Intra-articular Lower Limb Fractures

PV Fearon

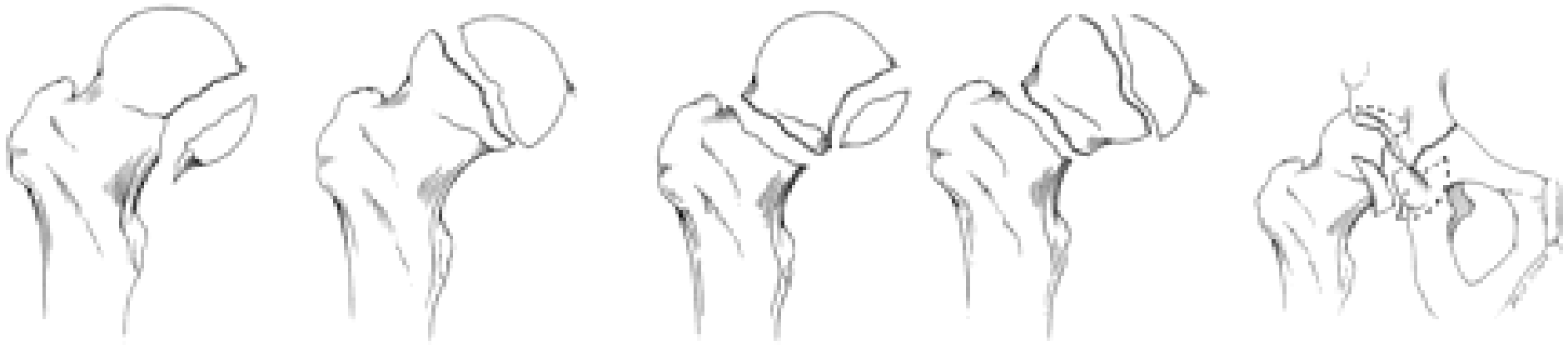
7th March 2011

Part 1

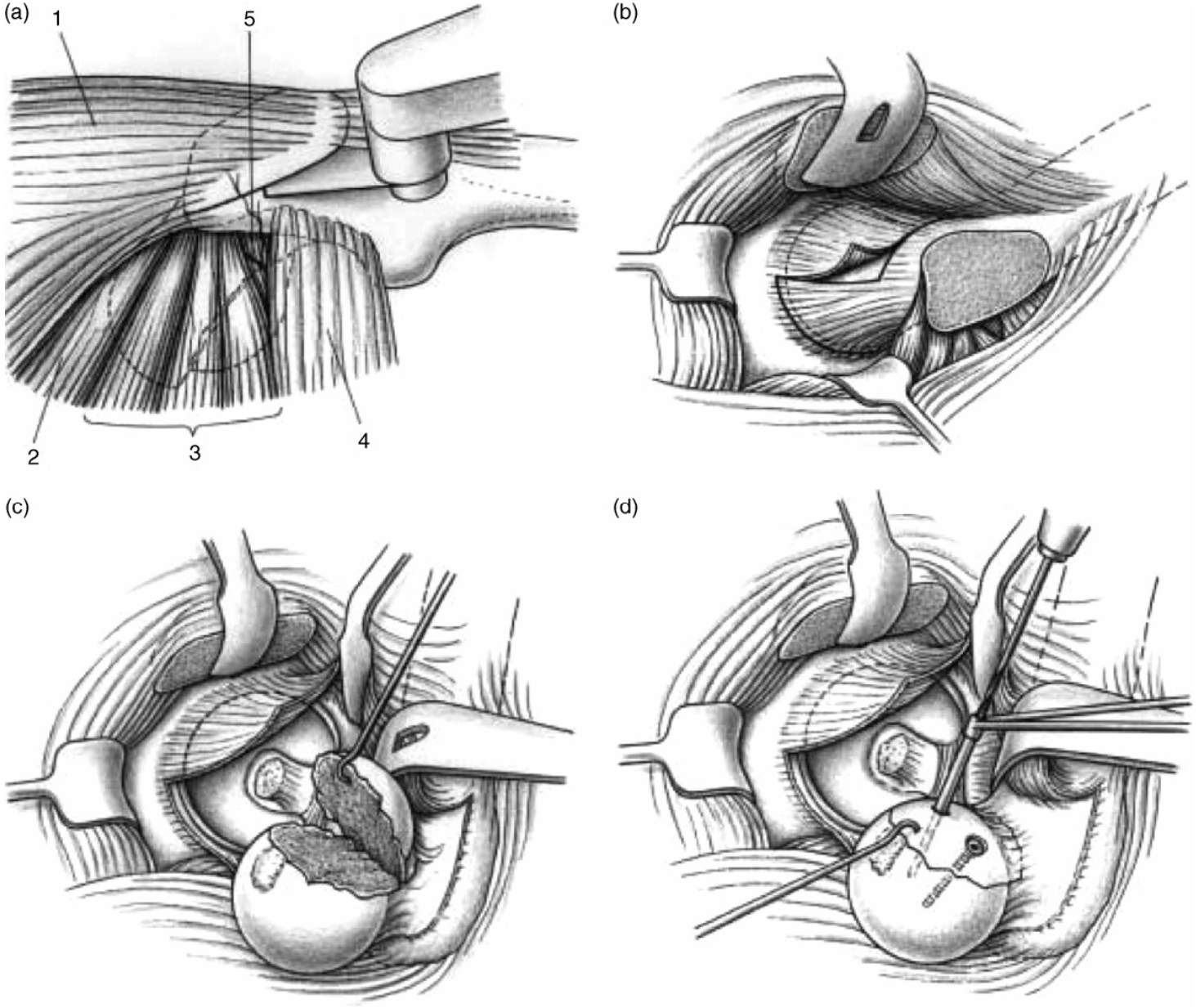
The Newcastle upon Tyne Hospitals NHS
NHS Foundation Trust

pipkin

Type I Type II Type III Type IV



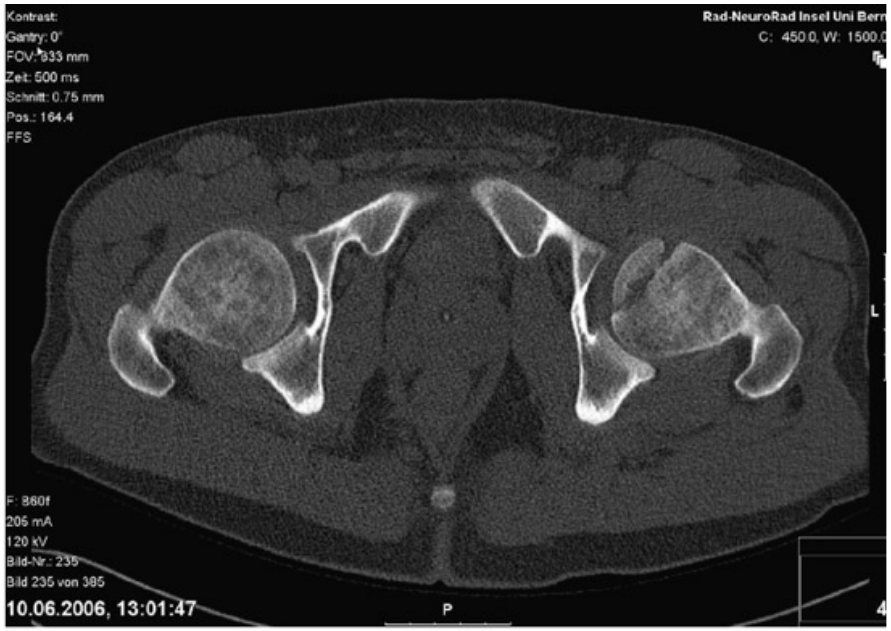
Type I, femoral head fracture inferior to the fovea centralis
Type II, fracture extended superior to the fovea centralis
Type III, any femoral head # with an associated femoral neck #
Type IV, any femoral head # with an associated acetabular #


(a)
1
5
2
3
4
(b)
(c)
(d)

Femoral head injuries: Which treatment strategy can be recommended?
Henle et al.,
Injury, Int. J. Care Injured (2007) 38, 478—488


Kontrast: i.v. KM
Gantry: 0°
FOV: 332 mm
Zeit: 500 ms
Schnitt: 2 mm
Pos.: -623
HFS
Rad-NeuroRad Insel Uni Bern
C: 450.0, W: 1500.0
F: B60f
181 mA
120 kV
Bild-Nr.: 73
Bild 73 von 117
10.06.2006, 11:05:15
P

(e)


Kontrast:
Gantry: 0°
FOV: 333 mm
Zeit: 500 ms
Schnitt: 0.75 mm
Pos.: 164.4
FFS
Rad-NeuroRad Insel Uni Bern
C: 450.0, W: 1500.0
F: B60f
206 mA
120 kV
Bild-Nr.: 235
Bild 235 von 385
10.06.2006, 13:01:47
P


Kontrast: i.v. KM
Gantry: 0°
FOV: 351 mm
Zeit: 500 ms
Schnitt: 5 mm
Pos.:
HFS
Rad-NeuroRad Insel Uni Bern
C: 450.0, W: 1500.0
F: B60f
187 mA
120 kV
Bild-Nr.: 20
Bild 20 von 35
10.06.2006, 11:05:08
F

(f)


Rad-NeuroRad Insel Uni Bern
Spin: -1
Tilt: 0
Spin: -25
Tilt: 0
10.06.2006, 13:01:37
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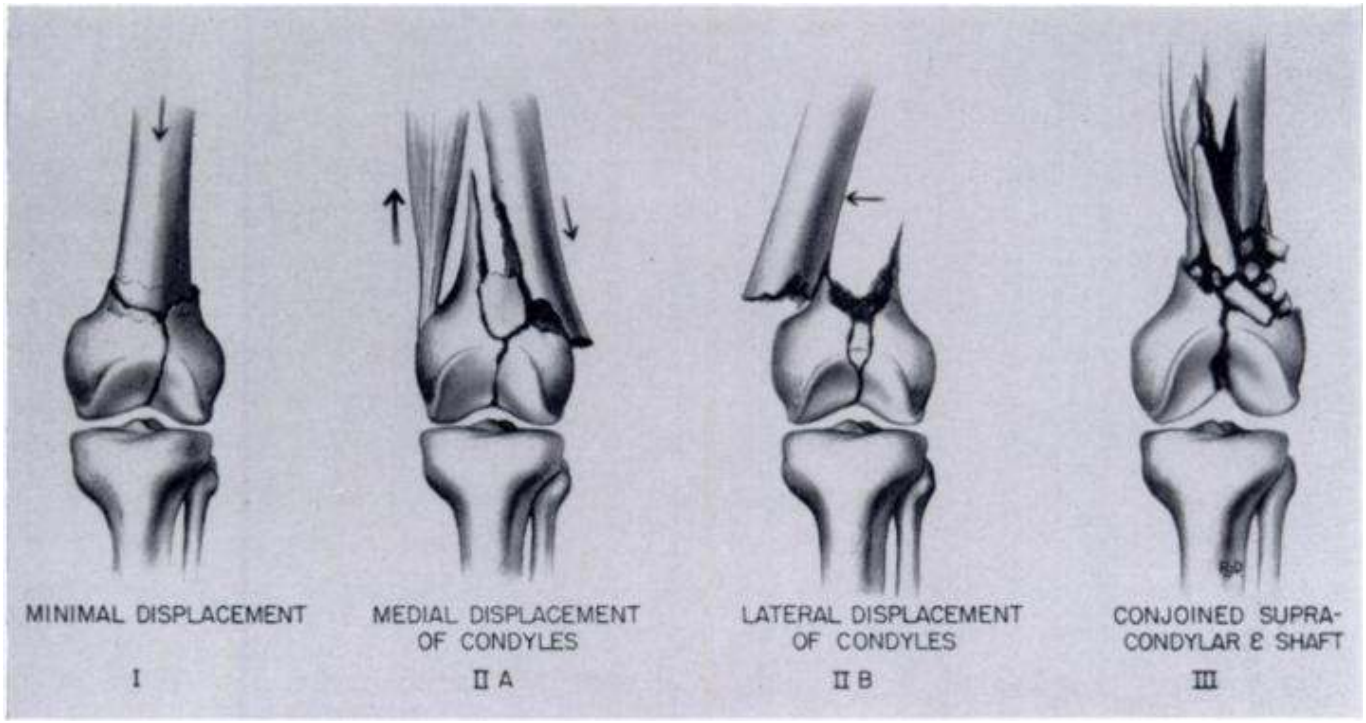
Radiologie Insel-UNI Bern
R
0.06.2006, 16:45:33

