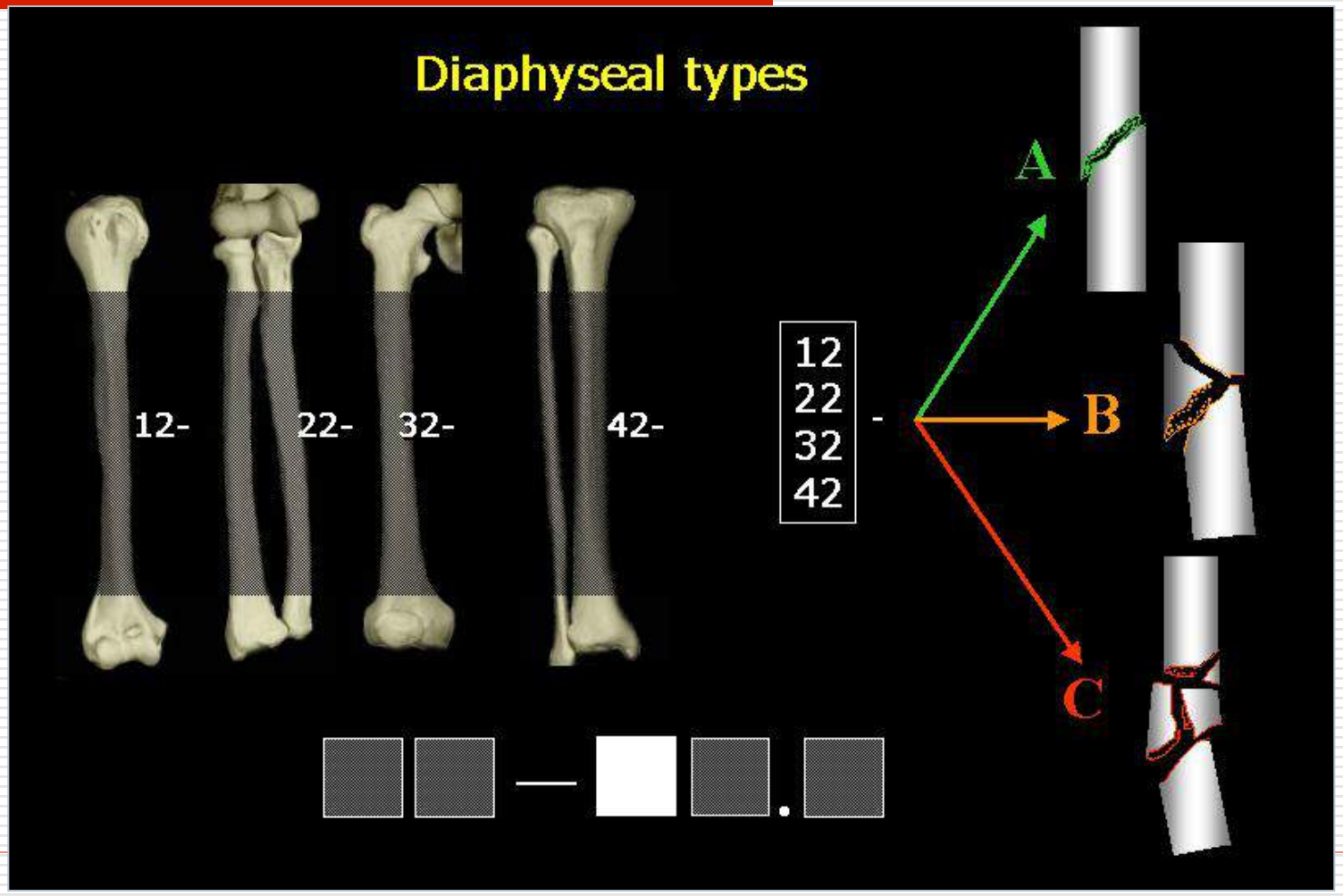
Fractures of the femur and lower leg

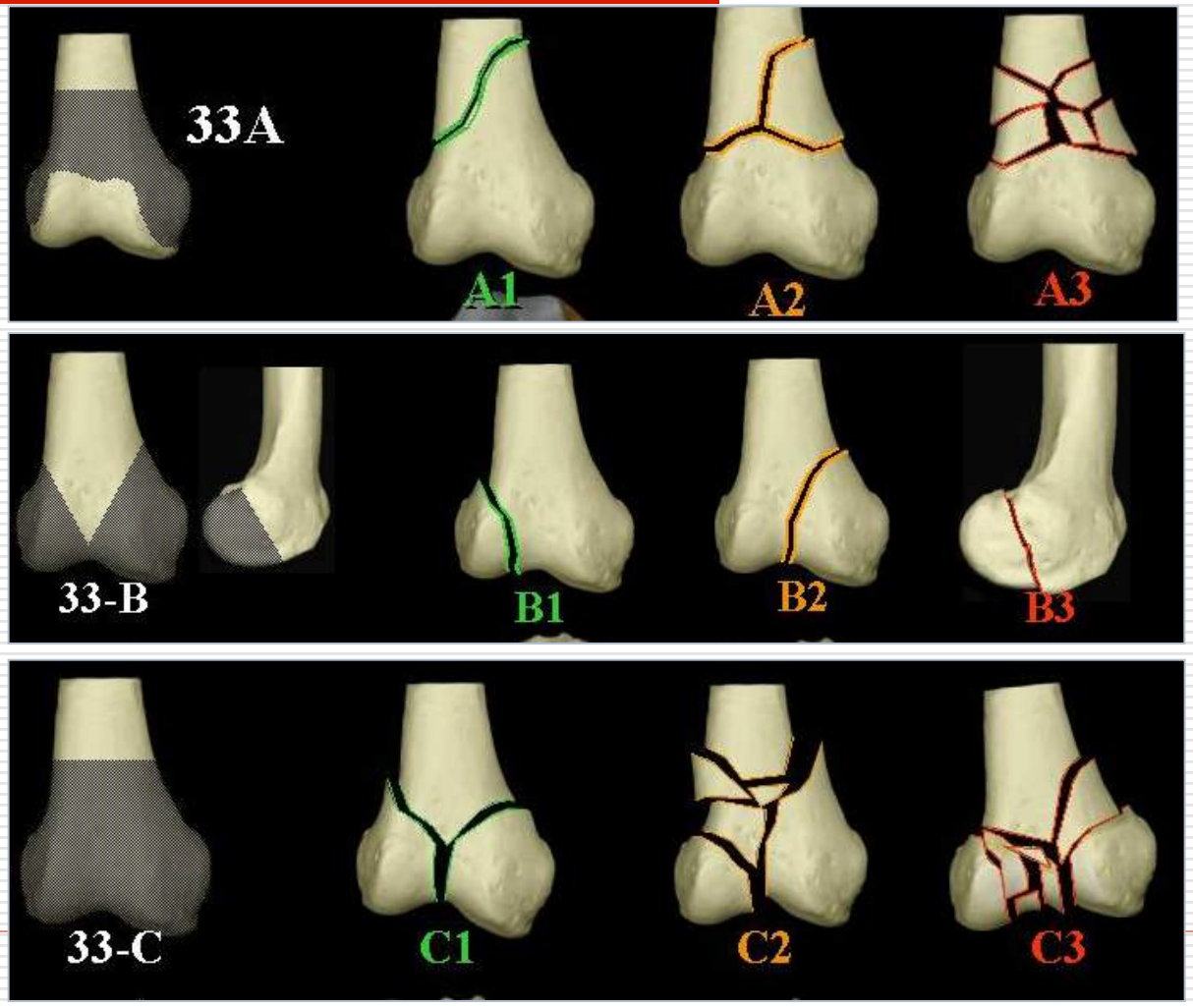
Norbert Wiegand

Dep. Of Traumatology and Hand Surgery

AO/ASIF - CLASSIFICATION



AO/ASIF - CLASSIFICATION



TREATMENT

Conservative (non-surgical):

extension - sceletal traction

cast fixation

Surgical:

plate

minimally invasive plate (MIPO)

intramedullar pin, TEN

intramedullary nail

- reamed

- unreamed

external fixator

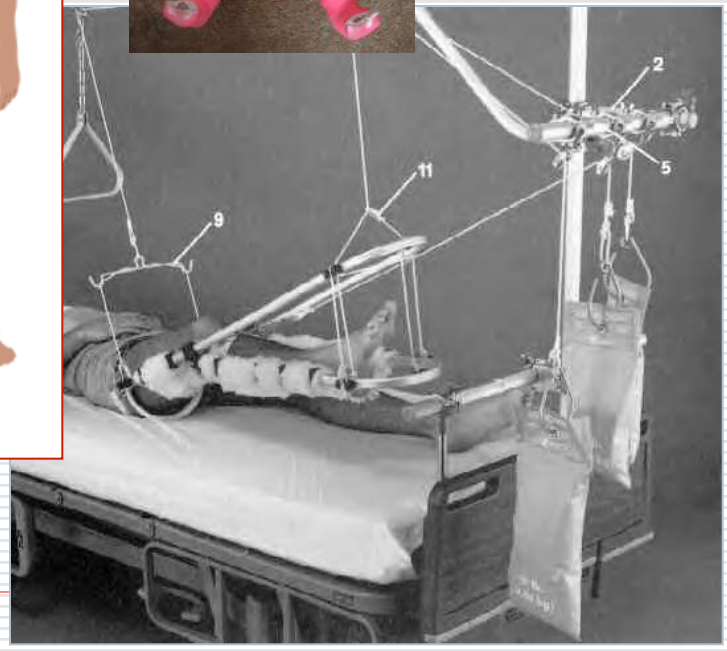
NON-SURGICAL TREATMENT

Indications:

- contraindications of surgery
- preparation for surgery
- infants

Methods:

- 6-12 weeks skeletal traction
- hip spica cast



SURGICAL TREATMENT

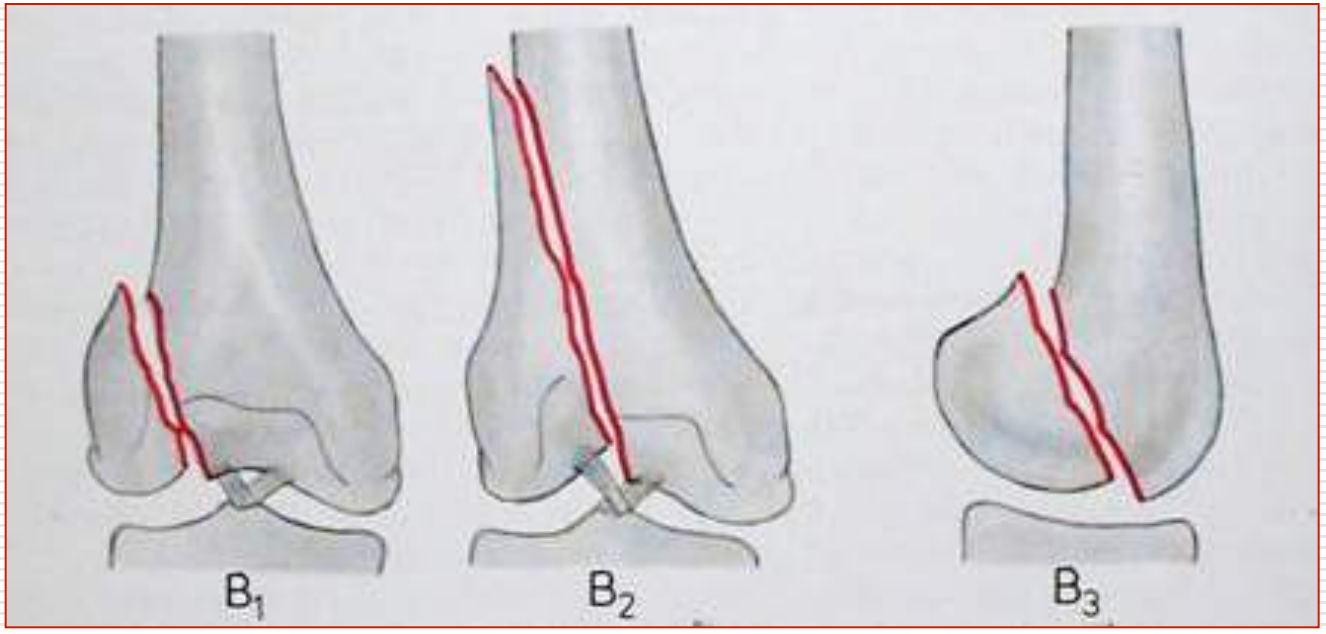
Indication:

'if there is no contraindication'

Aims:

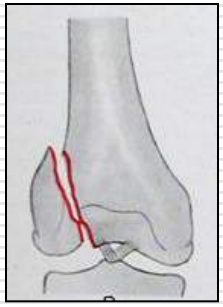
- Anatomic reduction of the joints surface
- Stable fixation
- Early movement of the joints
- Preserve the whole function of the extremity

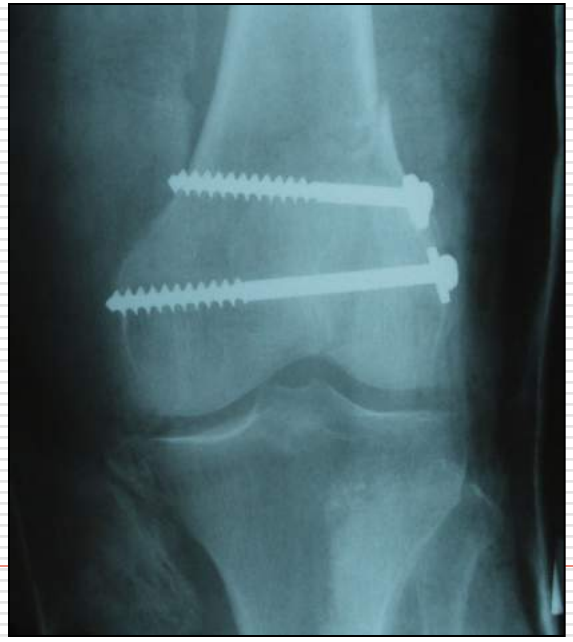
SCREW FIXATION



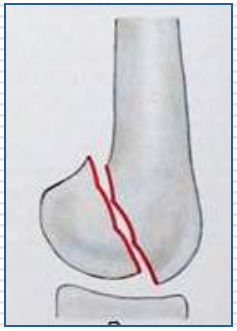
AO/ASIF TYPE B FRACTURES

TYPE B2 FRACTURES – CANCELLOUS SCREW





TYPE B3 'HOFFA' FRACTURES – CANCELLOUS SCREW



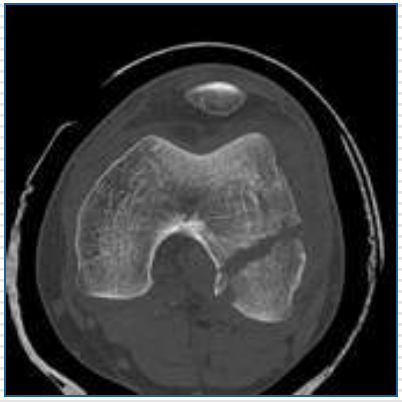


PLATE FIXATION

Indications:

- metaphyseal, intra-articular fractures
- periprostetic fractures
- vascular injury

Advantages:

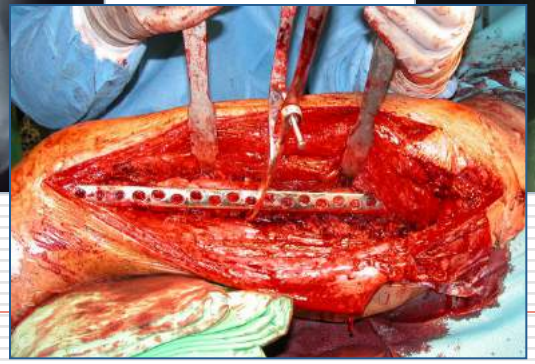
- anatomical reduction

Disadvantages:

- great approach
- damage of periosteal blood supply
- relatively higher rate of infection
- contractures

DC (dynamic compression) PLATE



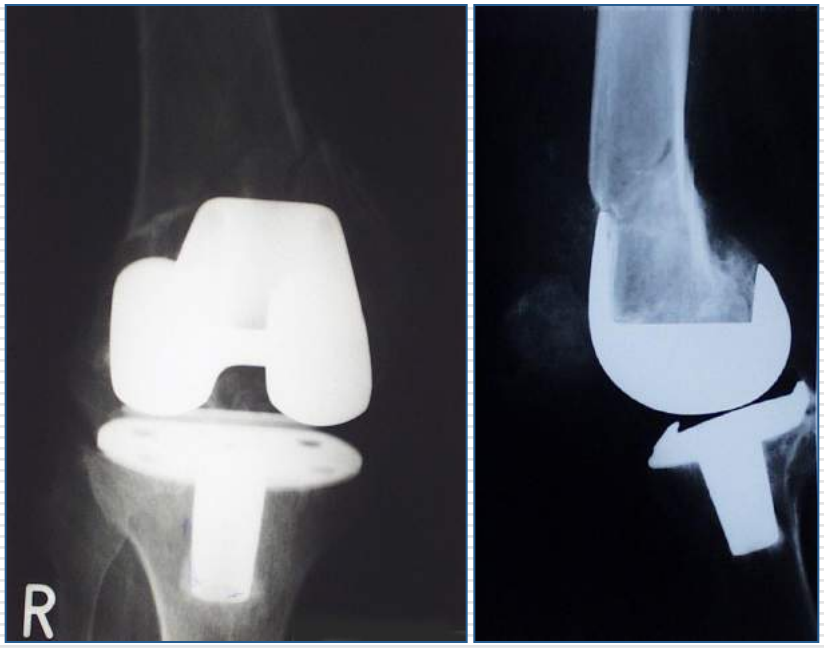


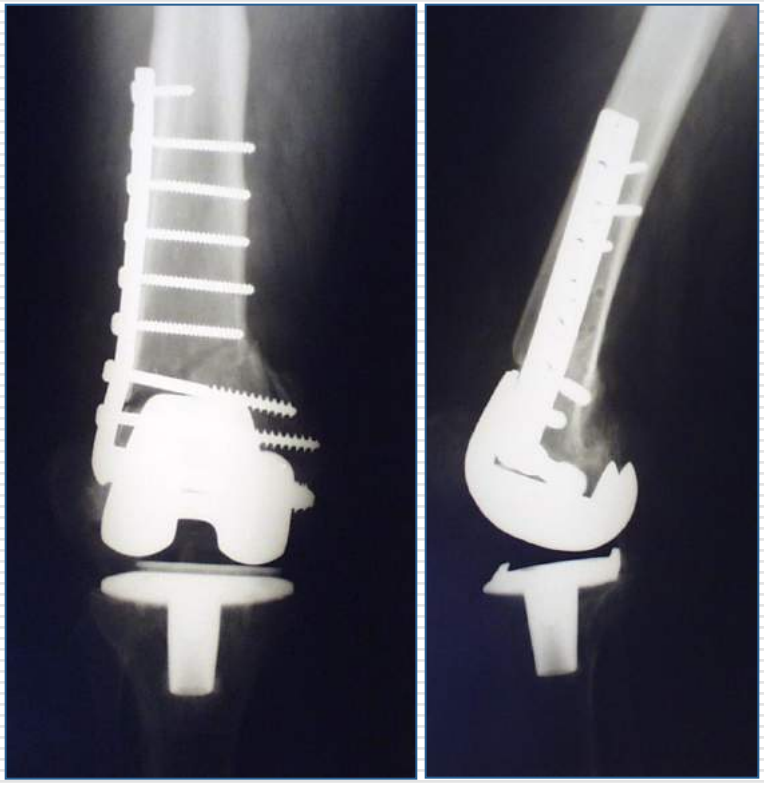
DC (dynamic compression) PLATE

BUTTRESS PLATE

DCS (dynamic condylar screw)

DCS (dynamic condylar screw)





LISS AND LCP SYNTHESIS

LISS: less invasive stabilising system

LCP: locking compression plate - ’fixateur interne’

