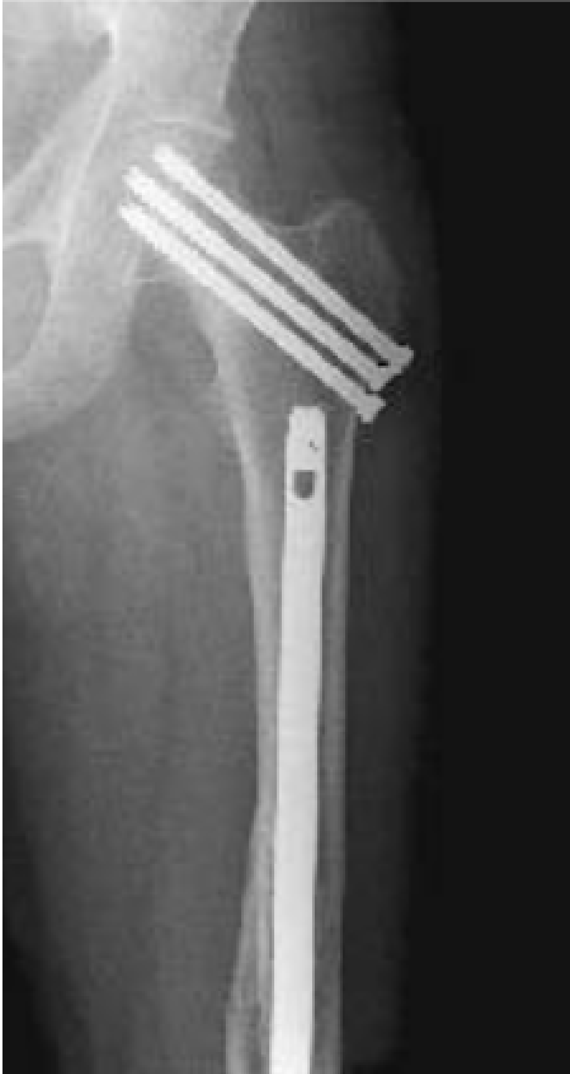
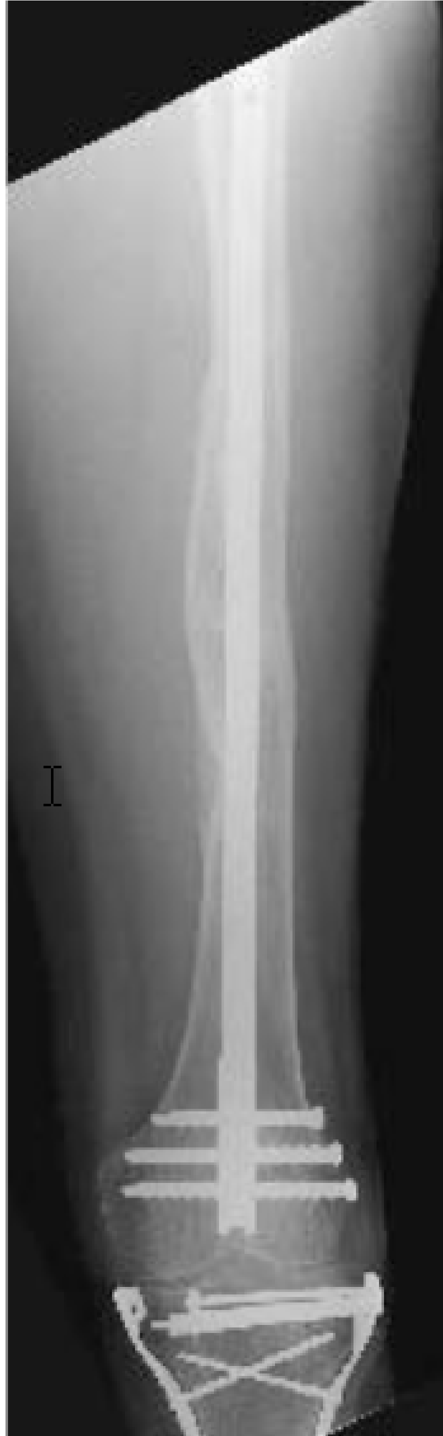
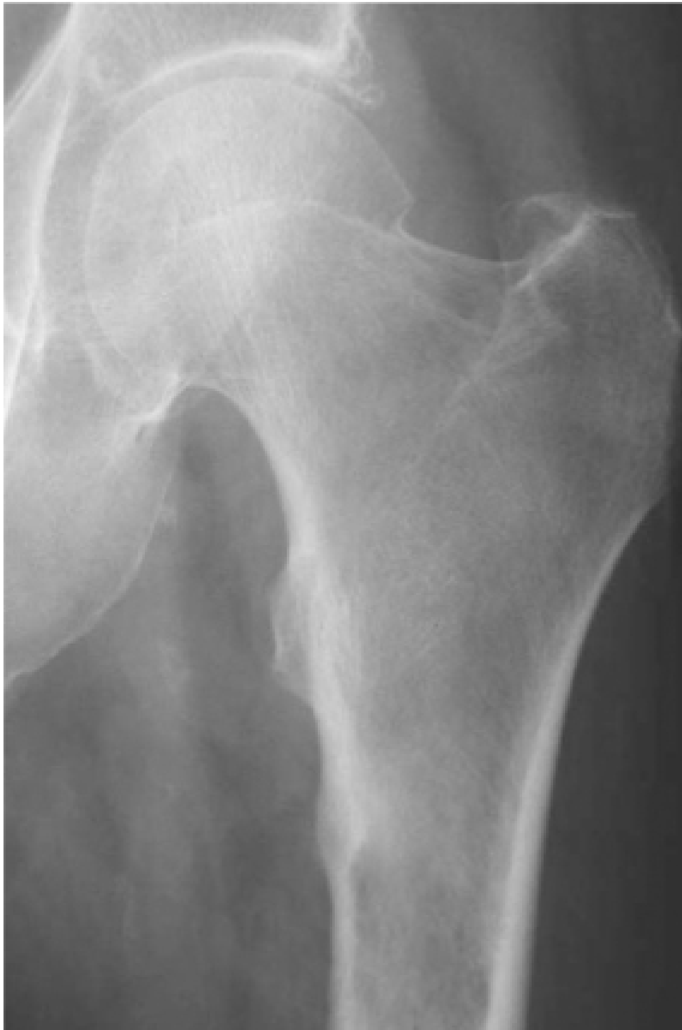
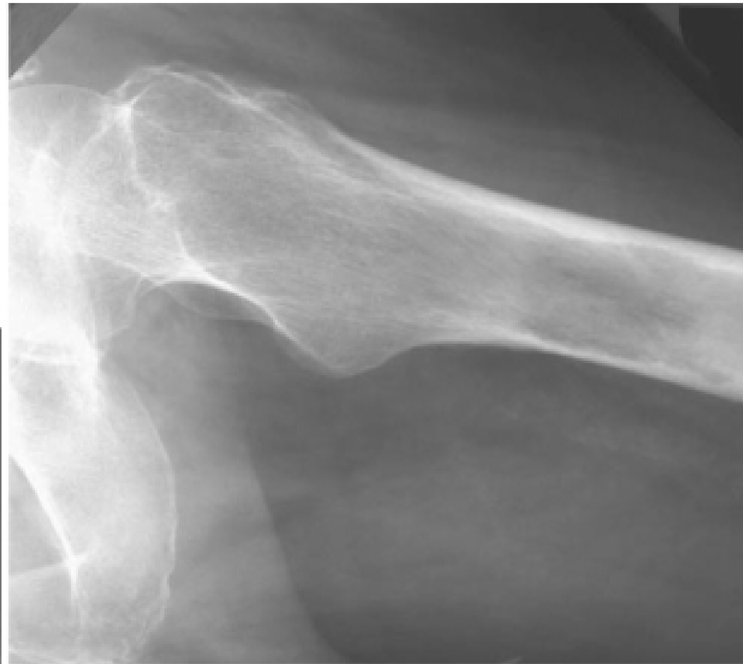