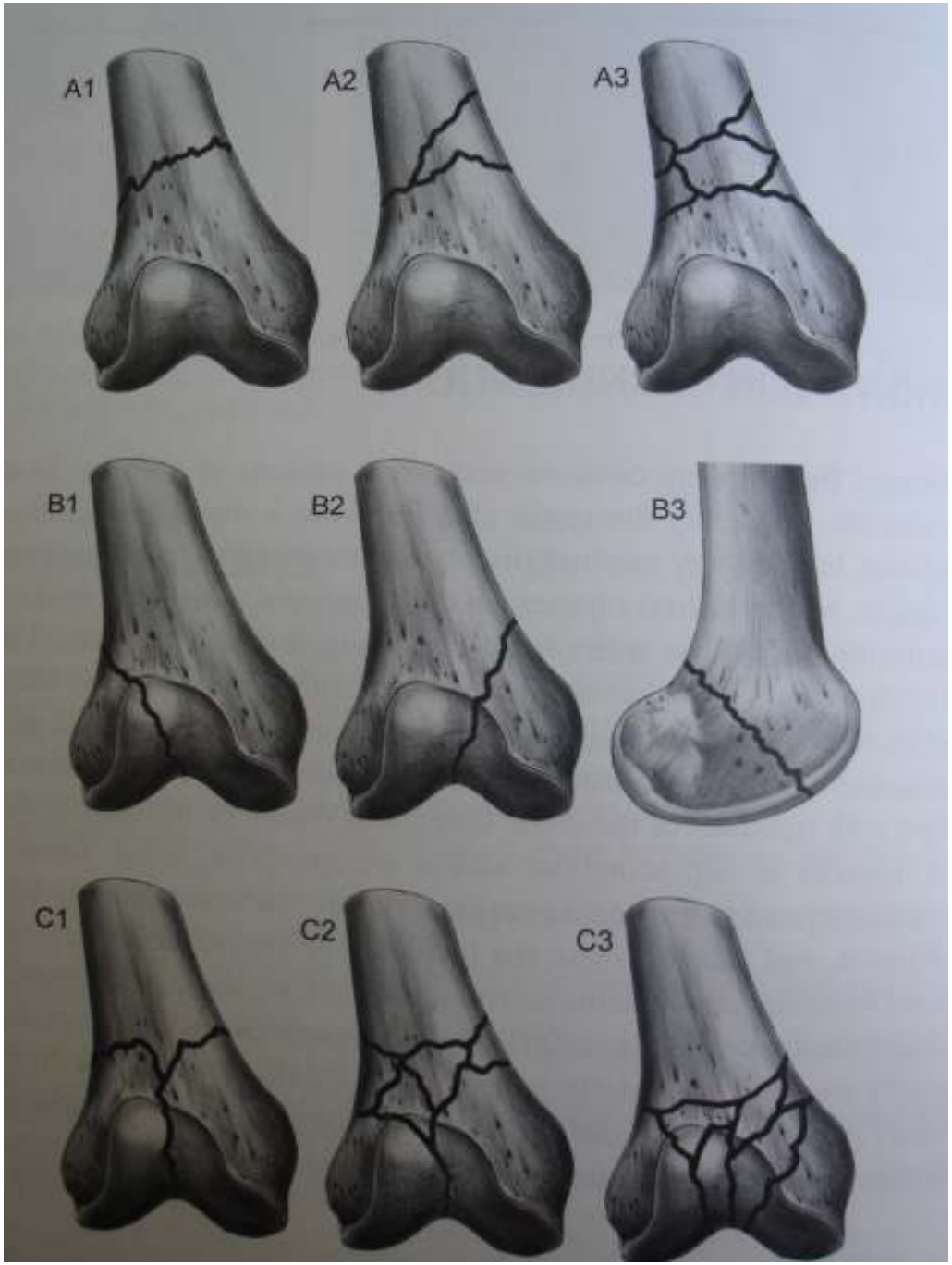

Radiologie Insel-UNI Bern
L

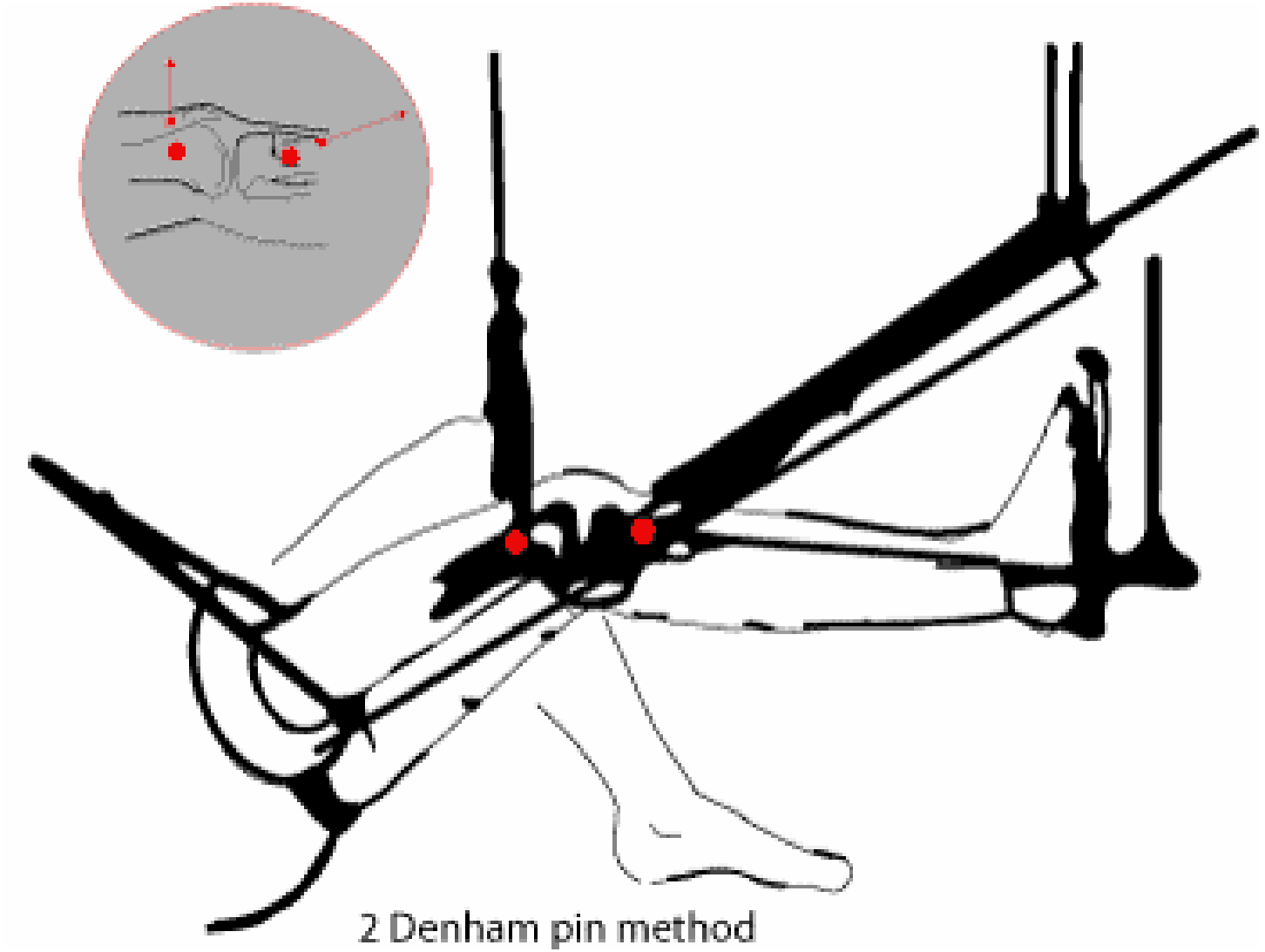
Distal Femur



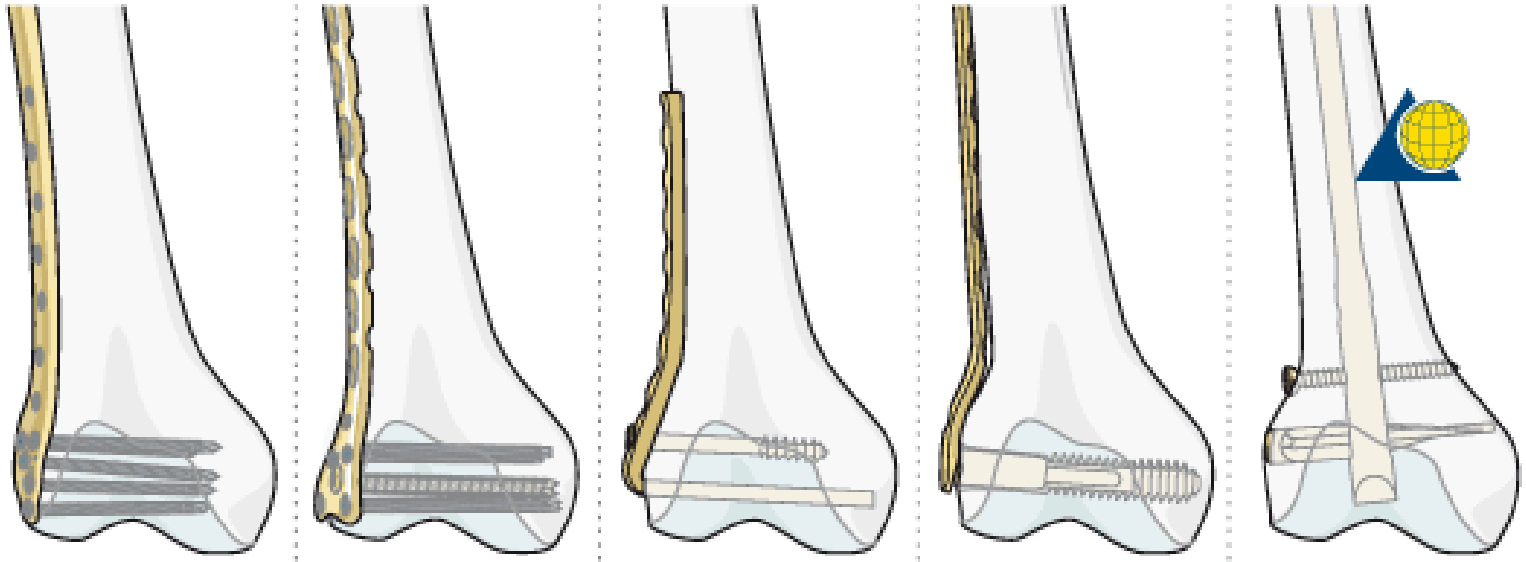
NEER et al., JBJS 1967;49:591-613.

Supracondylar Fracture of the Adult Femur: A STUDY OF ONE HUNDRED AND TEN CASES


A1
A2
A3
B1
B2
B3
C1
C2
C3

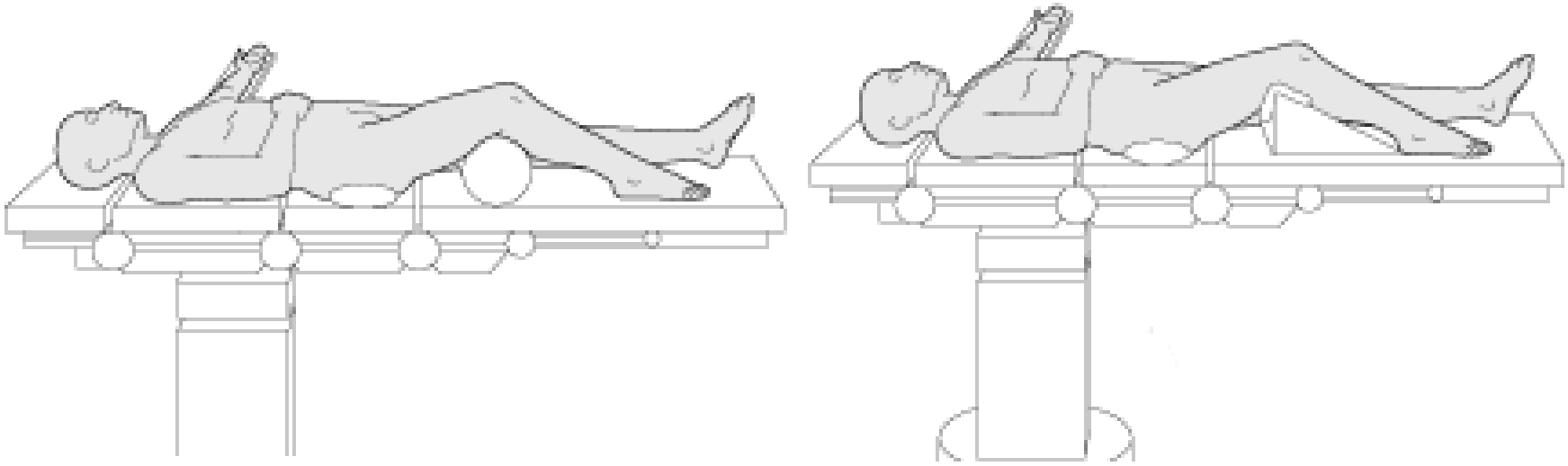


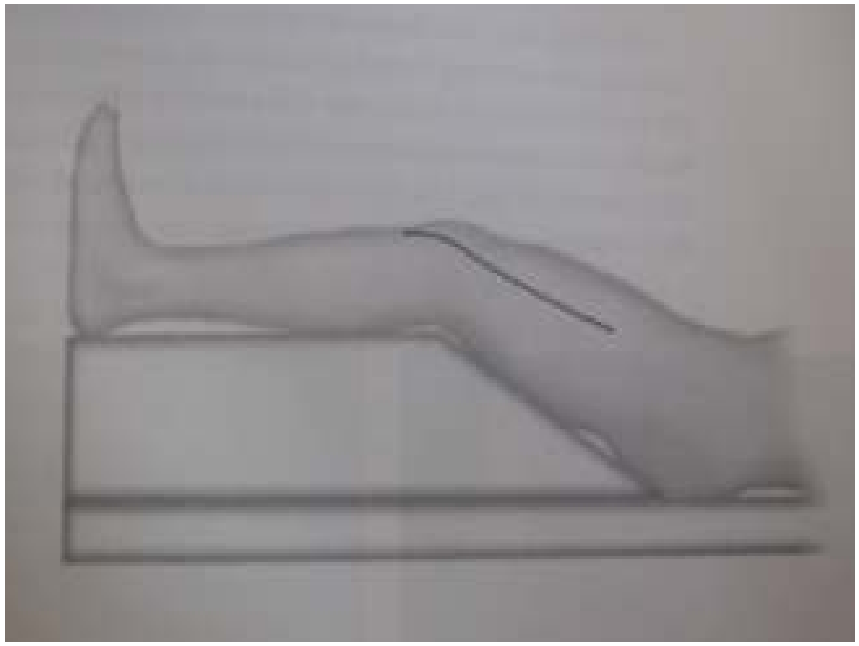
2 Denham pin method

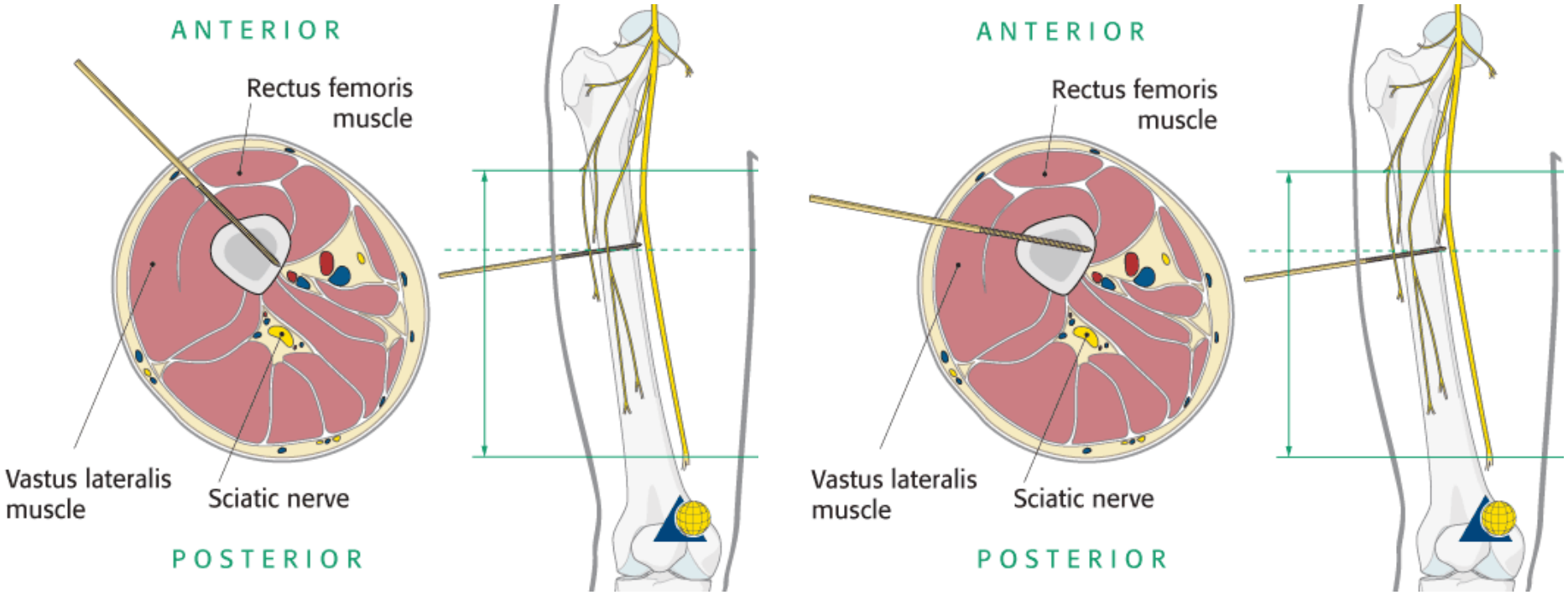


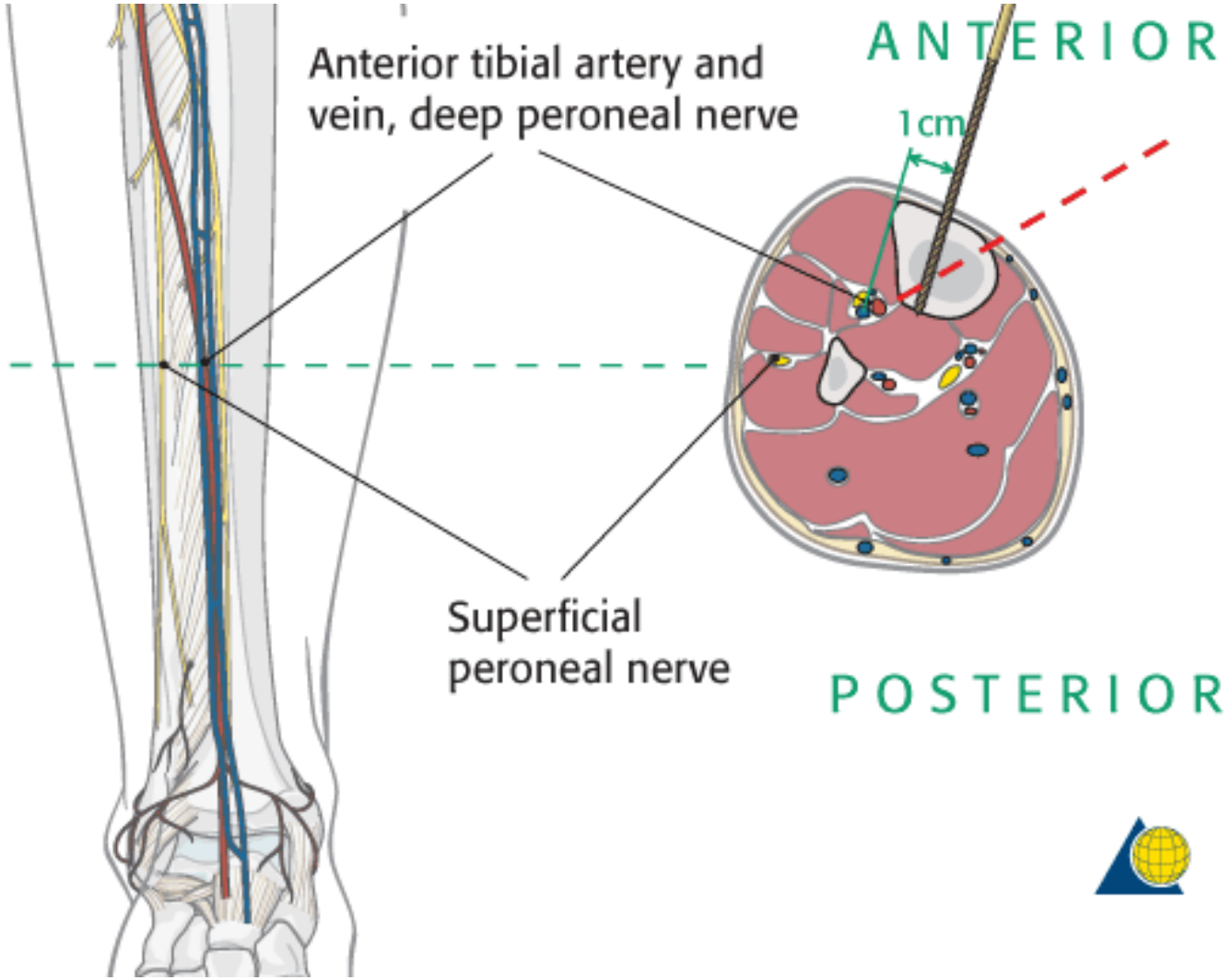
LISS	Condylar plate	95° Angled blade plate	95° Dynamic condylar screw	Retrograde nail (with 2 locking screws or spiral blade)
subchondral	*subchondral*	*1.5 – 2 cm*	*2 cm*	*6 cm*

Set up






ANTERIOR
Rectus femoris muscle
Vastus lateralis muscle
Sciatic nerve
POSTERIOR
ANTERIOR
Rectus femoris muscle
Vastus lateralis muscle
Sciatic nerve
POSTERIOR


Anterior tibial artery and
vein, deep peroneal nerve
ANTERIOR
1 cm
Superficial
peroneal nerve
POSTERIOR

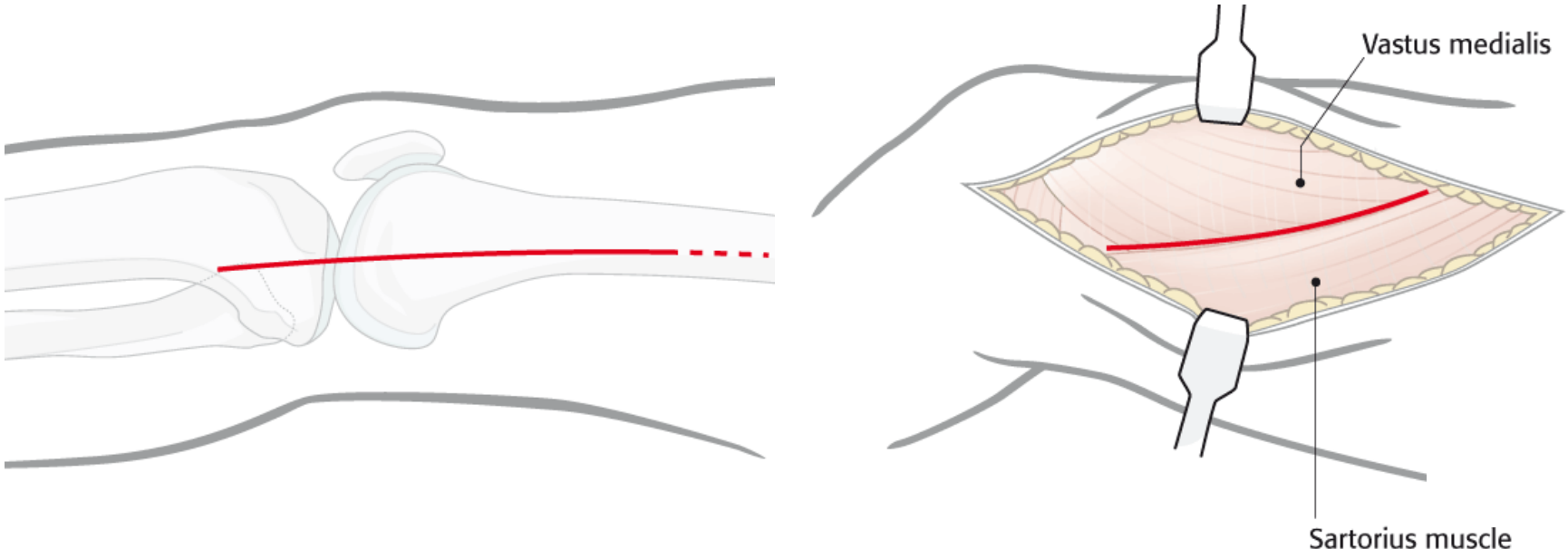
Approaches

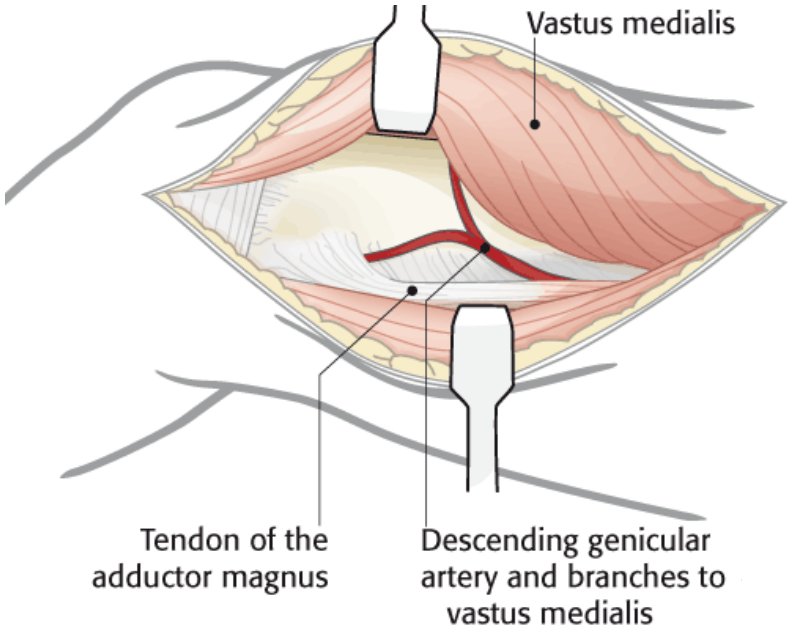
- Femur
  - Medial
  - Ant lat
  - Post lat