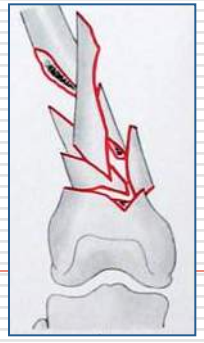
Indications:

- metaphyseal, intra articular fractures
- osteoporosis
- contraindication of nailing

Advantages:

- small approach
- minimal soft tissue damage
- micro movements
- stability

TYPE A3 DISTAL FEMUR - LISS



TYPE C2 DISTAL FEMUR and C1 PROX TIBIA - LISS

PEDIATRIC FEMUR DIAPHYSIS FRACTURE - LCP

INTRAMEDULLARY PIN – TEN (titanium elastic nail)

Indications:

- only in childhood

Advantage:

- minimal invasive

Disadvantage:

- low stability

REAMED INTRAMEDULLARY NAILING

Indications:

- closed fractures
- Grade I. open fractures
- monotrauma
- transverse and short oblique fractures

Contraindications:

- Grade II-III open fractures
- polytrauma
- segmental fracture
- compartement sy

Advantages:

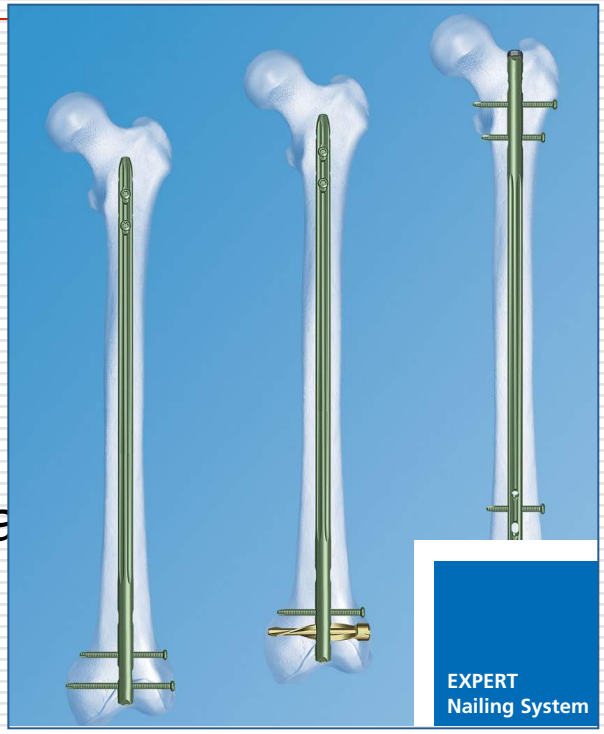
- high stability – full weight-bearing

Disadvantages:

- destruction of endosteal blood supply
- high pressure during reaming
- high risk of infection

REAMED INTRAMEDULLARY NAILING

UNREAMED INTRAMEDULLARY NAILING



Indications:

- closed fractures
- Grade I-III. open fractures
- polytrauma

Contraindications:

- Grade III/C open fra

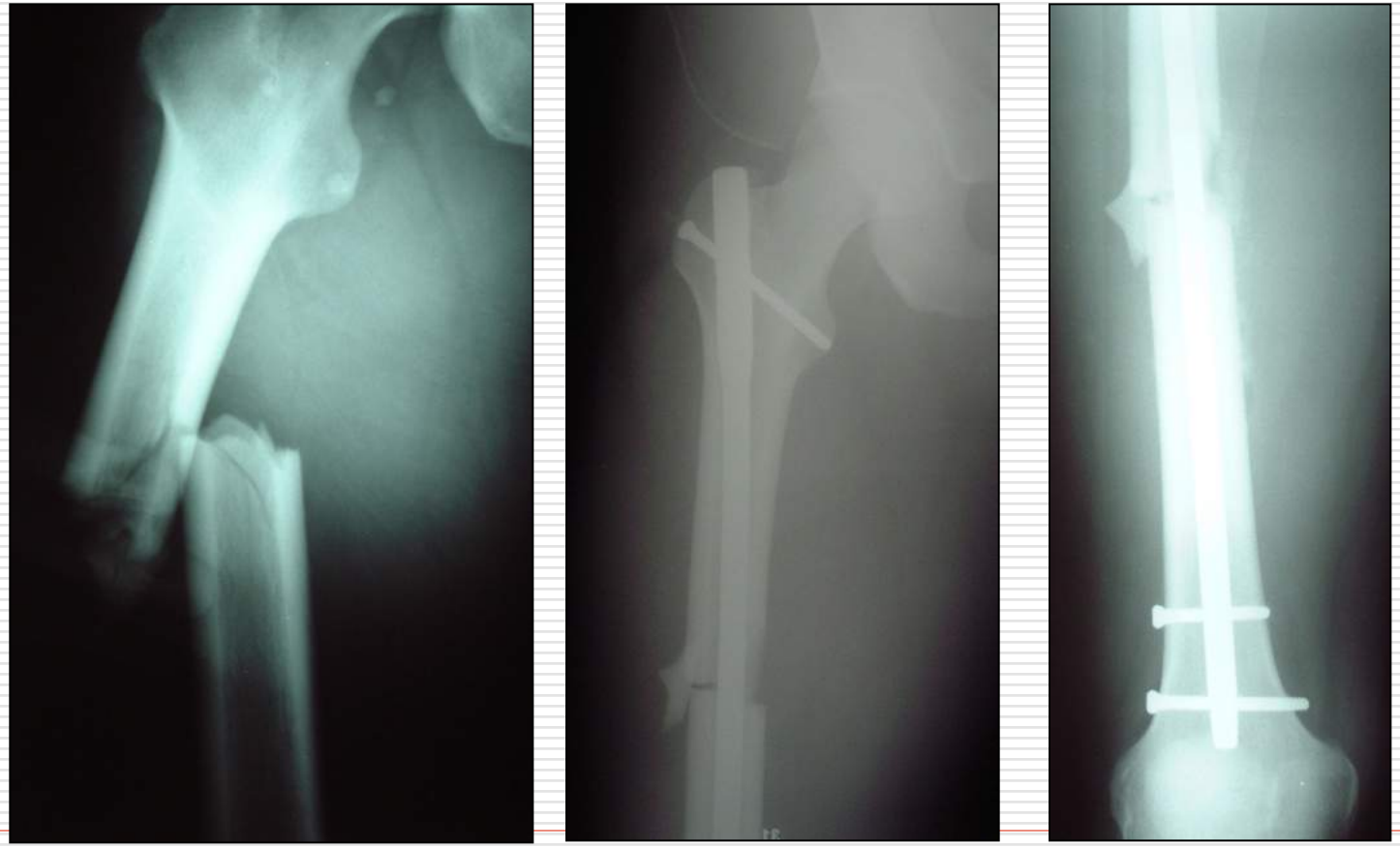
Advantages:

- low risk of infection
- good blood supply
- minimally invasive

Disadvantages:

- lower stability: partial weight-bearing

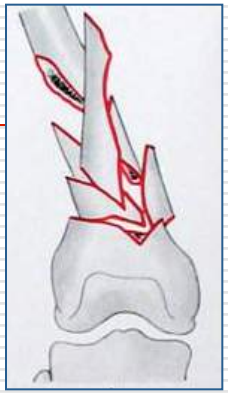
TRANSVERSE MIDSHAFT FRACTURE

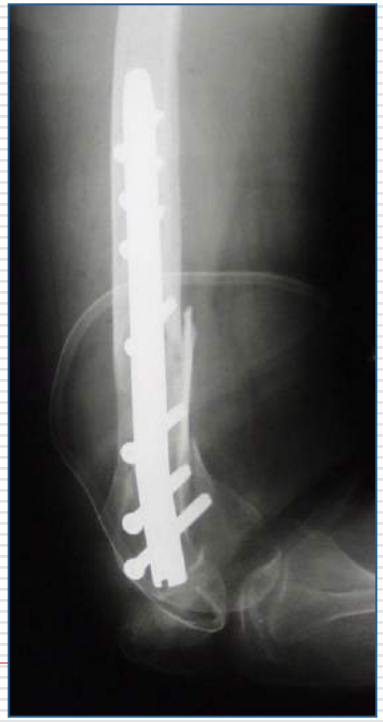


TRANSVERSE MIDSHAFT FRACTURE

TYPE A3 SUPRACONDYLAR FRACTURE

RETROGRADE NAIL





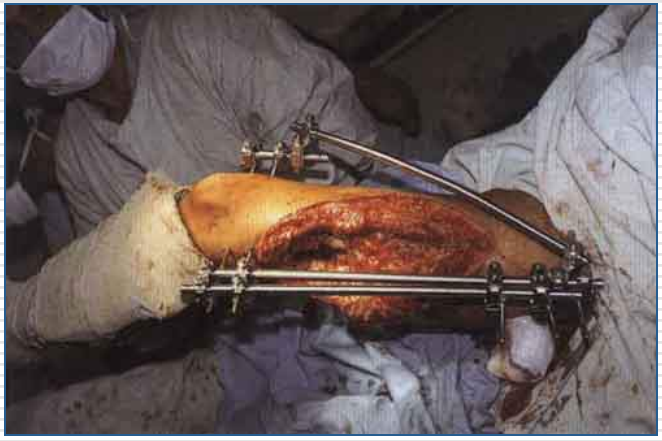
FIXATEURE EXTERNE

Indications:

- Grade II-III open fracture
- polytrauma
- transitional fix.
- septic complications

Advantages:

- fast
- minimally invasive
- good stability



Disadvantages:

- pin infection
- change in method
- contractures

PEDIATRIC DIAPHYSEAL FRACTURE

UNILATERAL EXTERNAL FIXATOR

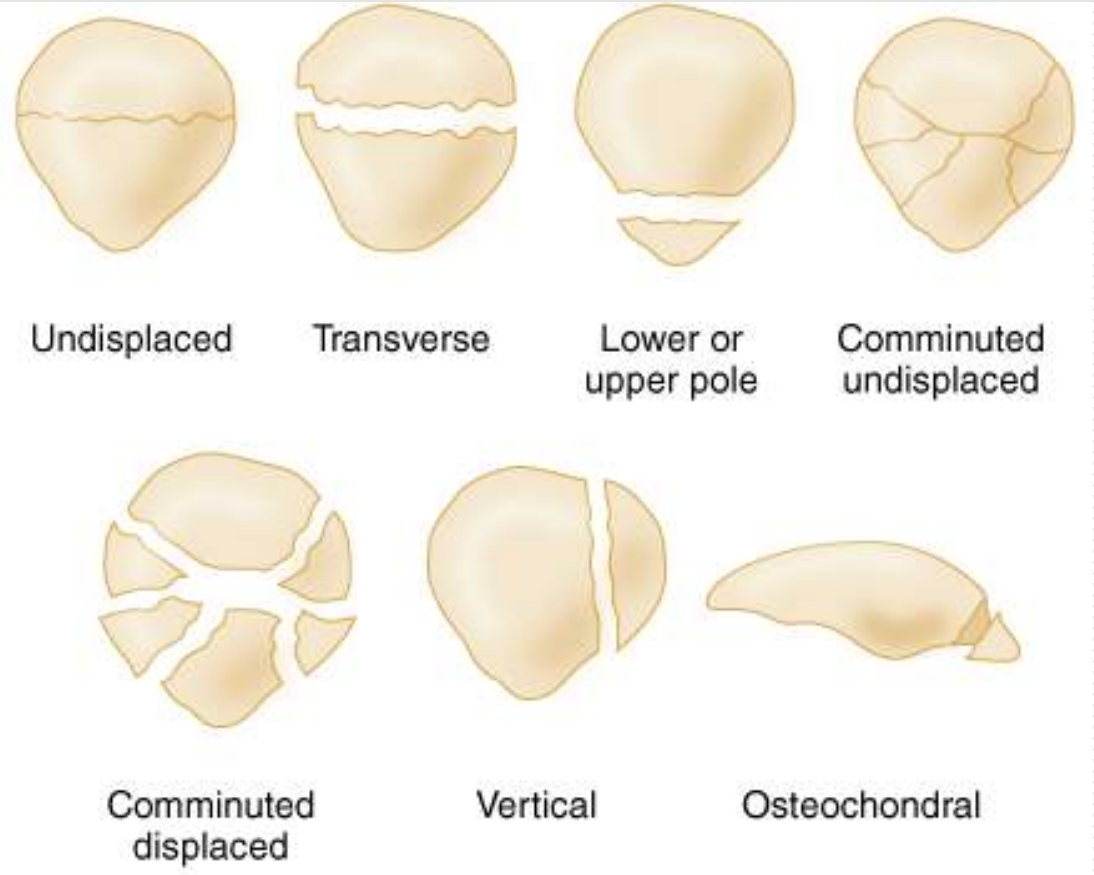
Fractures of patella

Norbert Wiegand

Dep. Of Traumatology and Hand Surgery

PATELLA FRACTURES

Classification



Diagnostics

- Physical examination – extensor function!!
- X-ray
- CT, MRI

Treatment

- Non-operative: undisplaced, closed patella fractures with intact extensor mechanism

- Operative: displaced open/closed patella fracture, or avulsed patella fractures

  - tension band
  - partial patellectomy with ‘anchoring’ the patella

Fractures of the lower leg

Norbert Wiegand

Dep. Of Traumatology and Hand Surgery

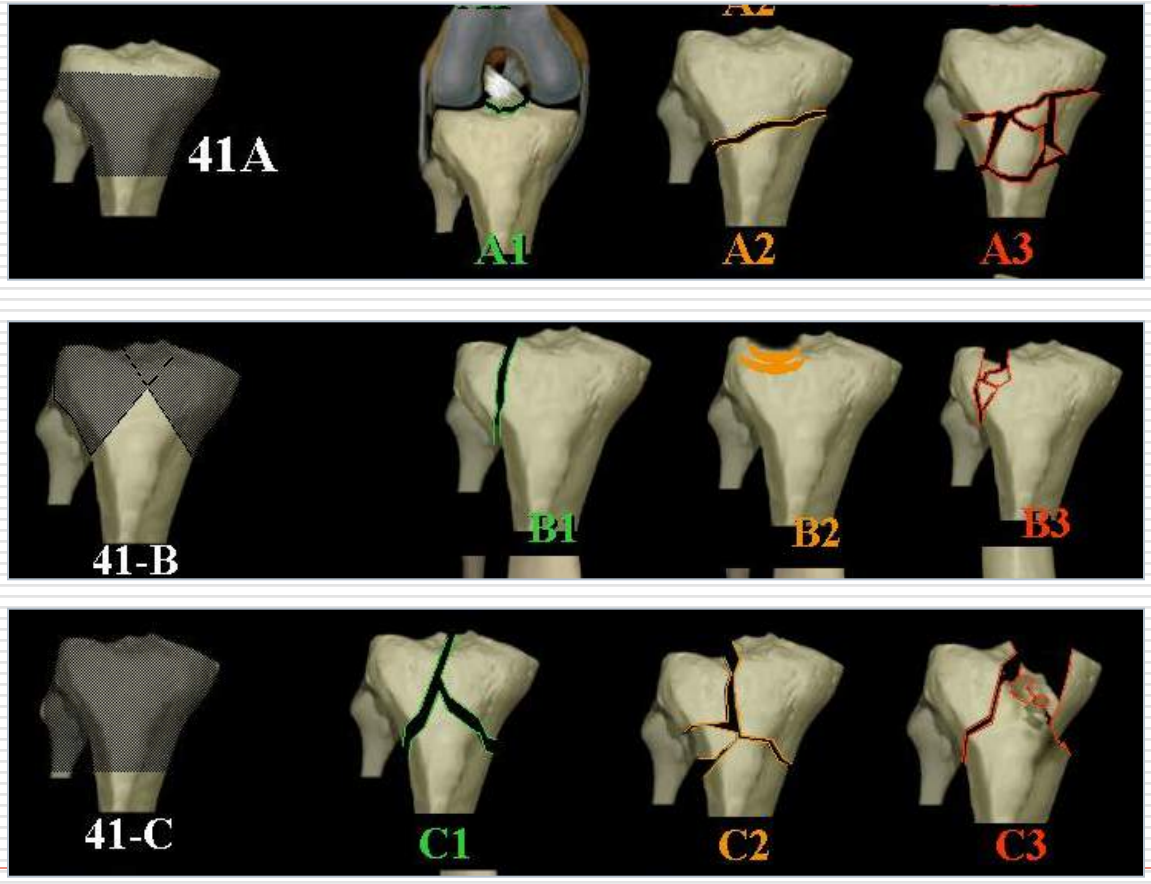
Tibial Fracture Classification

No universally accepted classification scheme.

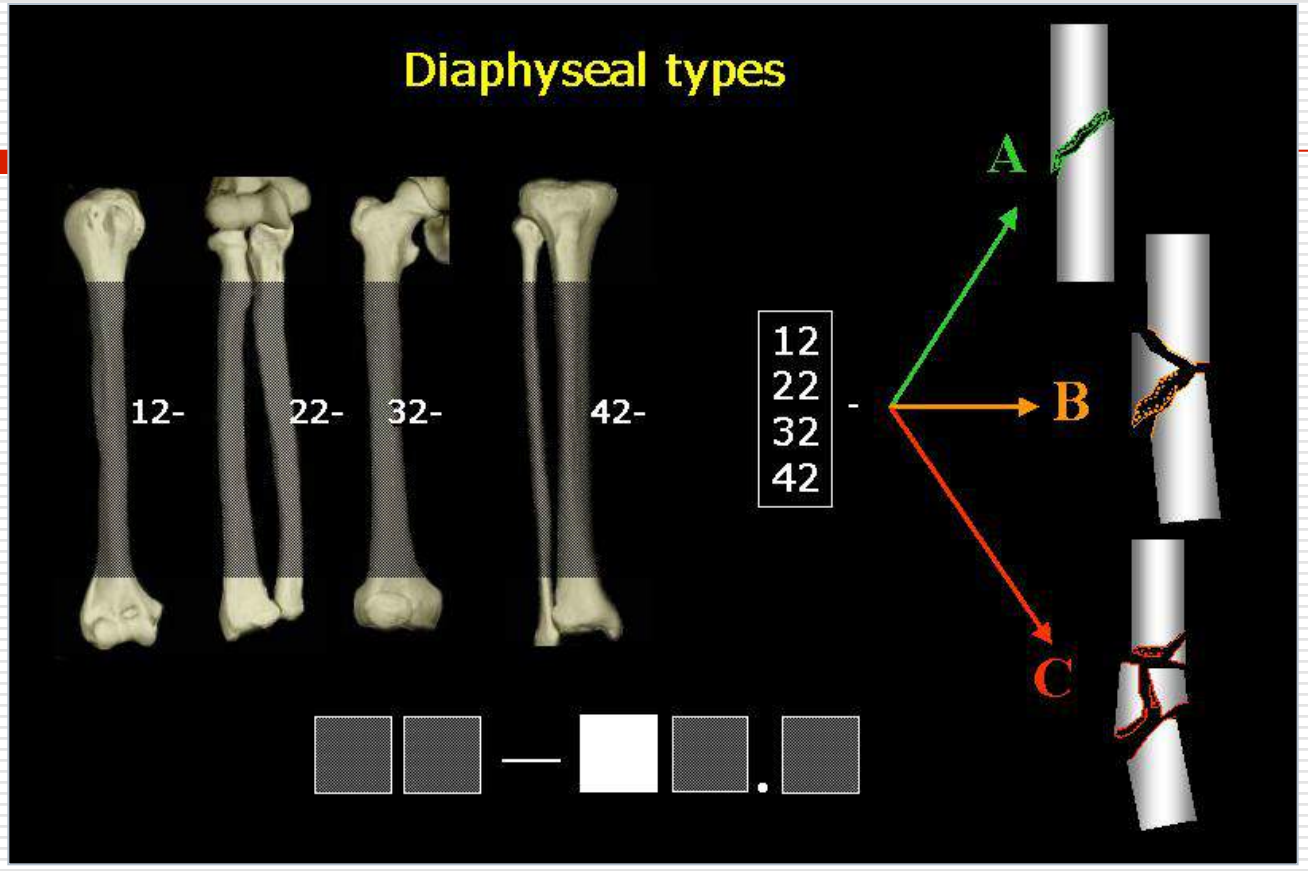
Describe the following

- Location (prox., middle, distal third)
- Configuration (transverse, spiral, comminuted)
- Displacement
- Angulation
- Length
- Rotation

