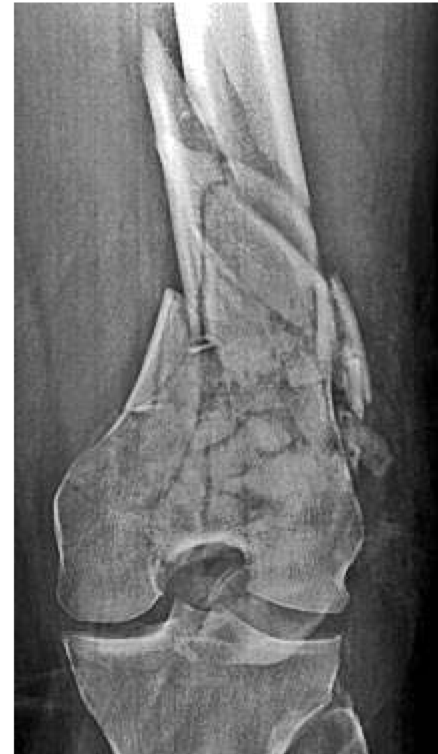
Daniel Dowen
ST3
Sunderland Royal Hospital

Distal femoral fractures

Introduction

- Background
- History
- Mechanism
- Classification
- Management
- Periprosthetic fractures



Background

- Distal 9-15cm femur
  - Distal femoral metaphysis (supracondylar)
  - Articular (Intracondylar)
- 7% of all femoral fractures

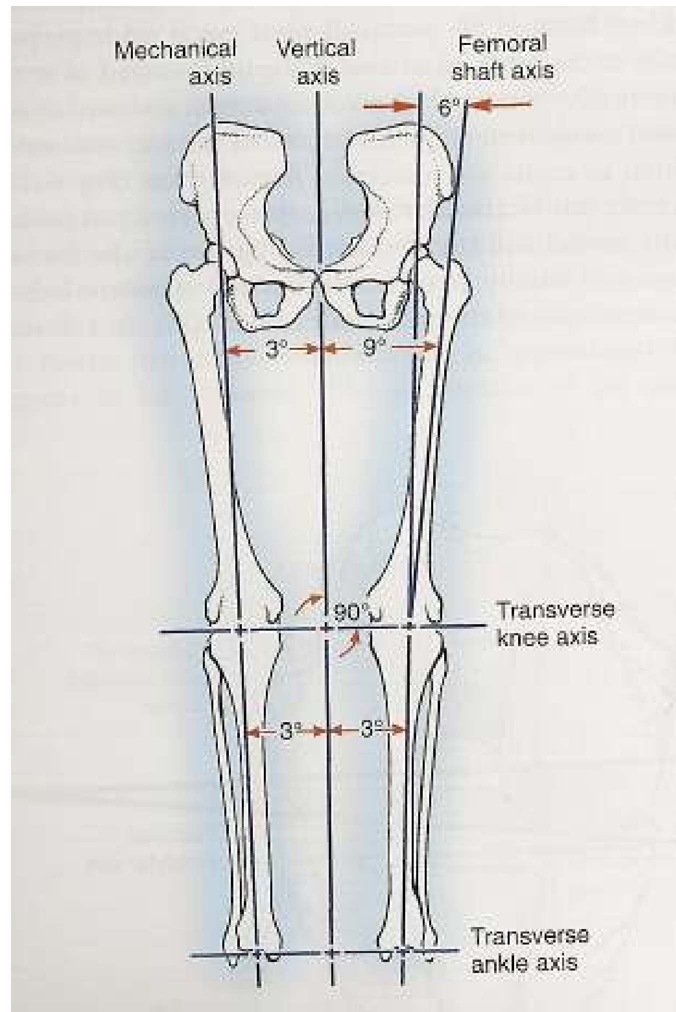
History

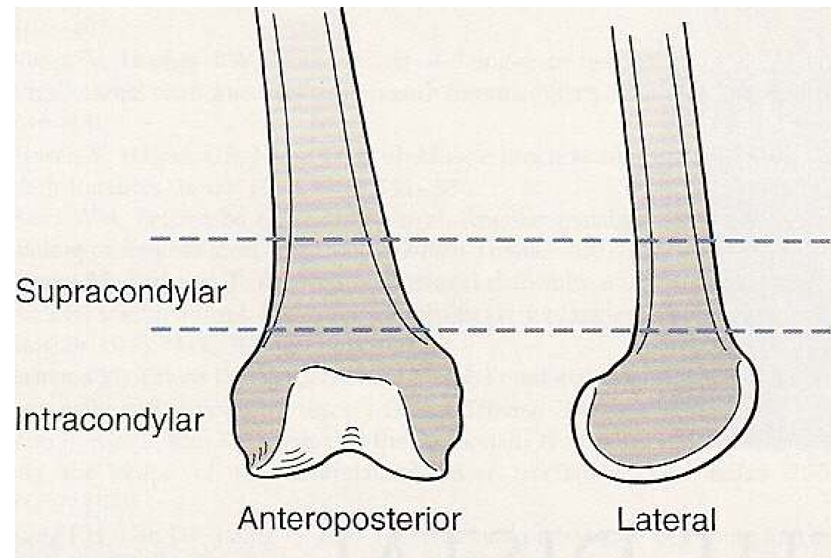
- Studies 1960's documented conservative > operative
    - Complications
        - Angular deformity
        - Joint incongruity
        - Knee stiffness
        - Delayed mobilisation

History…

- 1970's
  - AO principles and angled blade plate
  - Revolutionised management
  - Last 30 yrs trend towards reduction & surgical stabilisation

Anatomy

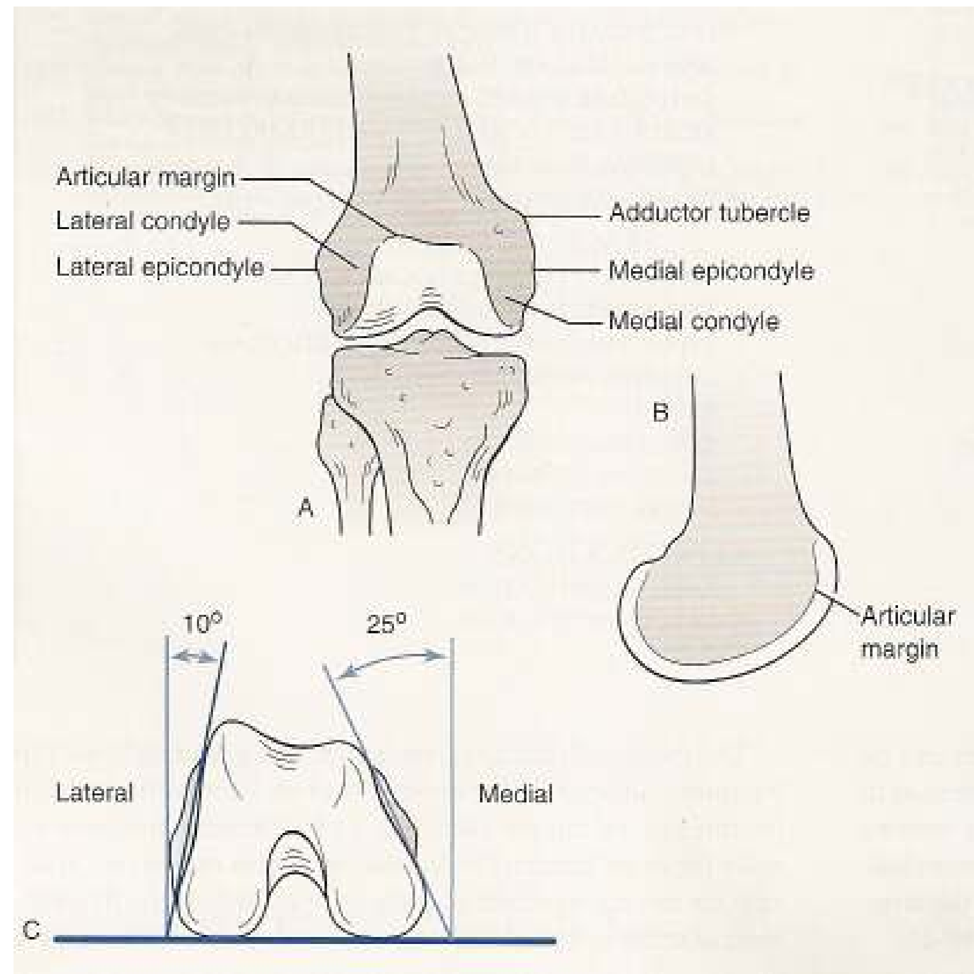




Anatomy...

- Bony
  - Medial condyle longer & extends distal
  - Medial epicondyle MCL
  - Adductor tubercle
  - Anatomic axis 9°

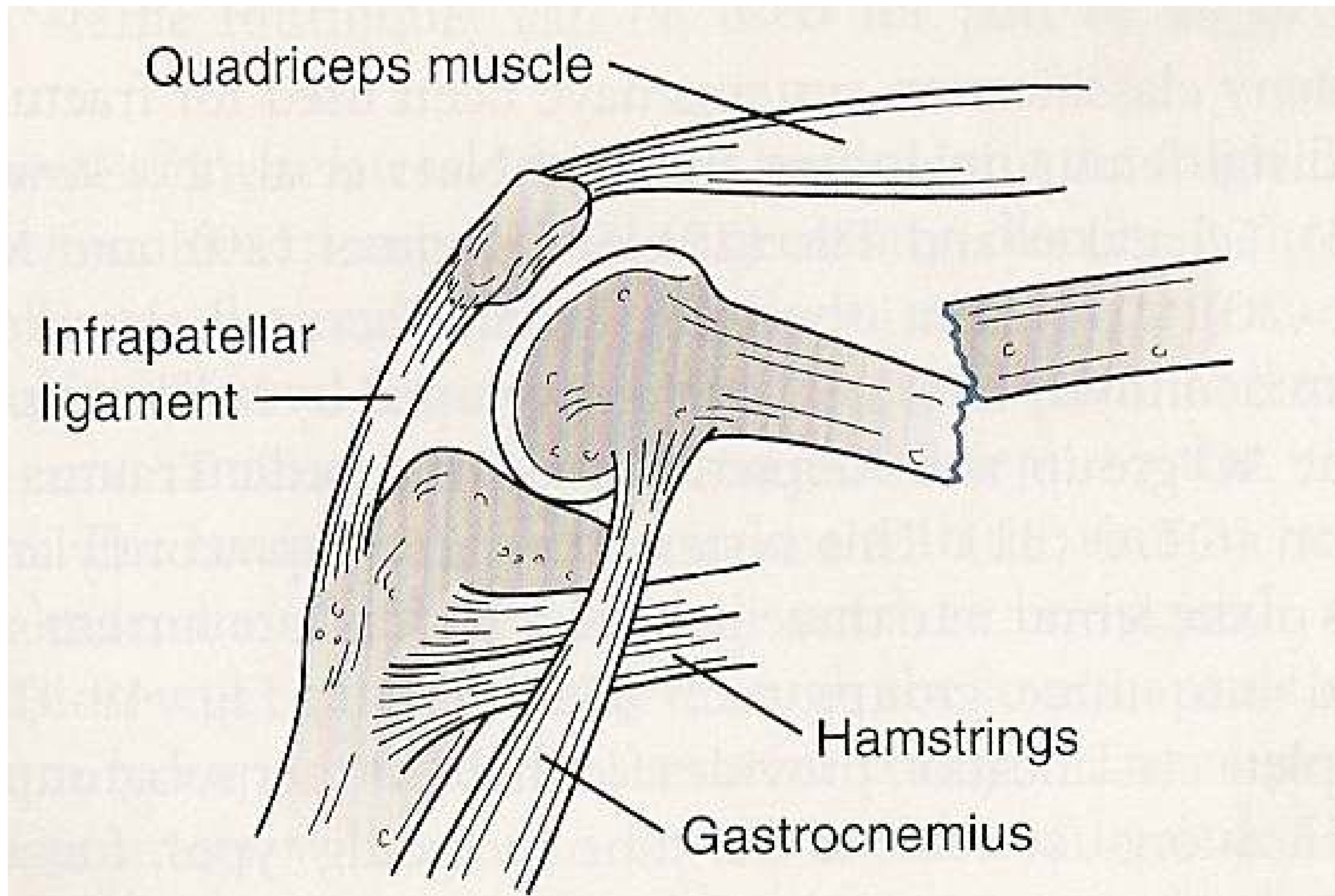
Anatomy…



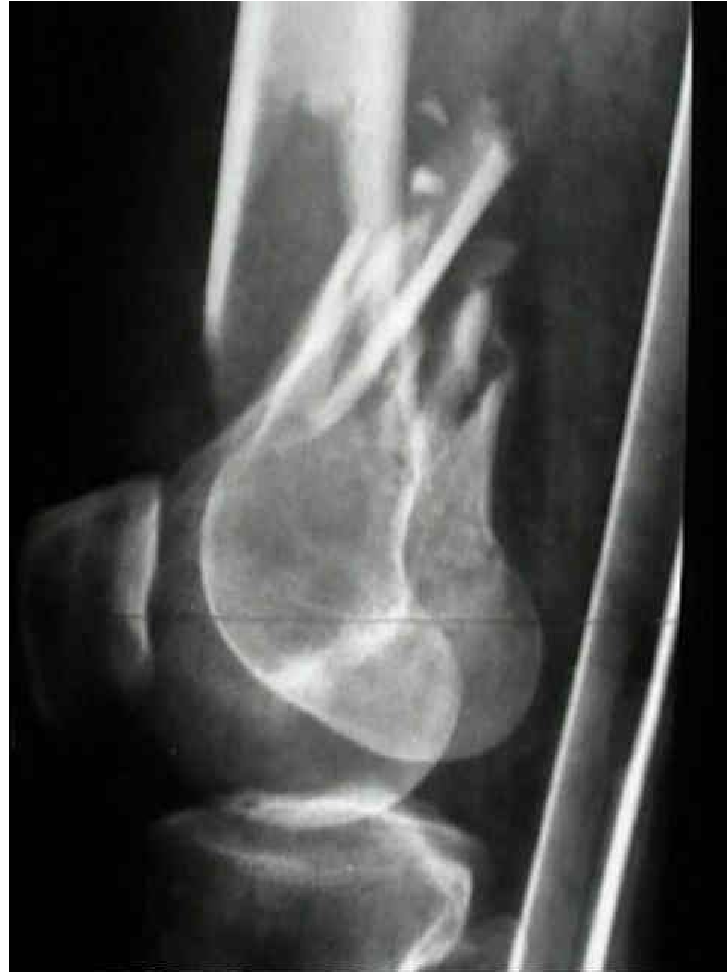
Anatomy...

- Soft tissue
  - Quadriceps
  - Seperated from post compartment by medial and lateral intermuscular septa
  - Medial and lateral heads of gastrocnemius
  - Femoral artery 10cm above knee joint

Deforming forces



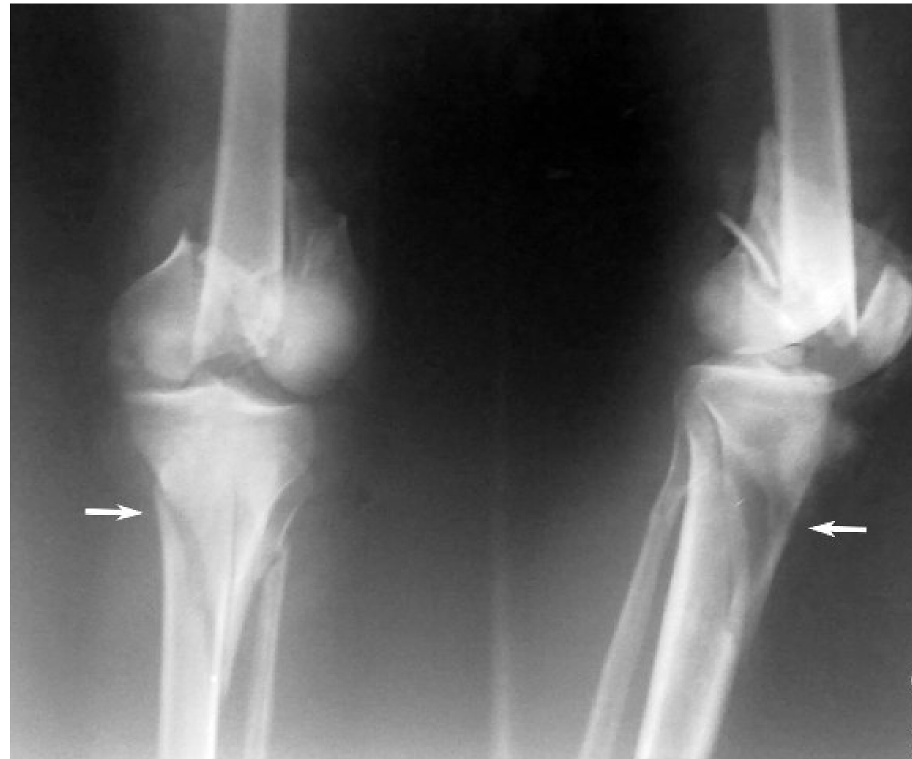
Deforming forces…



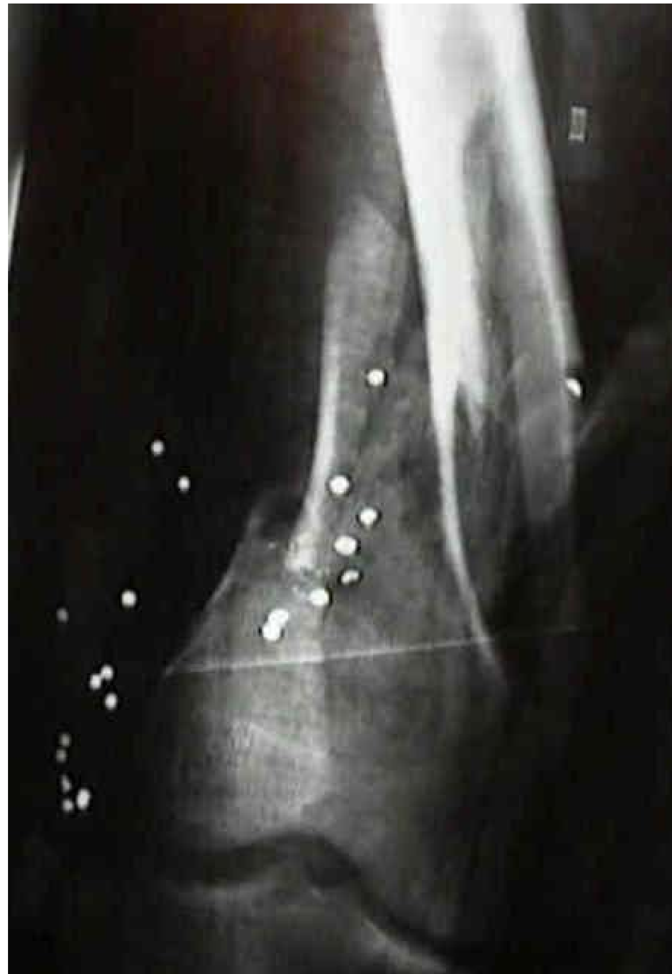
Mechanism

- Axial load to flexed knee
- Bimodal distribution
  - Low energy elderly osteoporotic
  - High energy young
- Associated injury
  - Vascular injury 2-3%
  - Knee ligament injury 20%[1]
  - Tibial plateau fractures
  - Open