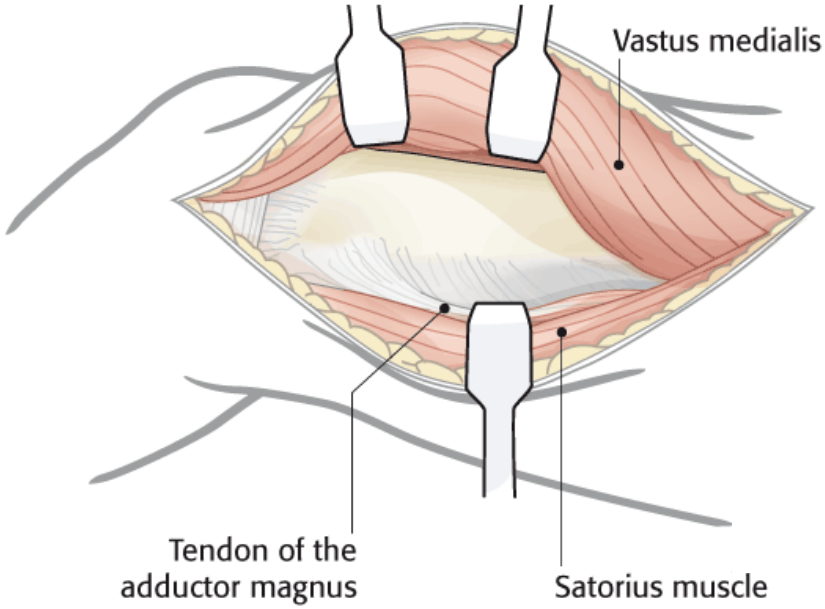
Medial Femur

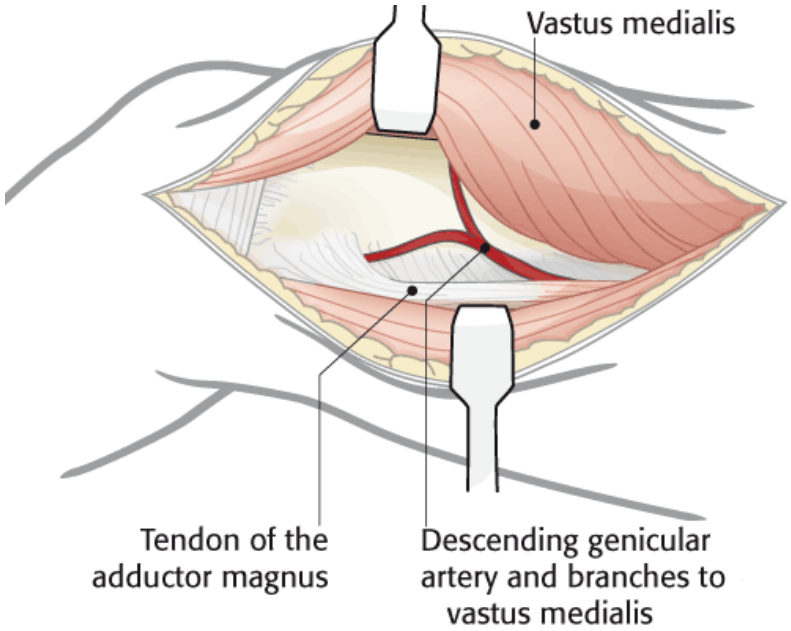
- Midway patella & posterior femoral condyle
- Proximal 10-13 cm (femoral artery)
- Between Vast Med & Add Mag (saphenous structures)
- Perforators & geniculate vessels

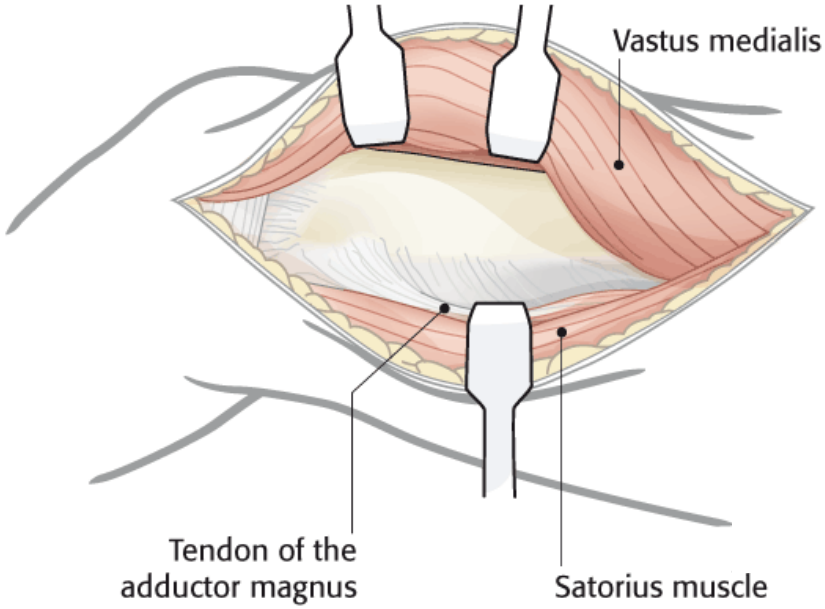
Medial Approach

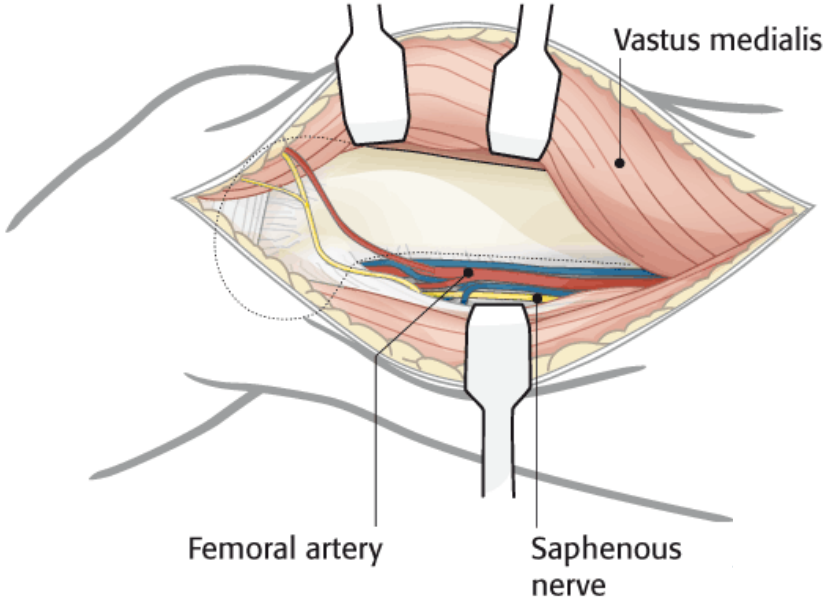



Vastus medialis
Tendon of the adductor magnus
Descending genicular artery and branches to vastus medialis

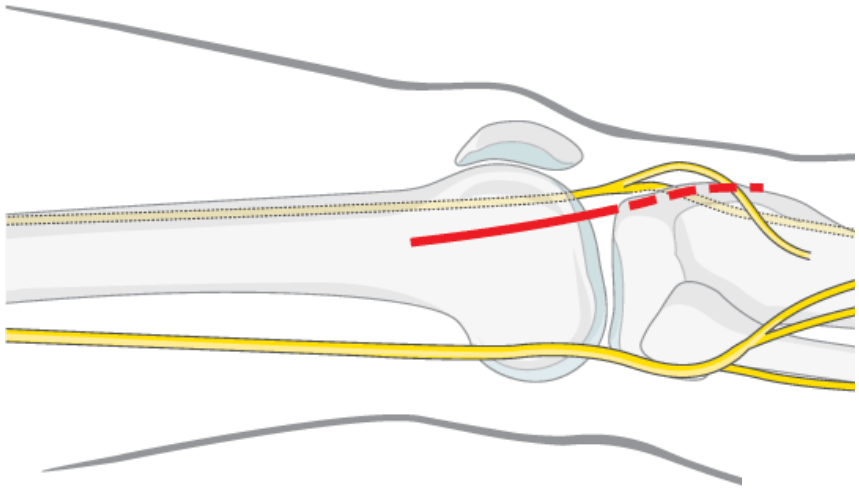

Vastus medialis
Tendon of the adductor magnus
Satorius muscle

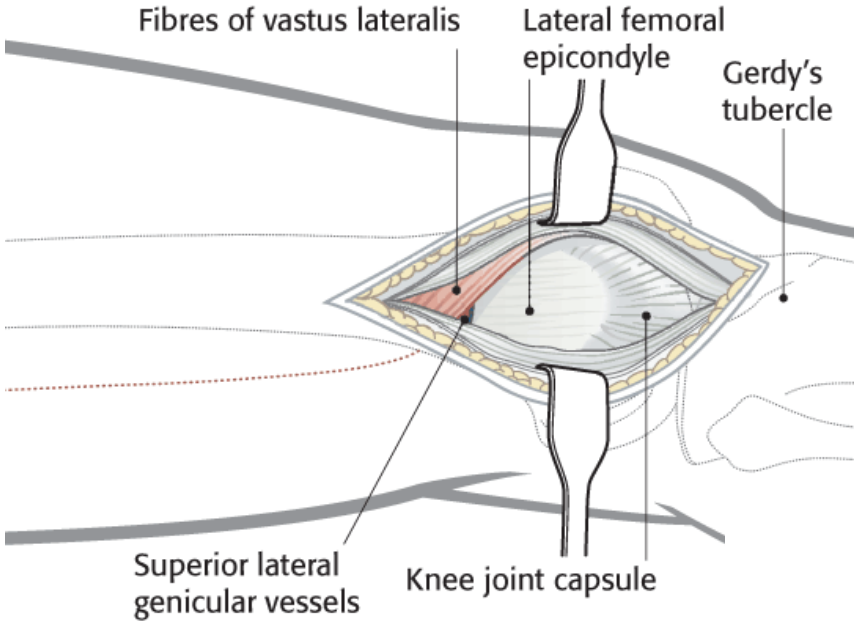

Vastus medialis
Tendon of the adductor magnus
Descending genicular artery and branches to vastus medialis


Vastus medialis
Tendon of the adductor magnus
Satorius muscle

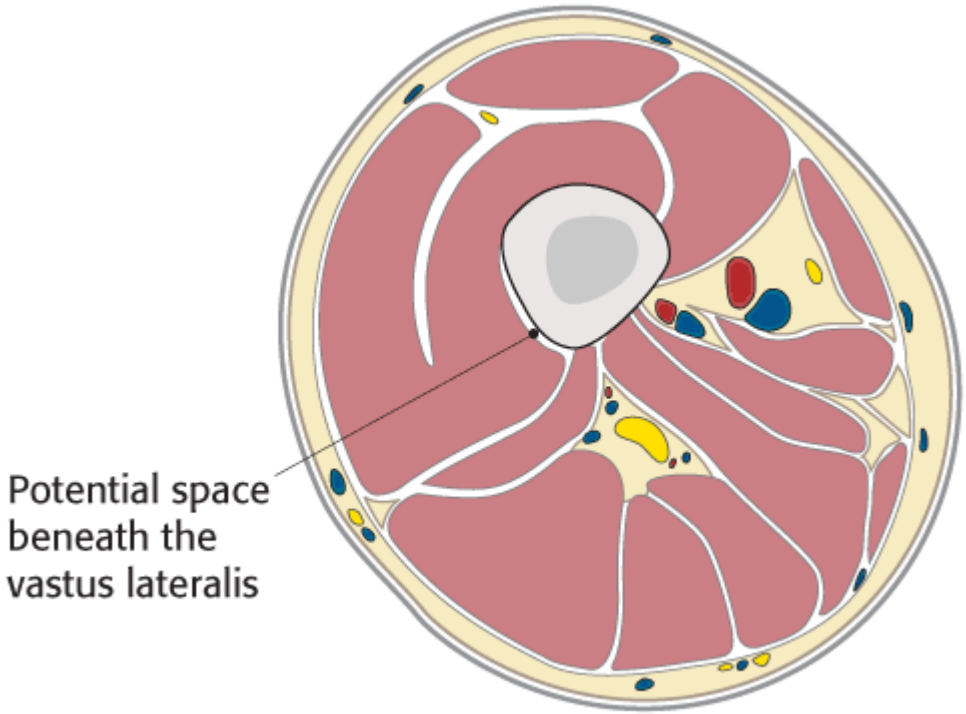

Vastus medialis
Femoral artery
Saphenous nerve

Lateral




Fibres of vastus lateralis
Lateral femoral epicondyle
Gerdy's tubercle
Superior lateral genicular vessels
Knee joint capsule

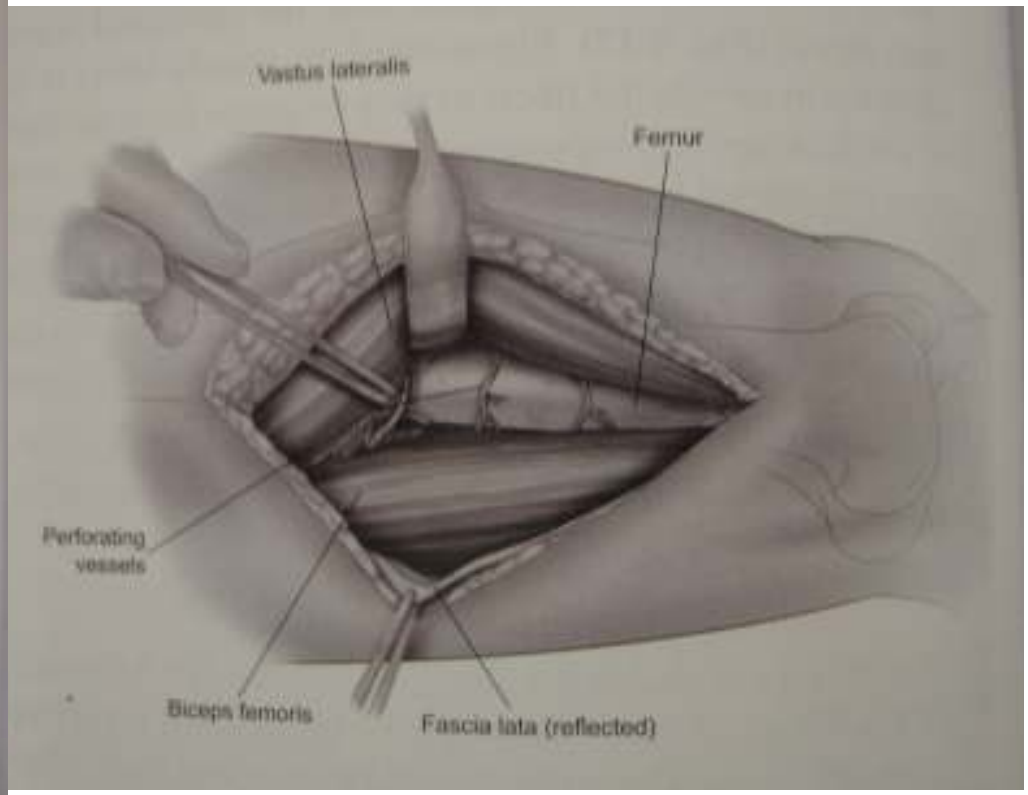
Lateral



Posterolateral

- Post edge LFC
- Split Fascia lat
- Elevation vastus lata (perforators)

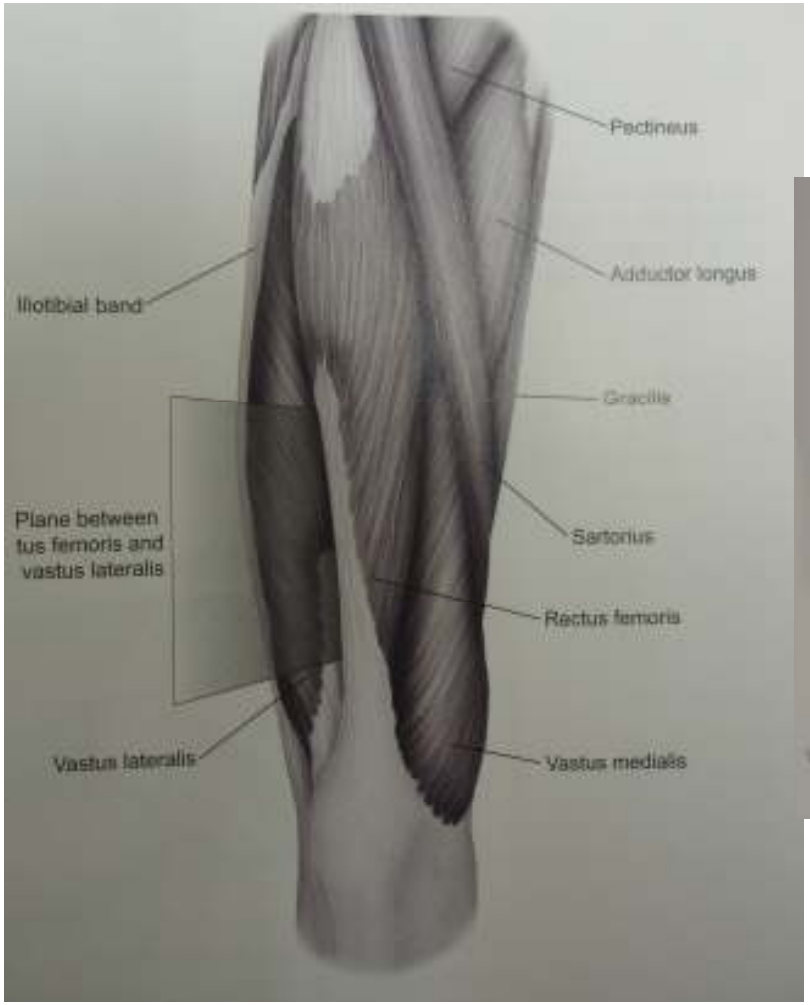
Posterolateral

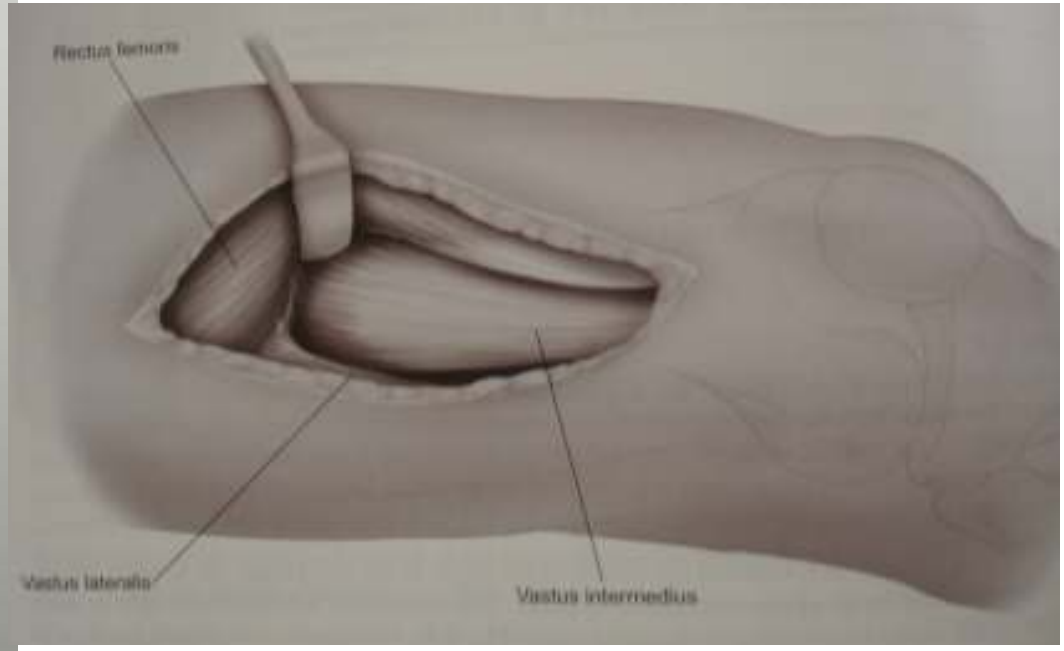


Anterolateral

- ASIS – lateral patella
- Rectus femoris / vast lat
- Lateral femoral circumflex A
- Split vast intermed