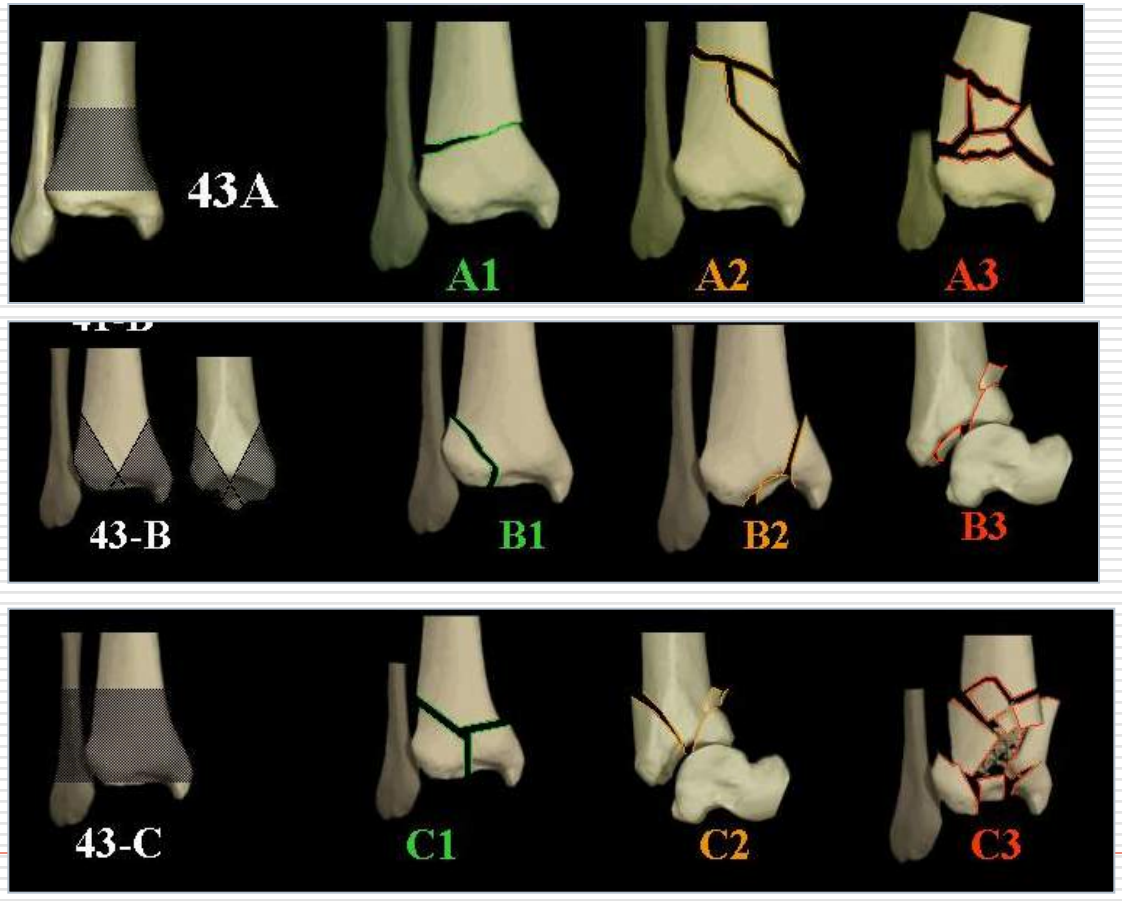
Proximal tibial fractures classification according to AO



Diaphysiseal fractures classification according to AO



Distal tibial fractures classification according to AO

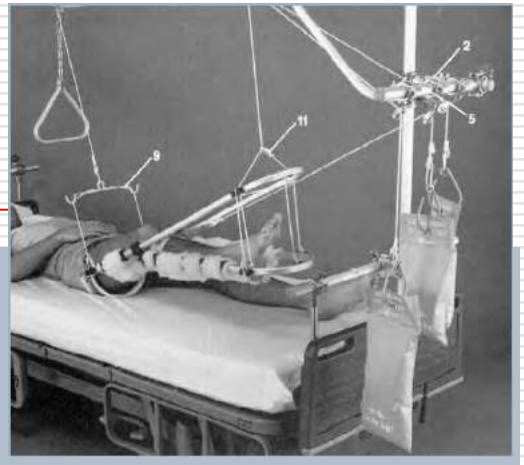


Possibilities for the treatment of tibial shaft fractures

Conservative:
- extension-sceletal traction
- plaster cast
- brace

Surgical:
- plate
- minimally invasive plate
- locking compression plate
- Intramedullar nail
  - unreamed
  - unreamed
- Fixateur externe

Conservative treatment



Indications:

surgical contraindication

isolated tibia fracture

low energy fracture

transverse or short oblique fracture

Ways:

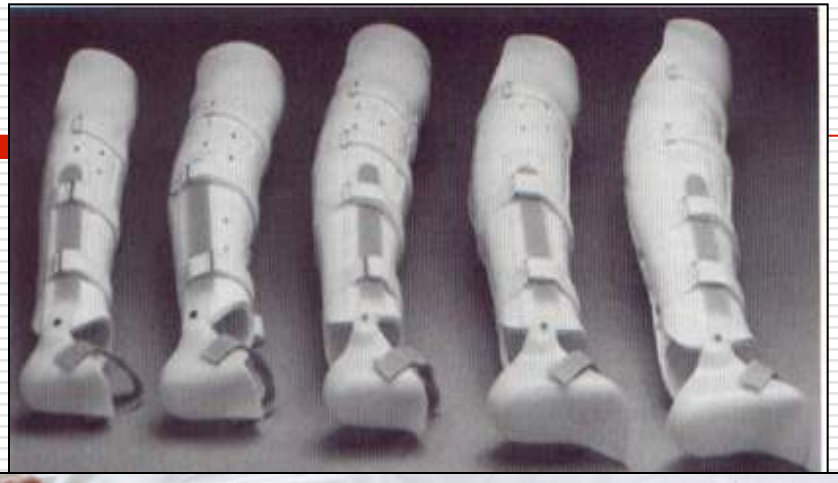
a/ 3 weeks sceletal tractions- 3 weeks long plaster cast- 6 weeks walking cast

b/3 weeks long splint- 3 weeks long circular cast- 6 weeks walking cast

c/ 4 weeks long cast- 8 weeks brace

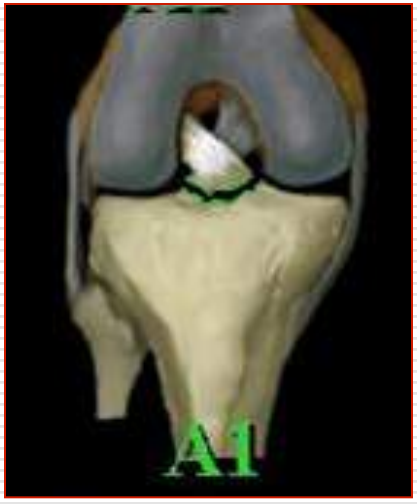
Conservative treatment

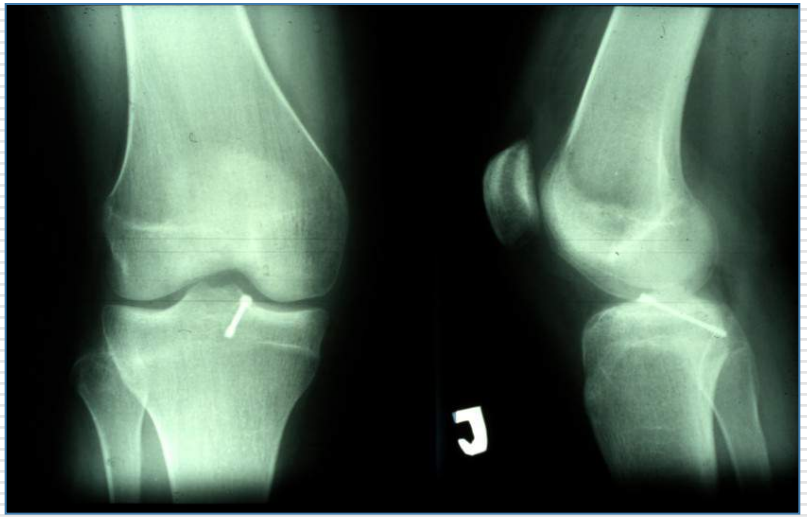
Sarmiento PTB /patellar - tendon –bearing/ brace



Screw

A1 type fracture avulsion of the eminentia interc. ant. reinsertio





Tibia lateral plateau vedge fracture: percutaneus screw fixation

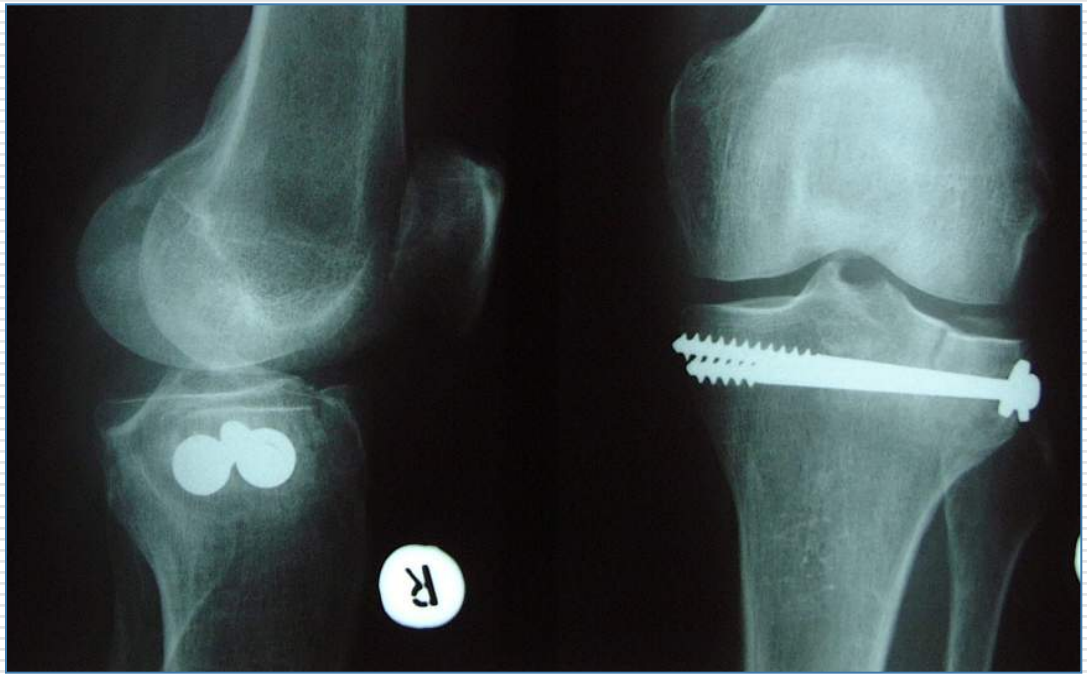


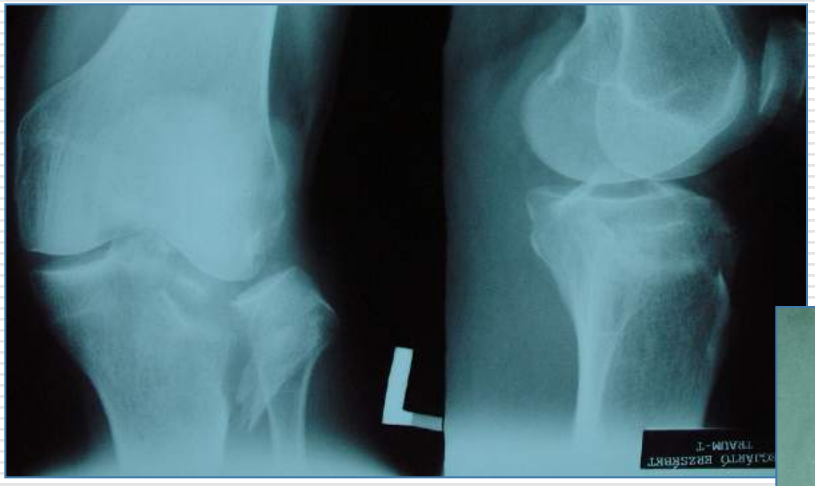
Plate OS

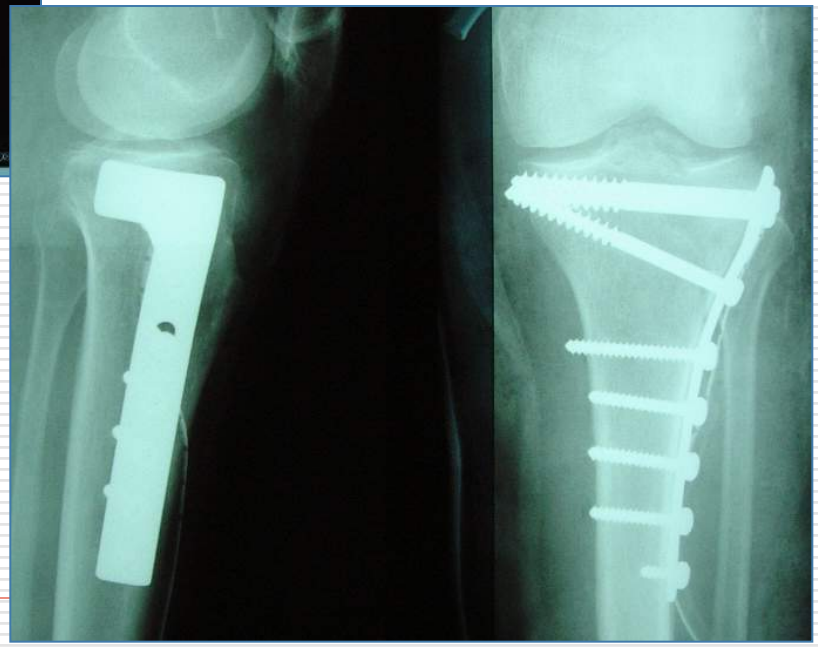
Indications:
- pediatric
- compartement syndrome
- vascular injury
- metaphyseal, intraarticular fractures

Advantages:
- anatomical reposition

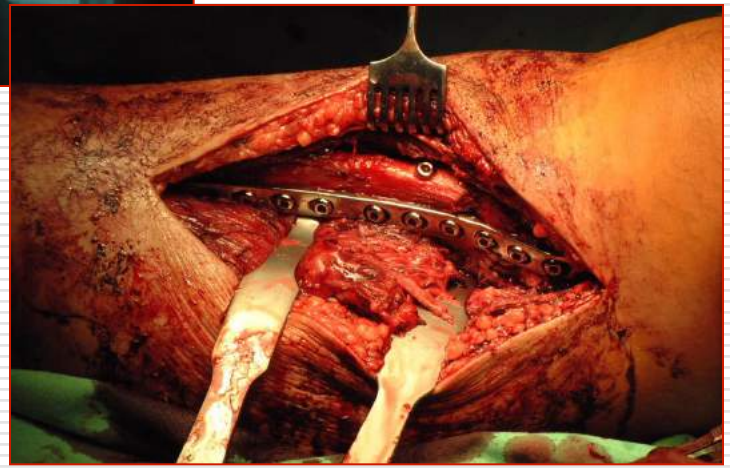
Disadvantages:
- great approach
- damage of periostel blood supply
- high rate of infection
- contractures

Lateral plateau intraarticular fracture: L-LCP plate

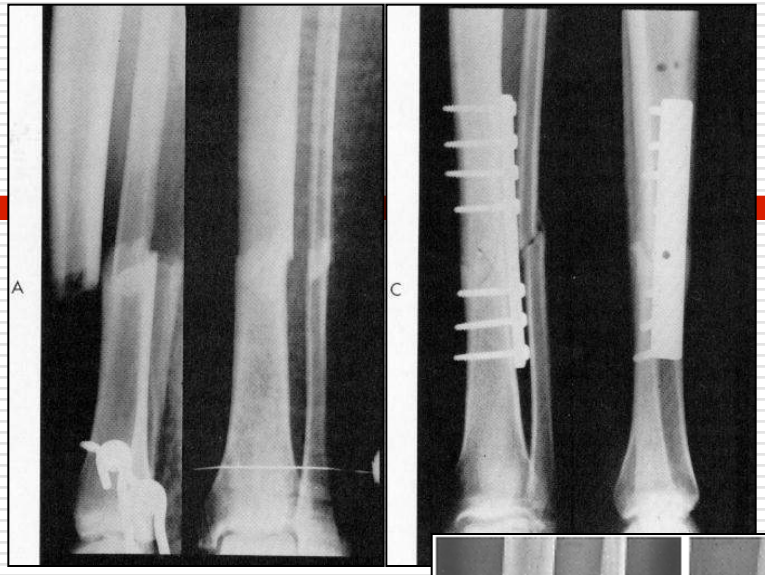


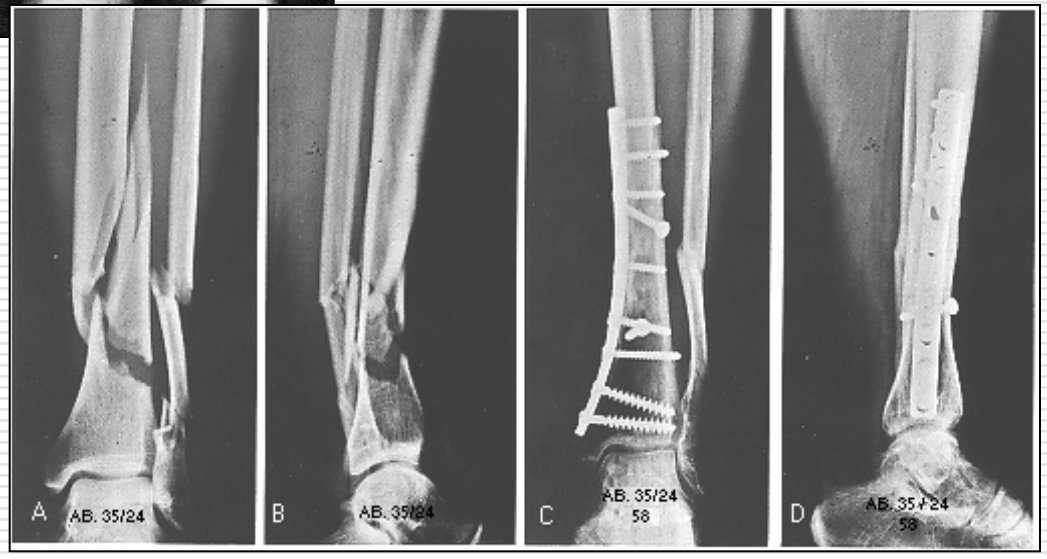


A3 type proximal tibia fracture Plate os

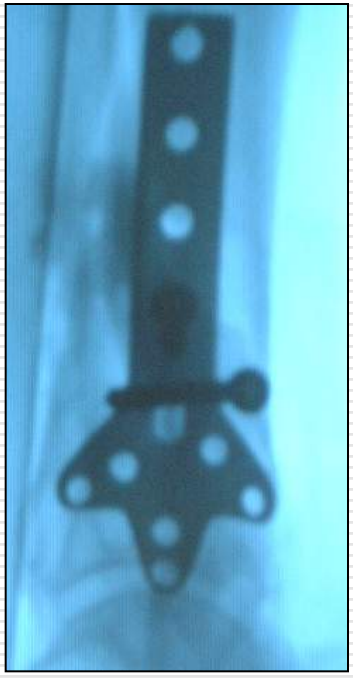


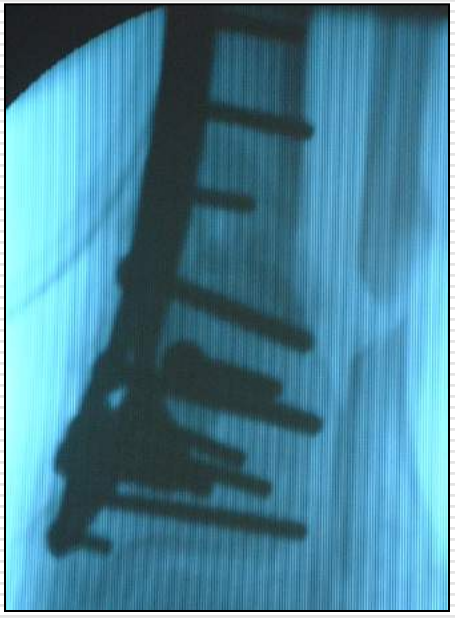
DC plates

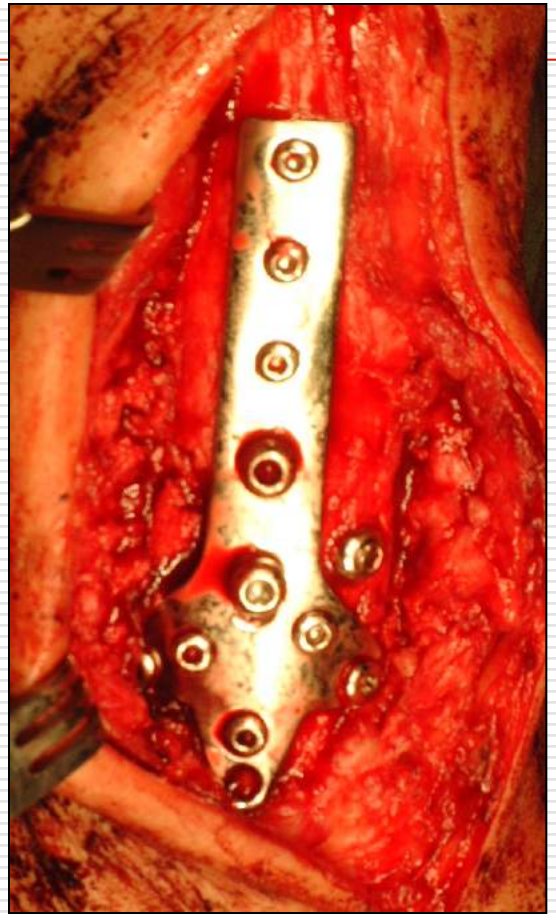




Supramalleolar fracture: butress plate







Minimally invasive plate OS

Indications :