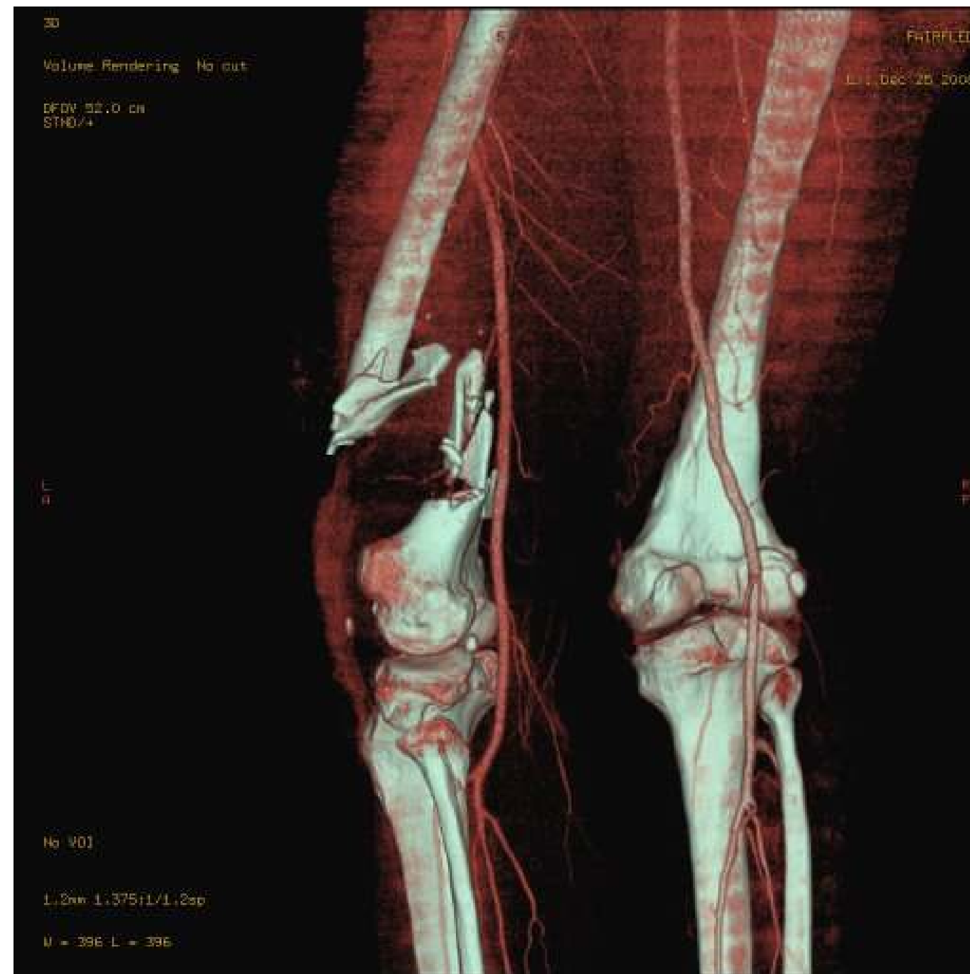
Associated injuries



Associated injuries

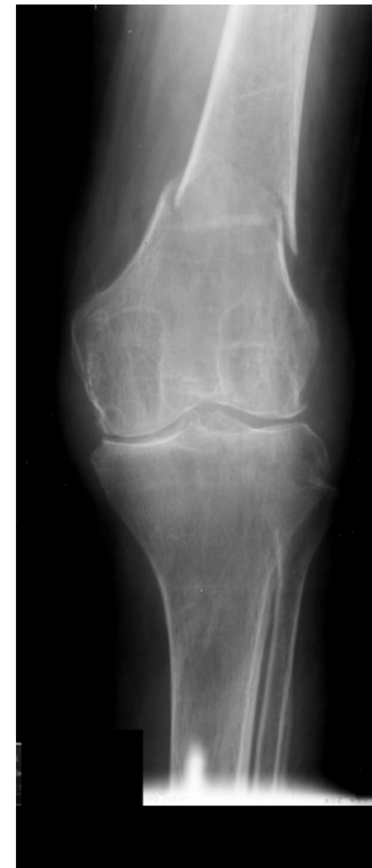


Associated injuries



Classification

- AO (Muller classification)
  - A
    - Extra-articular (Transverse)
  - B
    - Unicondylar
      - B1 Lateral condyle saggital
      - B2 Medial condyle saggital
      - B3 Coronal (Hoffa fracture)



Classification…

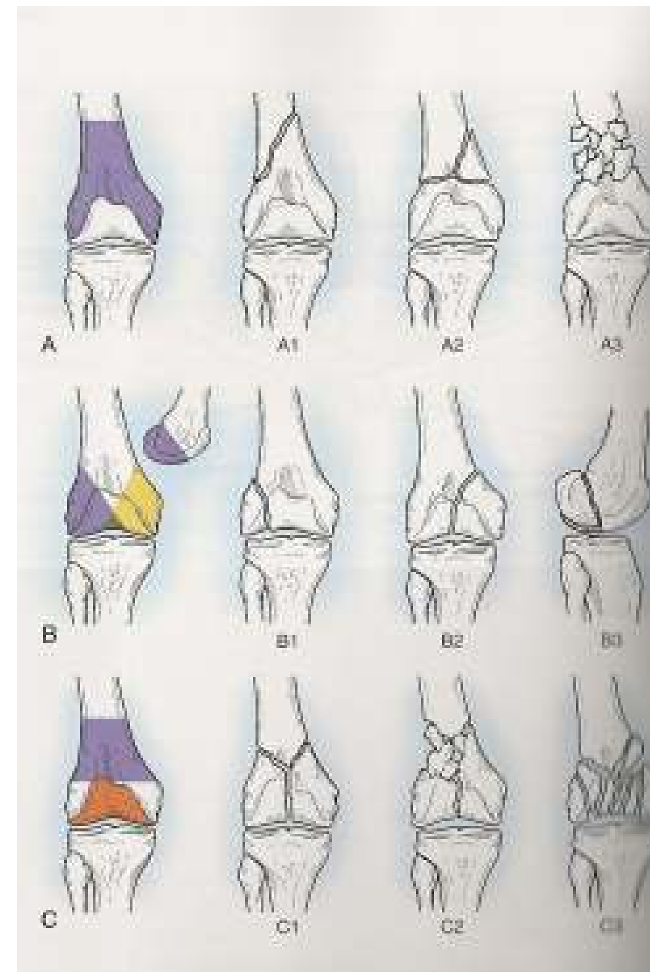
- C
  - Biconcylar fracture
    - C1 T condylar & Y condylar
    - C2 Comminuted shaft & 2 articular fragments
    - C3 Intraarticular comminution

Muller classification

- A Extraarticular
- A1 Simple
- A2 Metaphyseal wedge
- A3 Metaphyseal complex

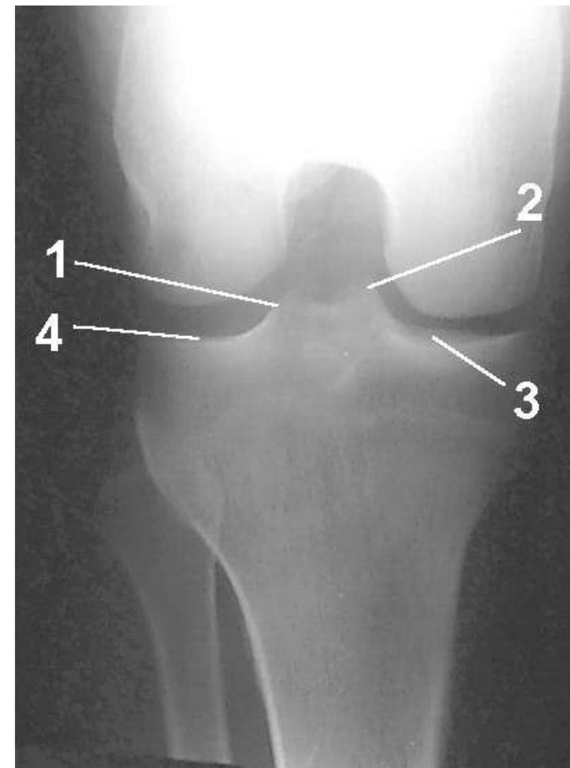
- B Partial articular
- B1 Lat condyle (sagittal)
- B2 Med condyle (saggital)
- B3 Hoffa (coronal)

- C Complete articular
- C1 Articular simple
- C2 Articular simple metaph comminution
- C3 Multifragmentary articular



Imaging

- X-Ray
  - AP
  - Lateral
  - Tunnel view
  - 45° oblique
- CT
- MRI



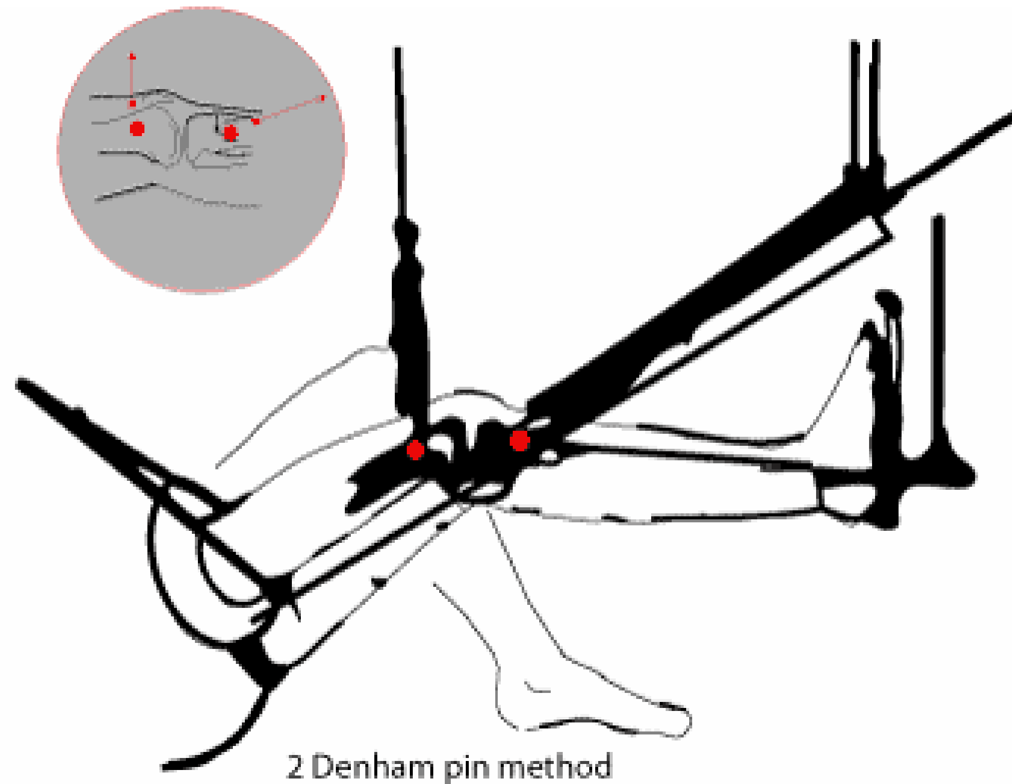
Non operative management

- Patient factors
  - Medical contraindications
  - Nonambulatory patients
- Fracture factors
  - Undisplaced
  - Impacted stable
  - Unreconstructable
  - Severe osteopenia

Non operative management…

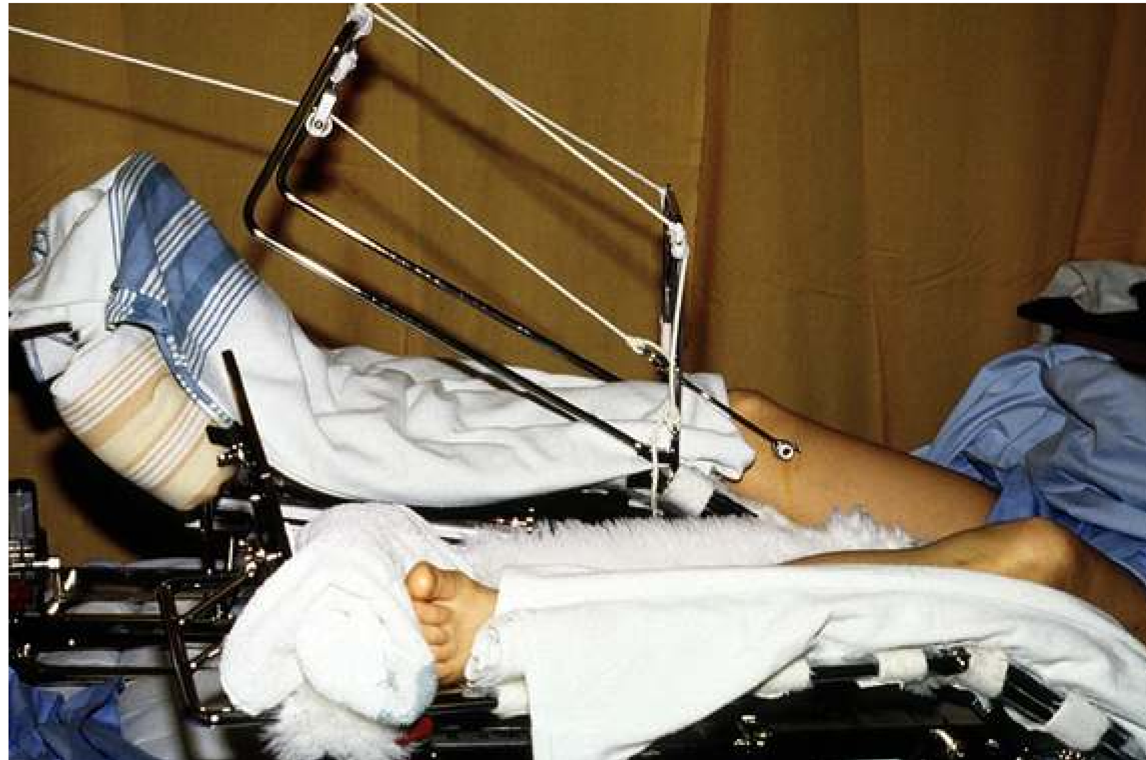
- Surgeon factors
  - Lack of experience
  - Unavailability of appropriate instrumentation