Anterolateral

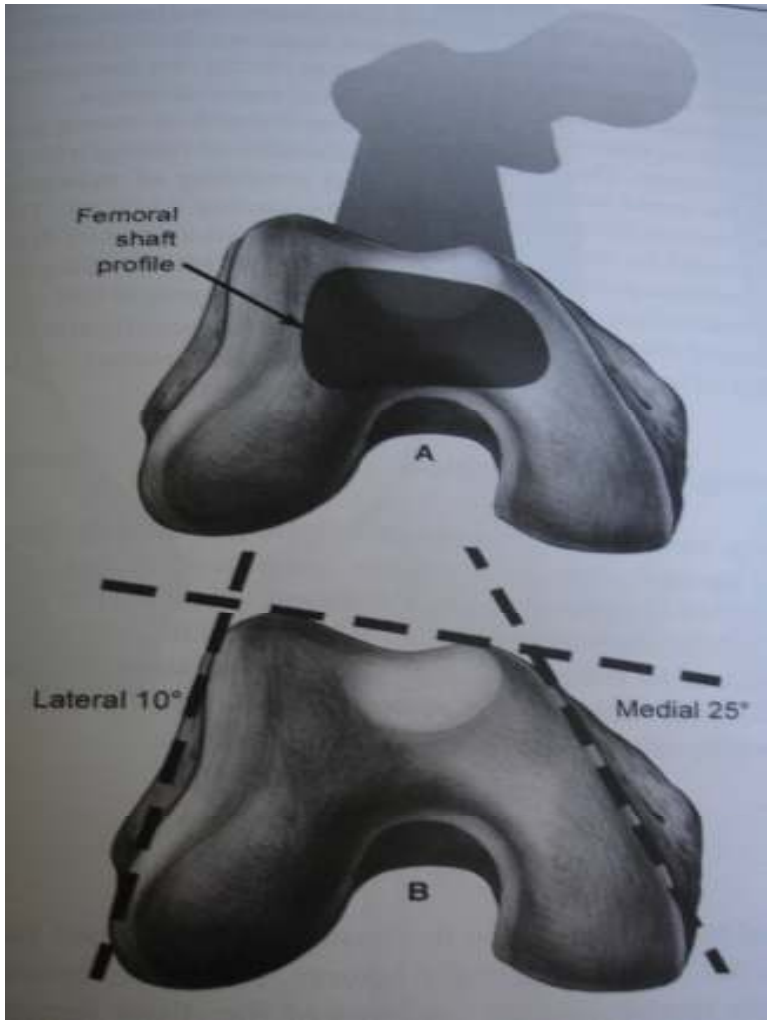


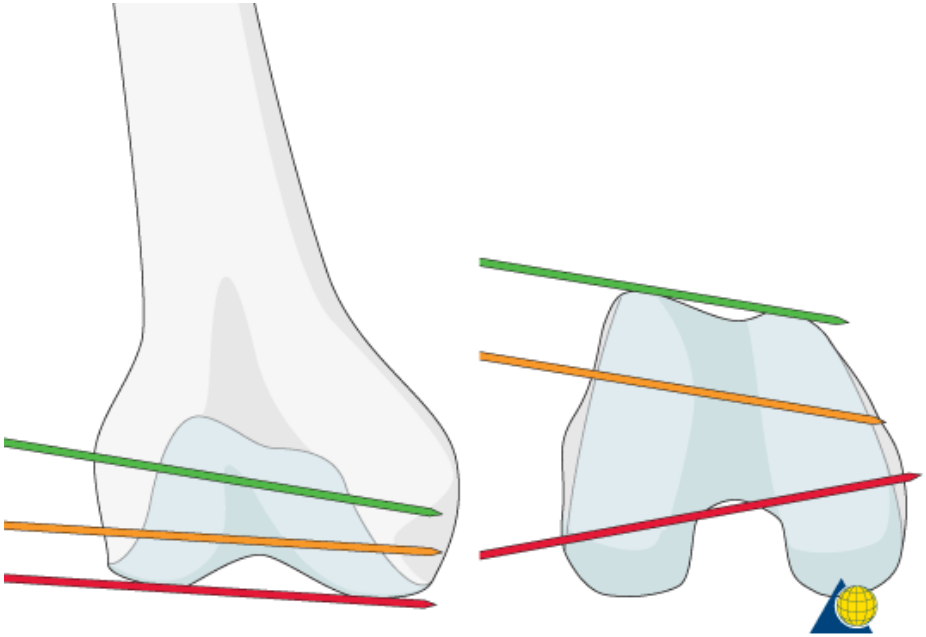


Stop

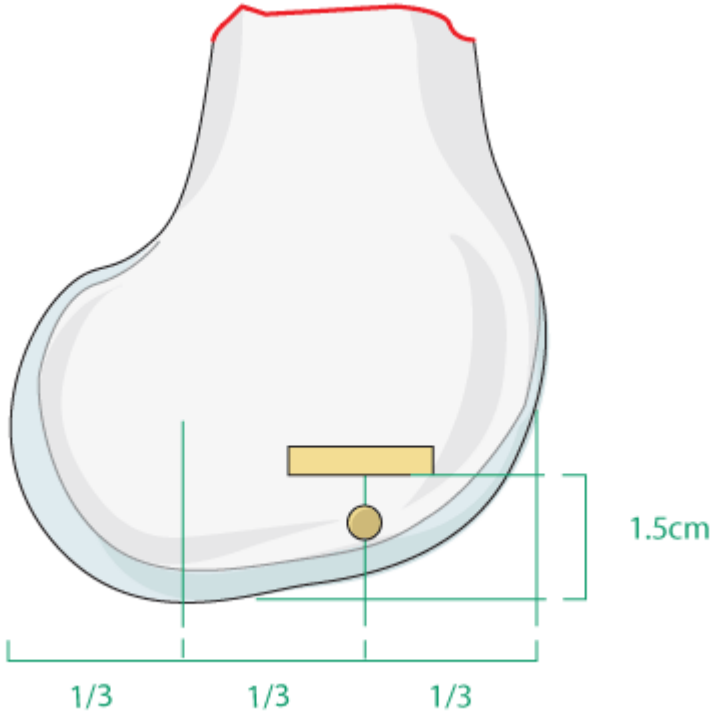
- Review approaches
- FRCS exam

Anatomy

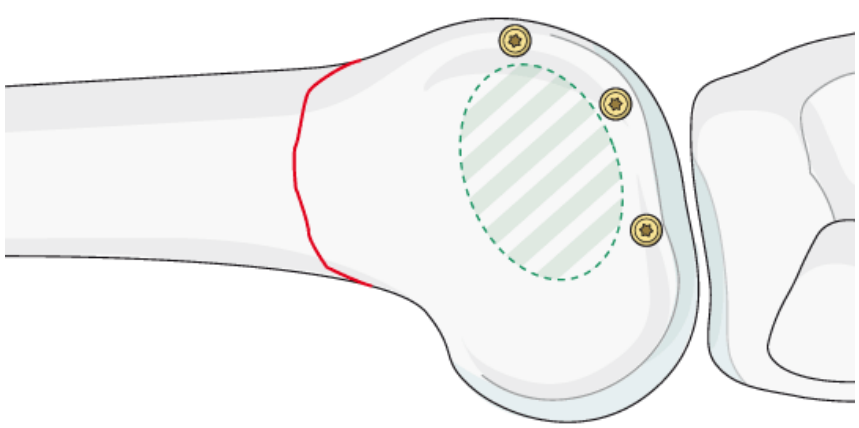


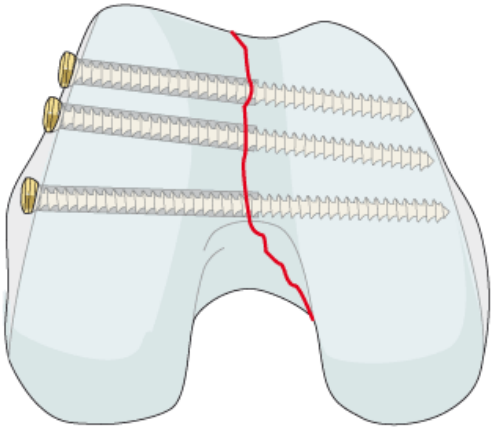


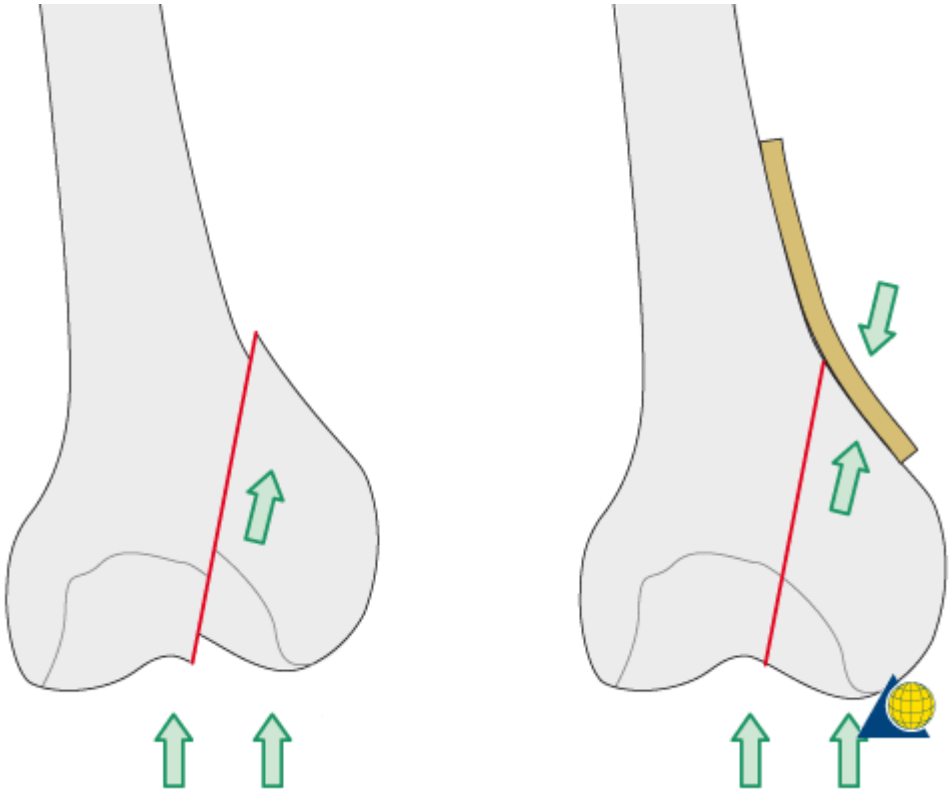
Orientation



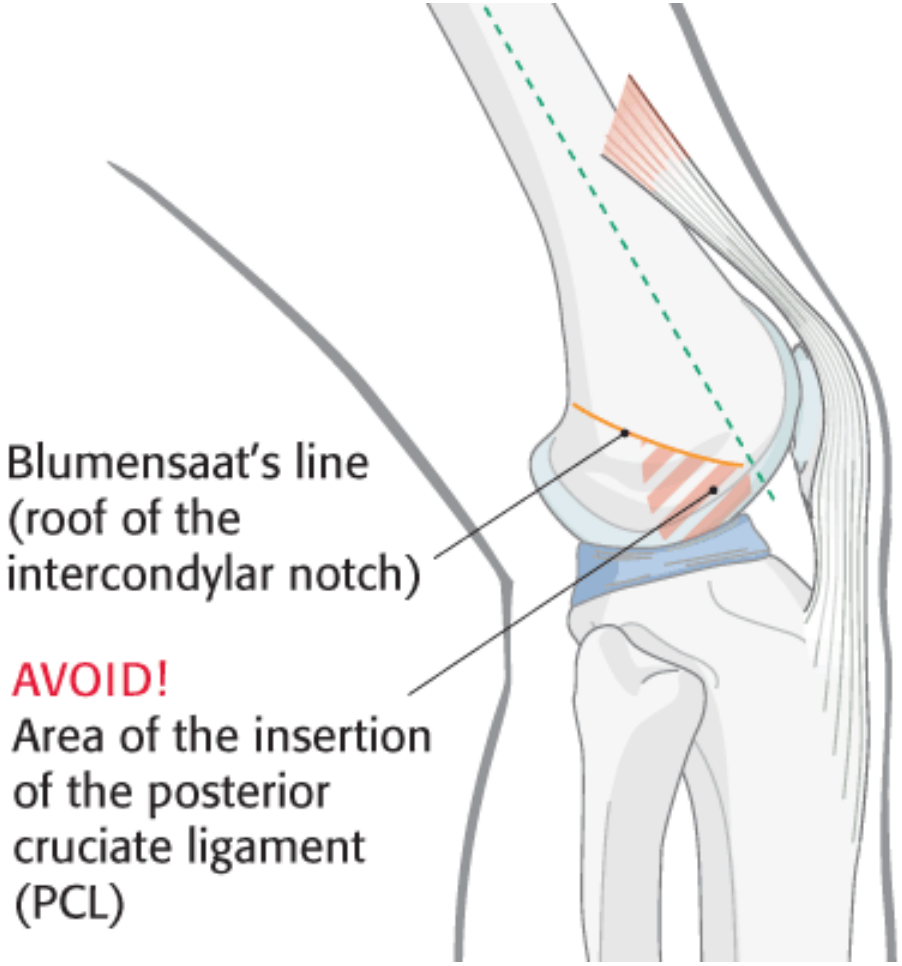

RT





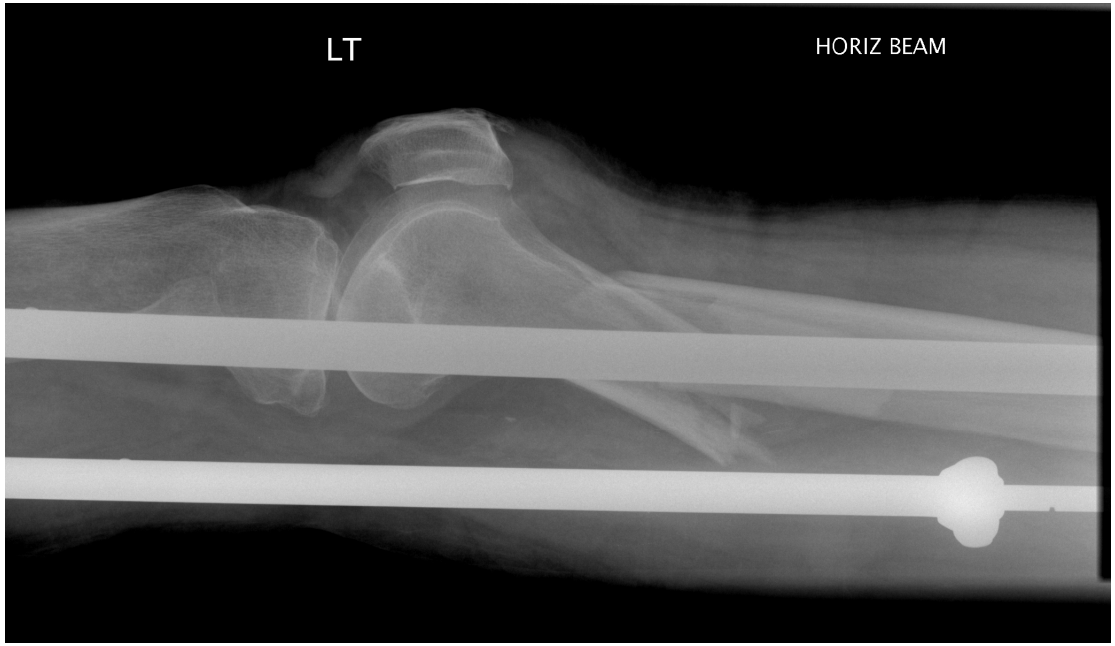


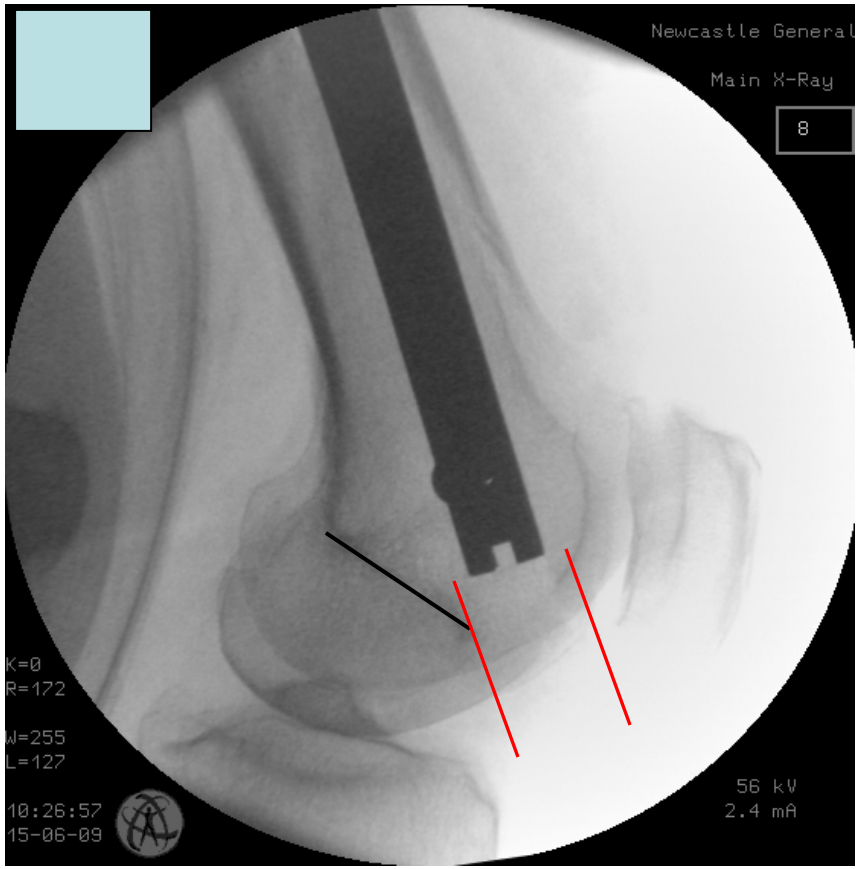
Retrograde Nailing

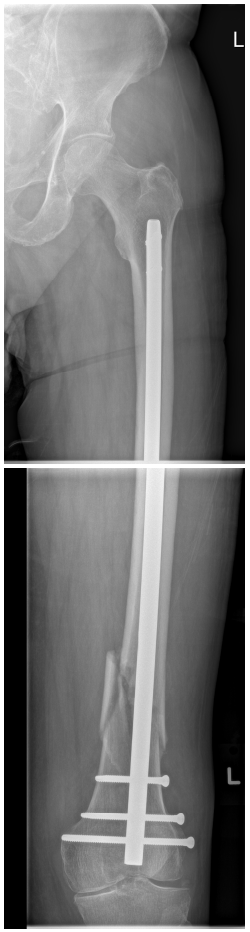


Case Example

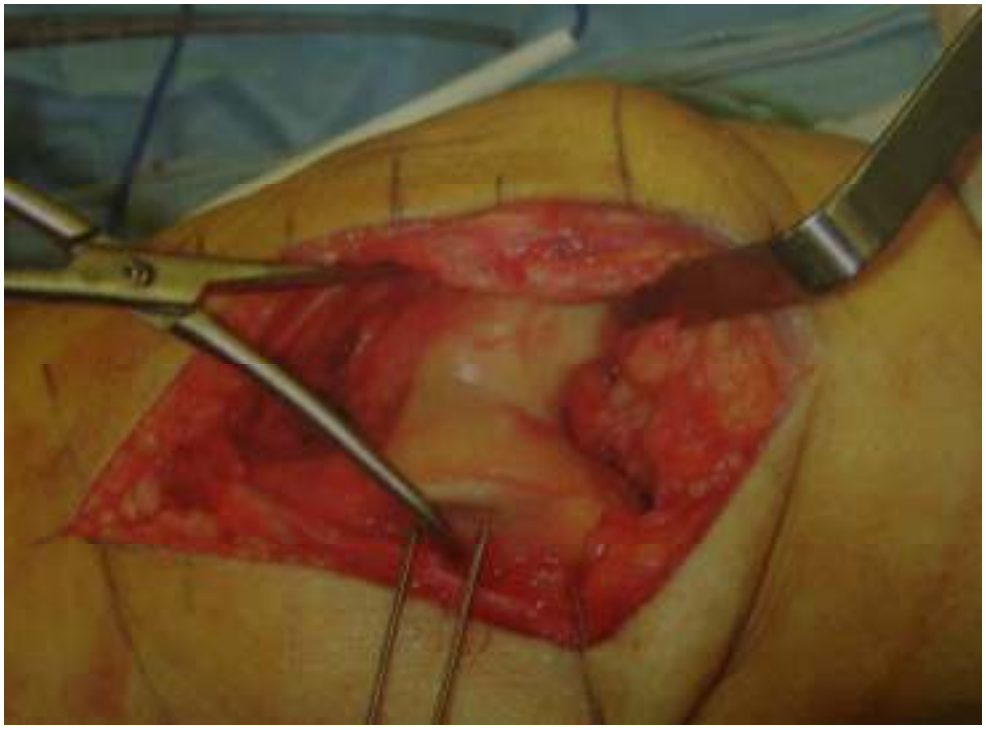

L


LT
HORIZ BEAM


Newcastle General
Main X-Ray
8
K=0
R=172
W=255
L=127
10:26:57
15-06-09
56 kV
2.4 mA


L
L

Principles



The Association Between Supracondylar-Intercondylar Distal Femoral Fractures and Coronal Plane Fractures

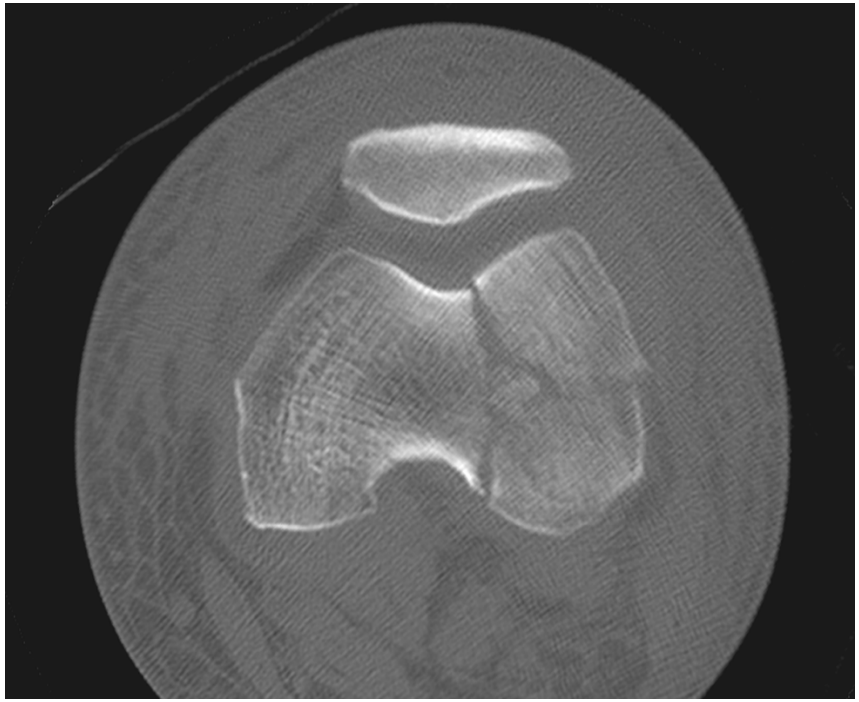
- discuss

- Isolated coronal #s (Hoffa) uncommon
- Can be difficult to diagnose
- Challenge to treat

J B&J S 2005;87:564-569 Nork et al.,