- pediatric
- metaphyseal, intraarticular fractures

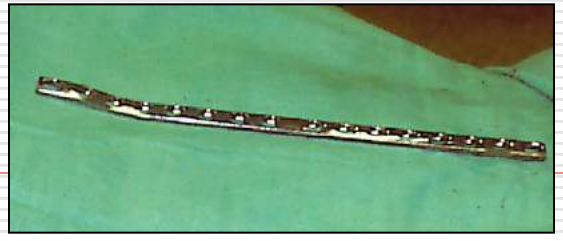
Advantages:

- small approach
- minimal soft tissue damage

Disadvantages:

- low stability

Proximal intraarticular tibia fracture: minimally invasive plate OS



Distal third tibia fracture: minimally invasive plate OS

LISS: less invasive stabilising system
LCP: locking compression plate
fixateur interne

Indications :

- metaphyseal, intraarticular fractures

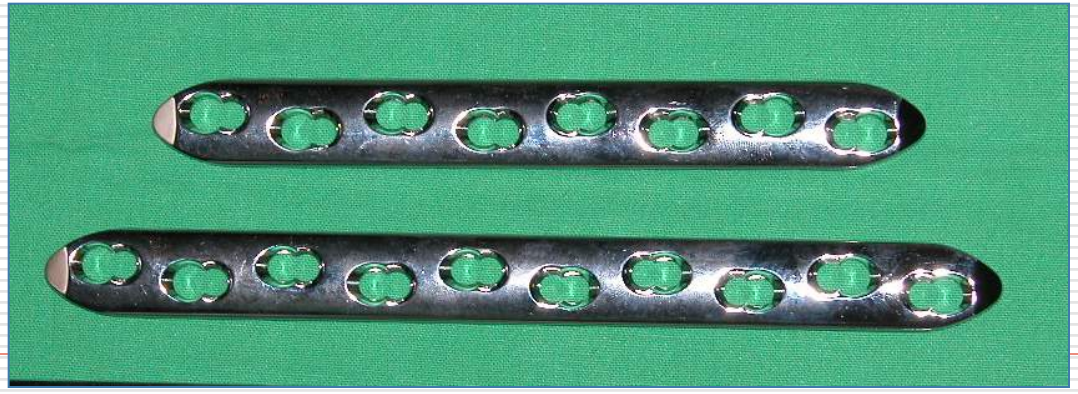
Advantages:

- small approach
- minimal soft tissue damage
- good reposition
- high stability

LISS: less invasive stabilising system

Proximal third tibia fracture : less invasive stabilising system OS

LCP: locking compression plate



B3 type proximal tibia fracture: L-LCP

Proximal third tibia fracture: locking compression plate

Proximal, diaphyseal and distal fractures: 2 pcs LCP

Supramalleolar fracture: LCP

Intramedullary pining

Indications :

- pediatric (TEN-titan elestic nail)

Advantages :

- minimally invasive
- fast

Disdvantages :

- low stability: + plaster cast

Intramedullary pining with TEN

Reamed intramedullar nailing

Indications:
- closed fractures
- grade I. open fractures
- monotrauma
- transverse and short oblique fractures

Contraindications:
- Grade II-III open fractures
- polytrauma
- segmental fracture
- compartement sy

Advantages:
- high stability – full weight-bearing

Disadvantages:
- destruction of endosteal blood supply
- high pressure during reaming
- high risk of infection

Middle third tibia fracture: reamed intramedullar nailing

Unreamed intramedullar nailing

Indications:
- closed fractures
- grade I-III open fractures
- polytrauma

Contraindications: ?

Advantages:
- low risk of infection
- good blood supply
- minimally invasive

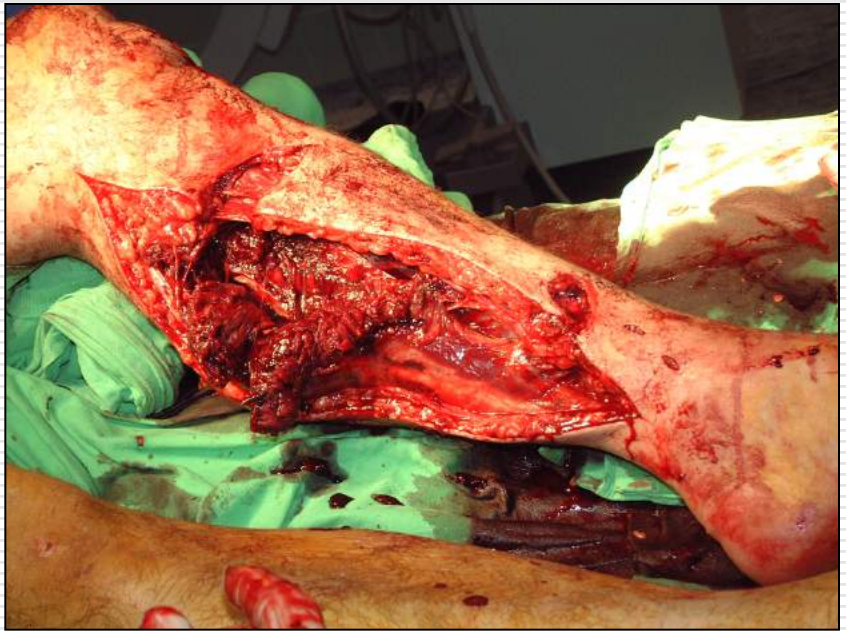
Disadvantages:
- lower stability: partial weight-bearing

Proximal third tibia fracture: unreamed im. nail

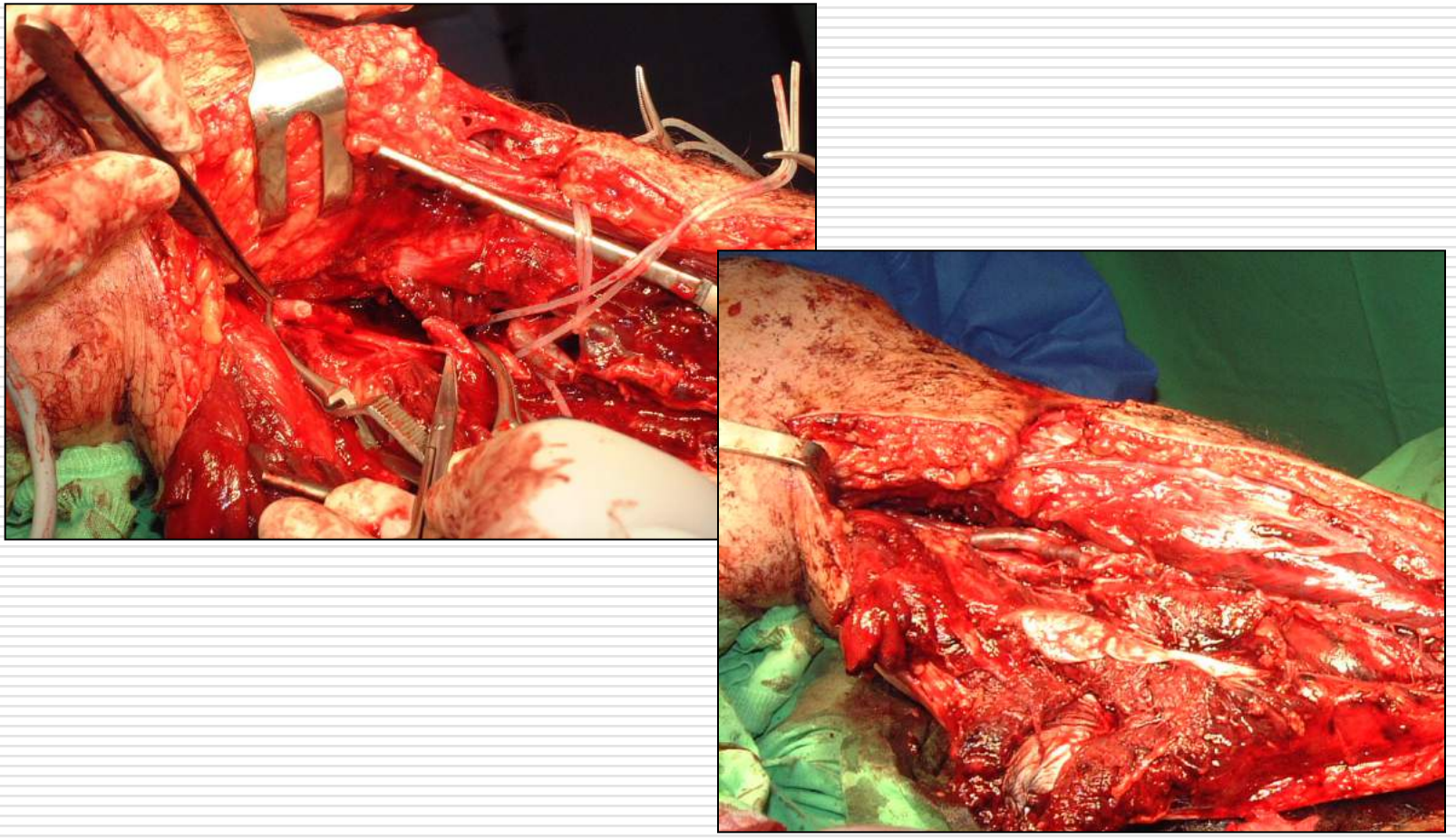
Spiral tibia fracture: unreamed im. nail

Distal third spiral tibia fracture: unreamed im. nail

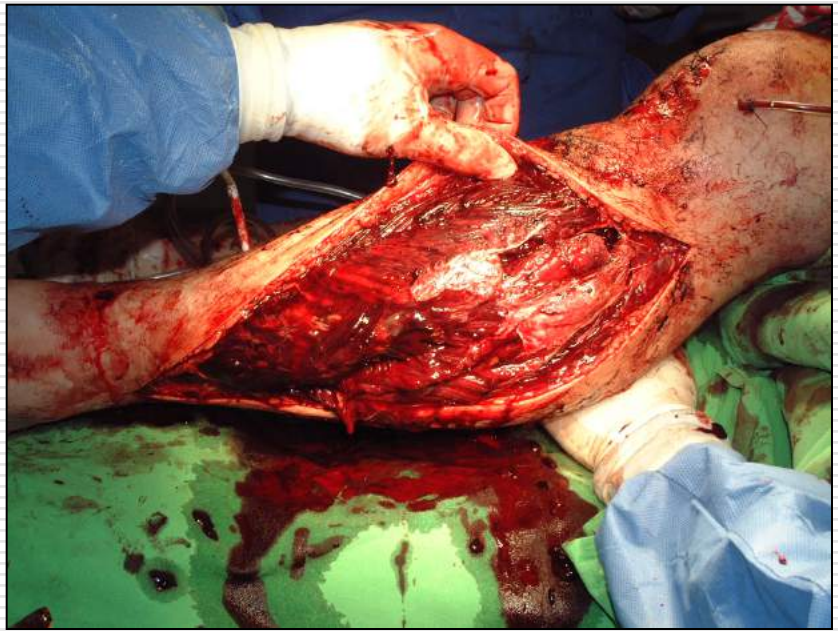
Type III/C open fracture arterial injury compartement syndrome



popliteal artery replacement with vein graft



Decompression



Soft tissue coverage with MESH graft

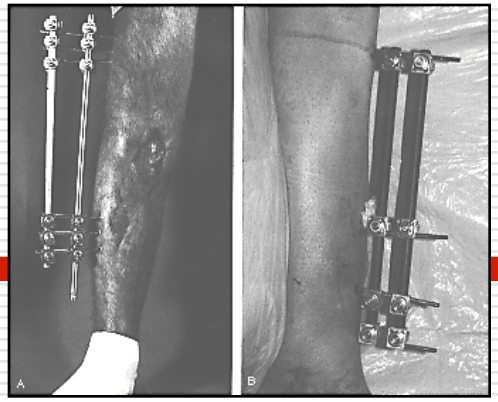
Fixateur externe

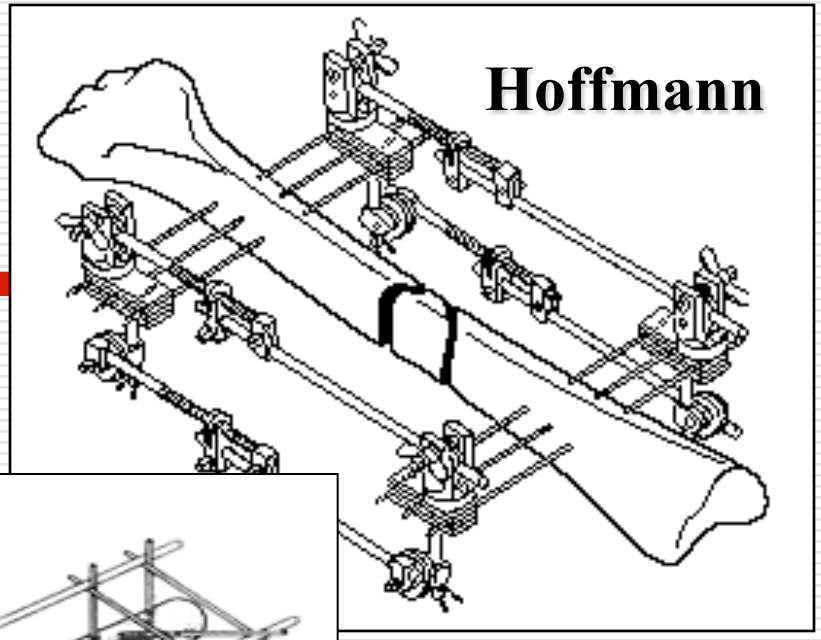
Indications:
- Grade II-III open fractures
- polytrauma
- temporary fixation (pinless)
- metaphyseal, intra-articular fractures
- septic complications

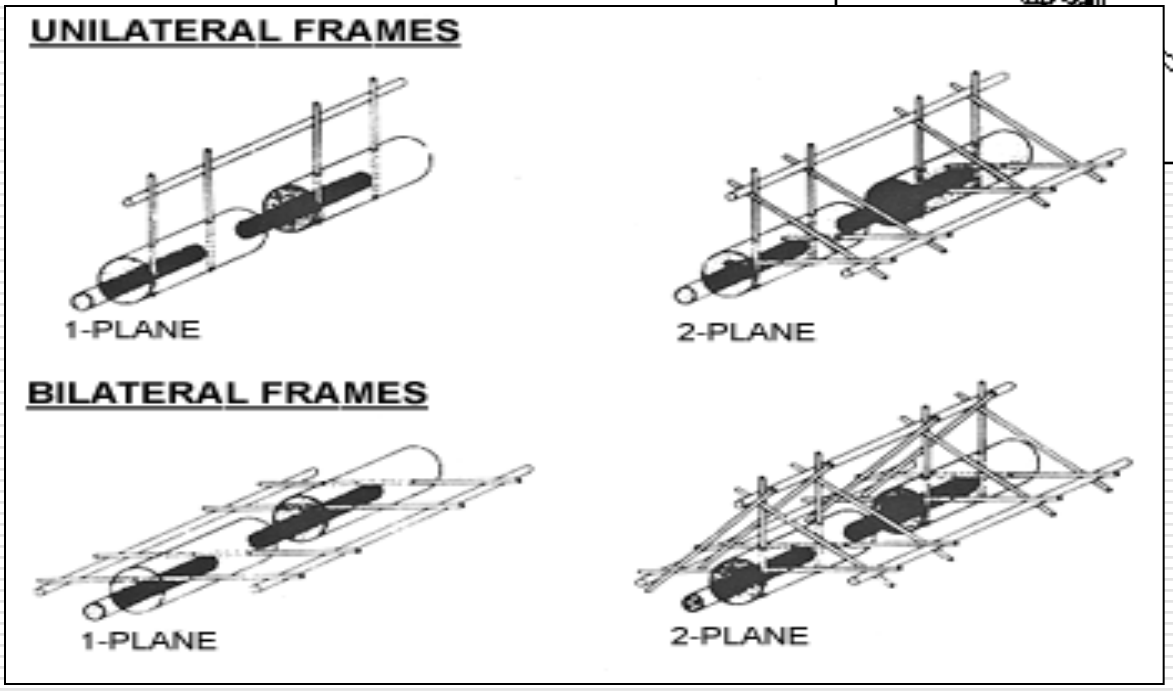
Advantages:
- fast
- minimally invasive
- low rate of infection
- high stability

Disadvantages :
- pin tract infection
- change in method
- contractures
- personal comfort

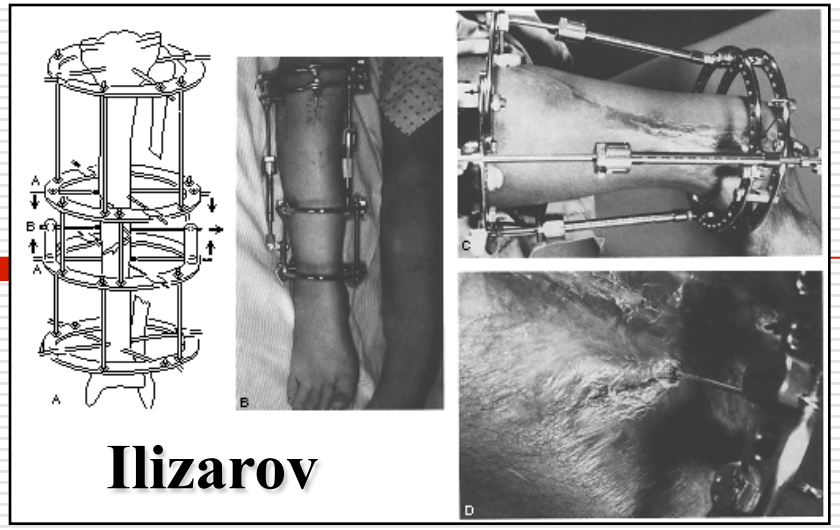
Fixateur externe I.