Non operative management



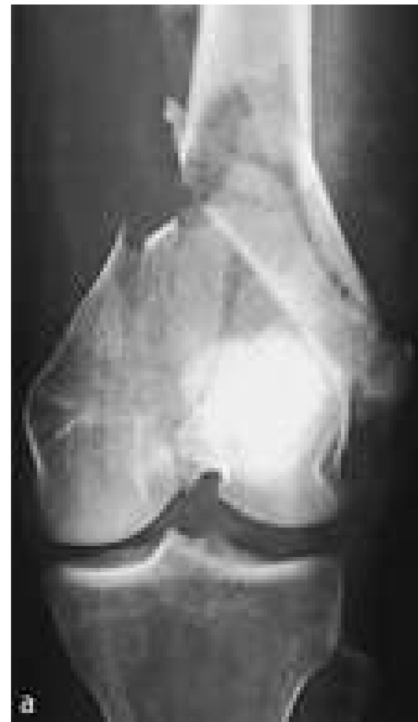
2 Denham pin method

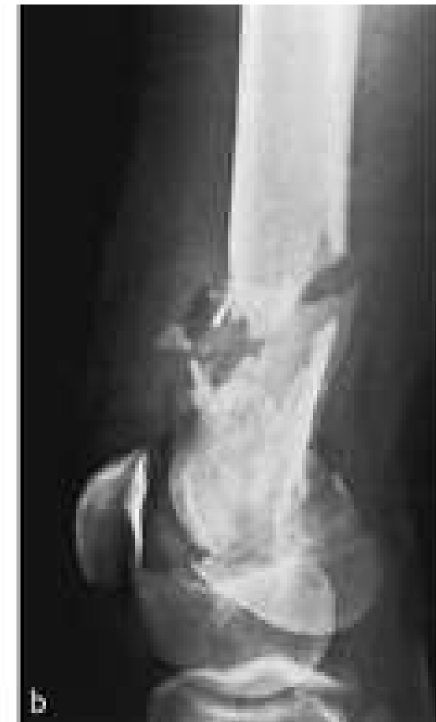
Non operative management



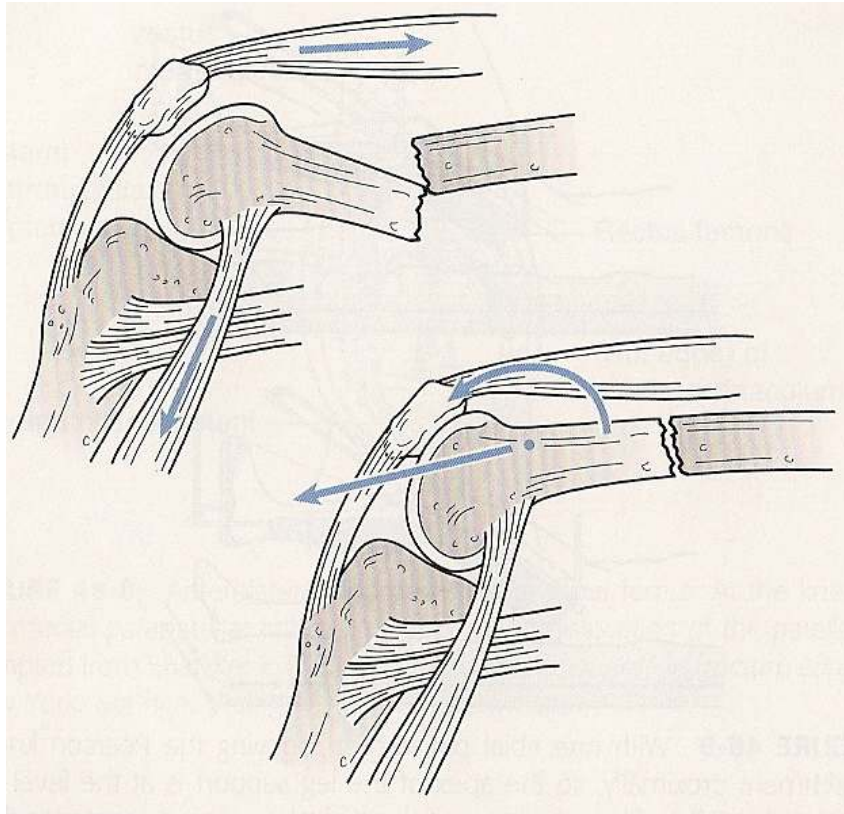
Surgical options

- ORIF
  - Screw fixation
  - Plate and screw
  - Blade plate
  - DCS
  - LISS
  - Intramedullary device
  - External fixator





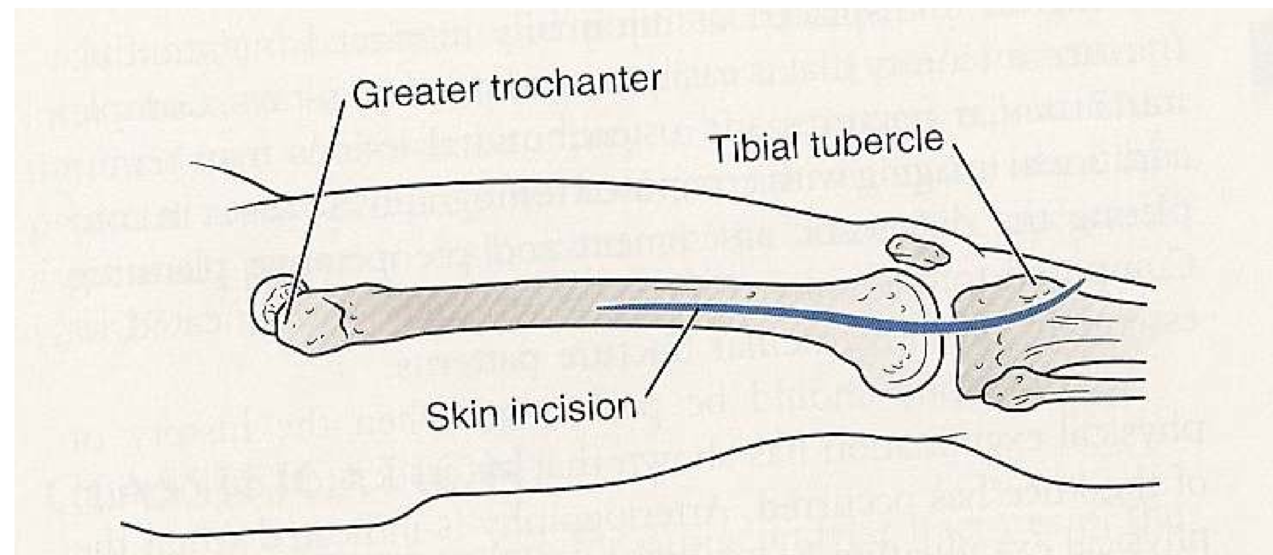
Patient positioning



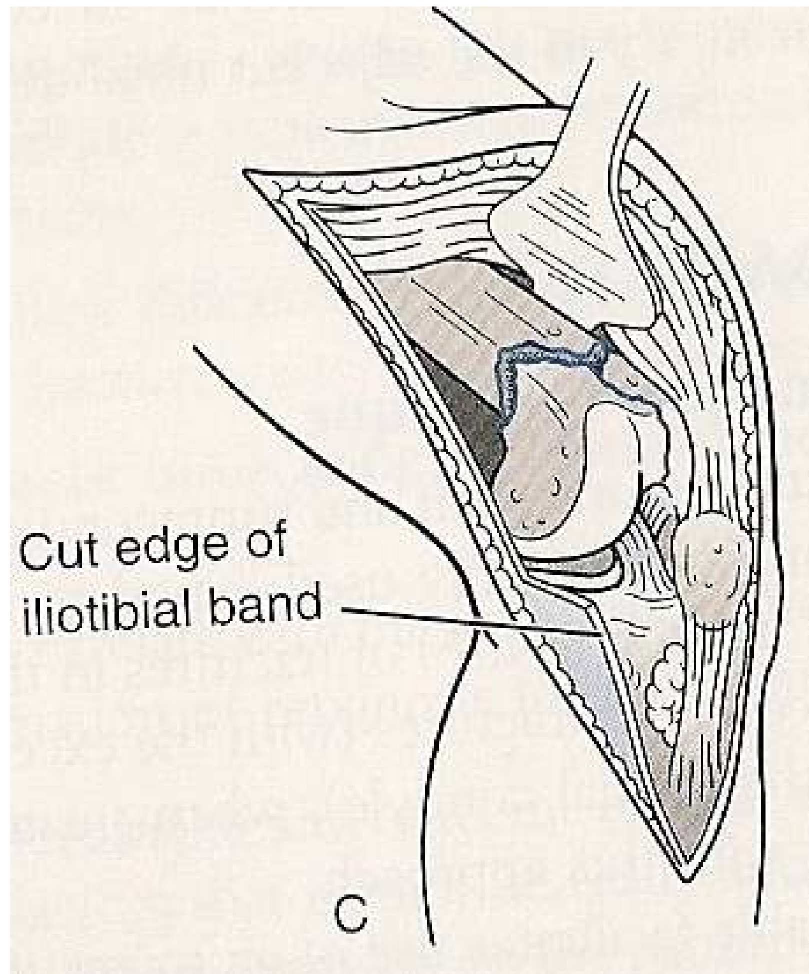
- Depends on operation
- Image intensifier
- Radiolucent table
- Supine
- Traction pin
  - Place anteriorly

Surgical Approaches

- Lateral Approach (standard)
  - Mid femoral – curve anterior to LCL distal to joint
  - ITB

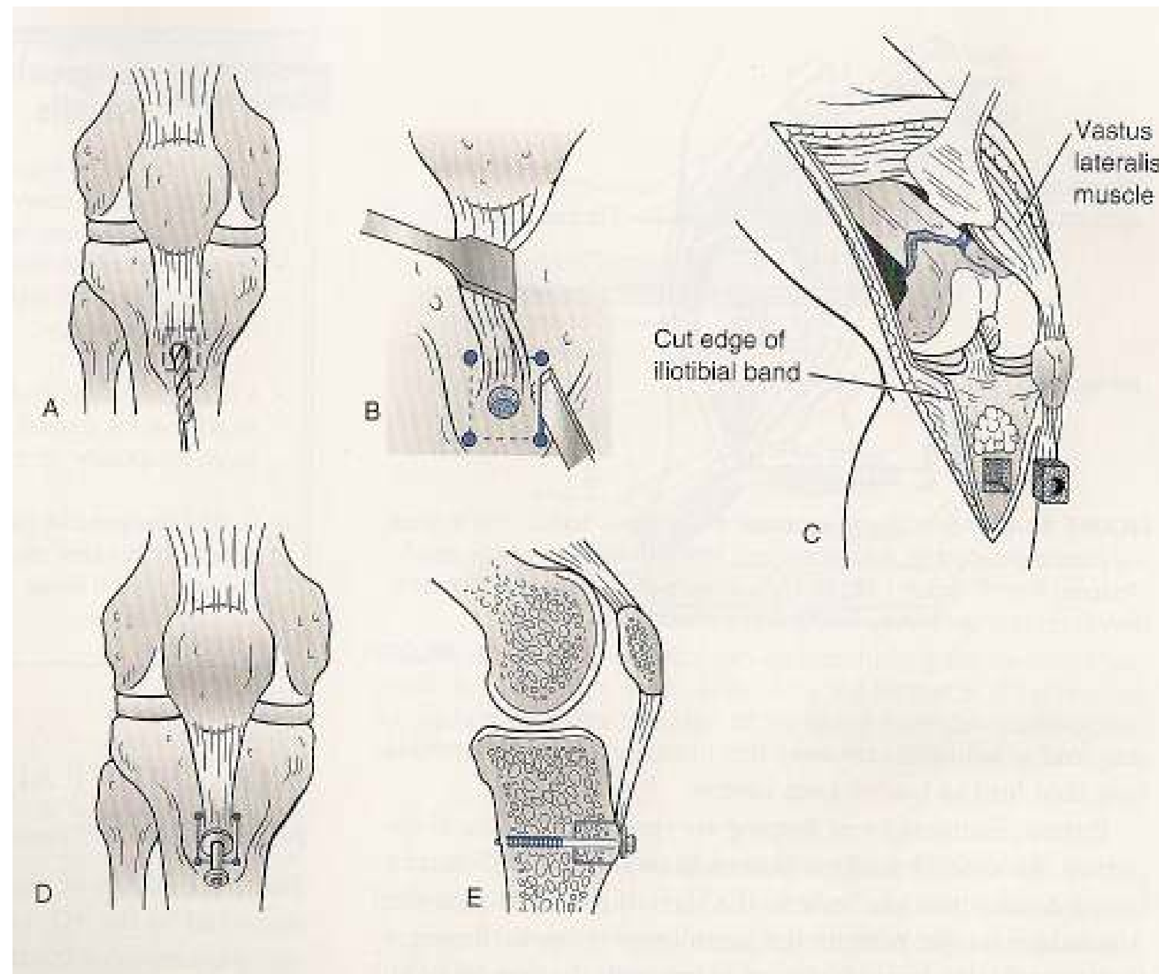


Lateral approach…



- Capsule & synovium
- Elevate vastus lateralis

Tibial tubercle osteotomy



Surgical Approach…

- Minimally invasive lateral approach
  - Minimise soft tissue injury and stripping
  - Limited implant
    - Dynamic condylar screw
    - Condylar butress plate
    - LISS
  - Cant visualise joint surface

Surgical Approach…

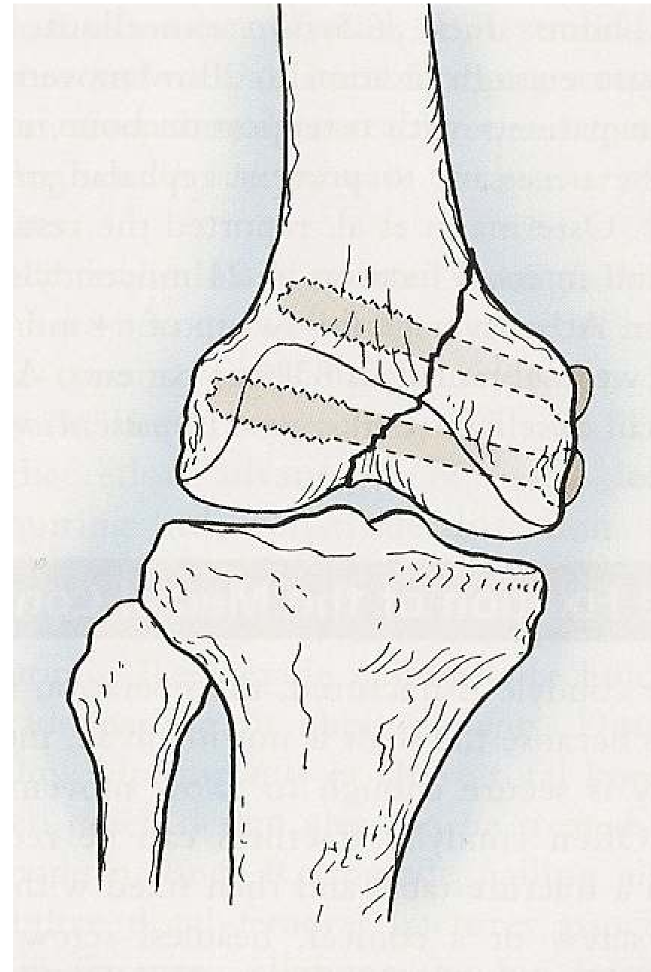
- Medial Approach
  - Isolated medial condyle fractures
  - Incision over medial condyle ant to Add tub
  - Deep fascia
  - Elevate vastus medialis from adductor magnus
  - Stay ant to MCL

Surgical Approach…

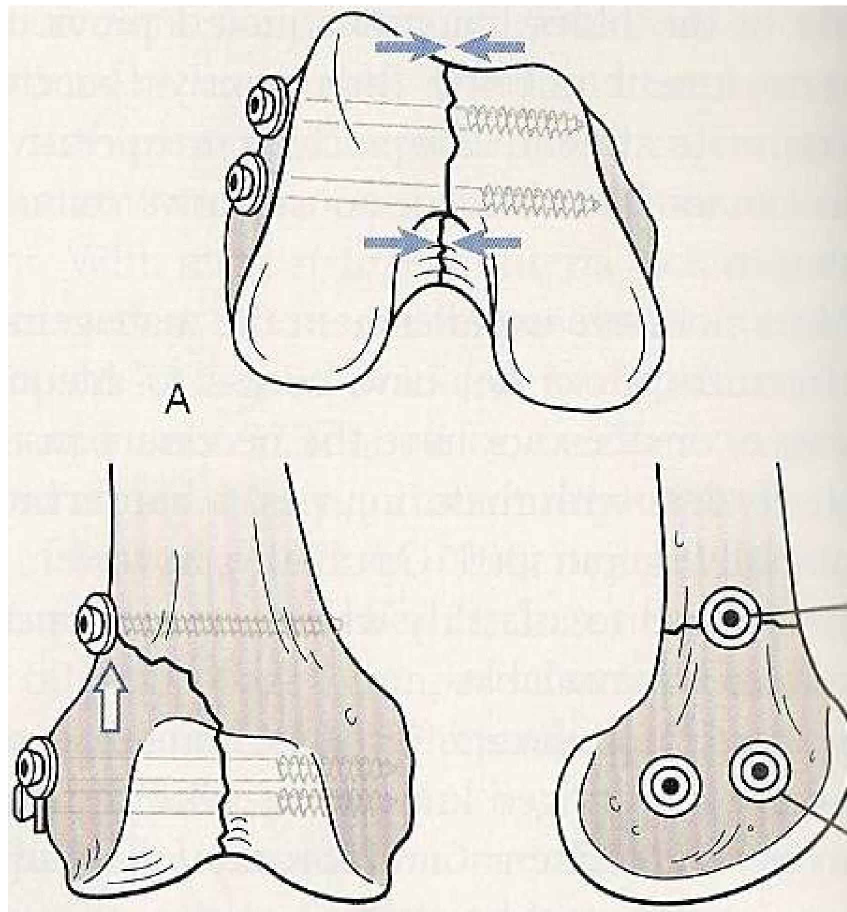
- Anterolateral approach
  - Disadvantage of splitting vastus intermedius