- 202 supracondylar-intercondylar #s
- 38% hoffa # (77 of 202#s)
- 77% single condyle (59/77) – 85% lateral
- 23% bicondylar (18/77)
- Open #s x2.8 hoffa involvement


L



- 10 hoffa #s unrecognised preoperatively
- None occurred in CT screened
- Implication for fixation esp medial

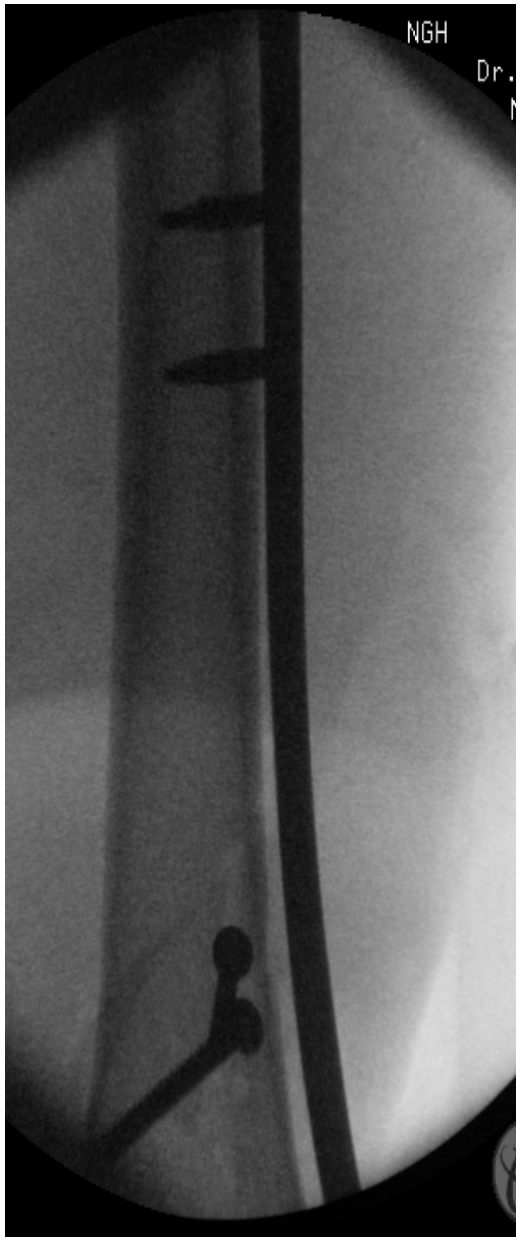
- Preoperative CT
- Strongly recommended high energy distal femur #s, esp open fractures

Case


NGH
Dr.
Main
50
0


NGH
1
1
1
86°
00 L 50
05.2010
54:24


NGH
Dr.
Main X-Ray
BONE
MAG 0
kV 55
mA 3.7
cGy cm2
28.4
min 0:33
NGH
Dr.
Main X-Ray
L 50
2010
BONE
MAG 0
kV 54
mA 3.6
cGy cm2
28.4
min 0:33

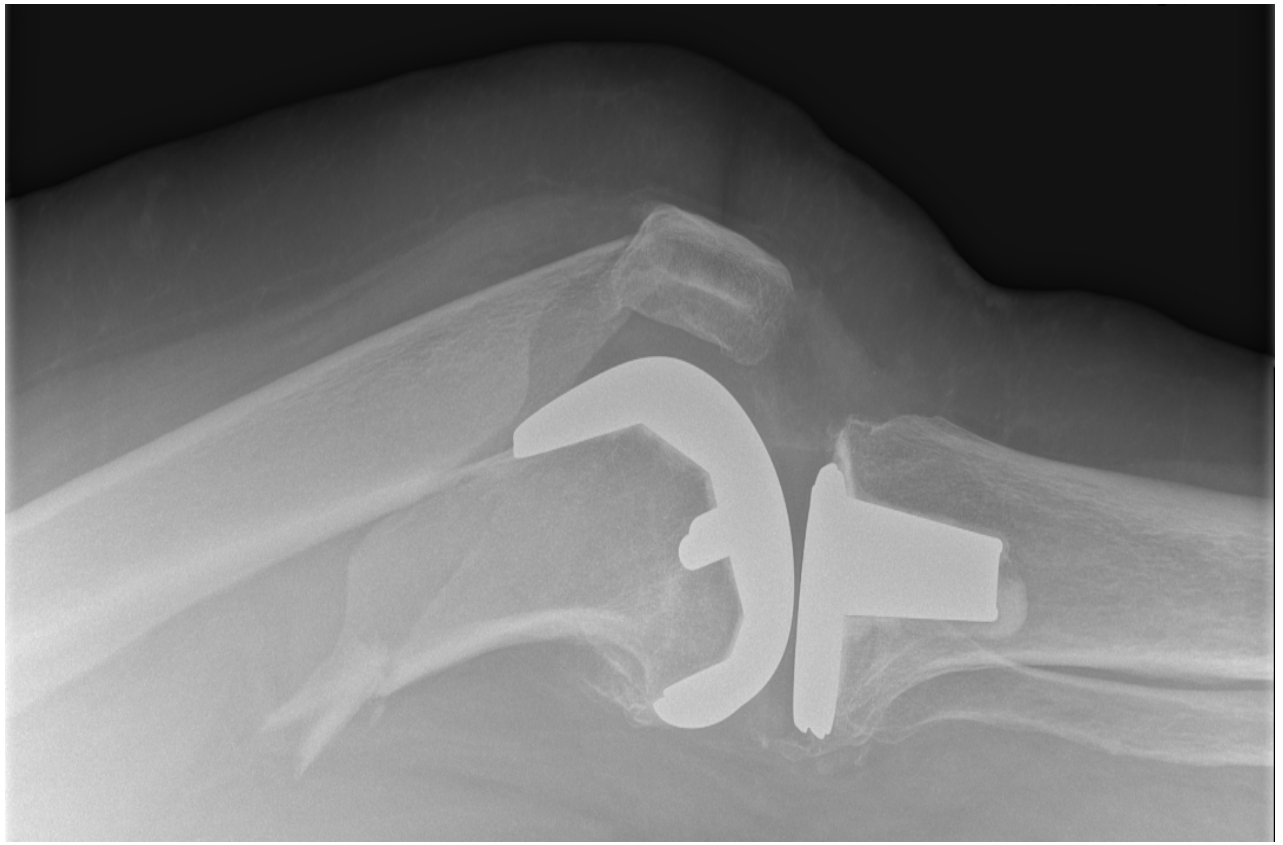

NGH
Dr.

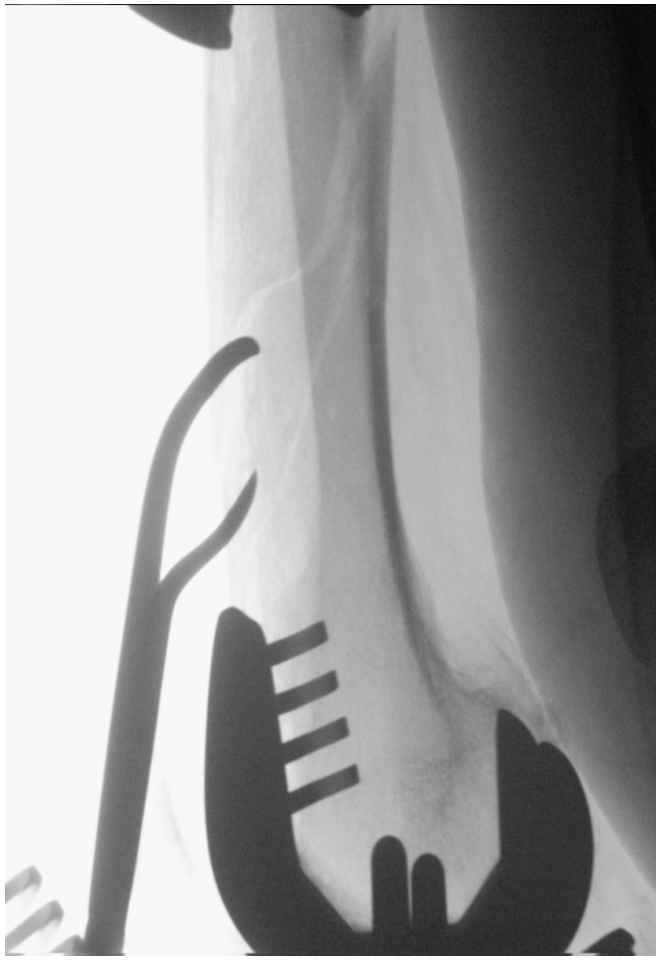

NGH
Dr.
Mai

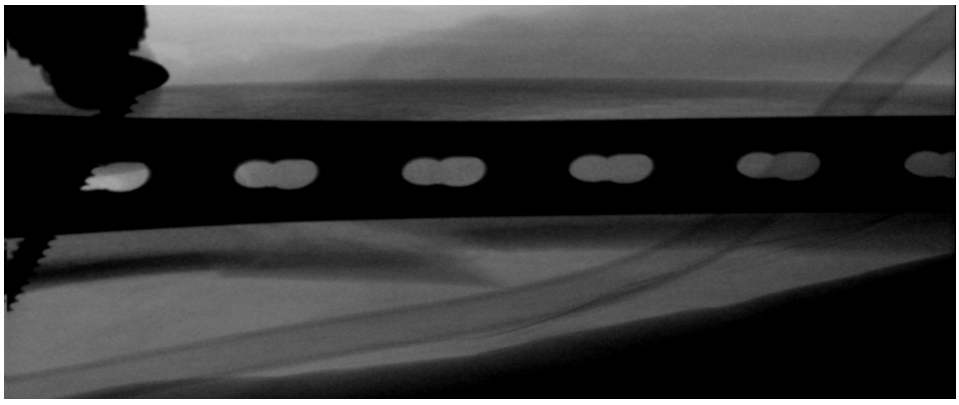

LT

Case


R








R


R

Fixation of distal femoral fractures above total knee arthroplasty utilizing the Less Invasive Stabilization System (L.I.S.S.)

- Injury, Int. J. Care Injured 32 (2001) S-C-64-75

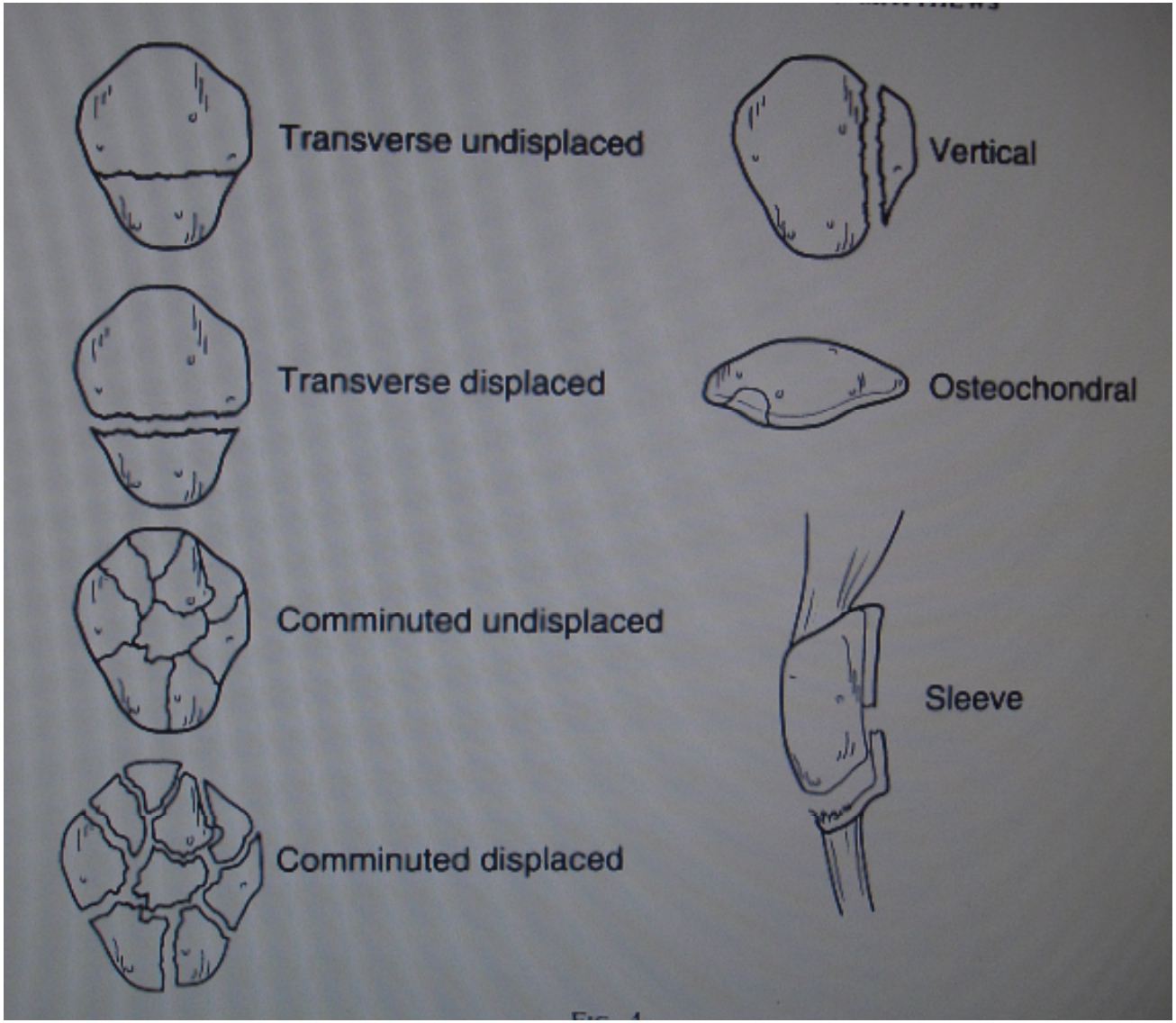
Kregor et al.