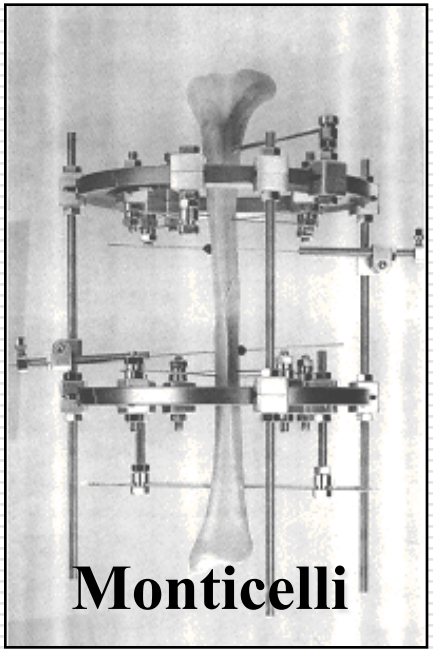
Fixateur externe II.



Ilizarov

circular

Hybrid

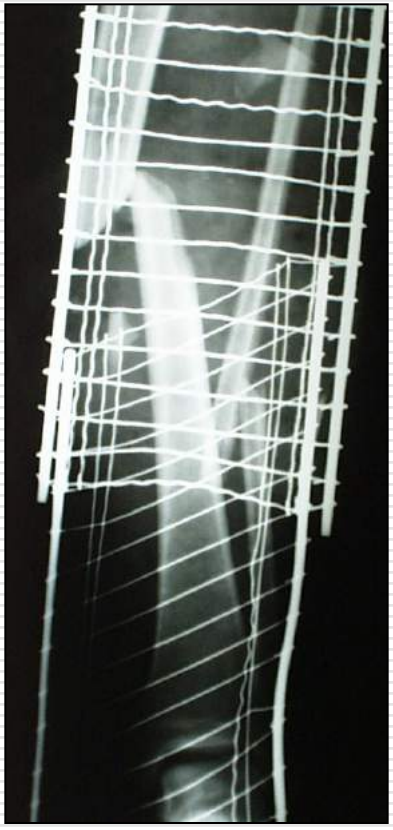


Monticelli

Semi-circular

Proximal third complex fracture: triangular fixateur

Grade III open fracture: unilateralis fixateur

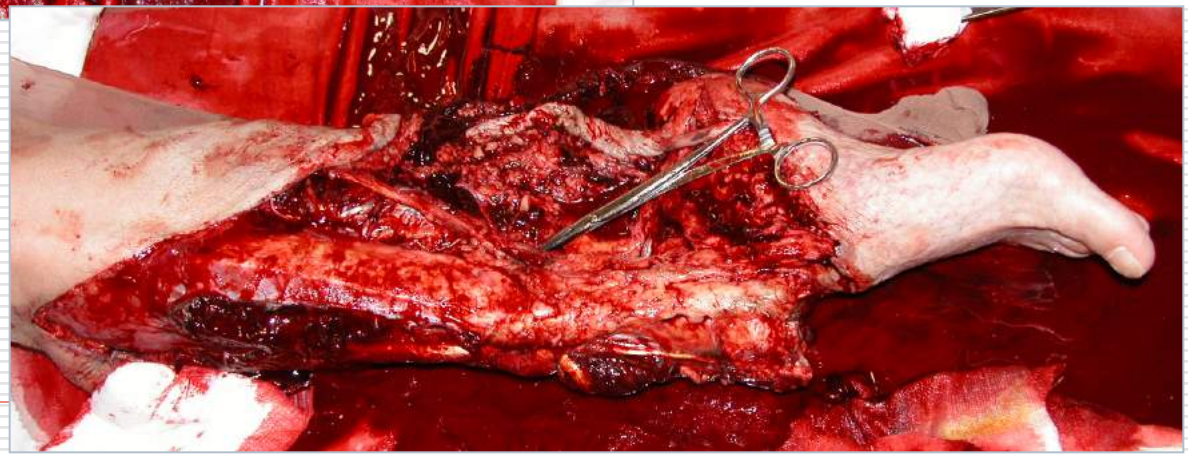



Supramalleolar tibia fracture: bilateral fixateur

Grade II. open C type distal fracture:

Triangular bridging fixateur

Grade IV open fracture: mission impossible



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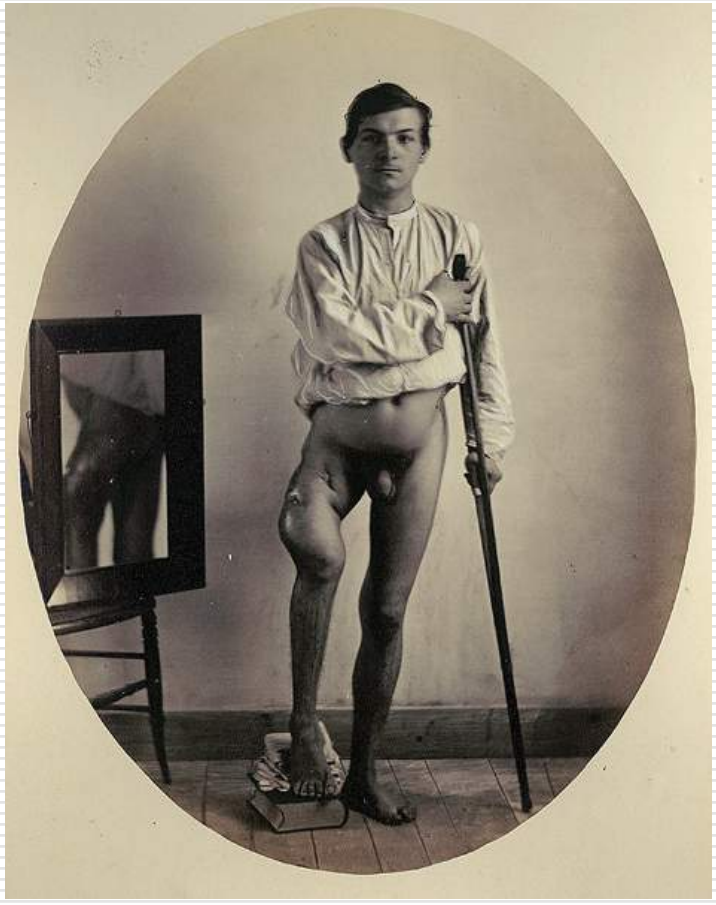


Introduction

- Very common injury

Movement:

flexion-extension

rotation

Stabilization:

ligaments, capsule, menisci, muscles

Anatomy

Femur:

- medial condyle (larger)
- lateral condyle (proximal)

Tibia:

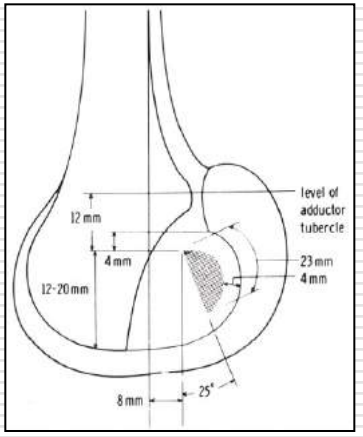
- double concave surface with mensci

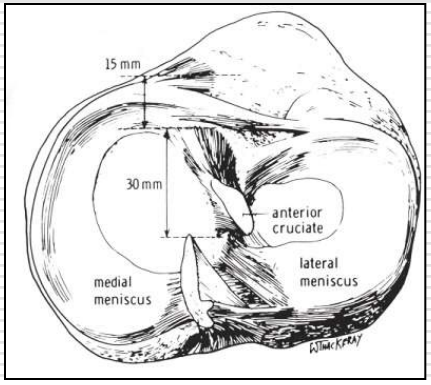
Patella:

- largest sesamoid bone

3 joints:

- tibio-femoral
- patello-femoral
- tibio-fibular

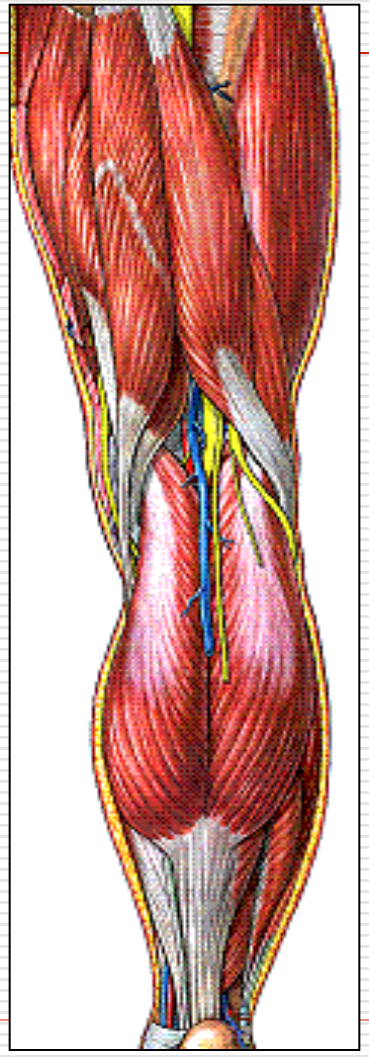




Anatomy – muscles

Flexors:

- Hamstring group:
  - Biceps femoris
  - Semitendinosus
  - Semimembranosus
- Pes anserinus group:
  - Gracilis
  - Sartorius
  - Semitendinosus
- Gastrocnemius
- Popliteus



Anatomy – muscles

Extensors:

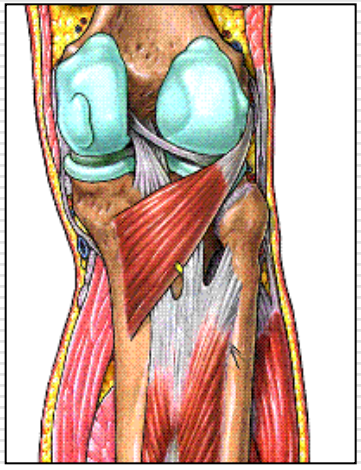
- Quadriceps group:
  - Vastus medialis, lateralis, intermedius
  - Rectus

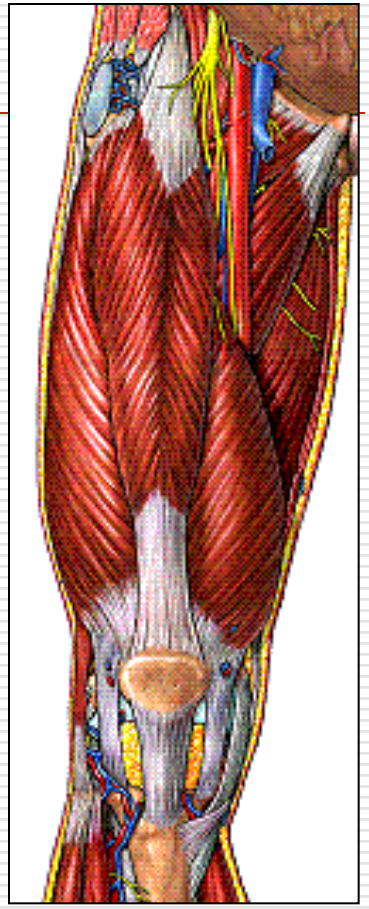
External rotator:

- Popliteus
- Semimembranosus
- Sartorius
- Gracilis

Internal rotator:

- Biceps

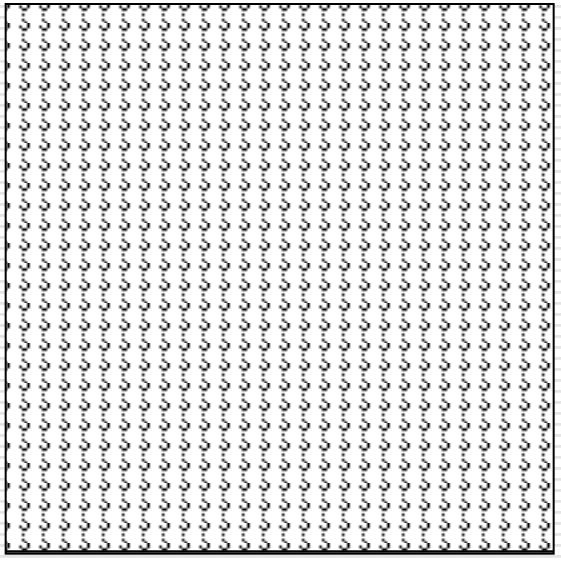




Anatomia – menisci

Function:

- deeper joint surface
- reducing stress
- stabilizing



Anatomia – menisci

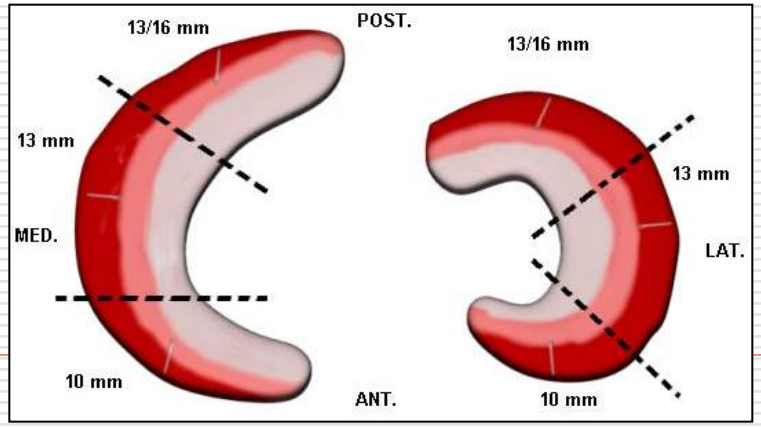
Blood supply:

Arteria circumflexa gen.

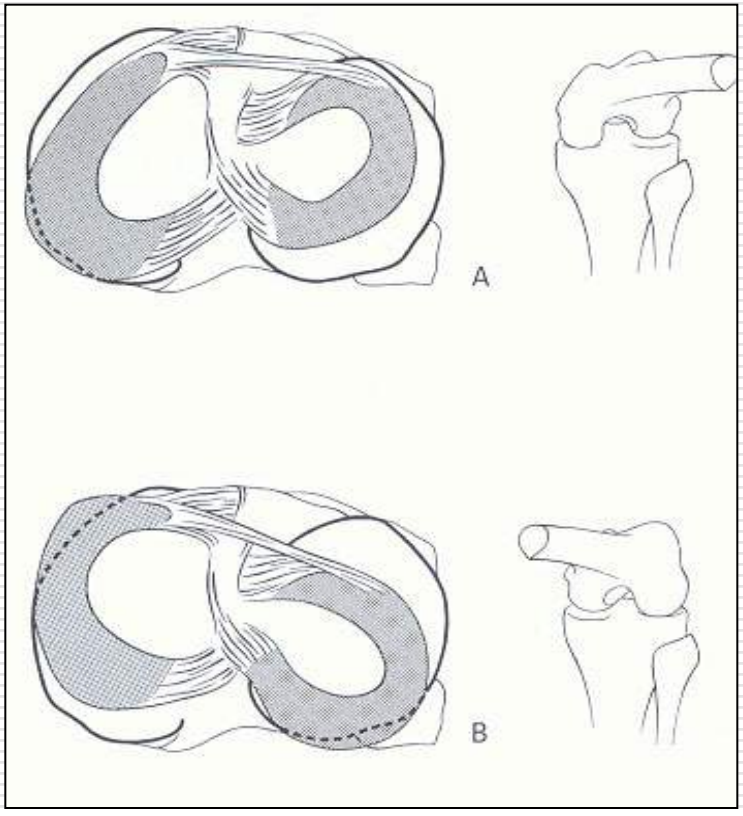
red – red zone: external 1/3 +++

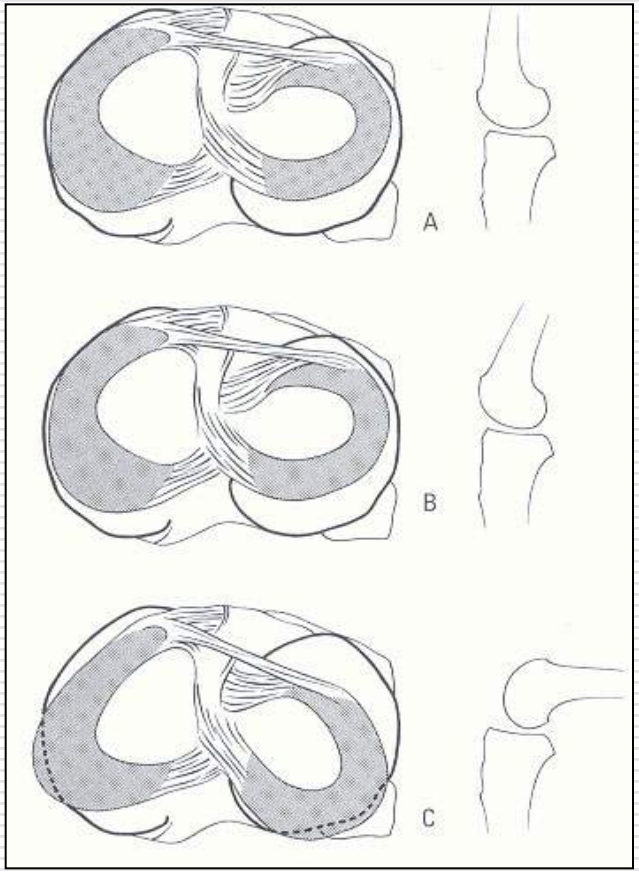
red – white zone: middle 1/3, +/-

white – white zone: : internal 1/3, ---

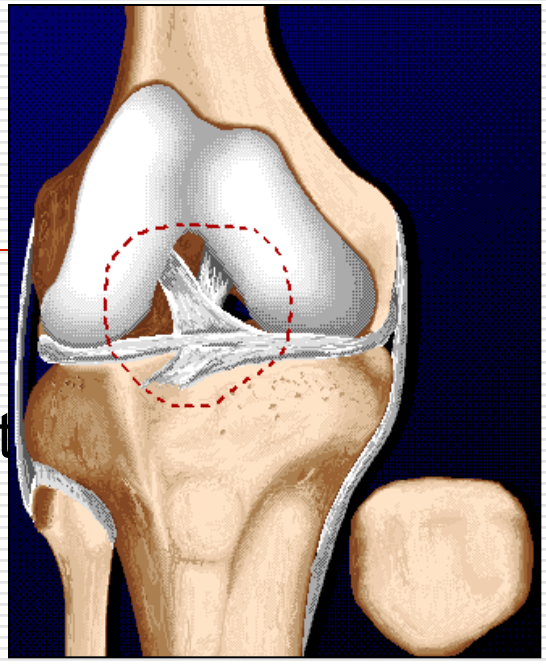


Different position of menisci





Anatomy - ligaments

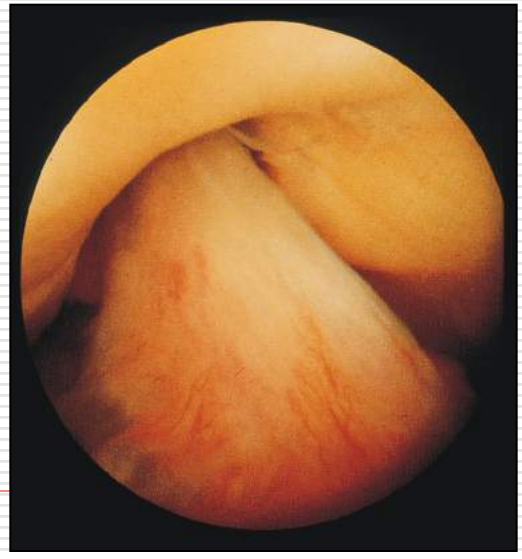


Anterior Crucial Ligament (ACL):

* posterolat. femur – anteromed. t
* stretched: extension
* function:

stabilizer: anterior and internal rotation

secondary stabilizer: valgus-varus stress

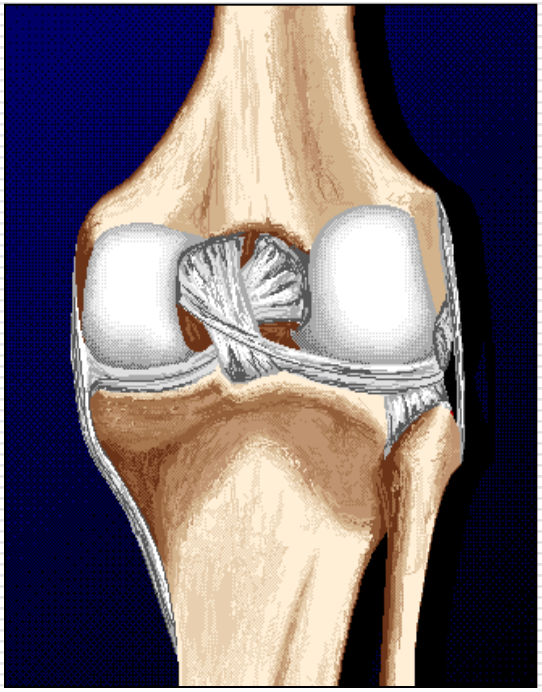


Anatomy - ligaments

Posterior Crucial Ligament (PCL):

* primary stabilizer
* stronger, than ACL!
*anteromed. Femur – posterolat. Tibia
* stretched: flexion
* function:

stabilizer: posterior and internal rotation



Anatomy - ligaments

Medialis collateral (MCL):

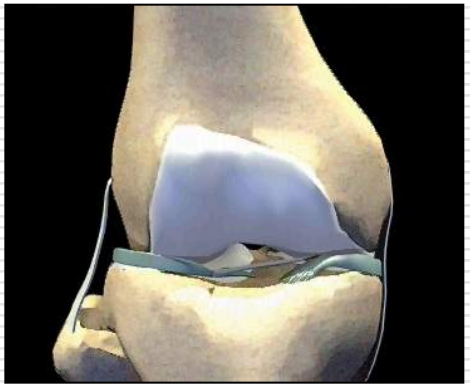
medial femur condyle – medial tibia condyle

connected to medial meniscus

Function:

Stabilizer: external rotation

valgus stress



Lateralis collateral (LCL):

lateralis femur condyle – fibula head

strong

Function:

external rotation

varus stress

Posterior capsue-ligament ‘ligamentum arcuatum’:

musculus popliteus – lateral meniscus

Examination of Stability – stress tests

Valgus test:

Extension and 30 degrees flexion
+: medial laxity
ACL, MCL, PM capsule injury

Varus test:

Extension and 30 degrees flexion
+: lateralis laxity
ACL, LCL, PL capsule injury

Examination of Stability – stress tests

Lachman test:

20-30 fokos flexion

+: anterior tibial translation

ACL sérülés

Anterior-posterior drawer test:

90 degrees flexion or sitting position

relaxed hamstring group!