Screw

- Used alone or with other devices
- Young with adequate bone stock sufficient (type B #s)
- Unicondylar



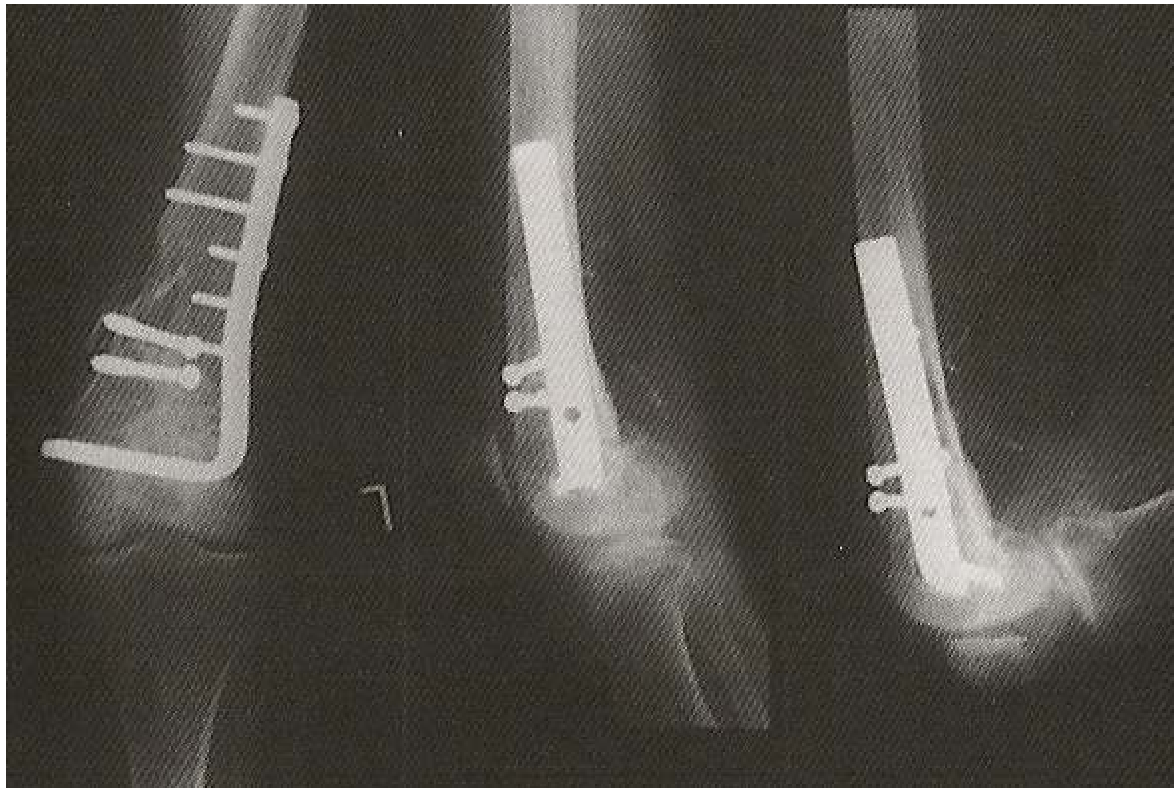
Screw



- Buttress screw with washer
- Interfragmentary screw

Plate and screw fixation

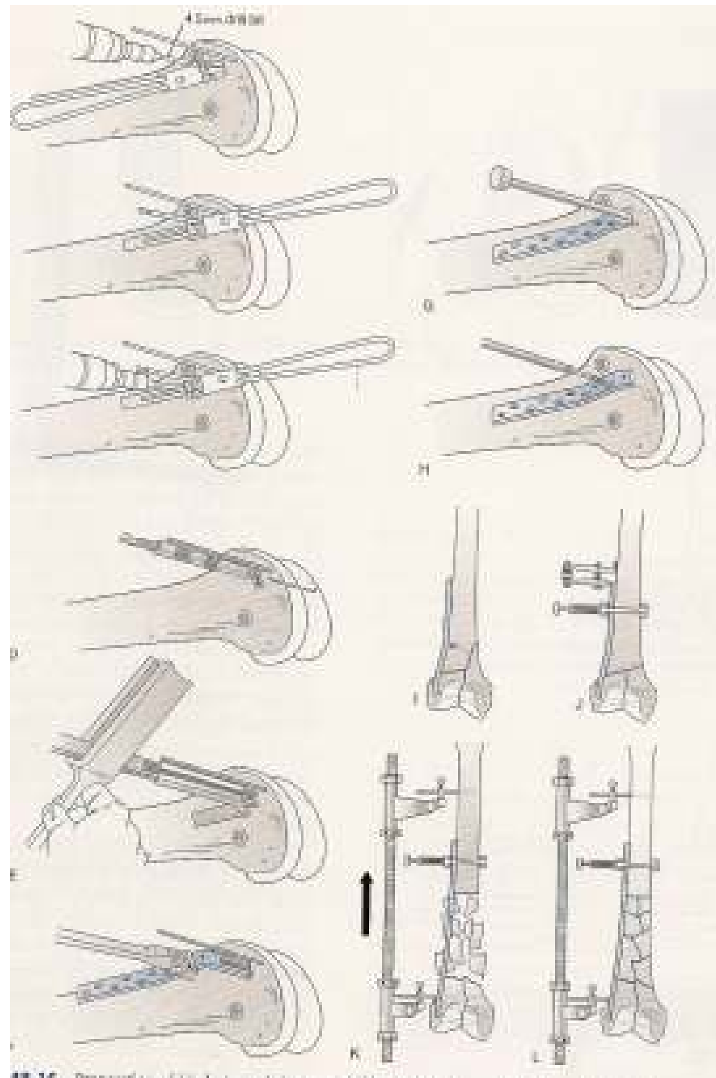
- AO blade plate
- Technically demanding



Blade plate…

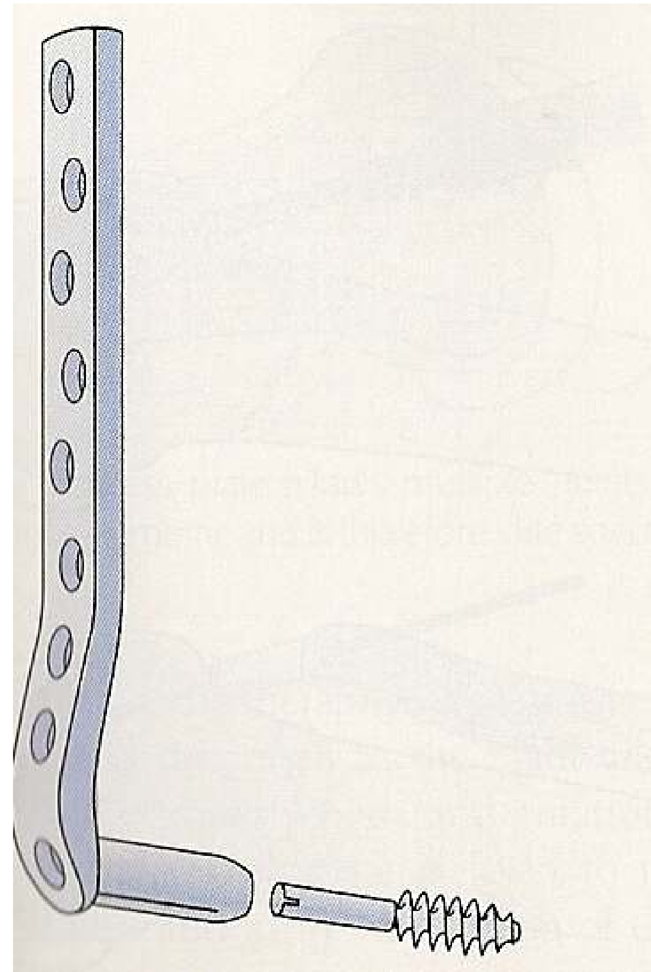
- Control alignment (valgus & varus)
- 95° fixed angle device
- Blade placed at 90° to distal femoral articular surface
- Templating on intact femur useful

Blade plate…



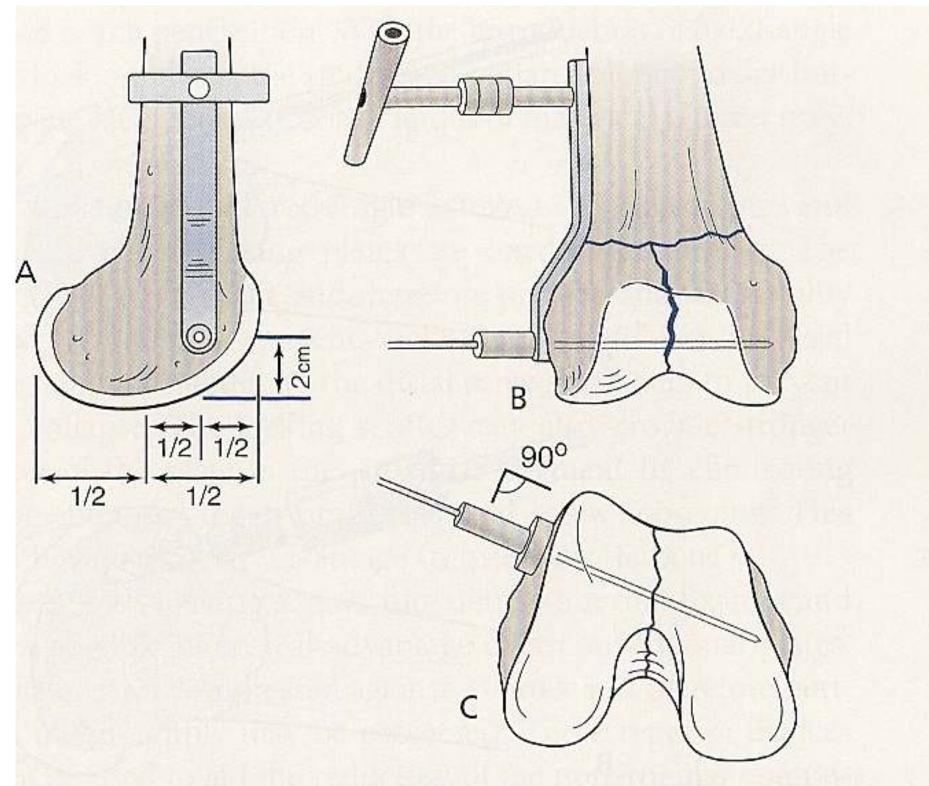
Dynamic condylar screw

- Less technically demanding than blade plate
- Evolved from sliding hip screw
- 4cm uncomminuted bone in condyles above intercondylar notch required



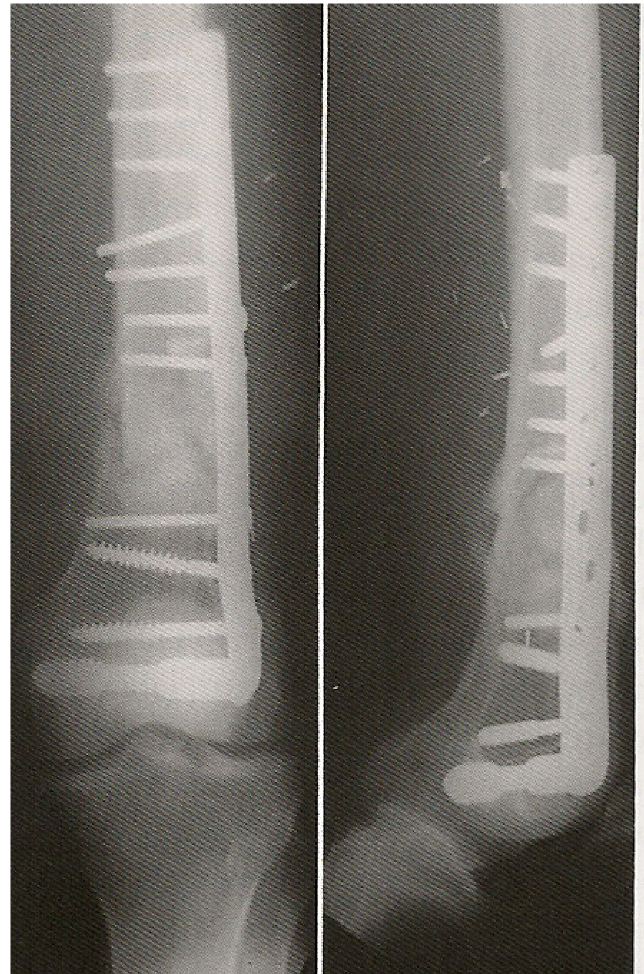
DCS…

- Modular device
- 95° fixed angle
- Can adjust flexion and extension once lag screw inserted

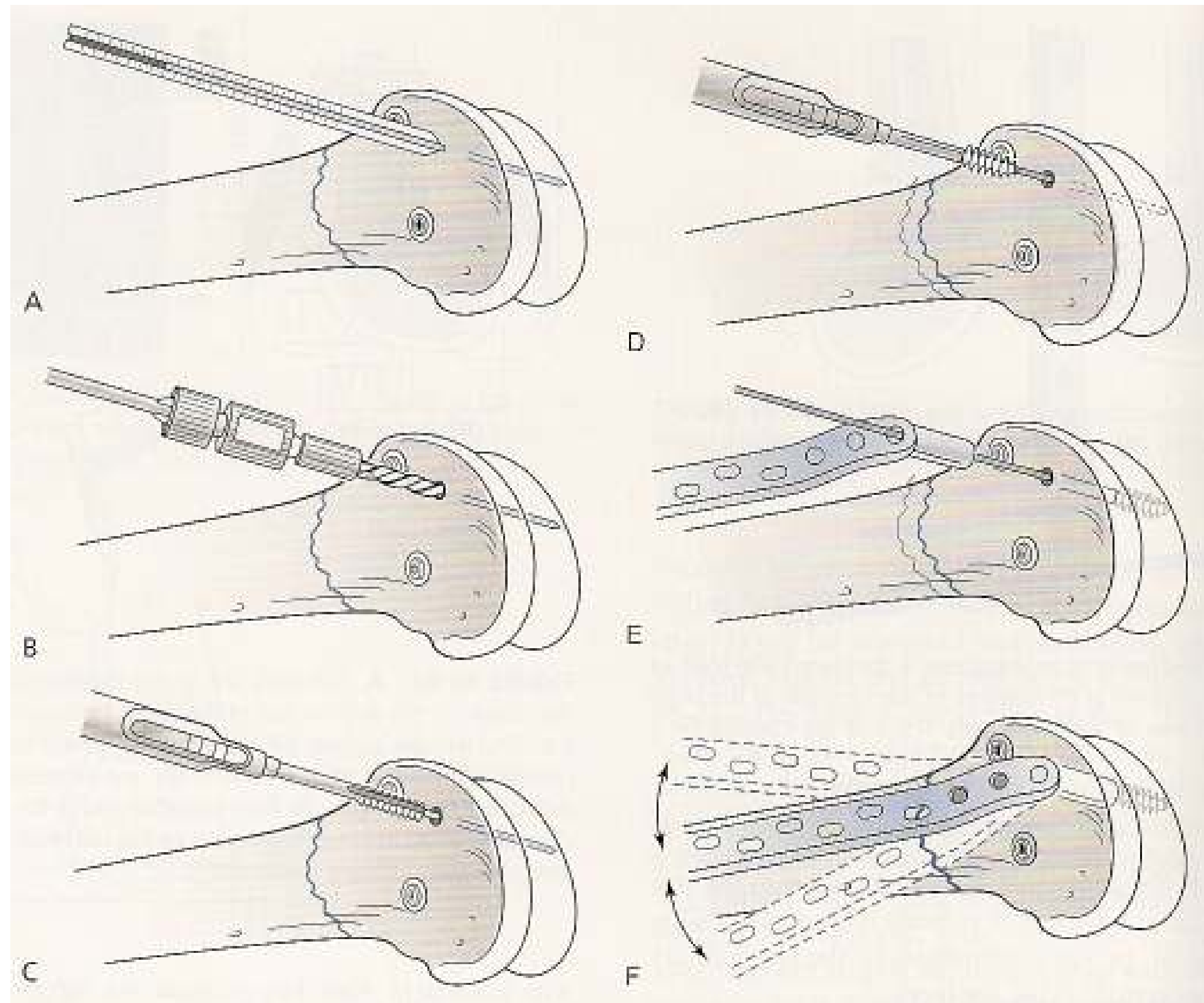


DCS…

- Lag screw removes a lot of bone
- Poor rotational control
- Limited use in distal #s