Intra-articular fractures of the distal femur: a long-term follow-up study of surgically treated patients

- J Orthop Trauma. 2004 Apr;18(4):213-9
- 67 cases (5-25 yr follow up)
- Average age 45 years (range 16-94 years)
- isolated fractures scored significantly better functionally
- secondary osteoarthritis in 36%
- Knee function increases through time
- Range of motion does not increase after 1 year.

Break

Patella Fractures



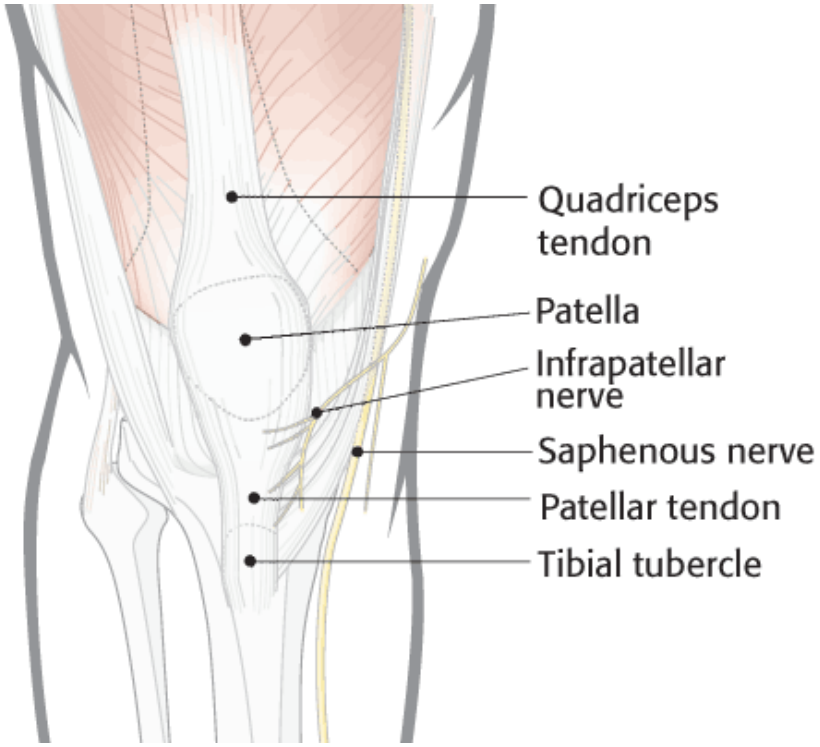
MOI

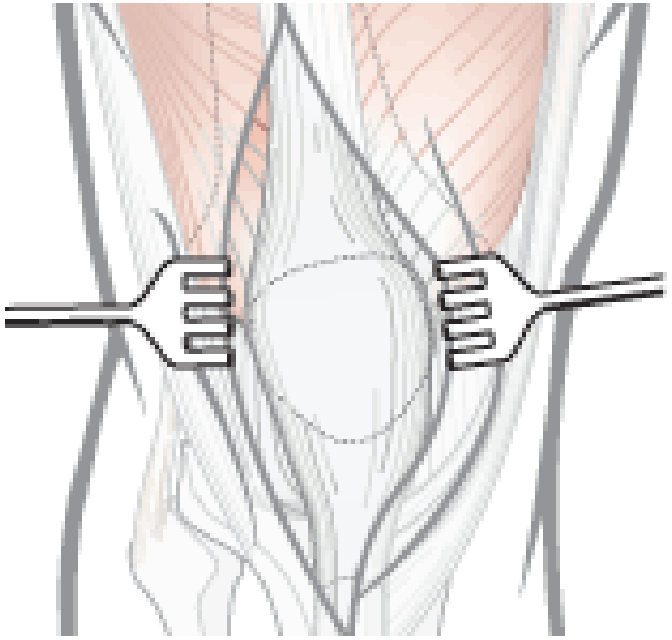
- Direct
  - Higher degree comminution
  - Less displacement #
  - More articular cartilage damage
- Indirect (rapid flexion/contacted quads)
  - Less comminution
  - Increased # displacement
  - Less cartilage damage

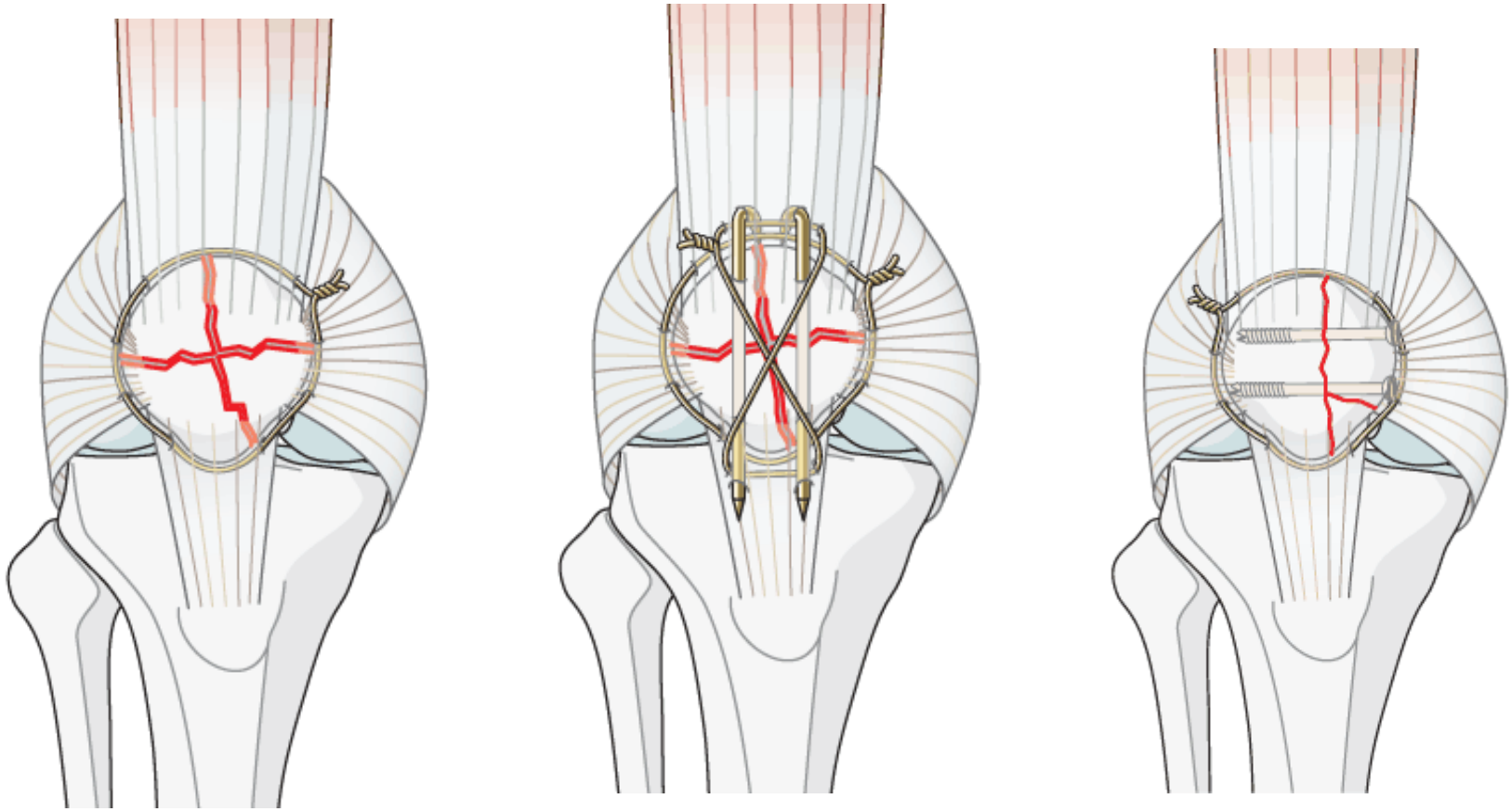
Bipartite

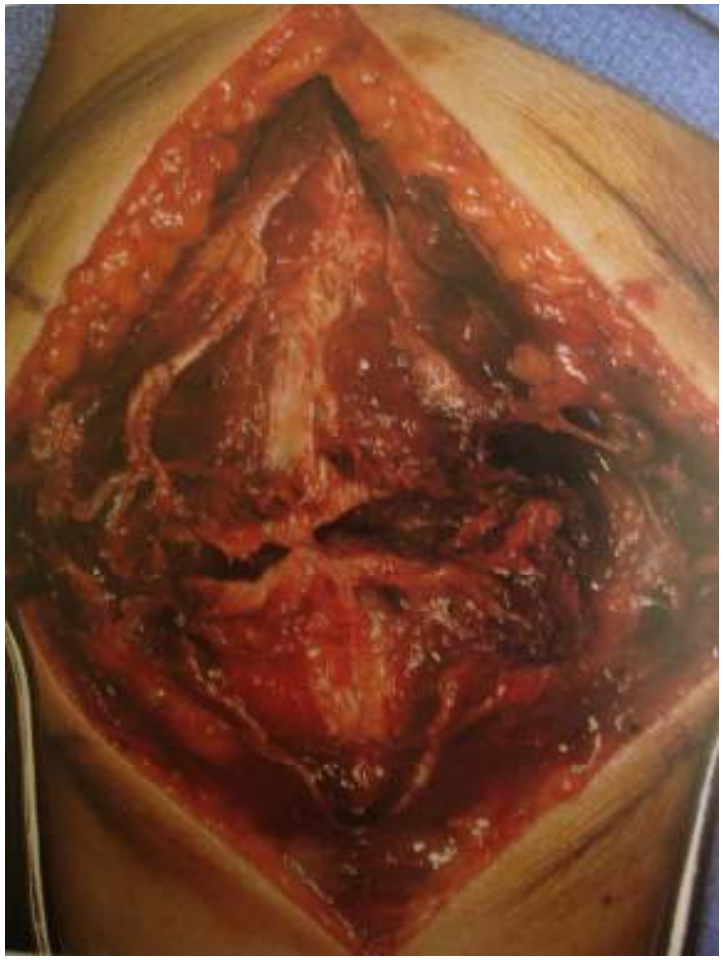
2% population
2% symptomatic
57% unilaterally

75% superolateral
20% lateral/vertical
5% inferior pole


Quadriceps tendon
Patella
Infrapatellar nerve
Saphenous nerve
Patellar tendon
Tibial tubercle

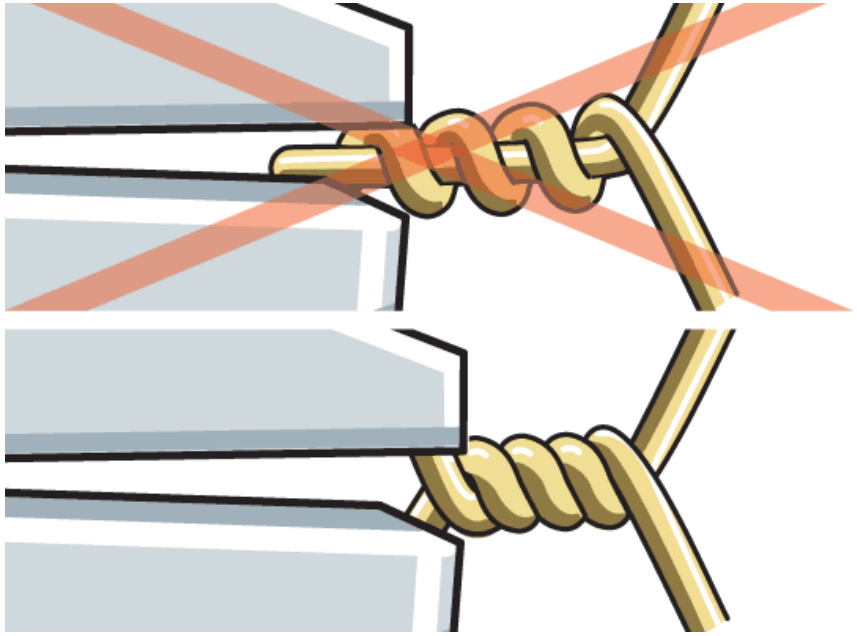






Correct Technique

- Retinacular repair!



Biomechanical Evaluation of Current Patella Fracture Fixation Techniques

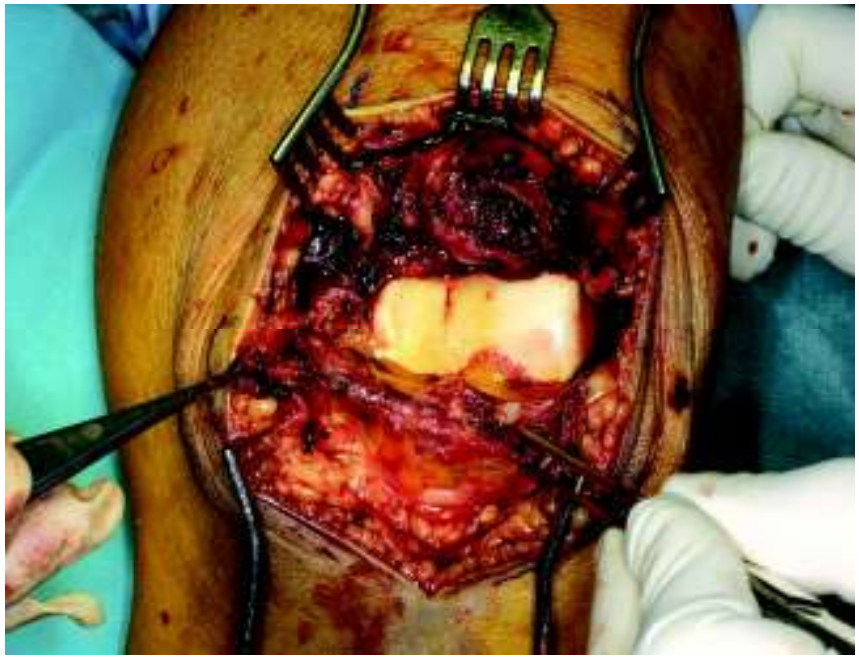
Journal of Orthopaedic Trauma:1997(11)351-356

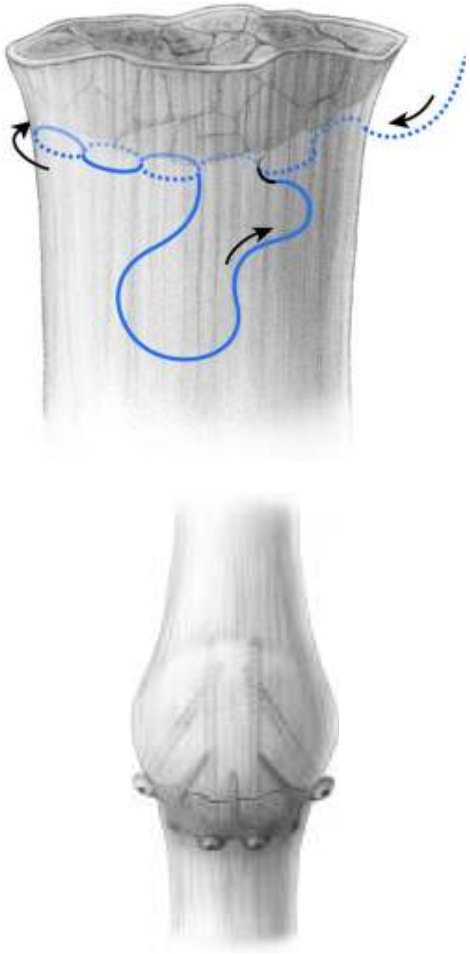
Inferior Pole

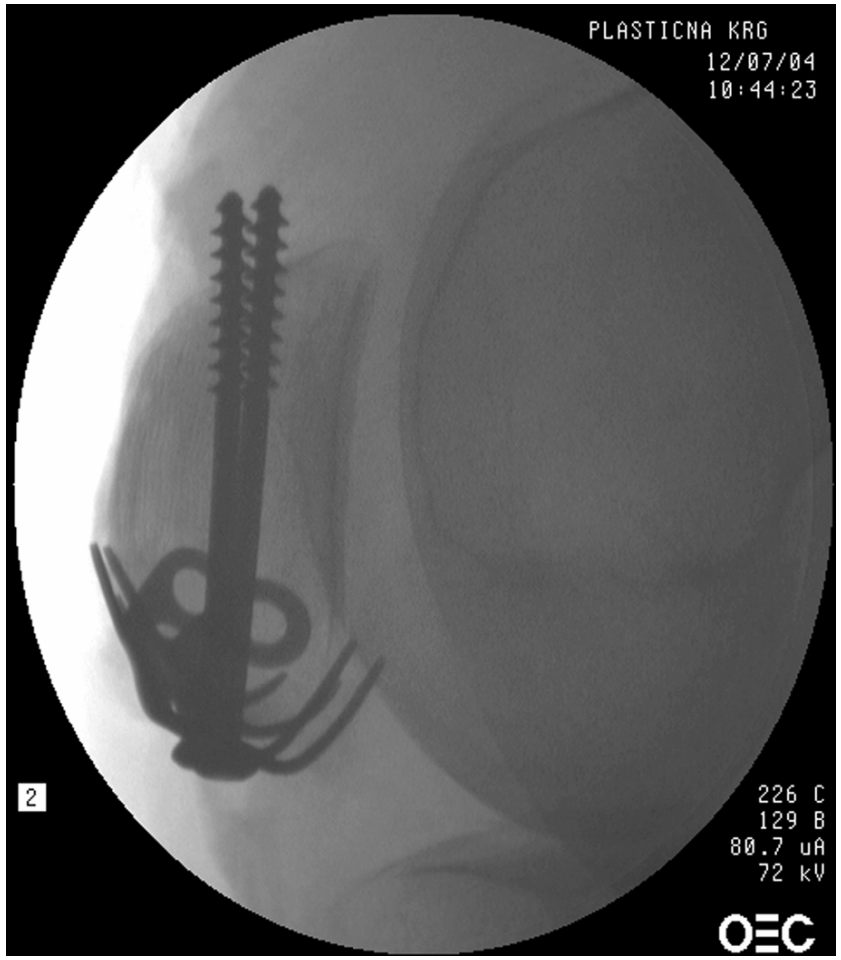
- Inferior patella pole avulsion fractures: Osteosynthesis compared with pole resection
- Veselko & Kastelec
- 2004;86:696-701