+: tibia A-P laxity

ACL - PCL szakadás

Examination of Stability – stress tests

Posterior sag test:

Acute knee injuries:

Contusion / distorsion
ACL tear
PCL tear
MCL tear
LCL tear
Knee discloation
Patellar dislocation
Patellar ligament tear
Quadriceps tendon rupture
Meniscus injury
Osteochondral fractures

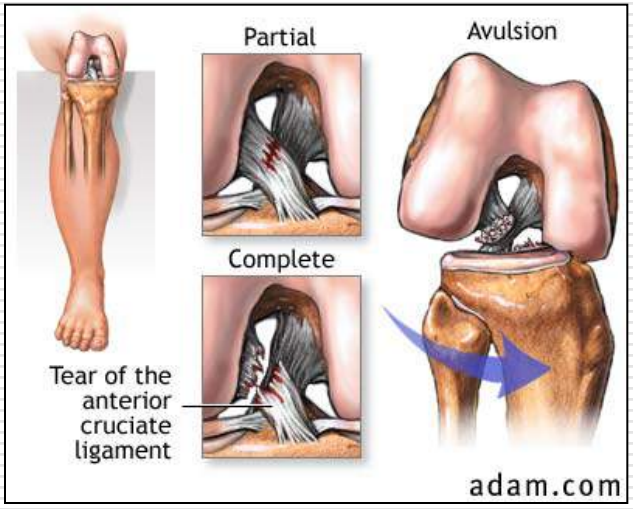
ACL injuries

Mechanism:

- Rotation:
  - External tibia rotation + valgisation of knee
- Hyperextension
  - Direct trauma, landing to the ground

Symptoms:

- Cracking-crunching sound
- Haemarthros immediately
- Loss of function
- Instability
- + Lachmann és anterior drawer test



Dg:

- Physical examination
- Ultrasonography
- MRI

Complete or partial tear!

ACL injury: conservative therapy

Indication:

- Chronic injury
- Minimal activity
- No instability
- No associated injury

Therapy:

- Immobilisation? Not really...
- Brace
- Fizikotherapy:
- Quadriceps exercises
- Hamstring group: relax a bit..

ACL injury: surgical treatment

Indication:

- Young patient
- Physical activity
- Instability
- Associated injuries

Treatment:

- Suture + augmentation
- Reinsertion
- Graft:
  - Autograft: Patella tendon (BTB), Hamstring (Semit.+Gracilis), Quadriceps tendon
  - Allograft: BTB, Achilles, Hamstring, ACL, IT branch
  - Xenograft: bovine
  - Synthetic graft
  - Tissue engineering graft: future

ACL suture

ACL reinsertion:

Indication:

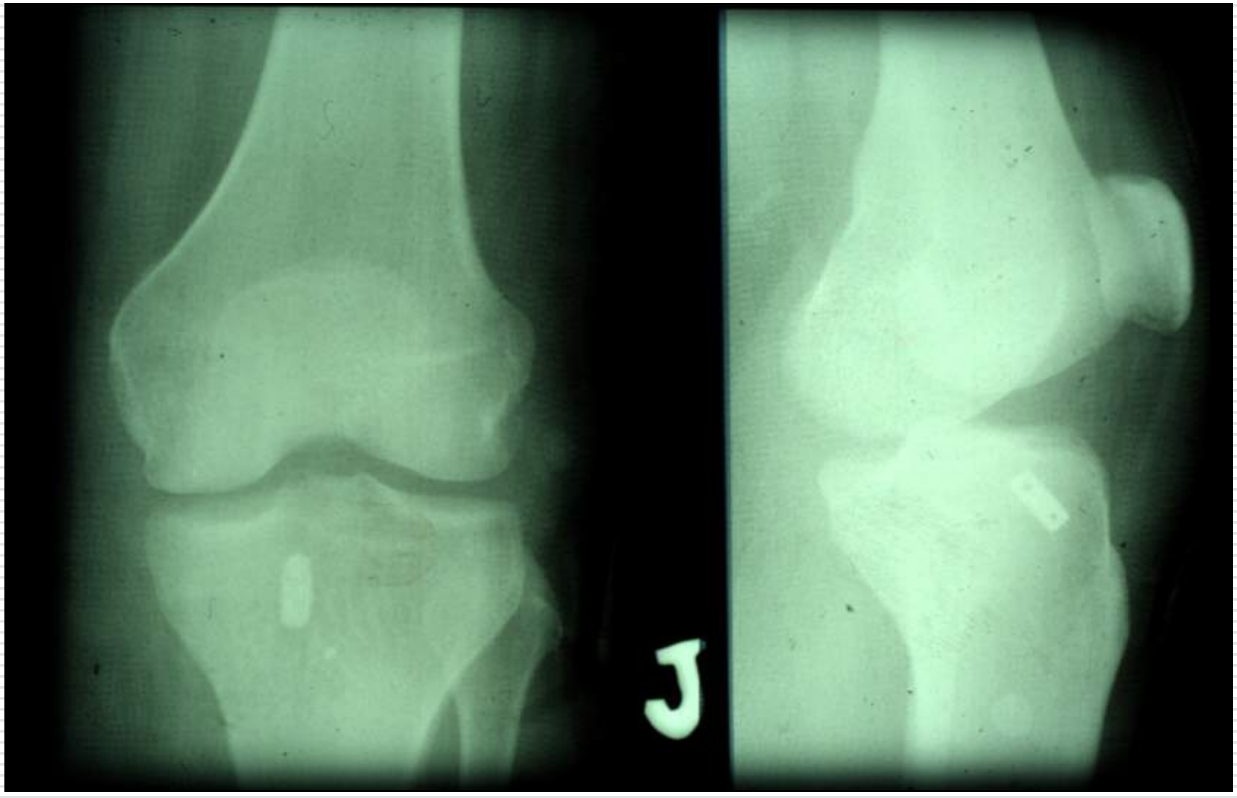
- Tear: proximal femur condyle
- Bony fragment with intact ligament

Methods:

- Over the top
- Over the button
- Anchor
- Suture

ACL femoral reinsertion: bone anchor

ACL tibial reinsertion: bone anchor



ACL - tuberositas tibiae reinsertion Herbert screw

ACL reconstruction - autografts

Grafts:

- Patellar tendon (BTB),
- Hamstring (Semitendinosus+Gracilis),
  Quadriceps tendon

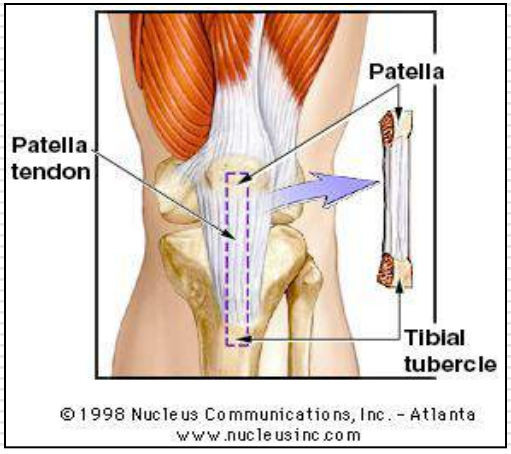
Fixation devices:

- Interference screw: titanium, absorbable
- Bone anchor
- Press fit

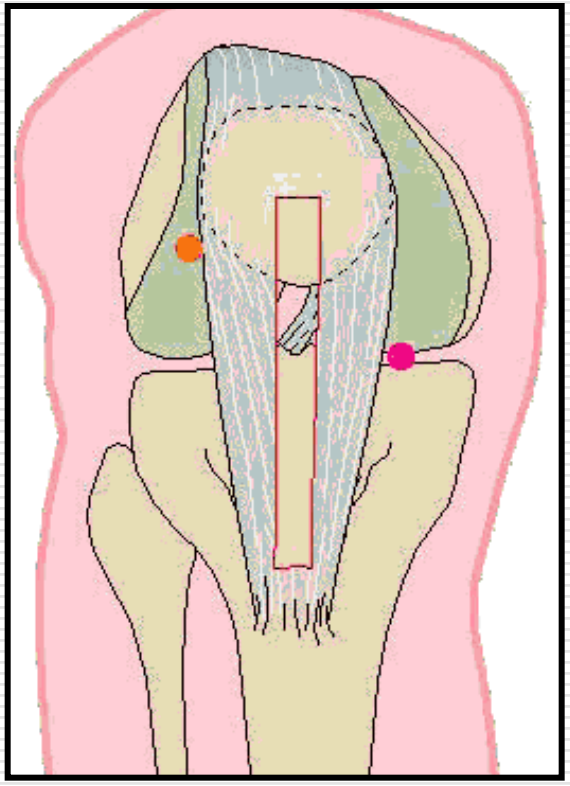
Surgery:

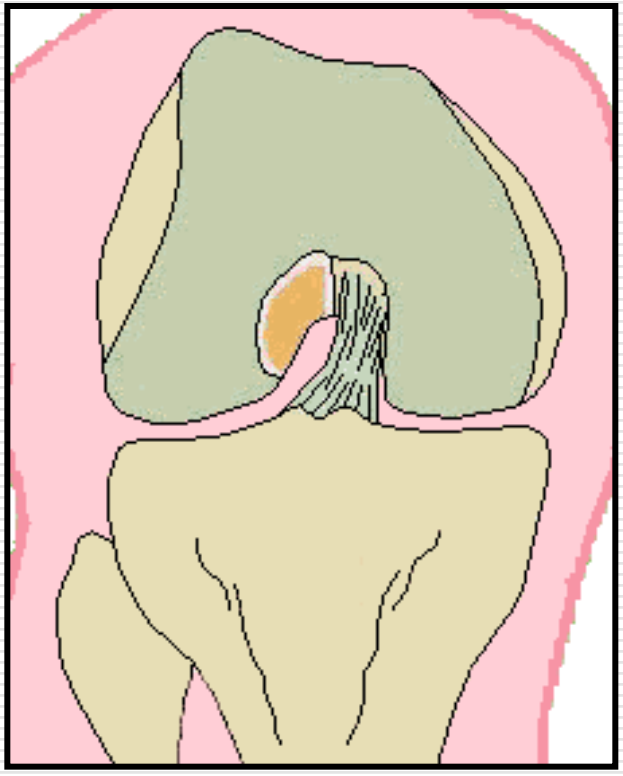
- Arthroscopy
- Surgical approach

BTB plastic
Graft extraction:

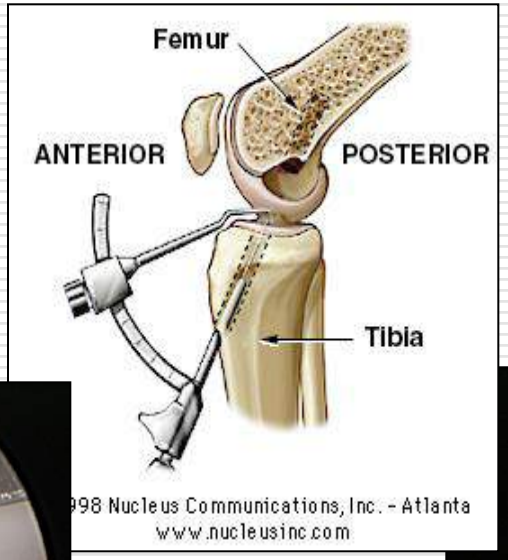


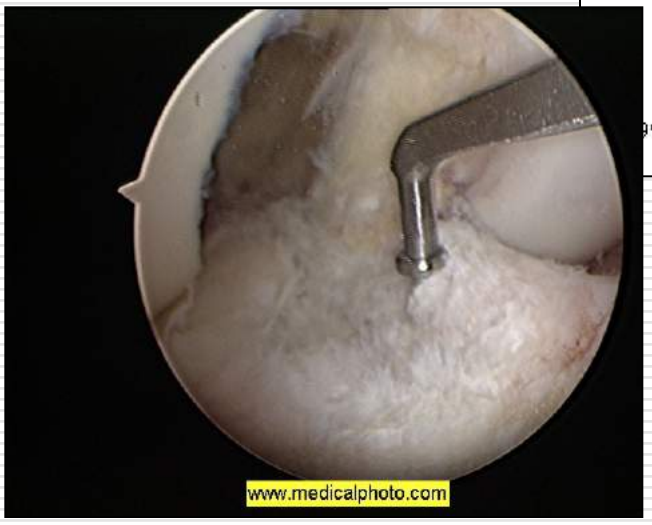
BTB plastic
Arthroscopy, notch plastic



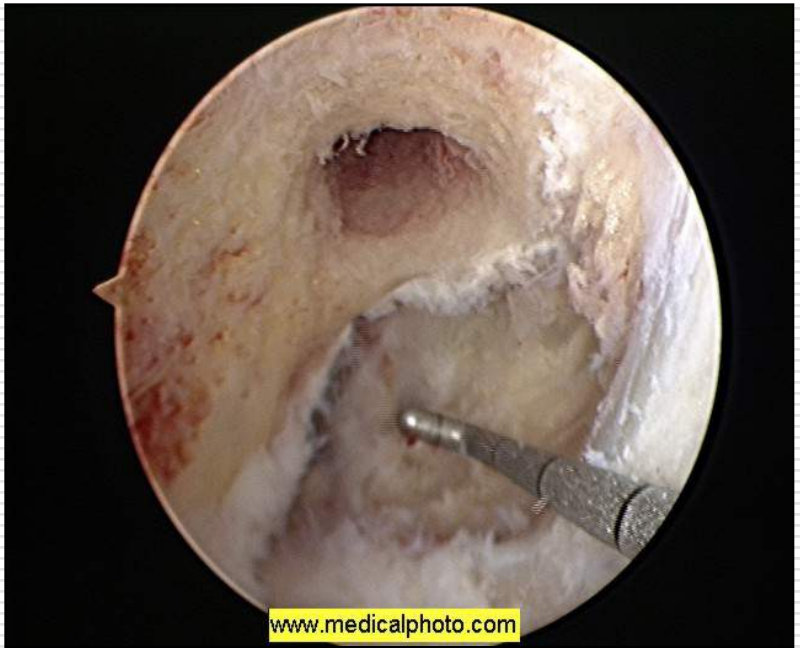


BTB plastic
Drilling through the tibia

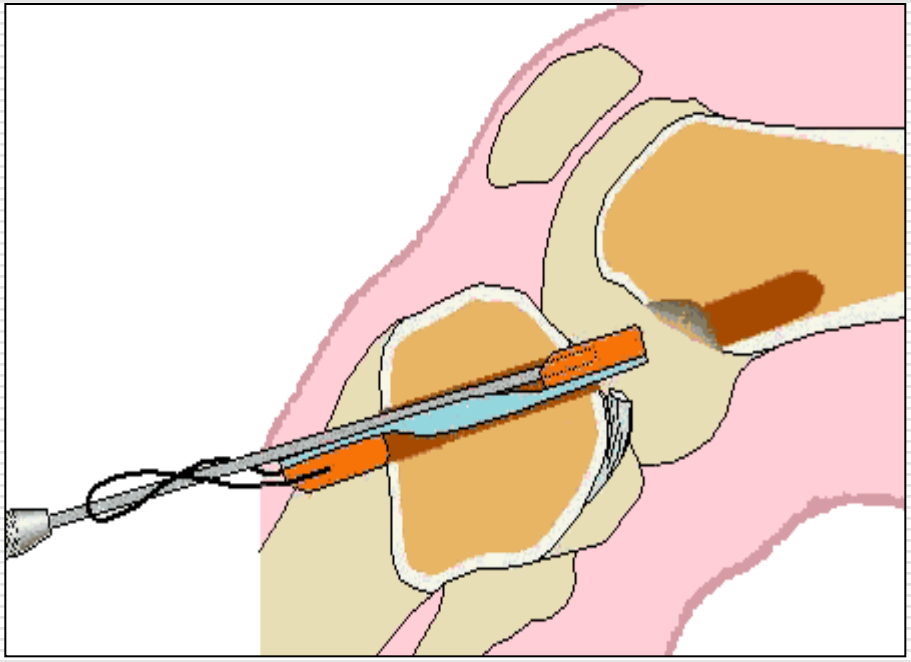




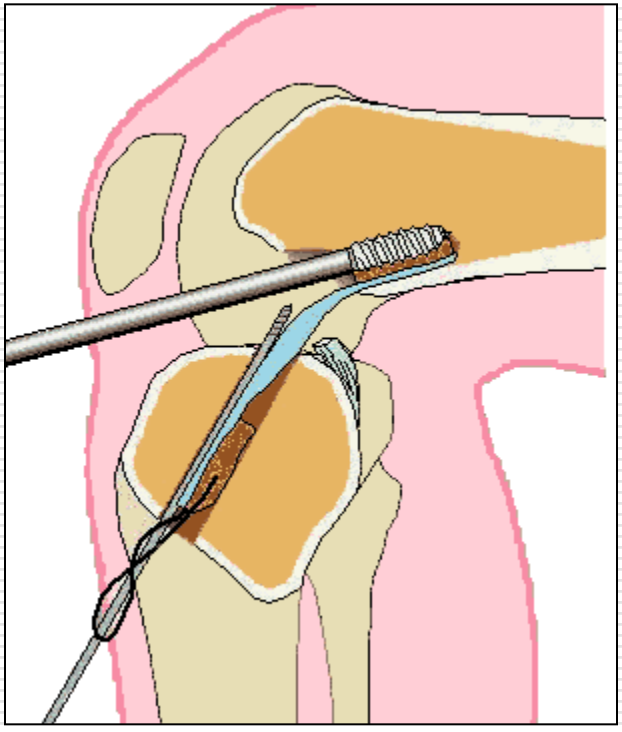
BTB plastic
Drilling through the femur + depth length