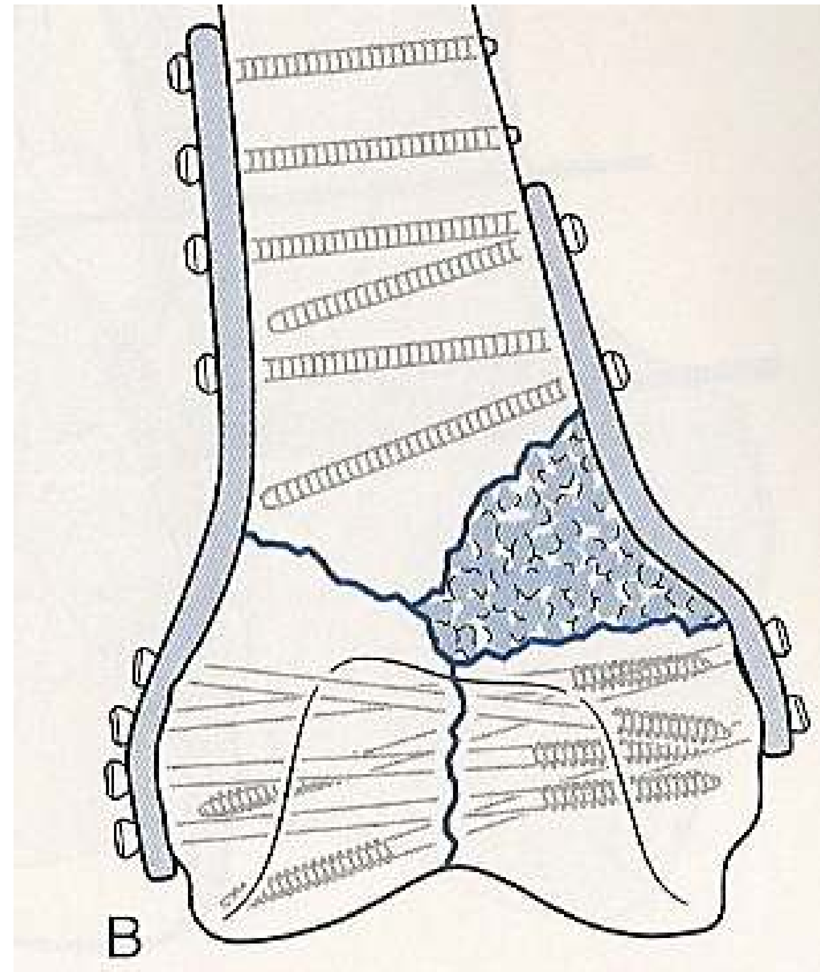


DCS…



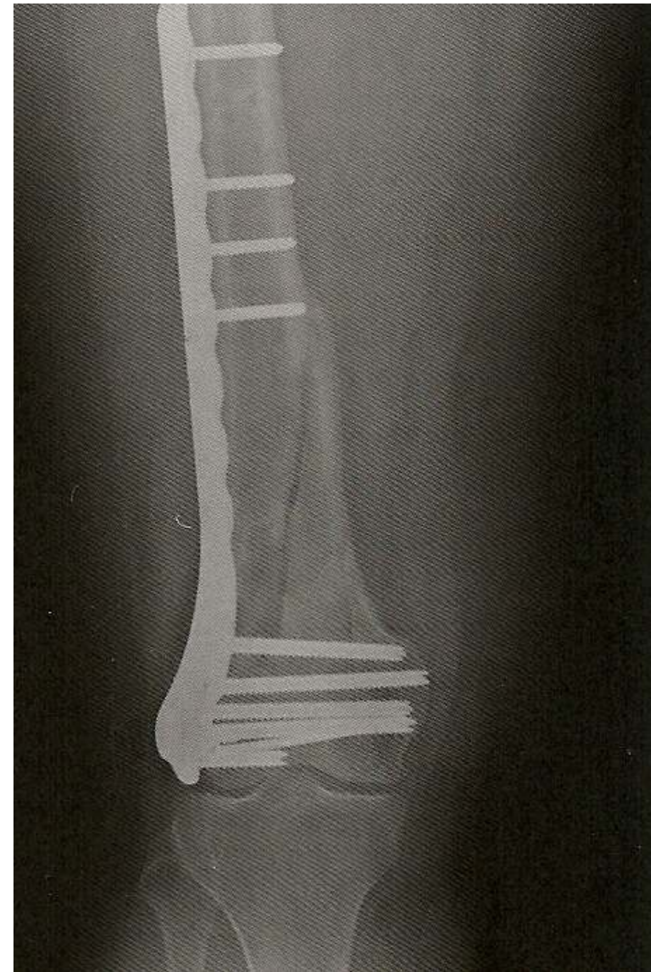
Nonlocking periarticular plates

- Condylar buttress plate
- Precontured
- Use of medial plate if cant reconstruct medial buttress



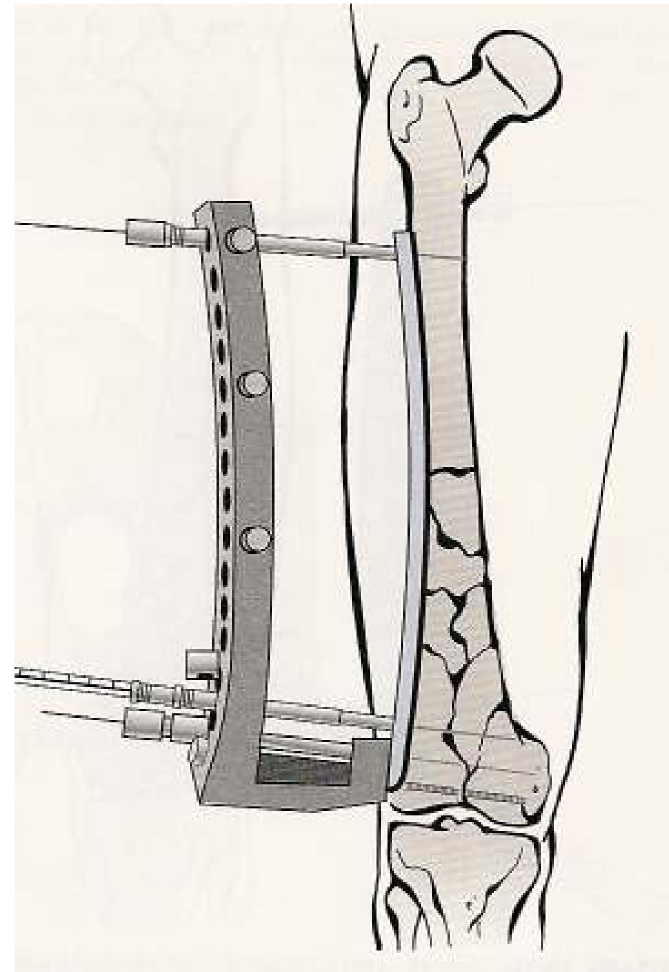
Condylar locking plate

- Similar stability to DCS
- Angular stability
- Avoid varus angulation present with medial femoral defect
- Reduce need for medial femoral plate
- Decreased tactile feedback of screw placement



LISS plate

- Less invasive surgical stabilisation
- Combines biologically friendly sub muscular plate placement and fixed angle construct
- Percutaneous screw placement



LISS

- Precontured plate
- Withstand higher loads compared to conventional plating[2]
- Allow 4 screws in proximal fragment
- Side specific plates

LISS

Plates

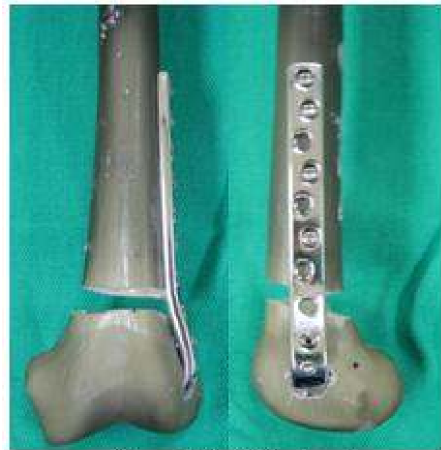


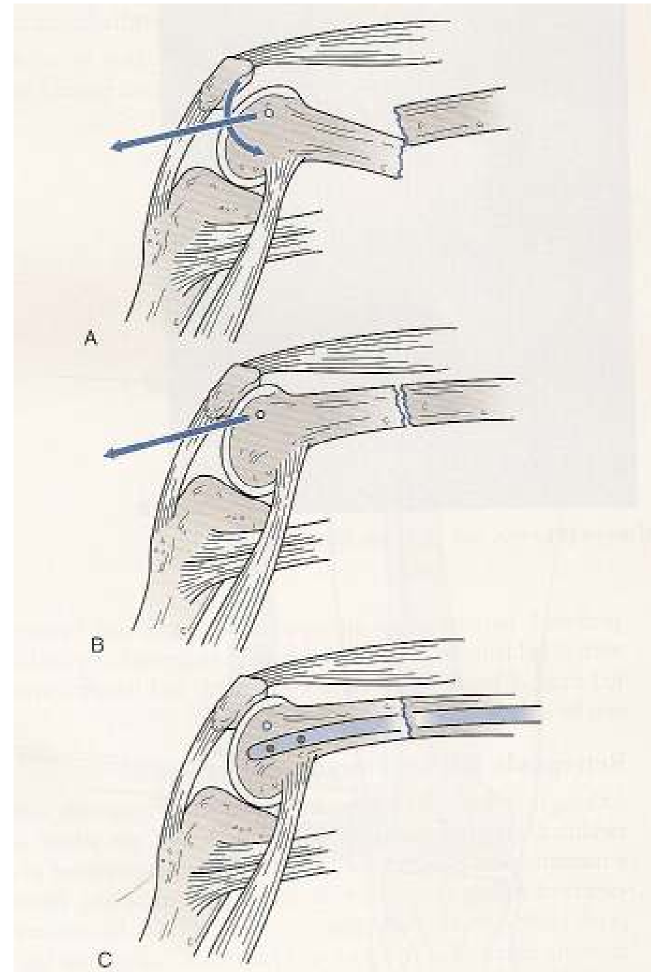
Figure 1: ABP Construct

Figure 2: LCP Construct

Figure 3: LISS Construct

Intramedullary devices

- Load sharing devices
- Less soft tissue disruption
- Antegrade
- Retrograde



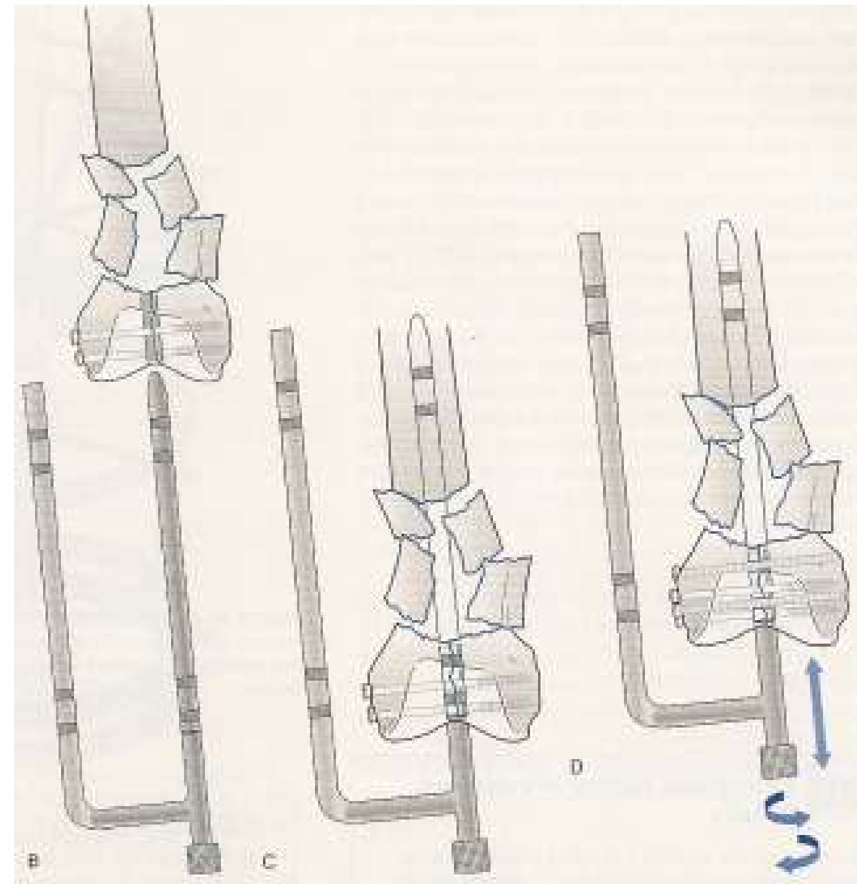
Antegrade locked nails

- Allow placement of 2 distal locking screws
- Reduction aided by careful placement of traction pin
- Supine position easier to control valgus and varus alignment

Retrograde locked nails

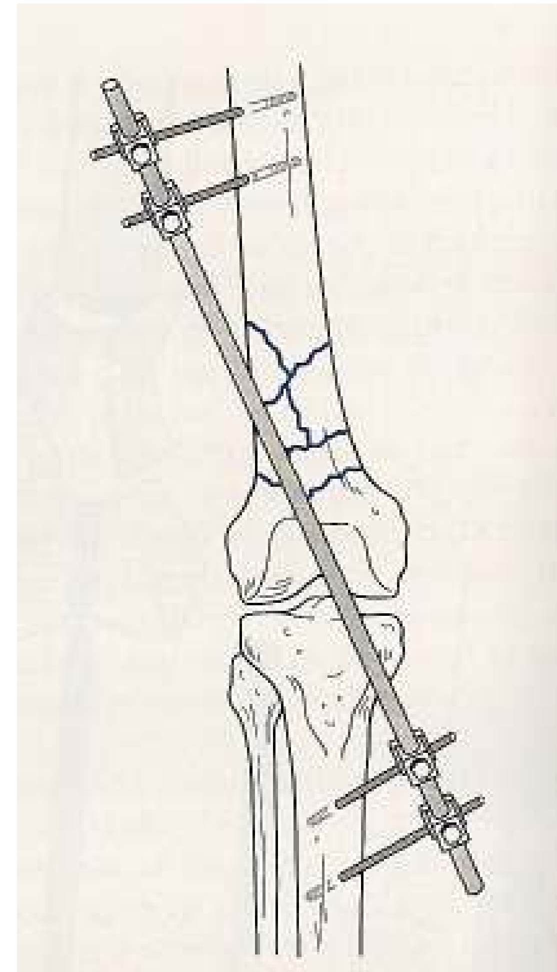
- Allows nailing in patients with proximal femoral instrumentation or deformity

- Further insult to knee joint



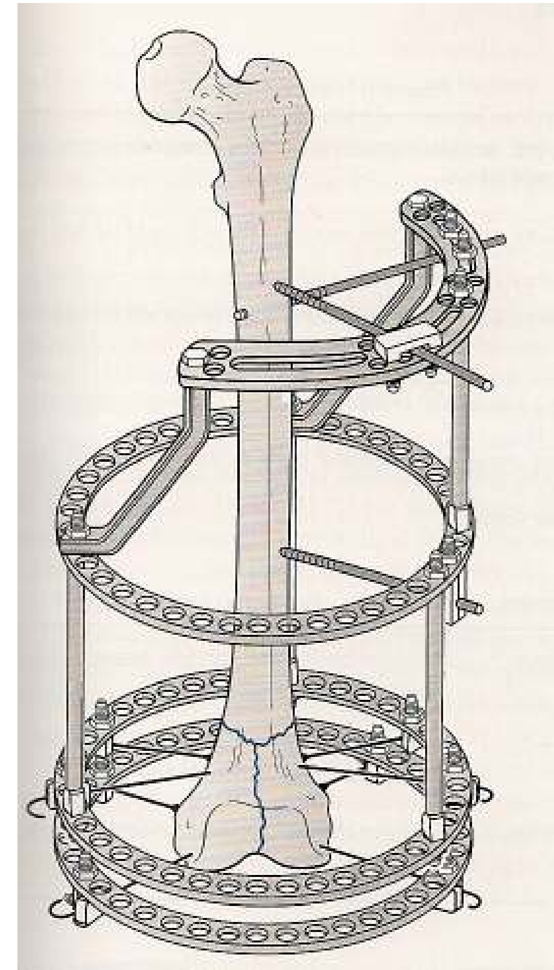
External Fixator

- Temporary Vs definative
- Spanning allows rapid stabilisation
- Place pin sites at remote location
  - Lateral prox femur
  - Ant tibial