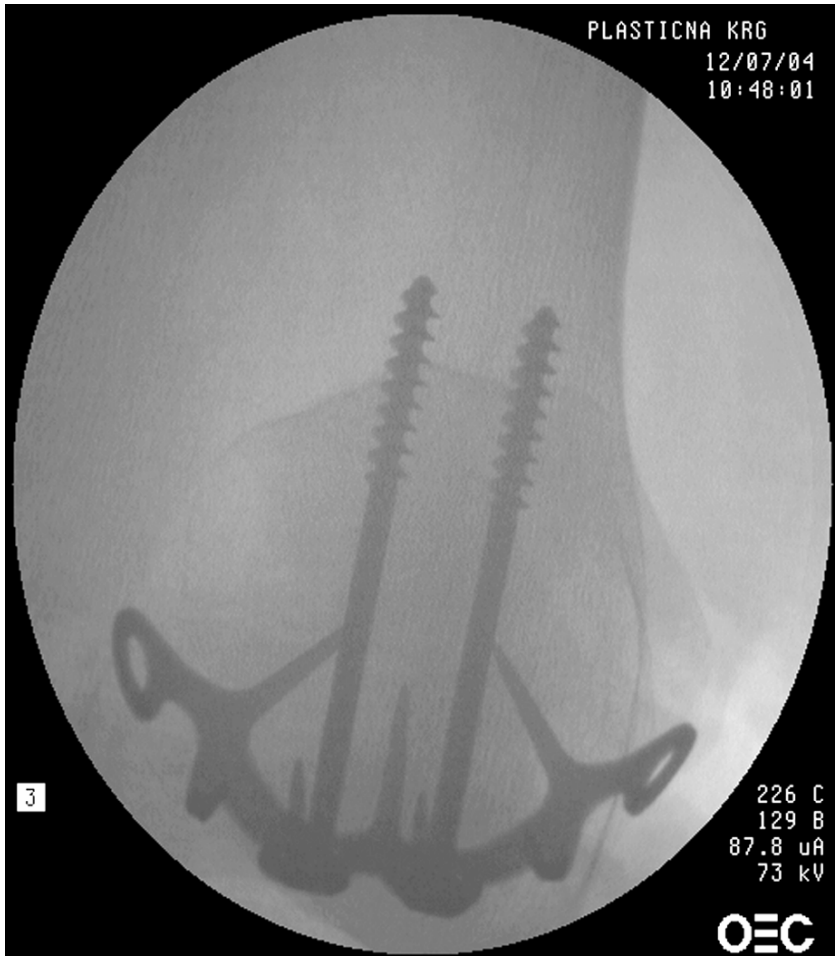
THE JOURNAL OF BONE & JOINT SURGERY
JB&JS

- 14 ORIF – basket plate
- 14 resection
- Patellofemoral score & height
- Sig diff
  - Knee pain
  - Level of activity
  - ROM
  - Patella baja ass with poor outcome



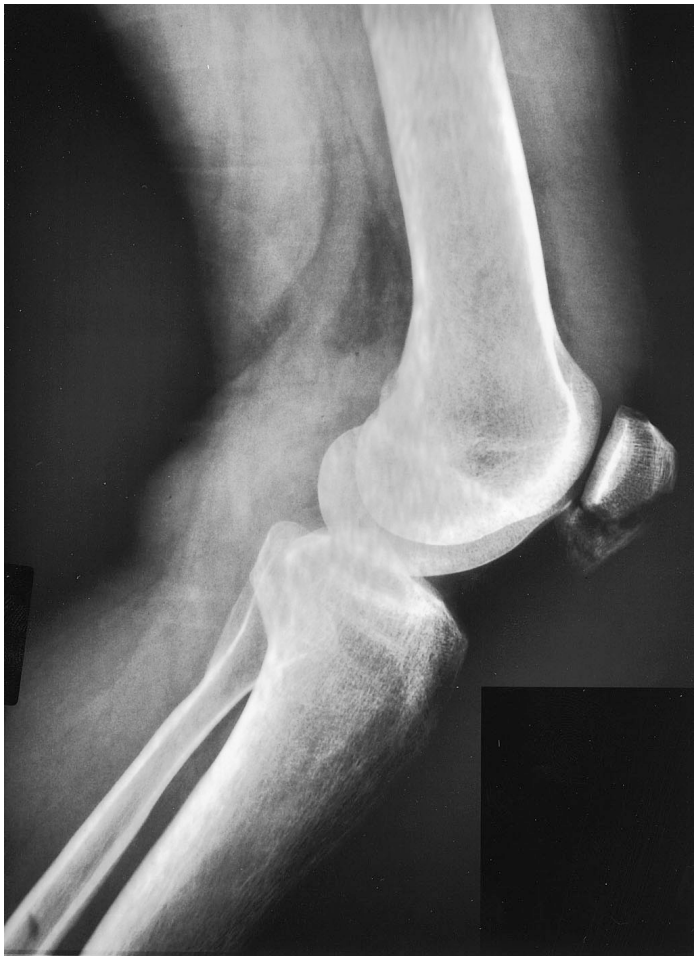



PLASTICNA KRG
12/07/04
10:44:23
2
226 C
129 B
80.7 uA
72 kV
OEC


PLASTICNA KRG
12/07/04
10:48:01
3
226 C
129 B
87.8 uA
73 kV
OEC

Complications

- Haemarthrosis
- Infection
- Loss of fixation/reduction
- Saphenous nerve damage
- Delayed/nonunion
- Arthrofibrosis
- PTOA



- osteotomy of the tibial tubercle and partial restoration of patellar height.


RT


RT
HORIZ BEAM


RT

Patellar Fracture After Total Knee Arthroplasty

Ortiguera & Berry 2002;84:532-540

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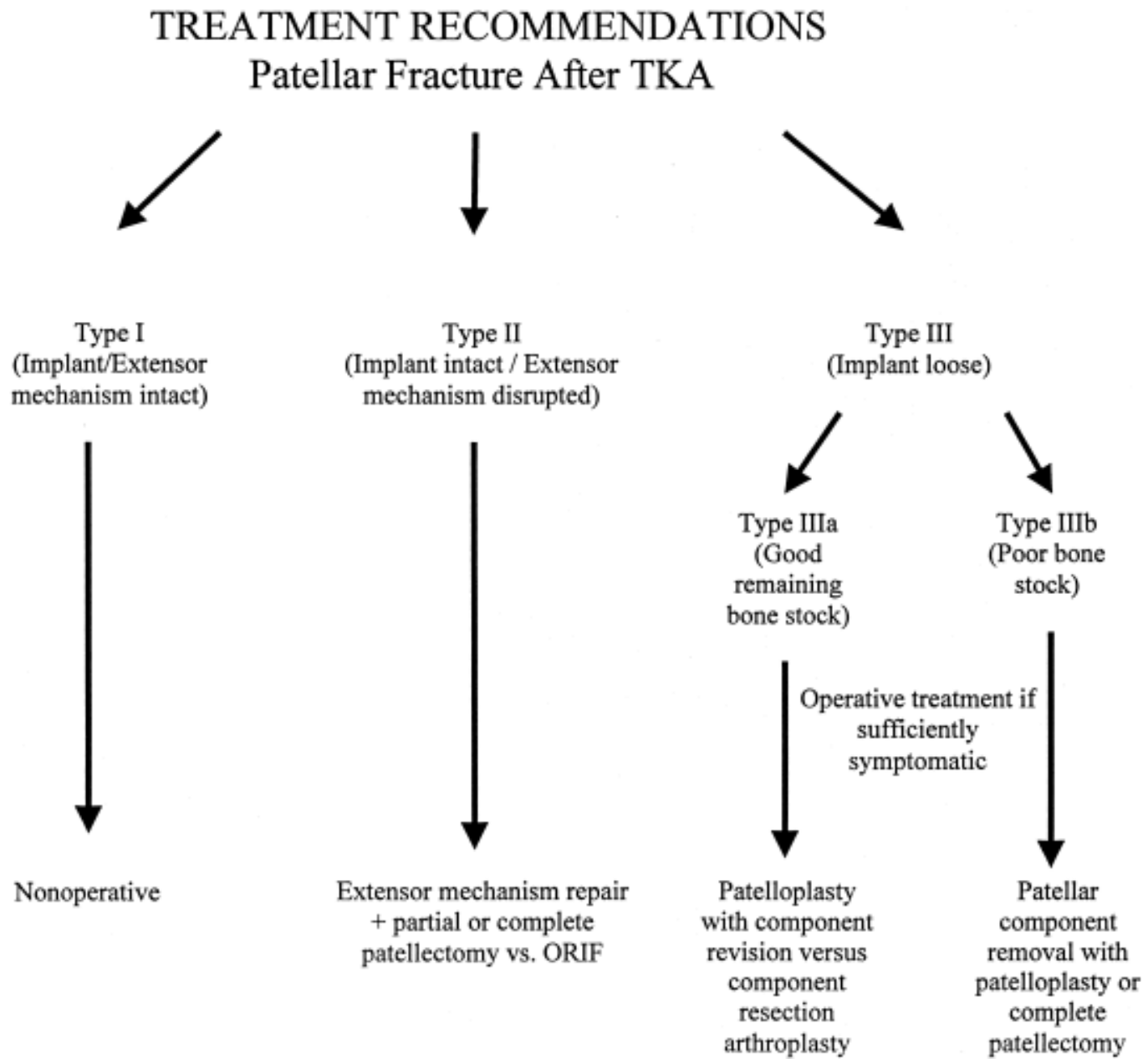
JB&JS


TREATMENT RECOMMENDATIONS
Patellar Fracture After TKA
Type I
(Implant/Extensor mechanism intact)
Type II
(Implant intact / Extensor mechanism disrupted)
Type III
(Implant loose)
Type IIIa
(Good remaining bone stock)
Type IIIb
(Poor bone stock)
Operative treatment if sufficiently symptomatic
Nonoperative
Extensor mechanism repair + partial or complete patellectomy vs. ORIF
Patelloplasty with component revision versus component resection arthroplasty
Patellar component removal with patelloplasty or complete patellectomy

Patellectomy

- Loss of patella fulcrum
- Decrease in moment arm
- Relative lengthening of quads
  - Can result in:-
  - Knee instability
  - Extensor lag
  - Quads atrophy
  - Loss of extensor strength

Open Fractures of the Patella: Long-Term Functional Outcome

- Journal of Trauma-Injury Infection & Critical Care: 1995 (39);439-444
- Average ROM 112 degrees, at an average follow-up of 21 months.
- Secondary surgical procedures 65%- symptomatic hardware
- Good to excellent knee scores 17 of 22

Tibial Plateau Fractures

- Overview
  - Geometry
  - Classification
  - Management
  - Outcome studies
  - Interactive cases

Geometry of Tibial Plateau

- Articular surface & ligaments
- Control biomechanical behaviour of joint
- Geometry TP direct influence
  - Biomechanics of TFJ
    - Translation
    - Location of centre of rotation
    - The screw home mechanism
    - Strain biomechanics of ligaments, eg ACL

Geometry of Tibial Plateau

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    - Translation
    - Location of centre of rotation
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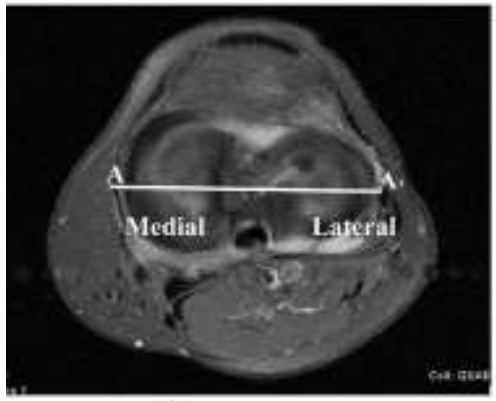
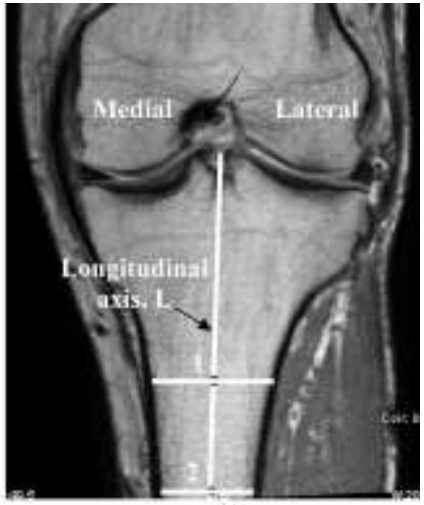
    - Strain biomechanics of ligaments, eg ACL

Tibial Coronal Slope



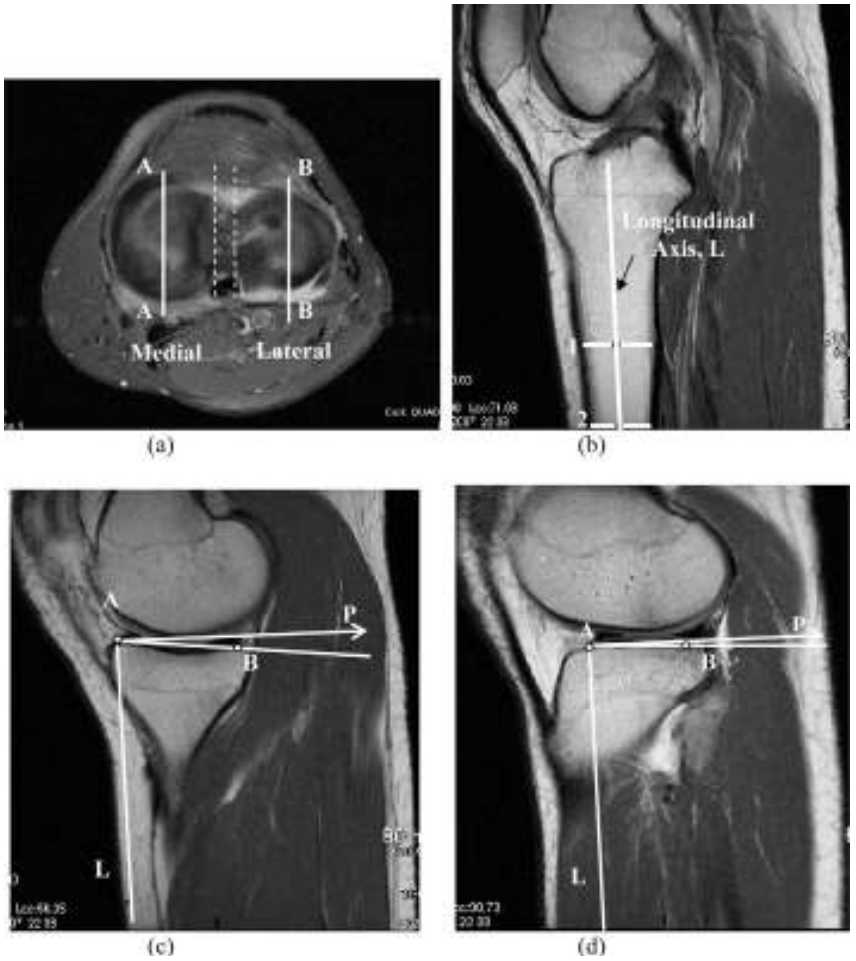
(a)

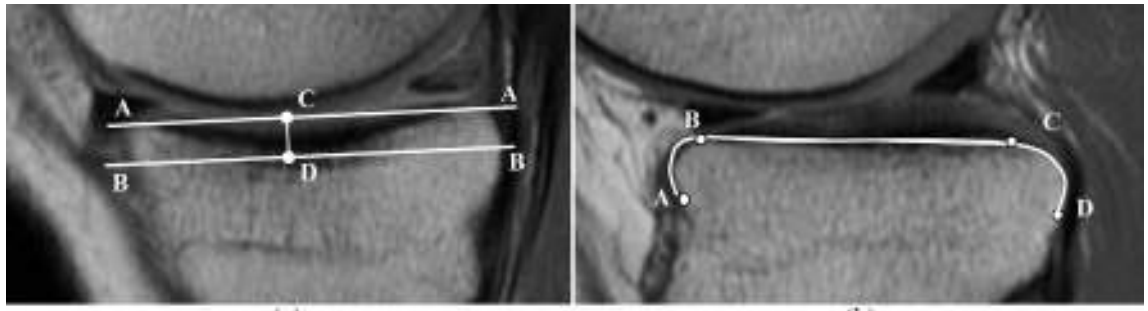


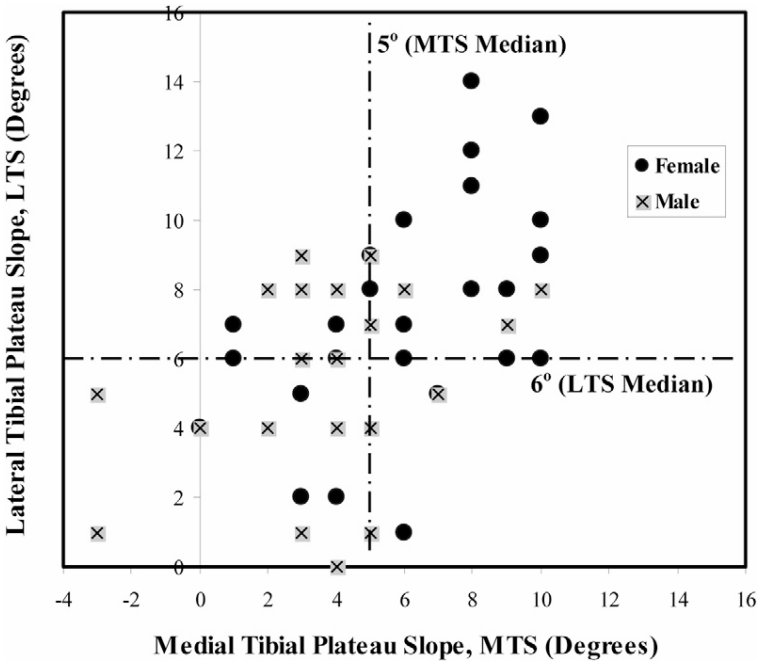
(b)

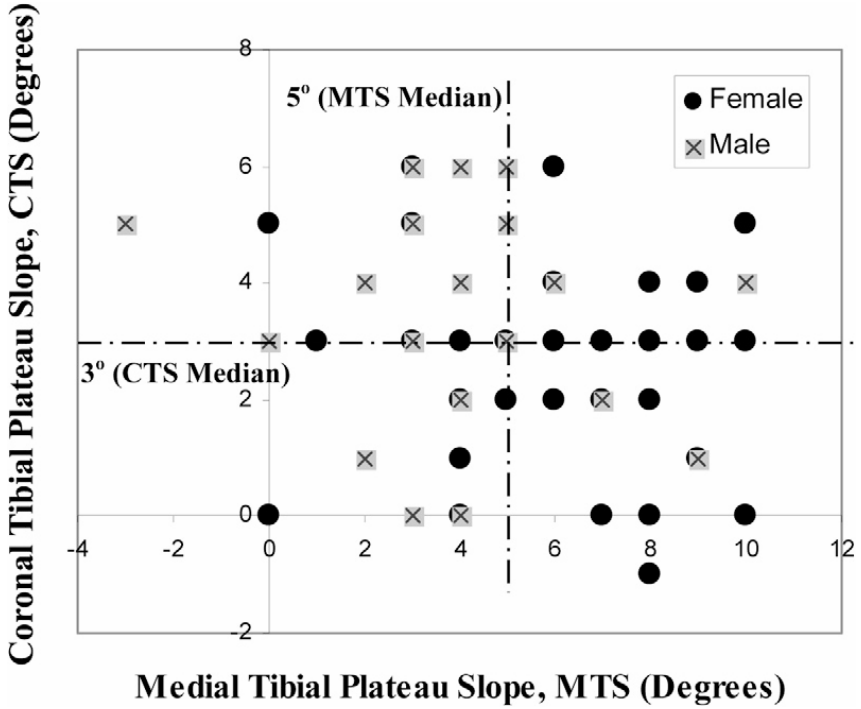
(c)