ATYPICAL FRACTURE

FIGURE 50-32 This elderly woman sustained a su
trochanteric fracture after a fall from standing. She h
been treated with alendronate for a number of yea
and had a several month history of proximal thigh pa
prior to her fracture. The fracture is relatively transver
and there is associated cortical hypertrophy in the su
trochanteric region (**A**). Treatment consisted of plac
ment of a cephalomedullary nail with a helical bla
(**B,C**). Healing progressed uneventfully as demo
strated at 5 years (**D,E**). (Case courtesy of Dean Lori





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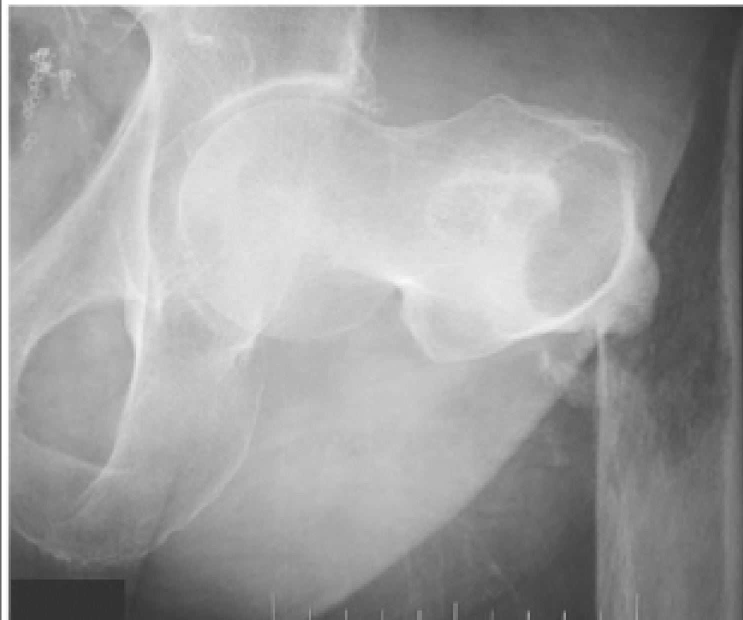

- DON’T MISS ASSOCIATED INJURIES
- DON’T MISS MULTIPLE FRACTURES
- DON’T MISS NEUROVASCULAR Cx
- AVOID COMPLICATIONS DURING Rx

- REHABILITATION!!! RETURN of FUNCTION