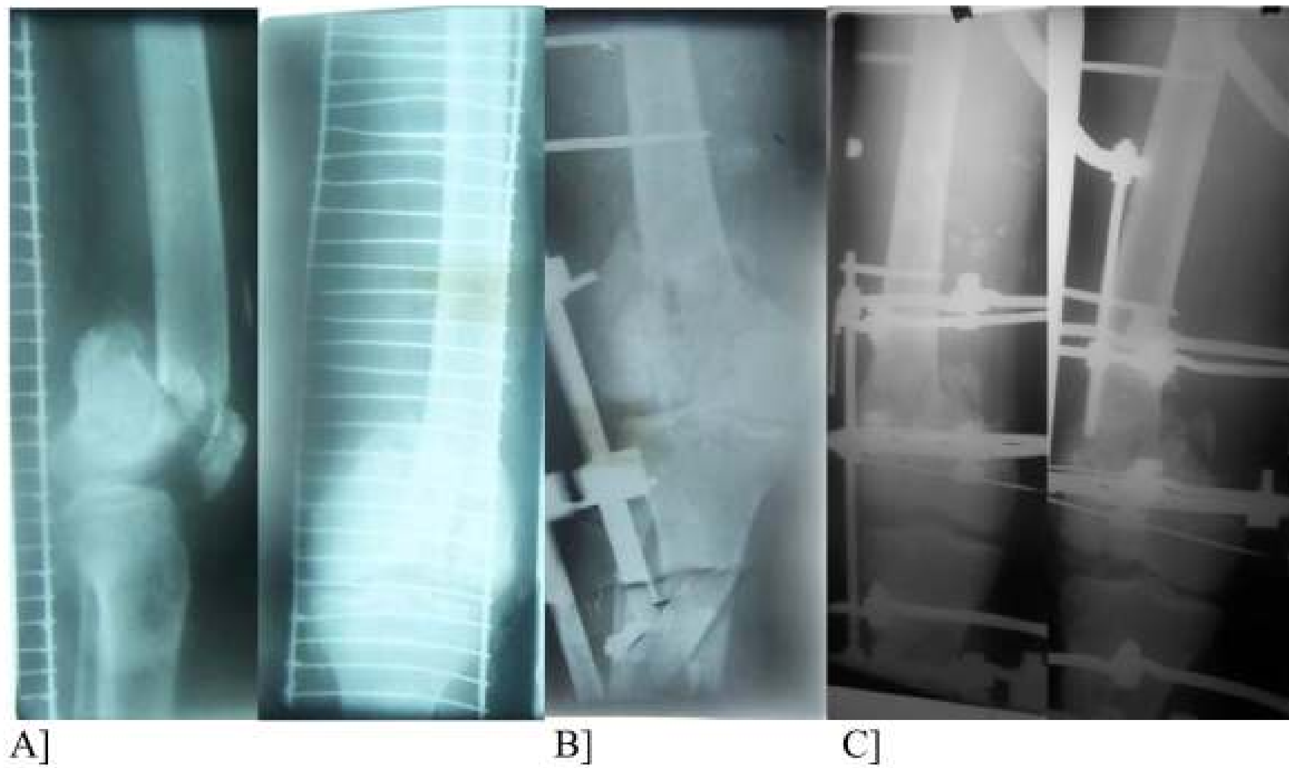


External fixation

- Hybrid ring fixator
- Good control of axial stability
- Difficult technique
- Poorly tolerated by patient



External fixation…



Periprosthetic fractures

- Increasing incidence around TKA's
  - Growing elderly population
  - Increased activity patients with TKA
- Femur, tibia, patella
- Conservative and surgical options

Periprosthetic fractures…

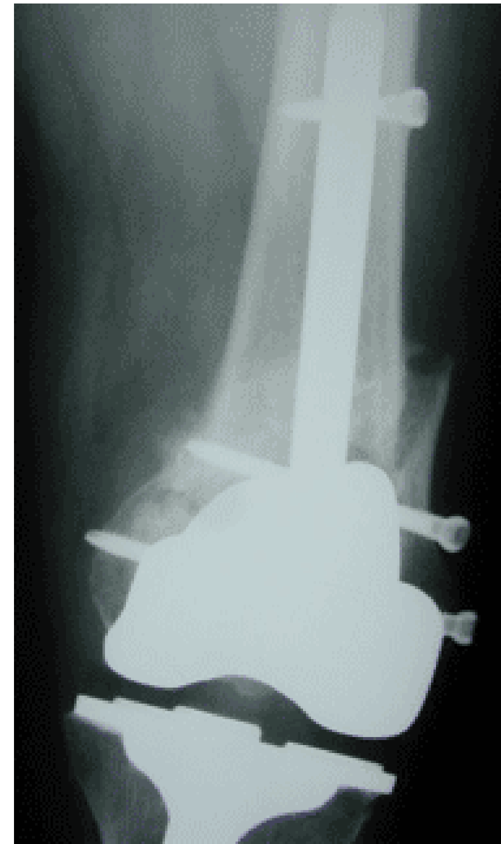
Table 1 Supracondylar periprosthetic fractures: classification systems.

Author	Type/group	Description
Neer et al.	Type I	Undisplaced
	Type II	Displaced >1 cm
	Type IIA	Lateral femoral shaft displacement
	Type IIB	Medial femoral shaft displacement
	Type III	Displaced and comminuted
DiGioia and Rubash	Group I	Extra-articular, undisplaced
	Group II	Extra-articular, displaced
	Group III	Severely displaced or angulated
Chen et al.	Type I	Undisplaced
	Type II	Displaced or comminuted
Lewis and Rorabeck	Type I	Undisplaced
	Type II	Displaced
	Type III	Displaced or undisplaced, loose/failing prosthesis

Periprosthetic fractures…

- Successful treatment goals
  - Absence of pain
  - Fracture union < 6 months
  - Normal ambulatory status

- Management challenging



Periprosthetic fractures…

- Supracondylar femoral fractures
  - Commoner in >60yrs
  - Osteoporosis
- Combination axial and torsional loads
  - Low velocity fall commonest
  - RTA's
  - MUA post TKA
  - Seizures[5]

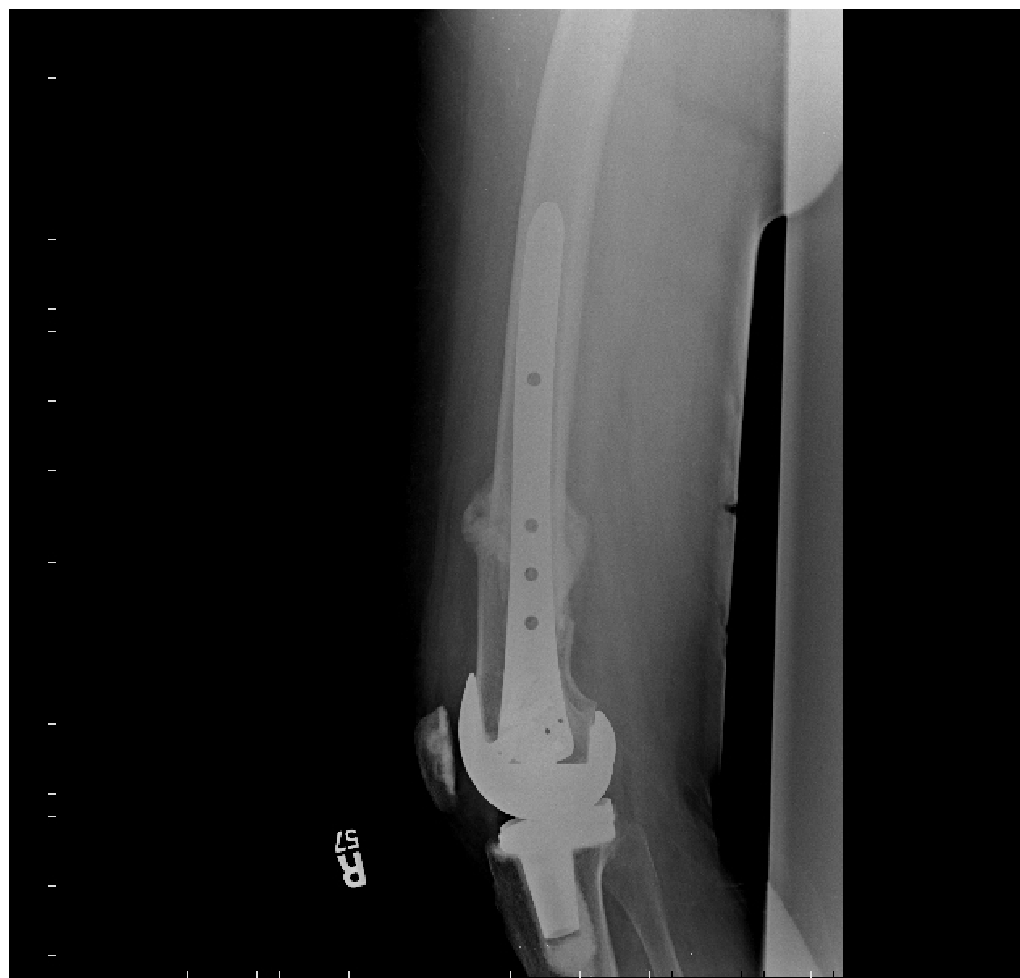
Periprosthetic fractures…

- Risk factors
  - Age
  - RA
  - Stress risers
  - Chronic steroid use
  - Osteolysis due to polyethylene wear debris
  - Female
  - Previous revision TKA
  - Rotationally constrained prosthesis

Periprosthetic fractures…

- Current evidence supports surgical management where feasible
  - Condylar plates
  - Intramedullary device
    - Flexible or rigid nails
  - External fixator
  - Cerclage wires
  - Strut grafts
  - Arthrodesis

Periprosthetic fractures…

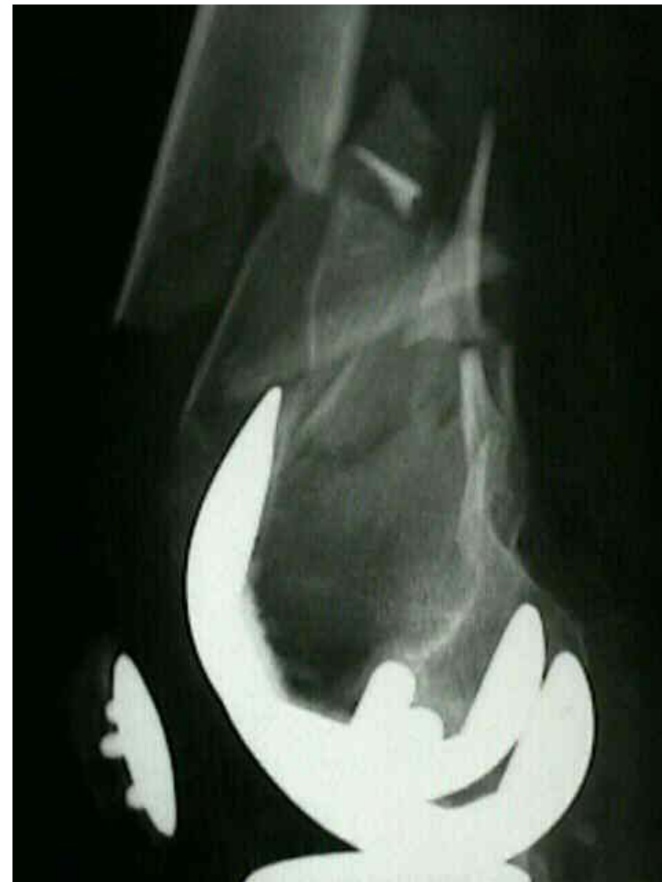


Summary

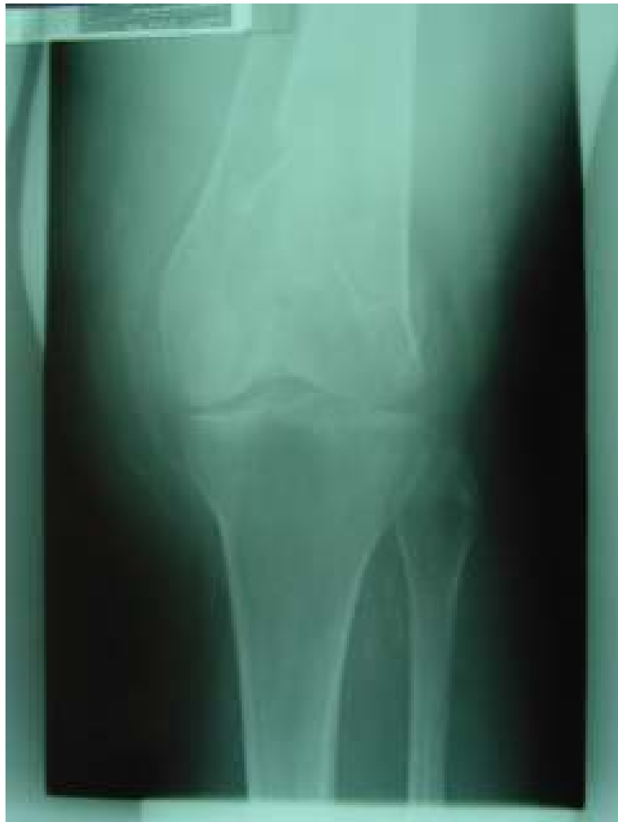
- Complex
- Associated injuries
- Management principles
  - Anatomical restoration and absolute stability of articular segment
  - Relative stabilisation of metaphyseal segment
- Different surgical options

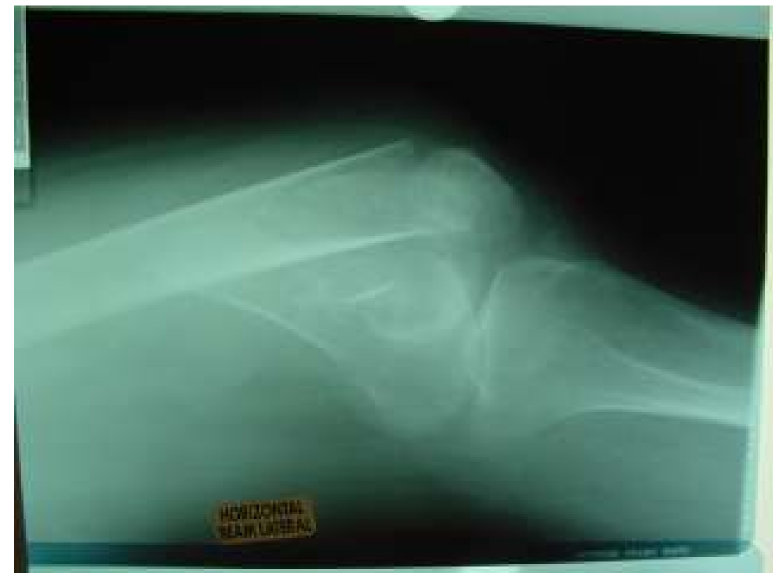
Summary…

- Periprosthetic fractures
  - Complex
  - Increasing in incidence
  - Risk factors
- Management
  - Conservative
  - Surgical