Medial & Lateral Tibial Slopes




A
C
A
B
D
B
(a)
B
C
A
D
(b)


5° (MTS Median)
6° (LTS Median)
Female
Male
Lateral Tibial Plateau Slope, LTS (Degrees)
Medial Tibial Plateau Slope, MTS (Degrees)
16
14
12
10
8
6
4
2
0
-4
-2
0
2
4
6
8
10
12
14
16


5° (MTS Median)
3° (CTS Median)
Female
Male
Coronal Tibial Plateau Slope, CTS (Degrees)
Medial Tibial Plateau Slope, MTS (Degrees)
8
6
4
2
0
-2
-4
-2
0
2
4
6
8
10
12

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JB&JS

- Hashemi et al., 2008;90:2724-2734
- 22♂ 23♀ skeletally mature, healthy knees

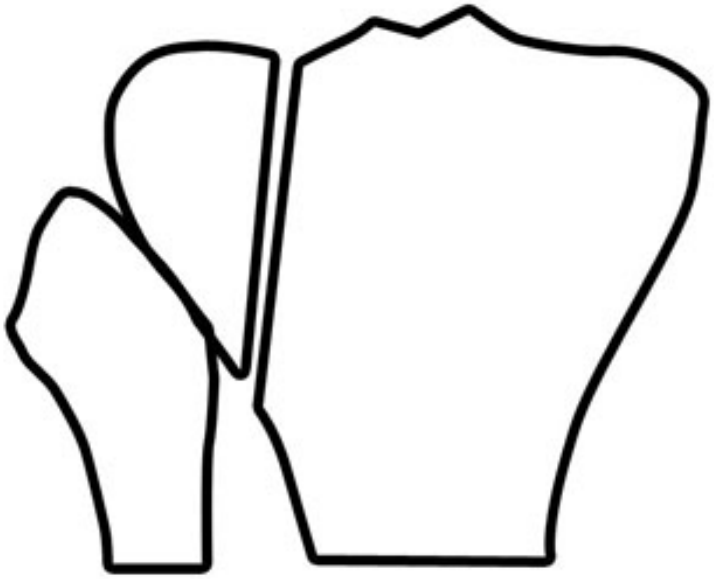
- 3 slopes
- medial & lateral tibial slopes greater ♀
- Coronal tibial slope greater ♂
- ?risk to OA, injury, preop planning arthroplasty

Plateau Fractures

Incidence

- 1% of all fractures
- Bimodal
- Young adults, older females

Classification

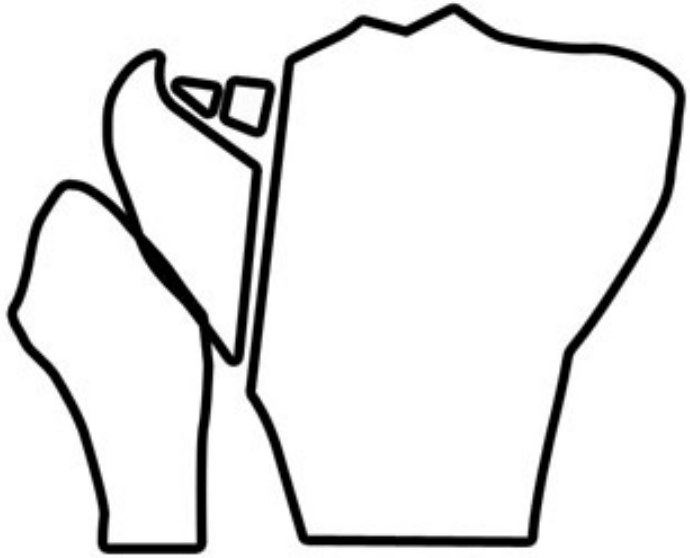


- **<u>Schatzker I</u>** - Split without depression

- Aetiology: valgus stress
  - younger patients with stronger bones, which are resistant to depression

- Associated injuries: Lateral meniscal tear

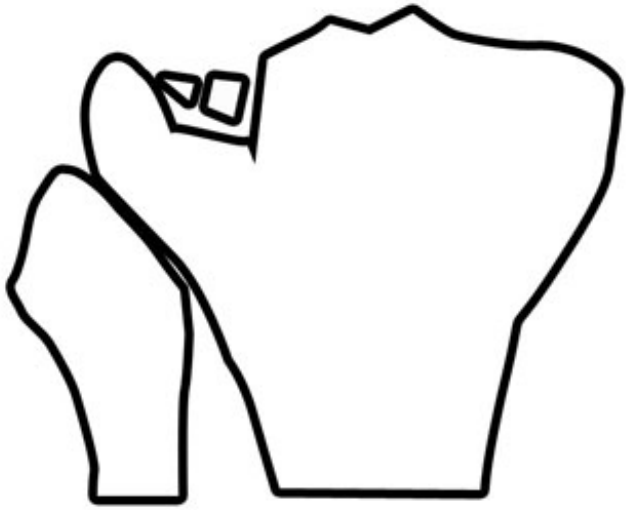

07/25/99
11:48:15



- **<u>Schatzker II</u>** - Split depression (Most common)

- Aetiology: valgus or axial stress.
  - older patients, osteoporosis, bones do not resist depression

- Associated injuries: Lateral meniscus, medial meniscus, and medial collateral ligament



- **<u>Schatzker III</u>** - Lateral depression

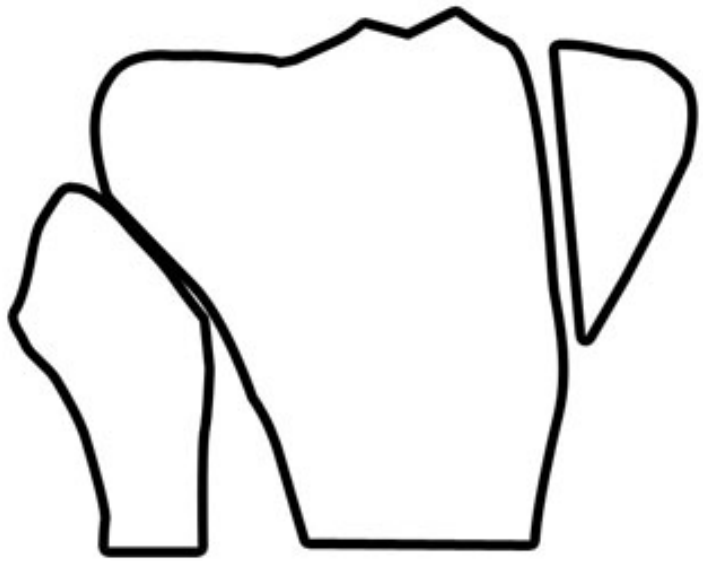
- Aetiology: Older patients,osteoporosis
  - Often just due to a fall

- Associated injuries: If the depressed fragments are lateral and posterior, it is associated with joint instability.

- ***The Incidence of Soft Tissue Injury in Operative Tibial Plateau Fractures: A Magnetic Resonance Imaging Analysis of 103 Patients***
- Gardner et al., 2005 ;19:79-84

- 77% sustained a complete tear or avulsion of 1 or more cruciate or collateral ligaments
- 91% had evidence of lateral meniscus pathology
- 44% had medial meniscus tears
- 68% had tears of 1 or more of the posterolateral corner structures of the knee
- The most frequent fracture pattern was a lateral plateau split-depression (Schatzker II) (60%)
- No pure depression injuries (Schatzker III, AO/OTA 41-B2) were seen

- Though the clinical importance of injury to each of these structures is unknown, the treating surgeon should be aware that a variety of soft tissue injuries are common in these fractures
- In addition, all fractures had at least 1 cortical split visible on magnetic resonance imaging, implying that pure depression patterns are very rare or may not exist



- **<u>Schatzker IV</u>** - Medial tibial plateau fracture

- Aetiology: Varus stress
  - Often severe trauma, dislocated knee

- Associated injuries: cruciates, LCL, peroneal nerve, popliteal artery

Medial Sub-Classification

Lateral # progression = severity increases
Neuro/vascular injuries in C-type classification
Risk of compartment syndrome increases A(14%) - B(33%) - C(67%)

JTII&CC 2007:63;1418-21 Wahlquist et al.,

Compartment Syndrome

Definition:

"A condition in which the circulation to, and function of tissues in, a closed space are compromised by an increased pressure within that space."

Incidence

- 7.3 and 0.7 per 100 000 for males and females respectively

(*McQueen et al, 2000*)

Risk Factors

Acute compartment syndrome

WHO IS AT RISK?

M. M. McQueen, P. Gaston, C. M. Court-Brown

From the Royal Infirmary of Edinburgh, Scotland

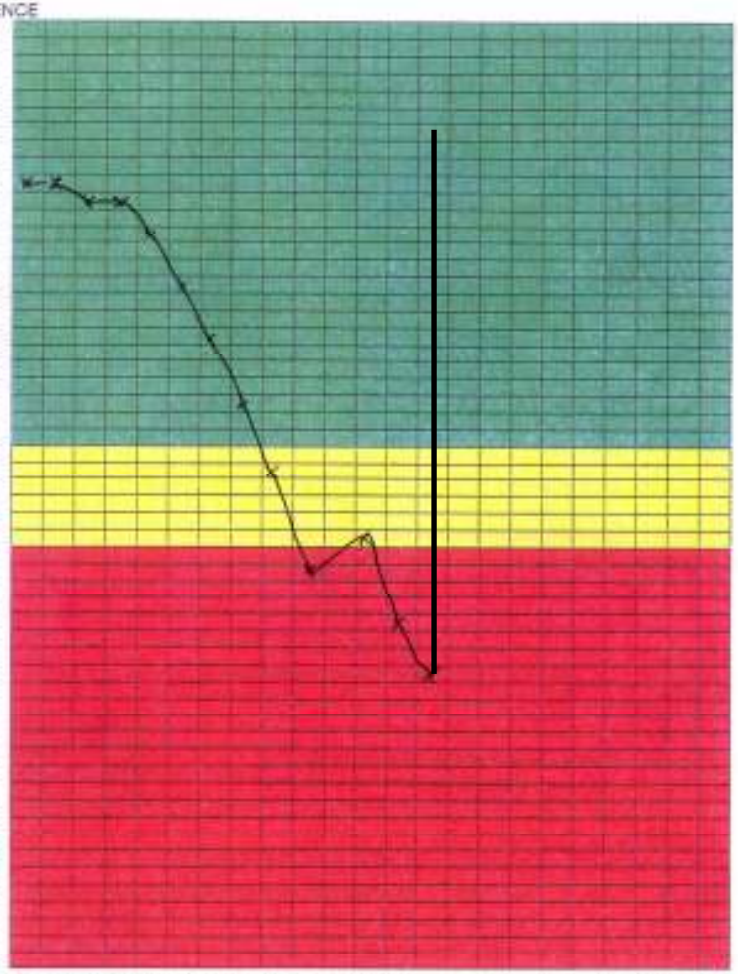
- tibial diaphyseal fractures, thigh, forearm, buttock
- age < 35
- men

- Continuous pressure transducer
  - 14 gauge needle
  - Arterial line

Patient name ..... Date ..../..../.....

Time

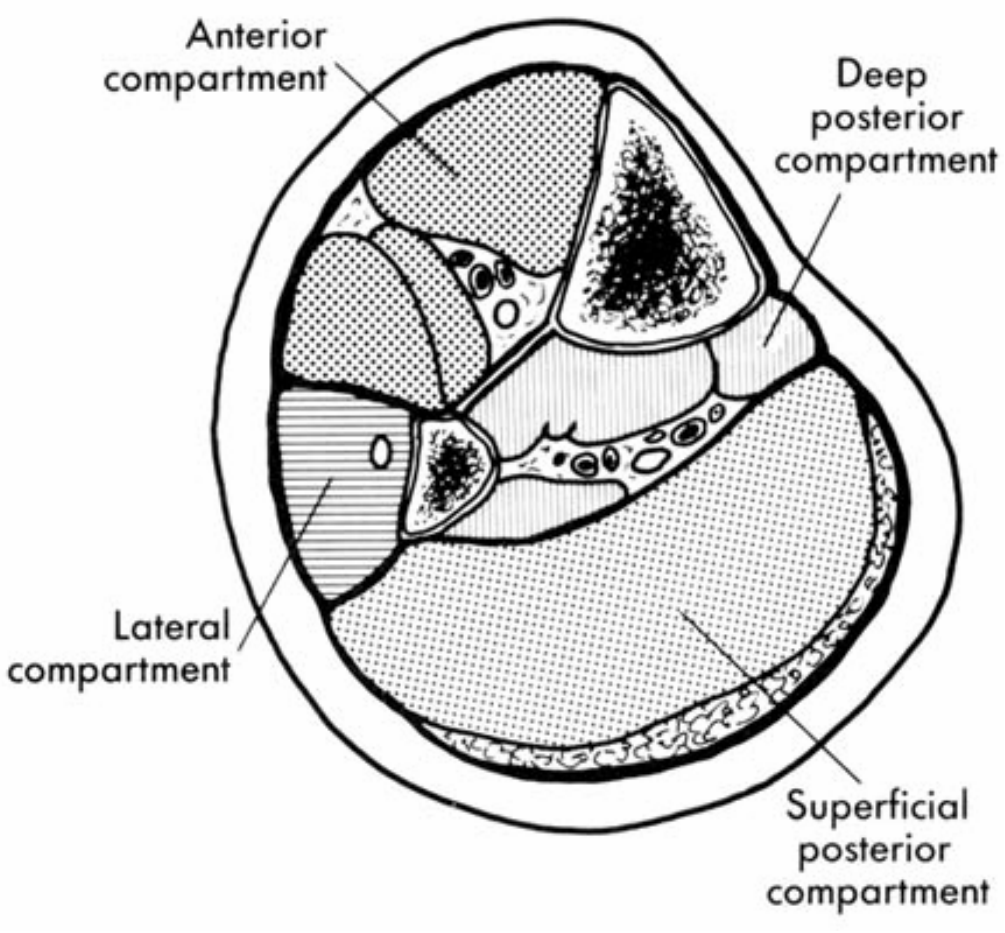
DIFFERENCE



Diastolic Reading	74	70	70	70	72	78	73	69	65	60	65	64	68
Monitor Reading	23	20	20	20	26	29	35	35	38	30	40	42	46
Difference	51	50	50	48	45	41	38	34	28	30	25	22	22
C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
S	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
M	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

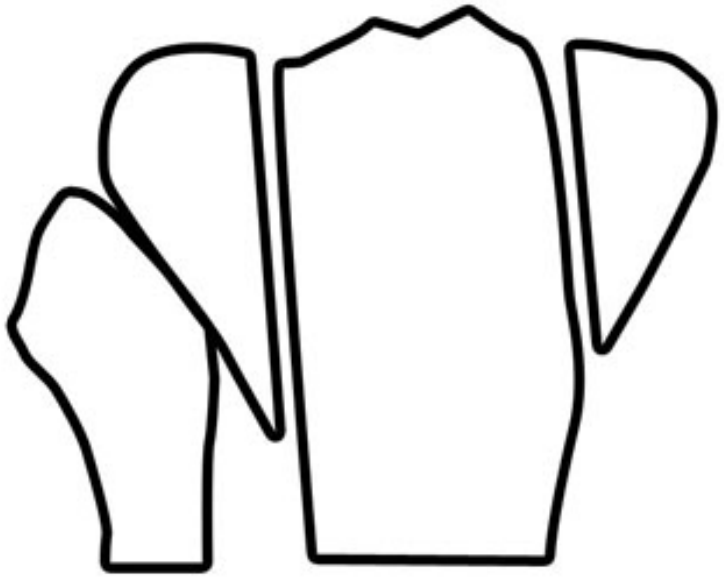
Action Taken .....

Fasciotomy

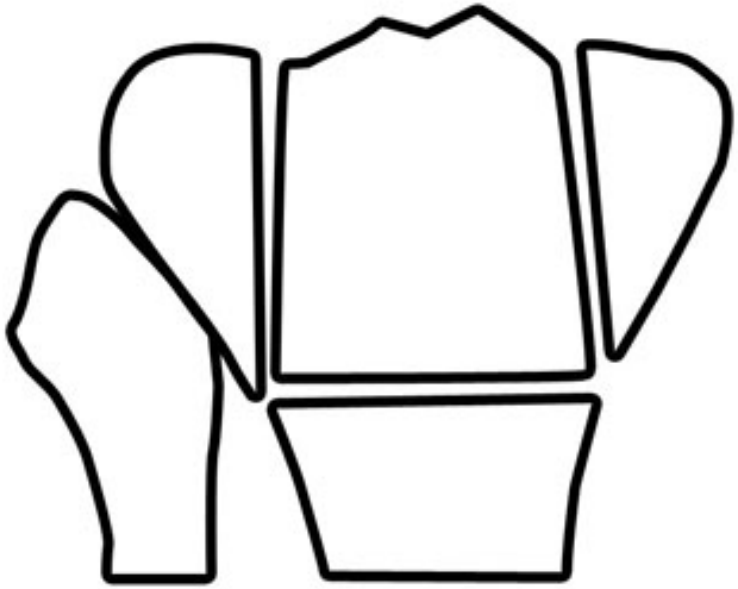

Anterior compartment
Deep posterior compartment
Lateral compartment
Superficial posterior compartment

Two incisions:

1. Medial: half way between posterior tibial border and mid point
   Posterior compartment and deep compartment
2. Lateral: half way between tibial crest and fibular line
   Anterior and lateral compartments.



- **<u>Schatzker V</u>** - Bicondylar
  - Metaphysis is still in continuity with the diaphysis
- Aetiology: axial stress with severe trauma
- Associated injuries: Neurovascular, ACL,meniscal



- **<u>Schatzker VI</u>** - Metaphyseal fracture that separates the articular surface from the diaphysis
- May involve the medial, lateral, or both articular surfaces

- Aetiology: High-energy trauma

- Associated injuries: Neurovascular injury,compartment syndrome, meniscal, ACL, and collateral ligaments

Initial Management

- ATLS
- Neurovascular exam & document
- Appropriate x rays
- Splintage / External fixation
- Further imaging
- Treatment plan

AO Principles

- # reduction + fixation to restore anatomical relationships
- # stability by fixation or splintage as the personality of the fracture and injury dictates
- Preservation of the blood supply to the soft tissues and bone by careful handling and gentle reduction
- Early safe mobilisation

Surgical Planning

- Anatomical fracture configuration
- Reduction plan!
- Mode of use (fracture healing environment)
- Open v's MIPO
- Need a locking plate?
- Can you use convention fixation
- Do you need an anatomical plate?
- Pattern of locking screws and sequence

Fracture Reduction

- Anatomical v's alignment (art v's met)
- Open v's percutaneous ? mode of use
- Time to surgery
- Reduction aids
- Not after insertion of locking screws
- Use of screw types and sequencing