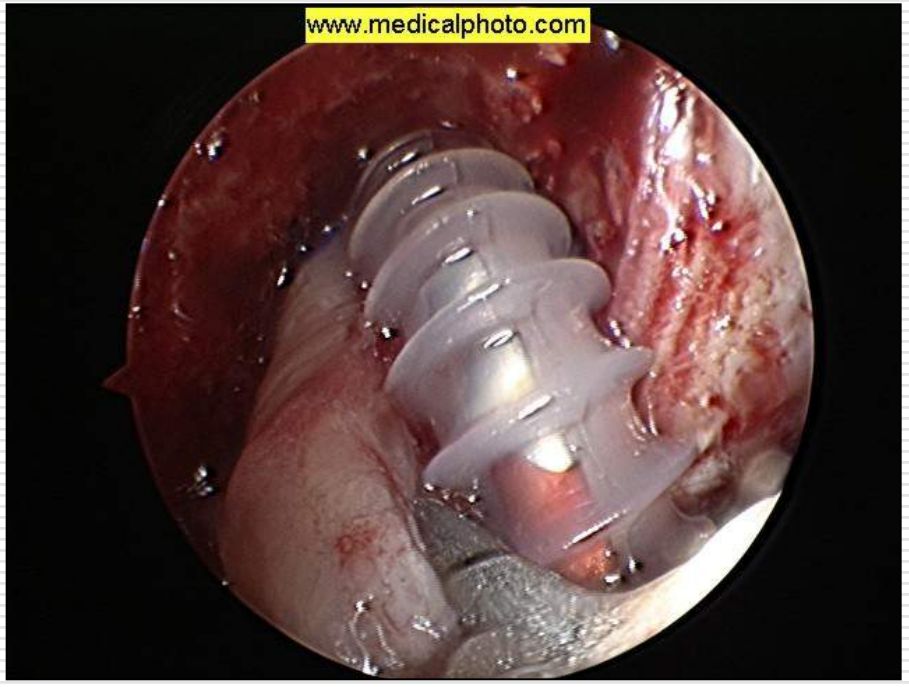


BTB plastic
Graft insertion

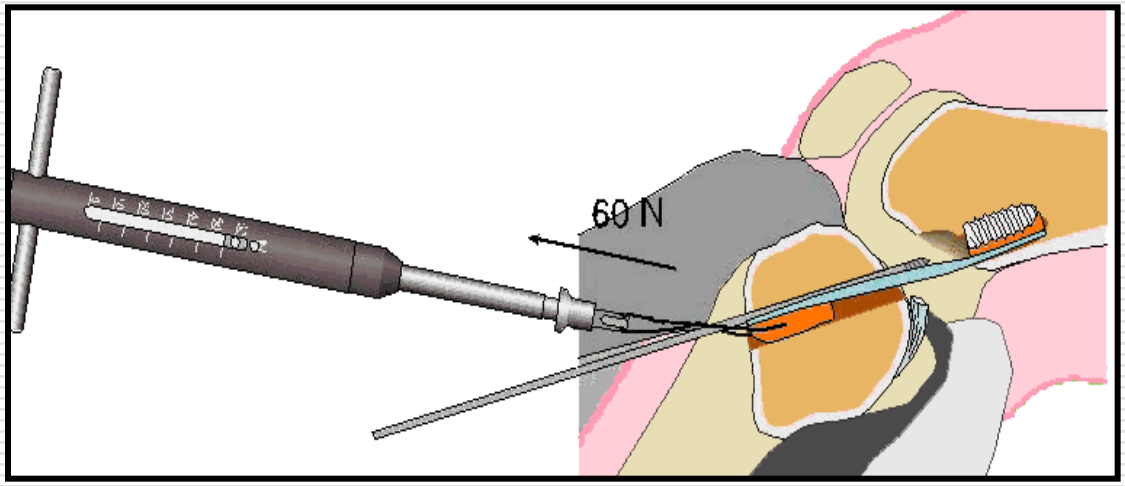


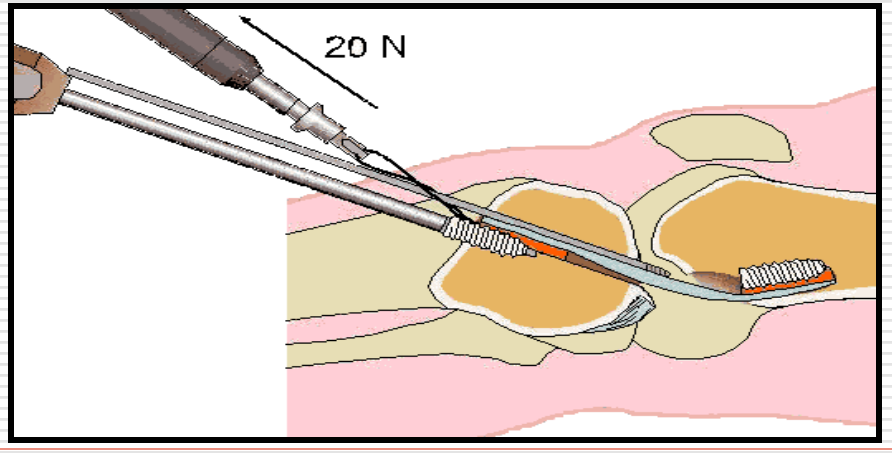
BTB plastic
Femoral fixation



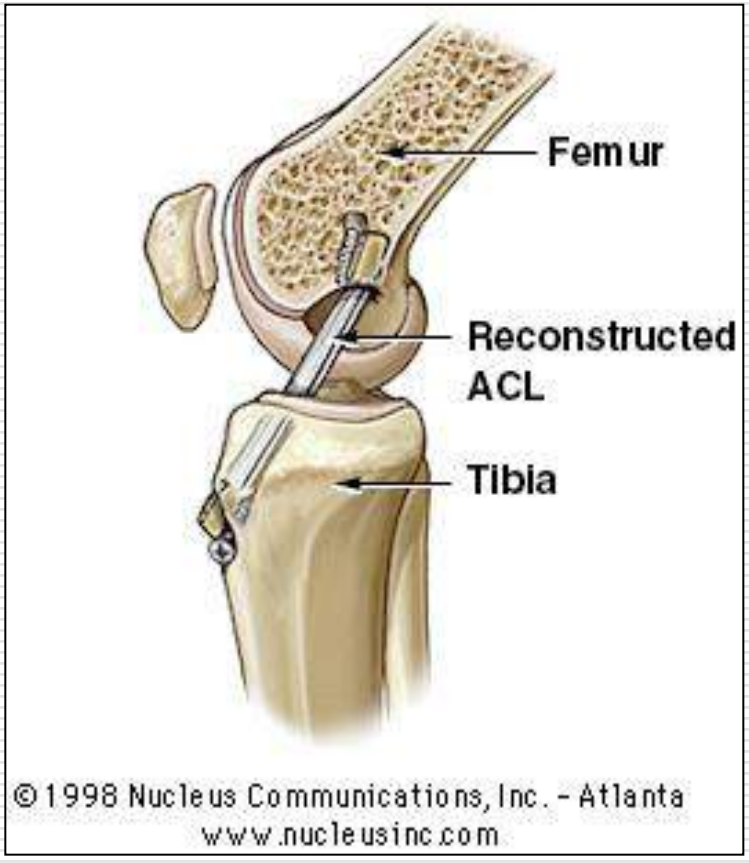


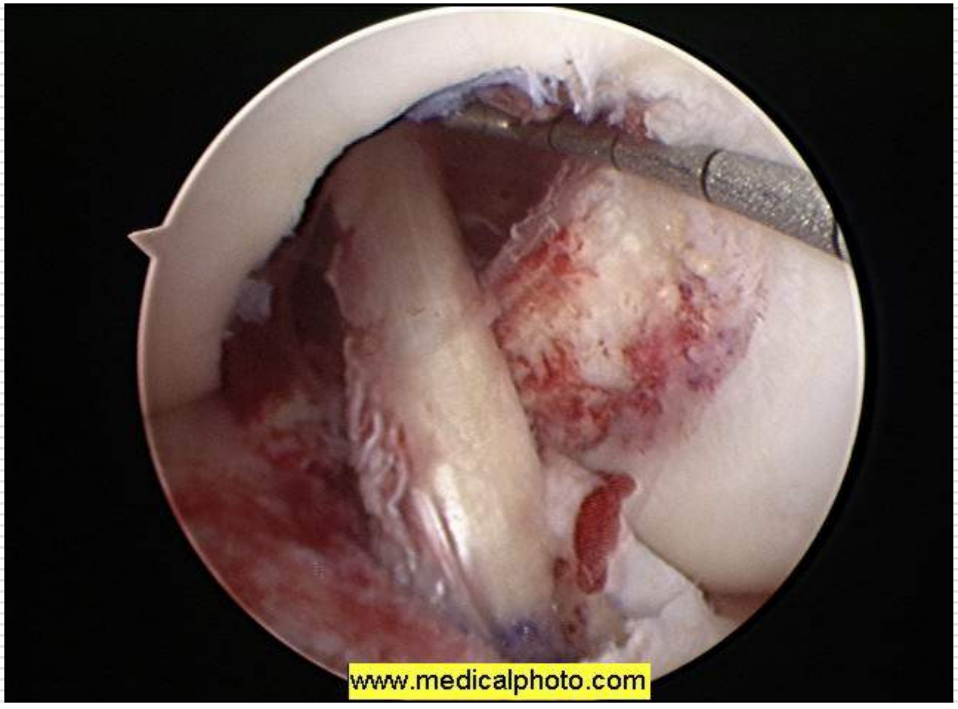
BTB plastic
Tibial fixation





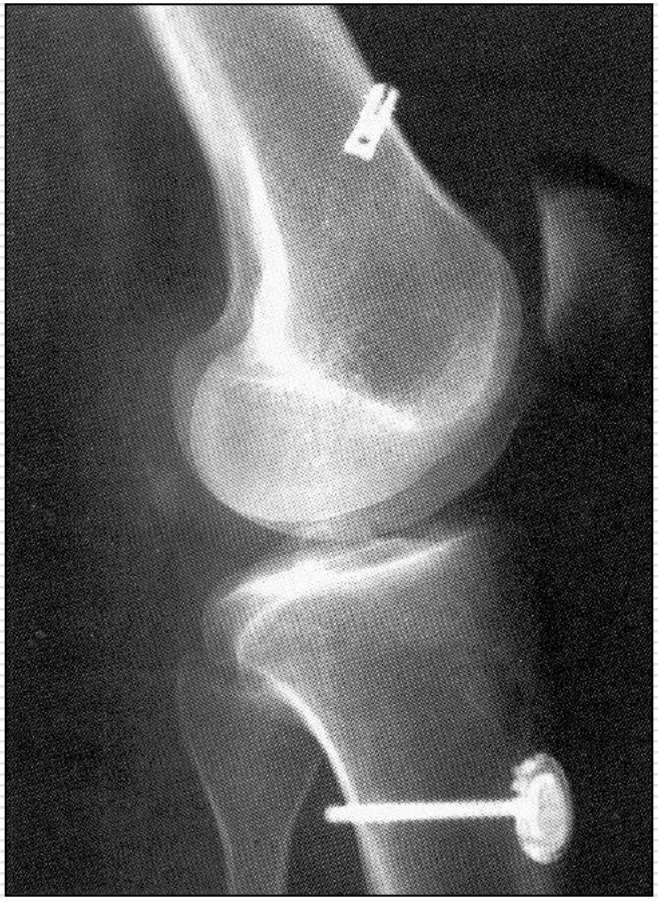
BTB plastic
Final result





BTB graft – interference screw

Hamstring graft – bone anchor



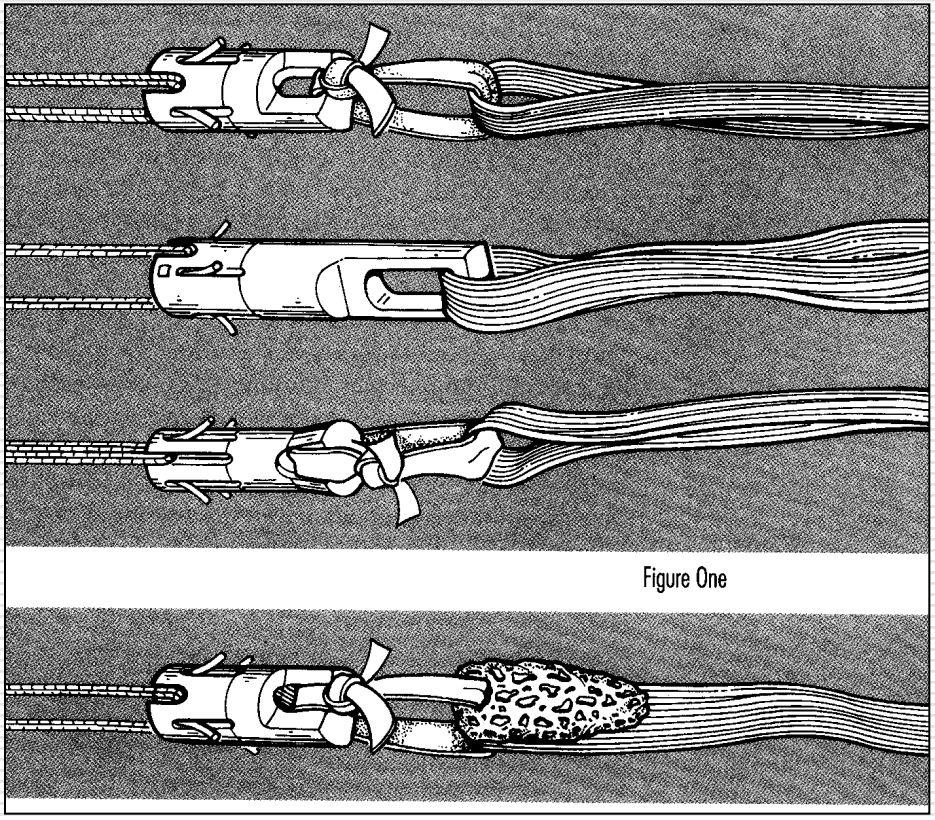
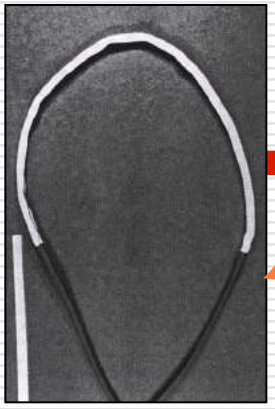


Figure One

ACL allograft

ACL synthetic graft



Gore-Tex: polytetrafluorethylen

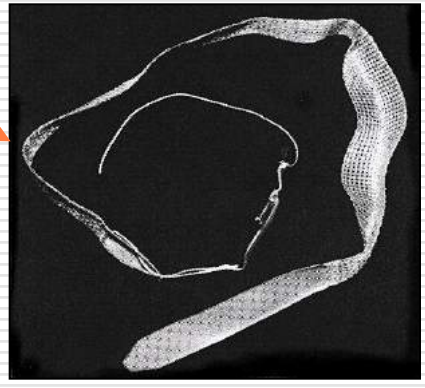
Stryker-Dacron: polyester

Augmentation

Kennedy LAD

Tissue ingrowth

Leeds-Keio: polyester (Dacron)



Surgery:

Arthroscopy

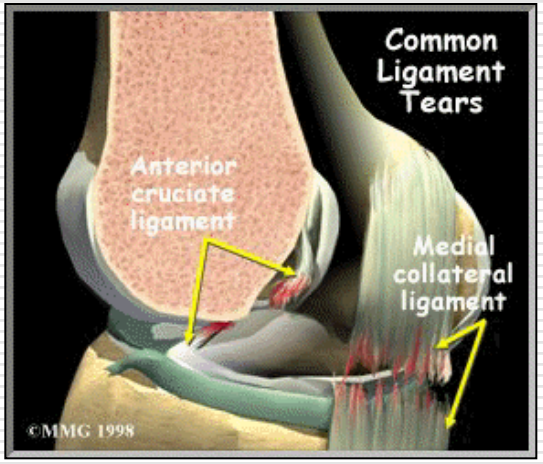
Unhappy triad

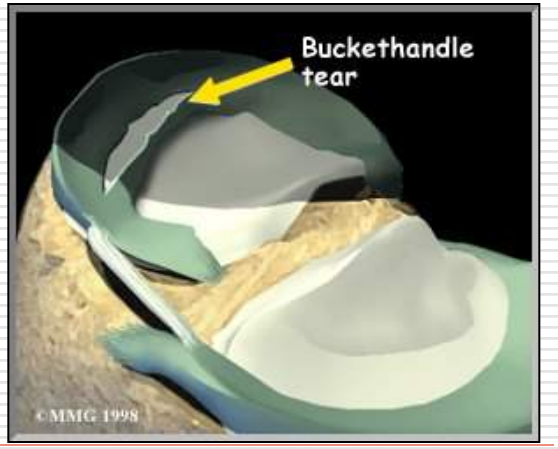
Injured:

- ACL
- MCL
- Medial meniscus

Therapy:

- Operation !
- Arthroscopy:
  - Meniscus injury
  - ACL reconstruction





Dislocation of the Knee

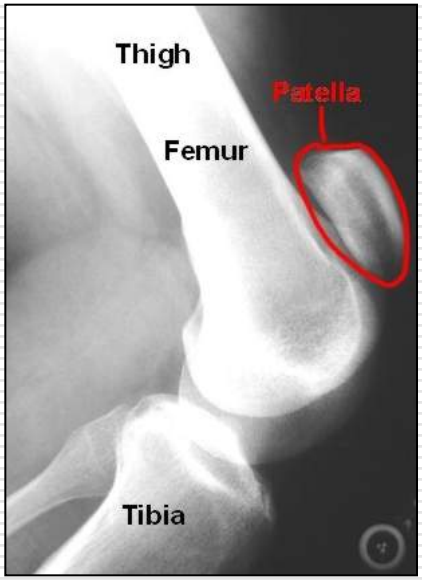
Severe injury
High energy trauma

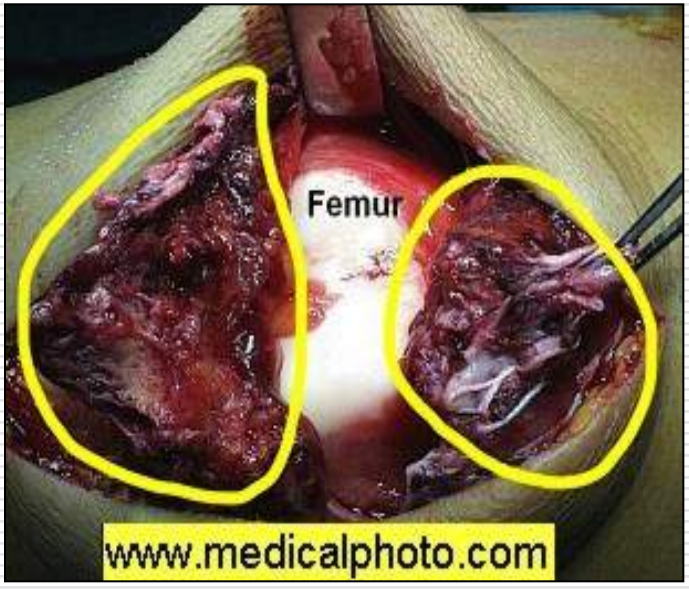
Injured:	ACL, PCL, MCL, LCL
	meniscus
	politeal tendon
	capsule
	hamstring group
	peroneal v. tibial nerve
	popliteal artery and vein
	bone
	cartilage
Symptoms:	immovable
	loss of function
	extreme swelling
	hypaesthesia
	lack of paplable pulse
Therapy:	reduction
	primary: artery and nerve injuries
	secondary: ACL, capsule

Knee Dislocations:

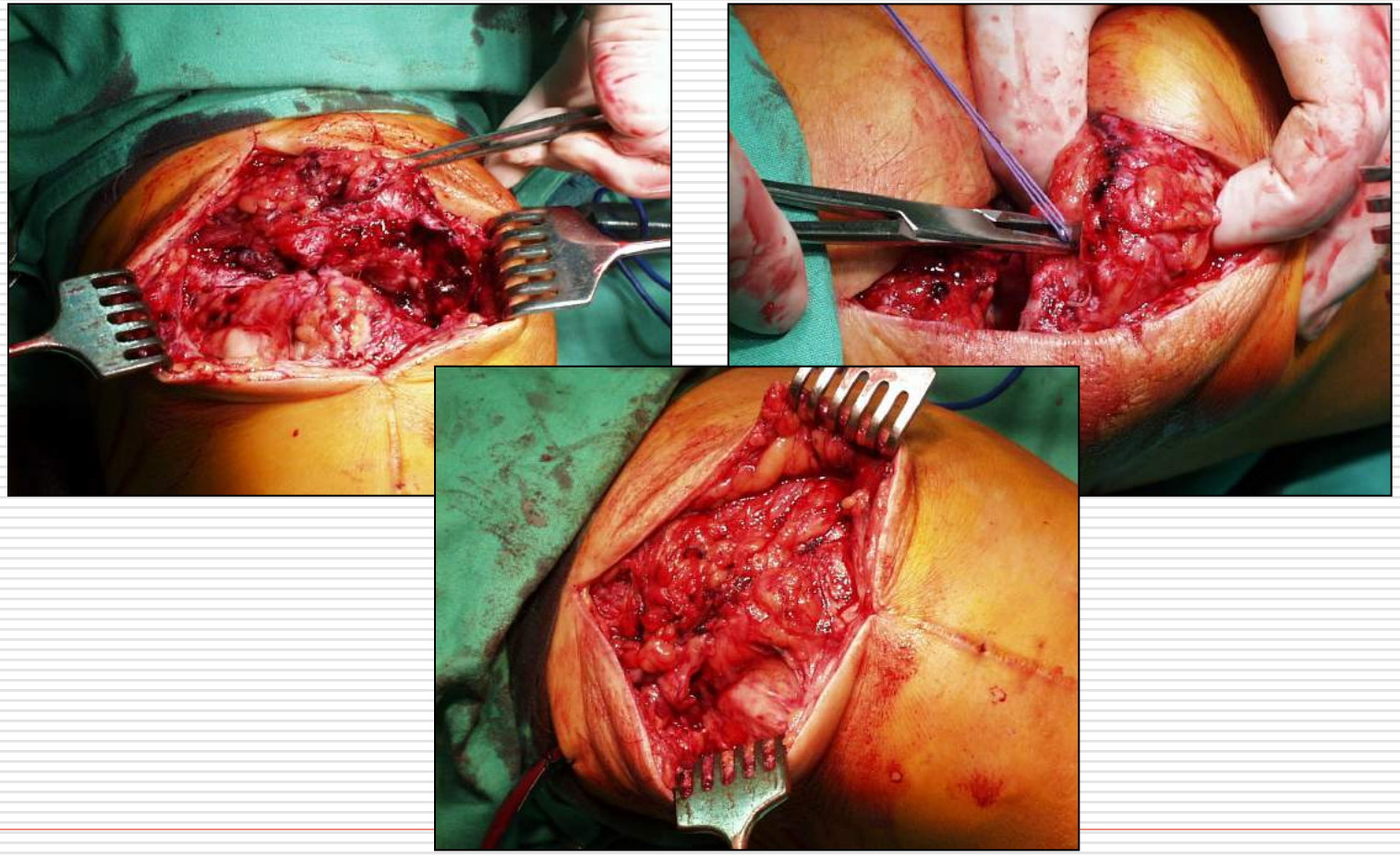
- Posterior
- Anterior
- Rotation

Tear of Patellar Ligament





M.Quadriceps reinsertion with bone anchor



Meniscus injuries

Mechanism:

sudden twist - lower leg in ‘fixed’ position

Symptoms:

pain

hydrops

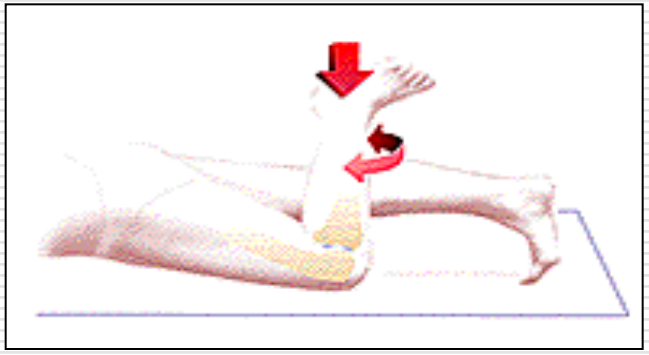
haemarthros (tear at the base)

joint lock up

Diagnostics:

Physical examination:

- Steimann:
  - knee in flexion
  - lower leg rotation
- Böhler:
  - extended knee
  - lower leg ab/adduction
- Appley:
  - prone position
  - knee: 90 degrees flexion
  - axial compression + rotation
- McMurray:
  - knee and hip: 90 degrees flexion + rotation test



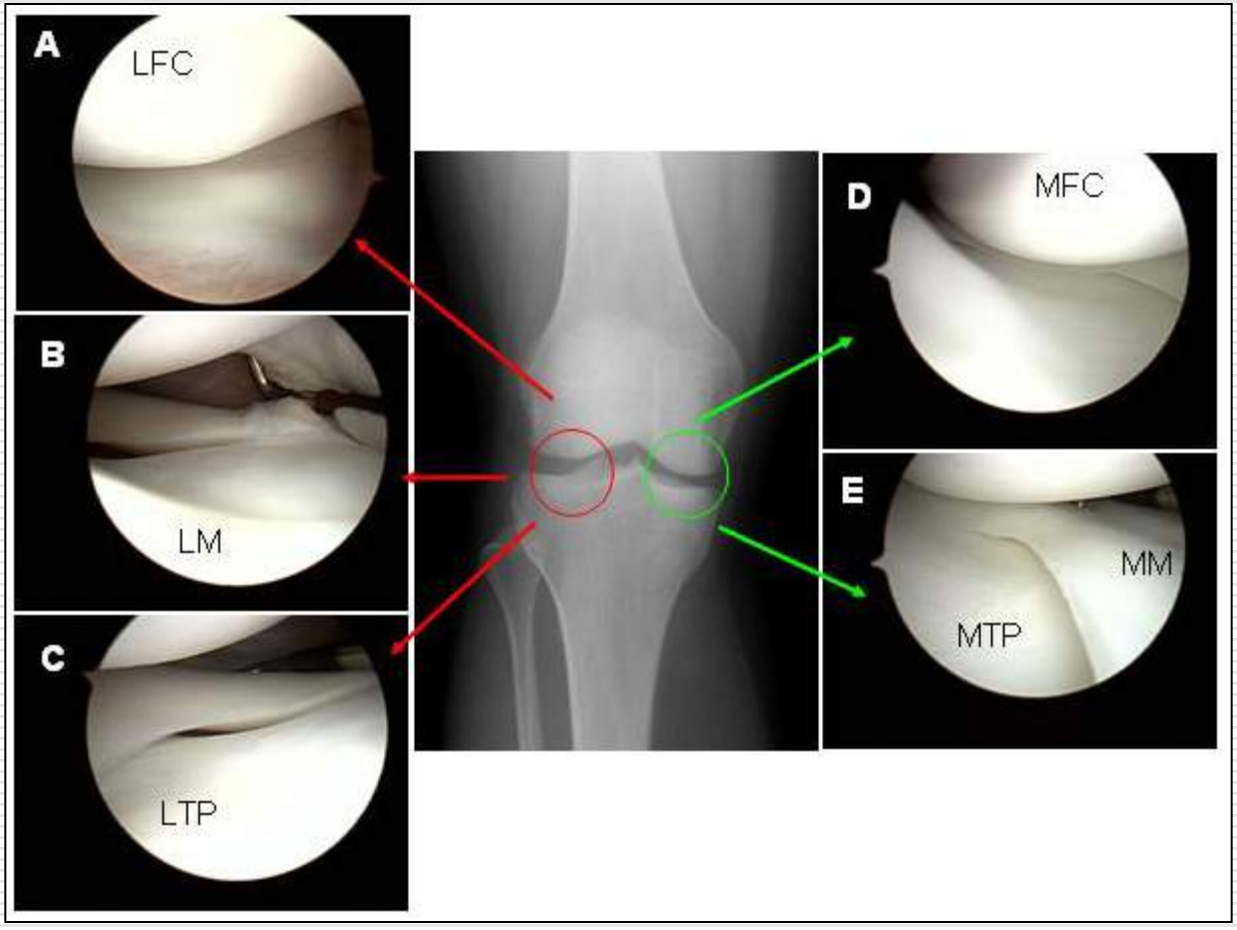
Diagnostics:

Ultrahang

MR

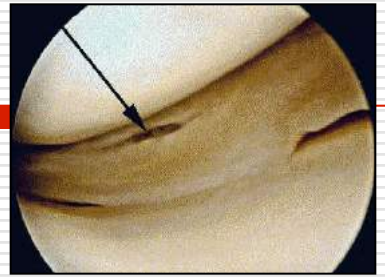
Arthroscopy

Intact menisci - arthroscopy



Meniscal injuries:

Vertical

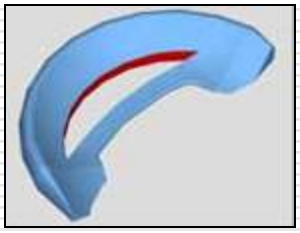


Radier

Incomplete

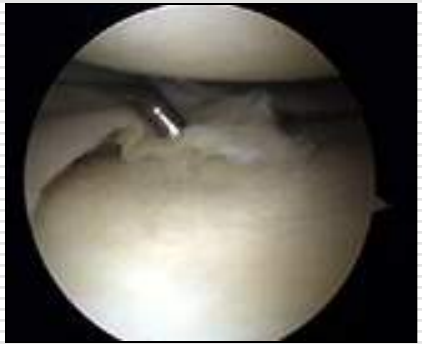
Complete

Bucket handle



Meniscal injuries:

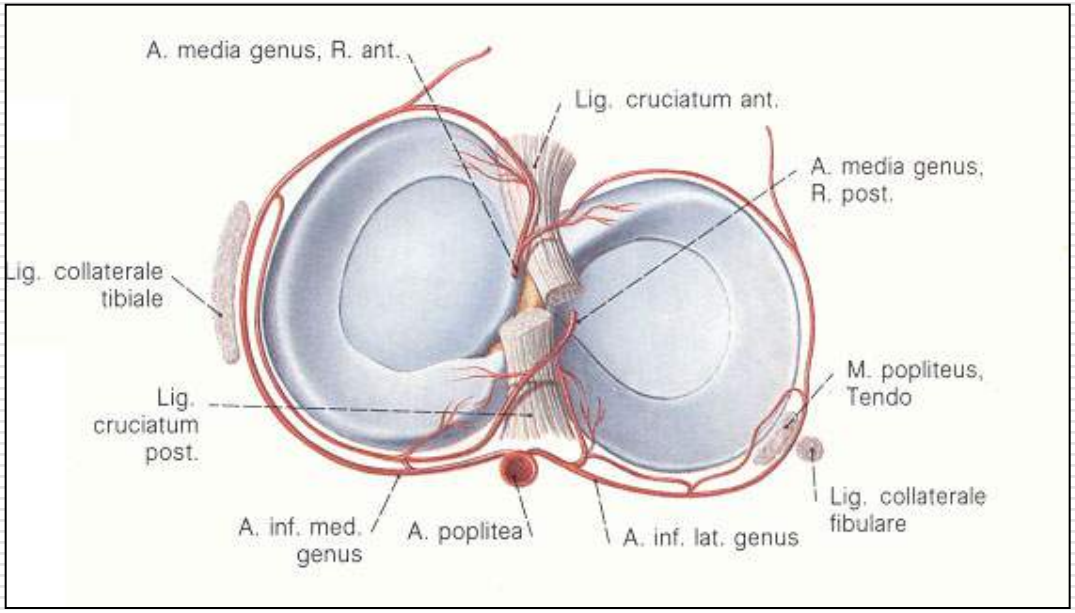
Medial posterior horn

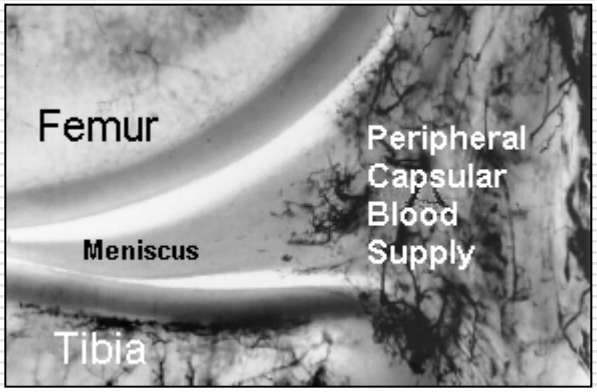


Lateral posterior horn incomplete

Lateral posterior horn complete

Blood supply



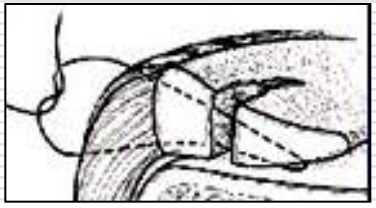


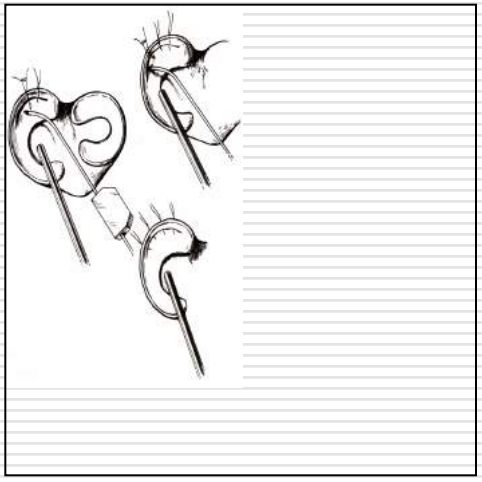
Treatment:

~~Arthrotomy~~

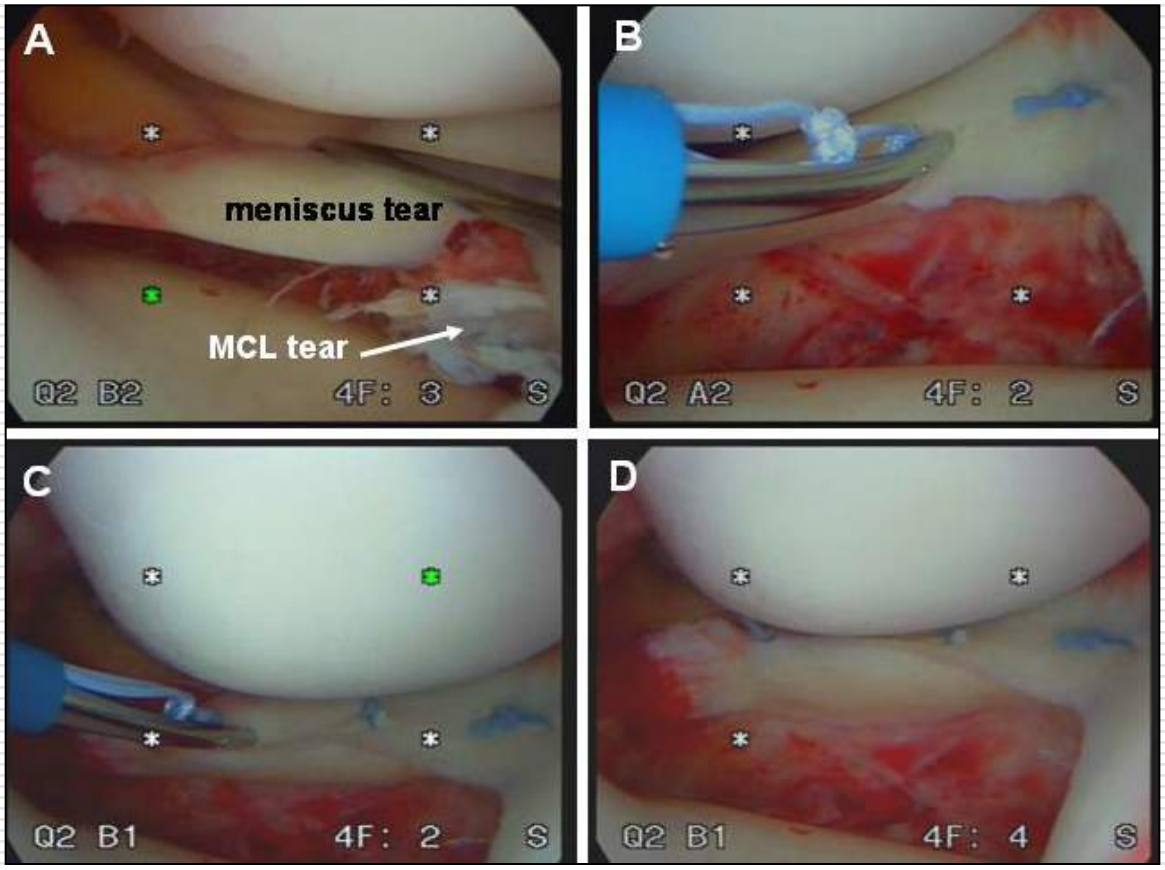
Artroscopy

suture



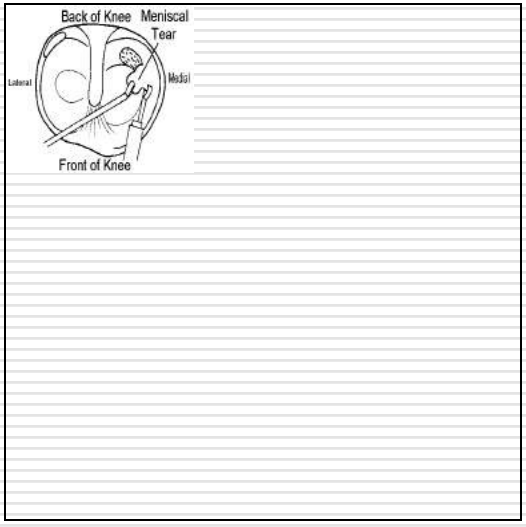


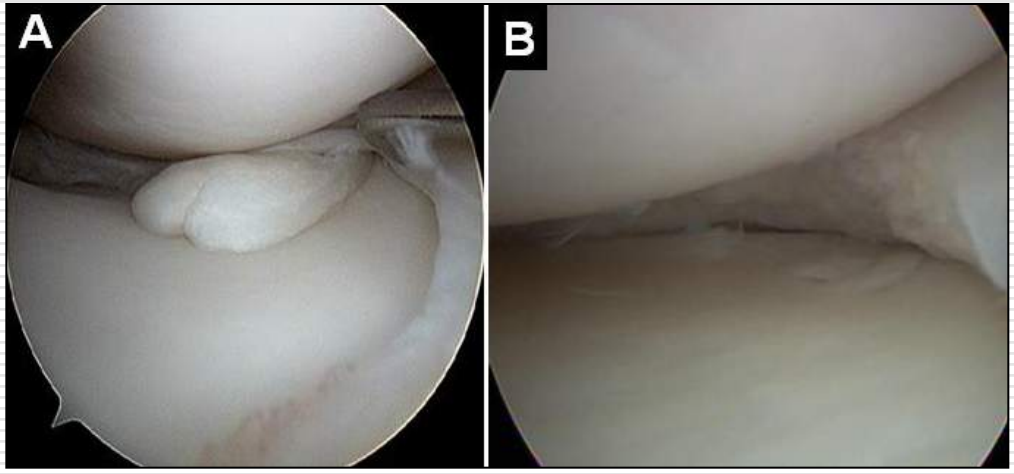
Meniscus suture



Meniscus resection

Partial resection





Meniscus resection

Total resection

Meniscus transplantation