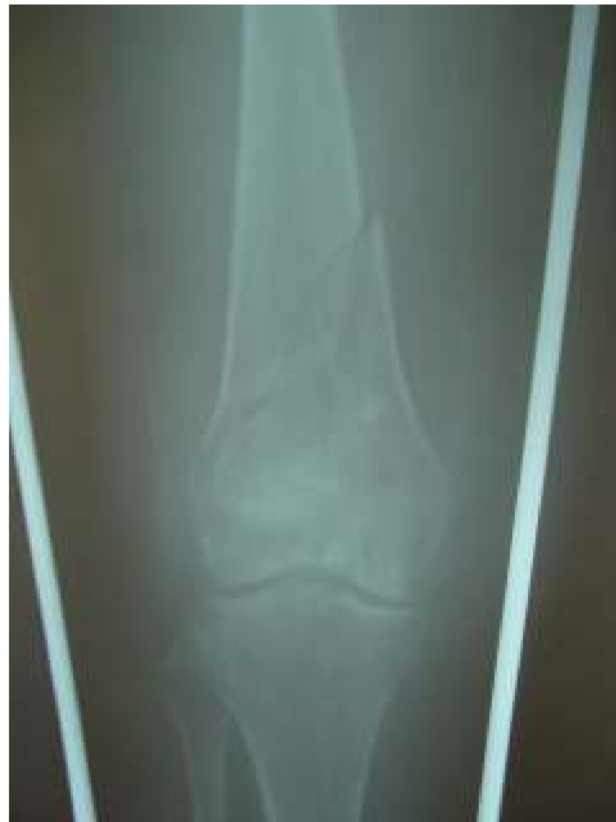


Case 1

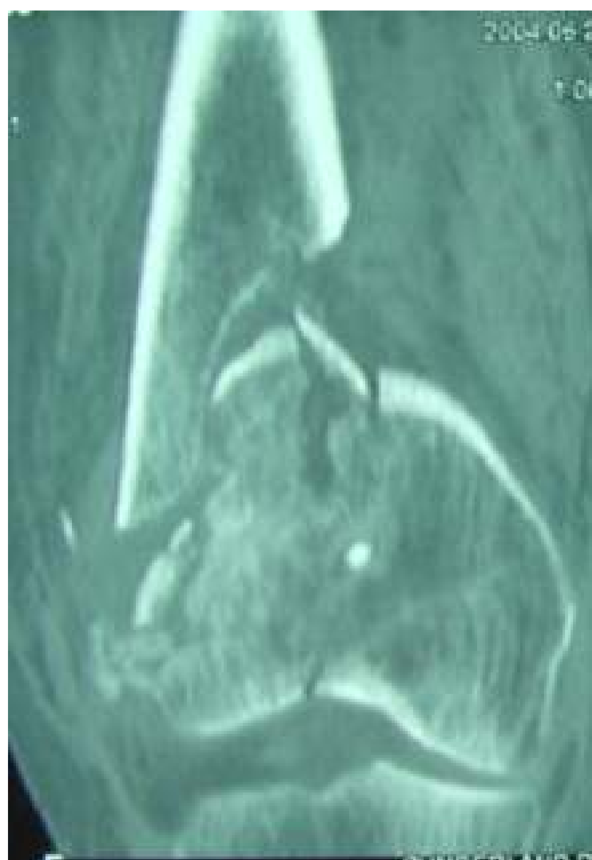




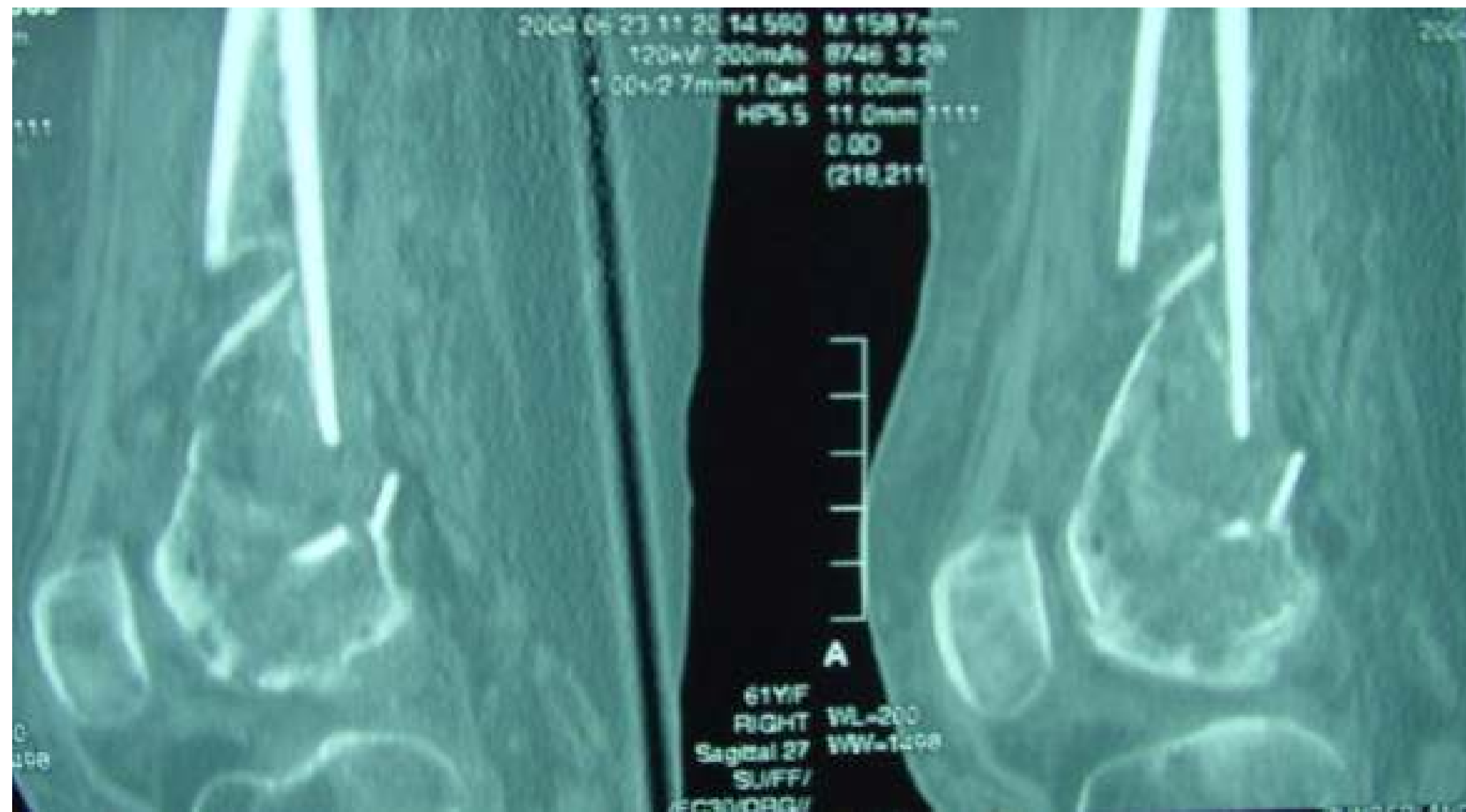
Case 1



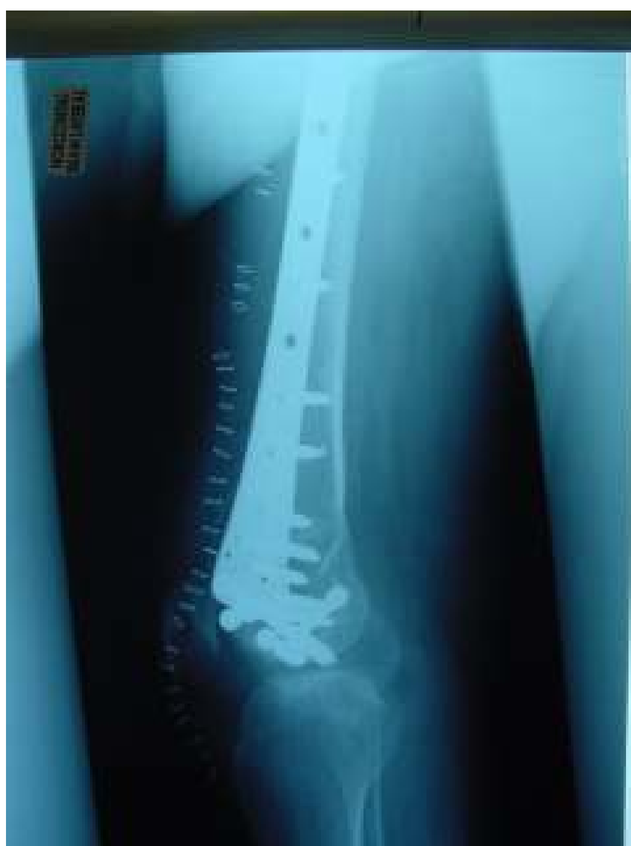
Case 1



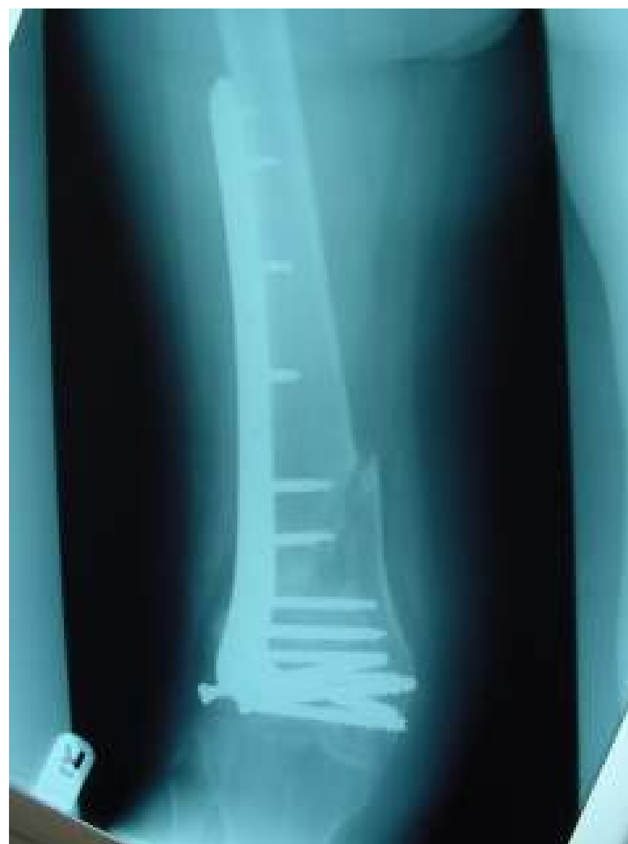
Case 1



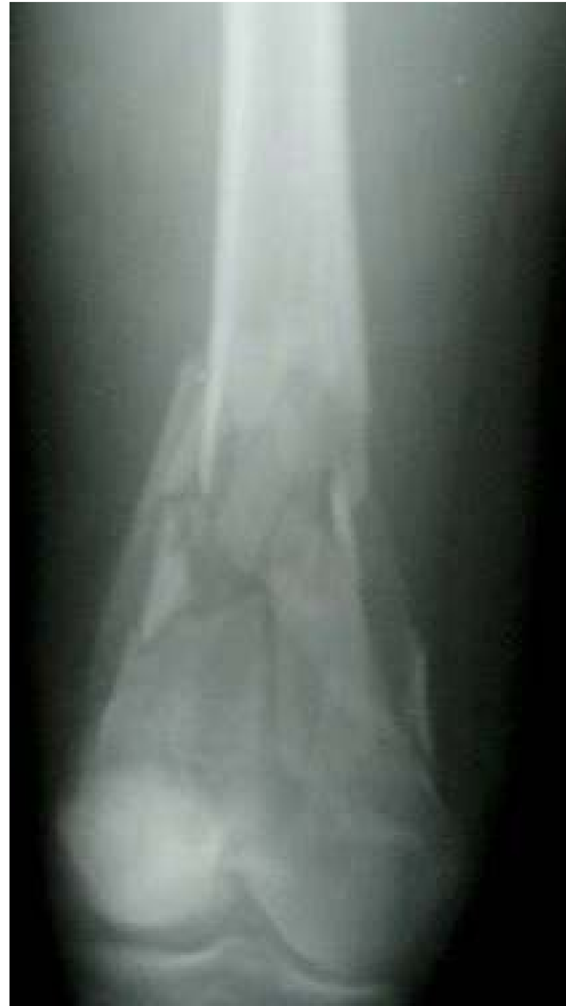
Case 1



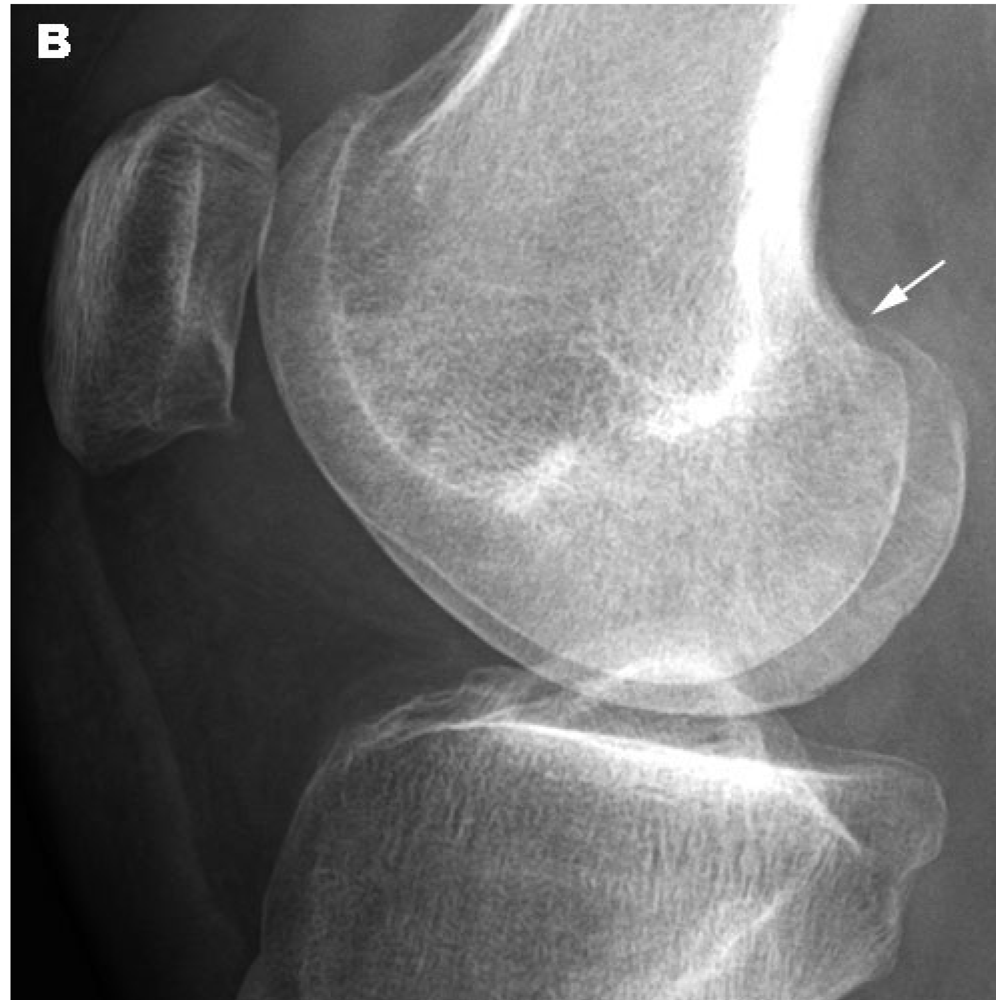
Case 1



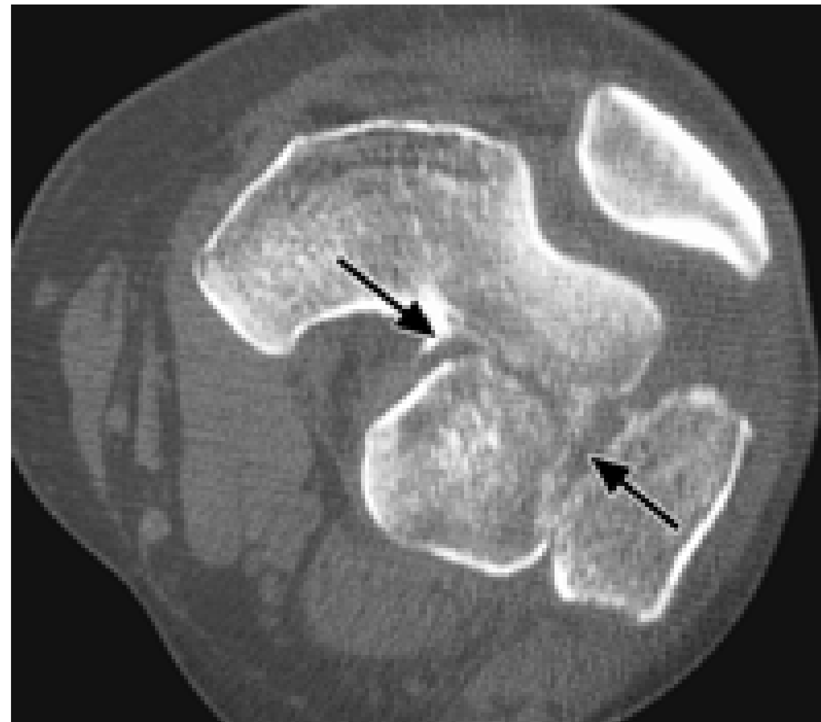
Case 2



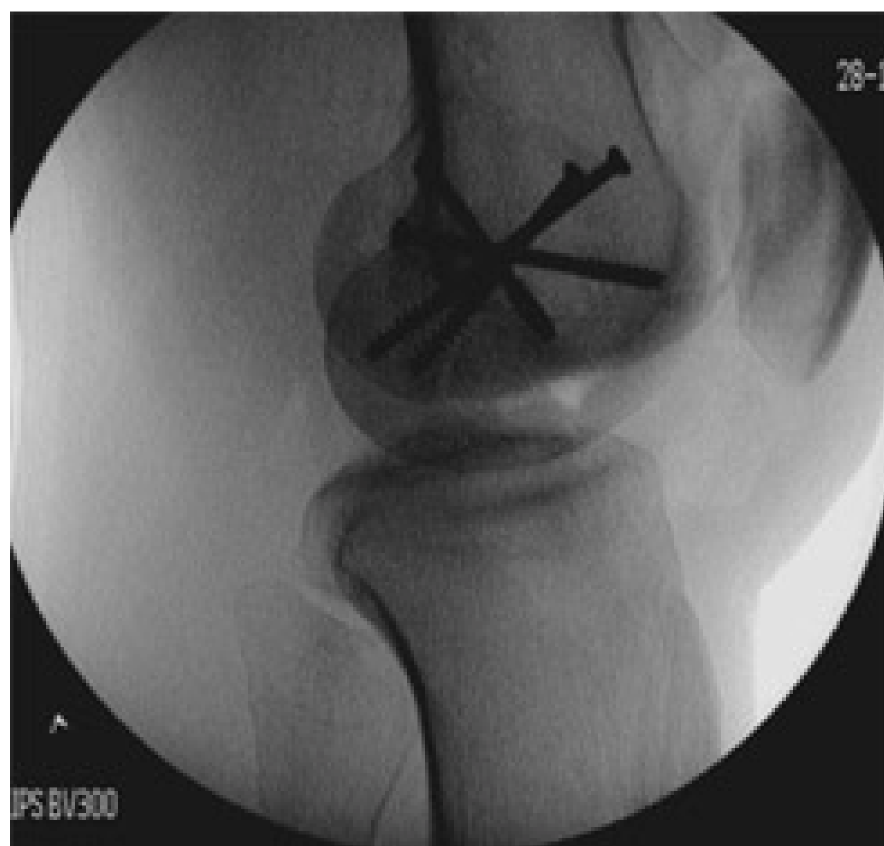
Case 3



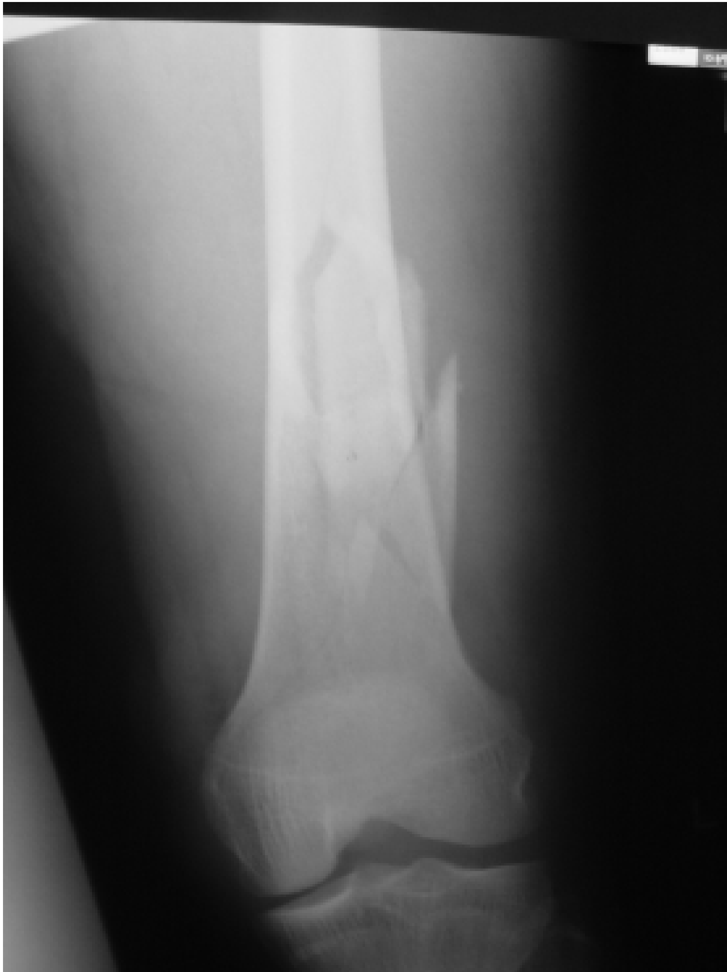
Case 3

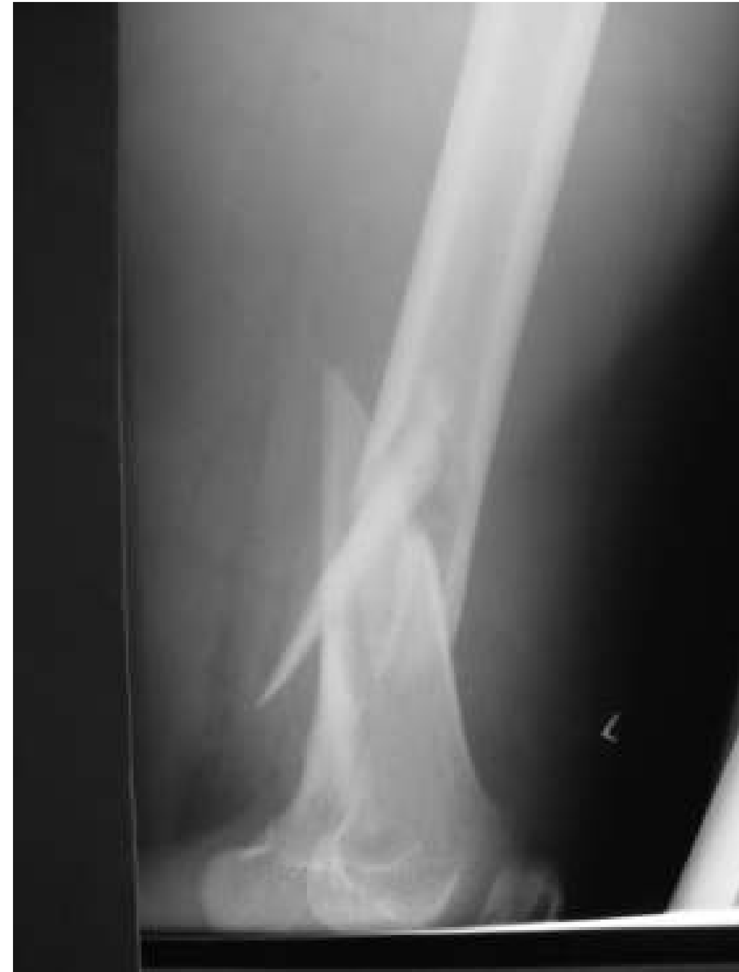


Case 3

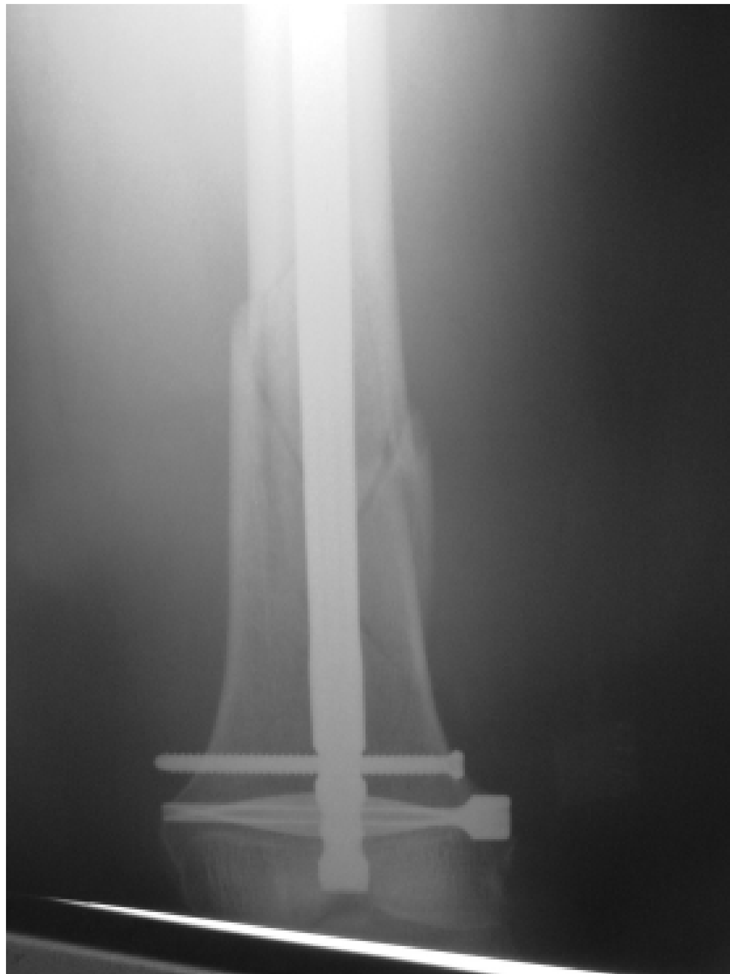


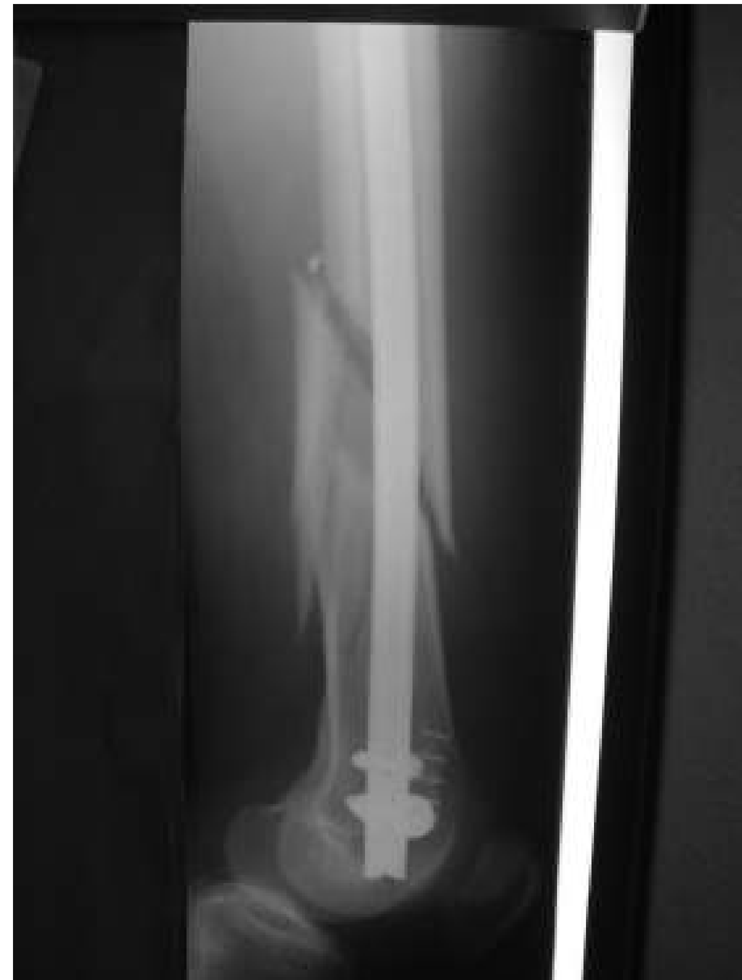
Case 4



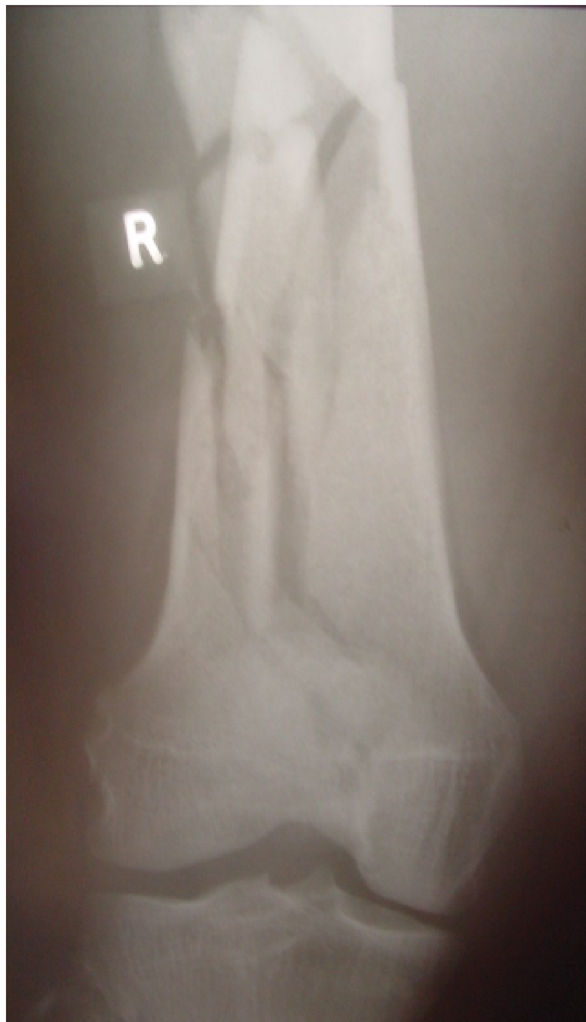


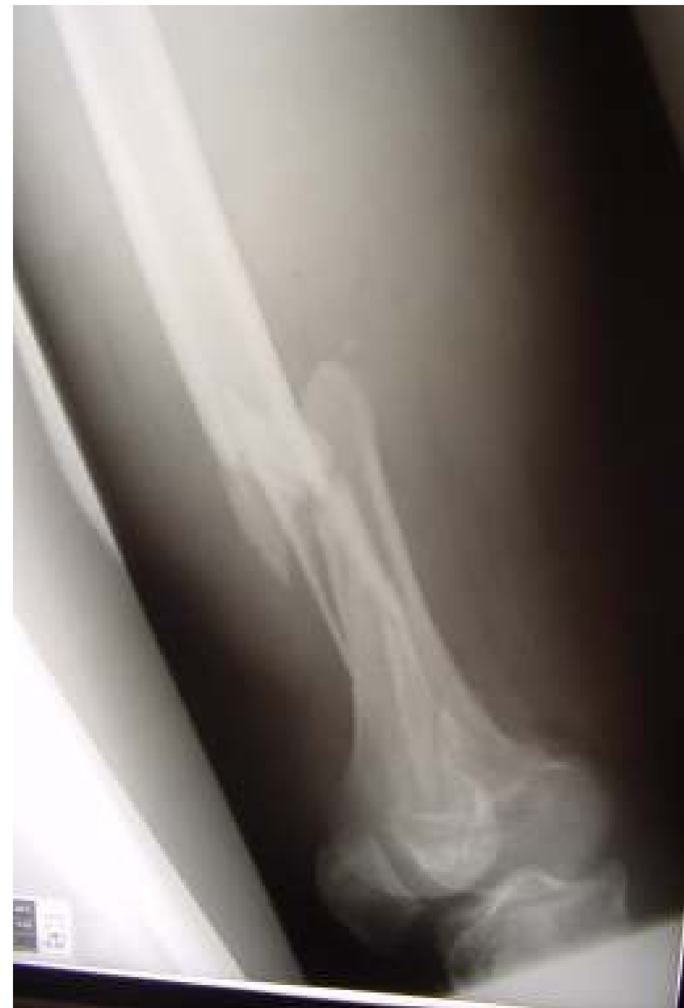
Case 4



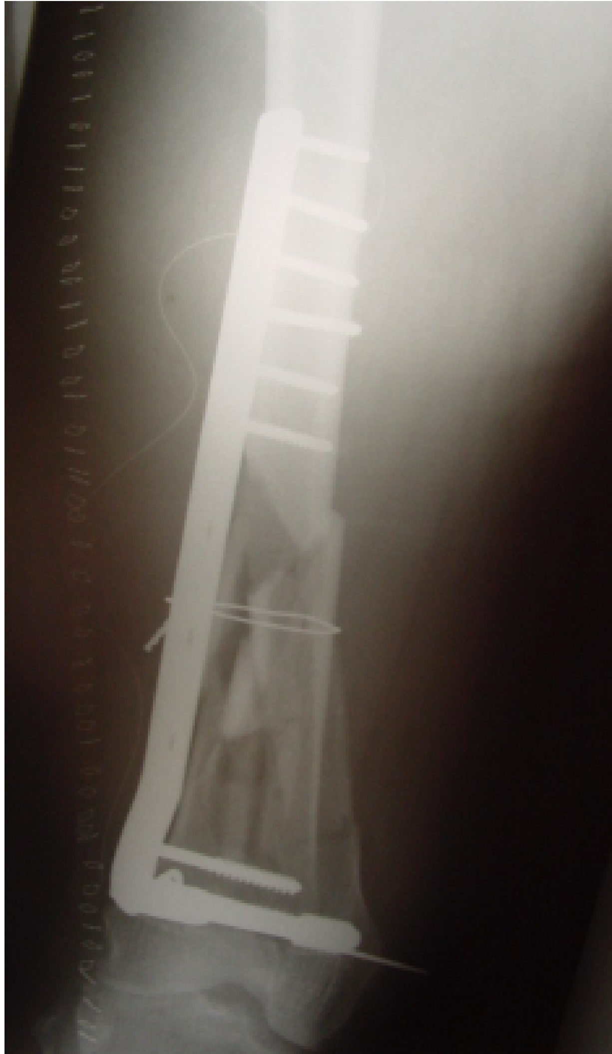


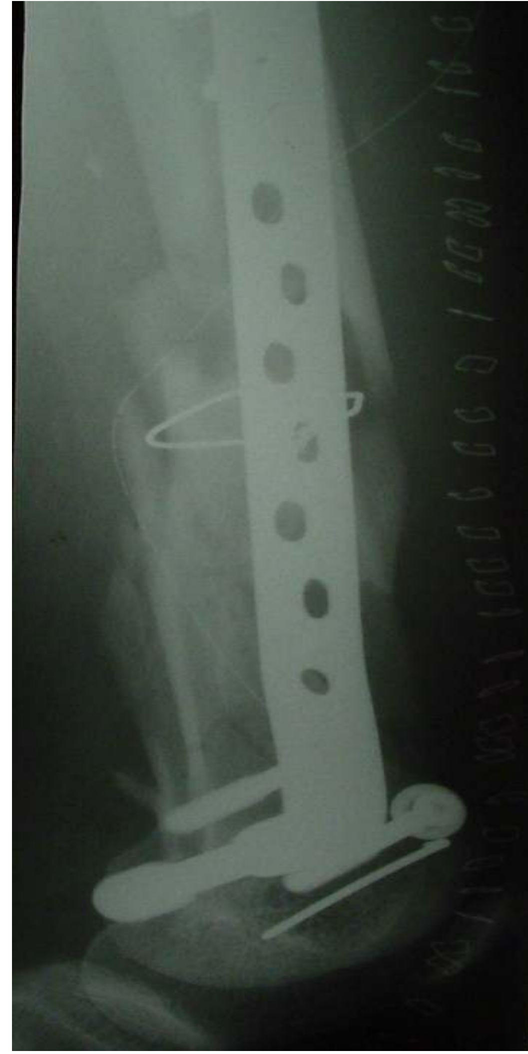
Case 5





Case 5





References

- 1 Browner, B.D, Levine A.M, Jupiter,J.B., Skeletal trauma:fractures, dislocations, ligamentous injuries, 2nd edition. Philadelphia: WB Saunders, 1997
- 2 Marti,A., Fankhouser,C., Frenk et al Biomechanical evaluation of Less invasive Stabilisation System for the internal fixation of distal femoral fractures. J Orthop Trauma 2001;15(7):482-487
- Rockwood & Greens, 6th ed. Fractures in adults Vol 2; 1916-1967
- Campbell's Operative Orthopaedics, 11th ed Vol 3.
- 5. Su, ET, DeWal, H., Di Cesare. Periprosthetic femoral fractures above total knee replacements. J Am Acad Orthop Surg 2004; 12(1):12-20.