Distal Femur Fractures

Steven A. Olson, MD
Goldner-Jones Professor
Duke University Medical Center

Disclosures

- No financial disclosures for this talk

- “I get by with a little help from my friends”

  Some slides in this talk are from colleagues

DUKE ORTHOPAEDIC TRAUMA

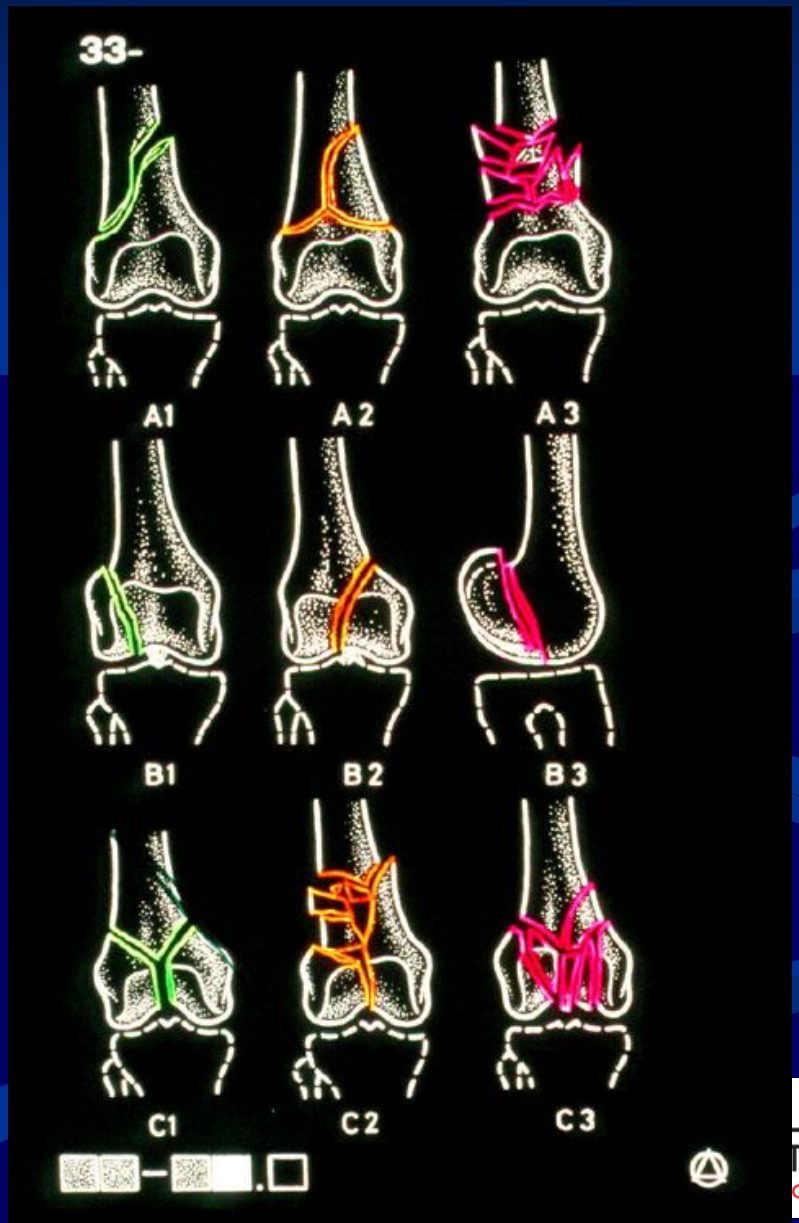
Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

OTA/AO Classification

Extra-Articular

Partial Articular

Complete Articular

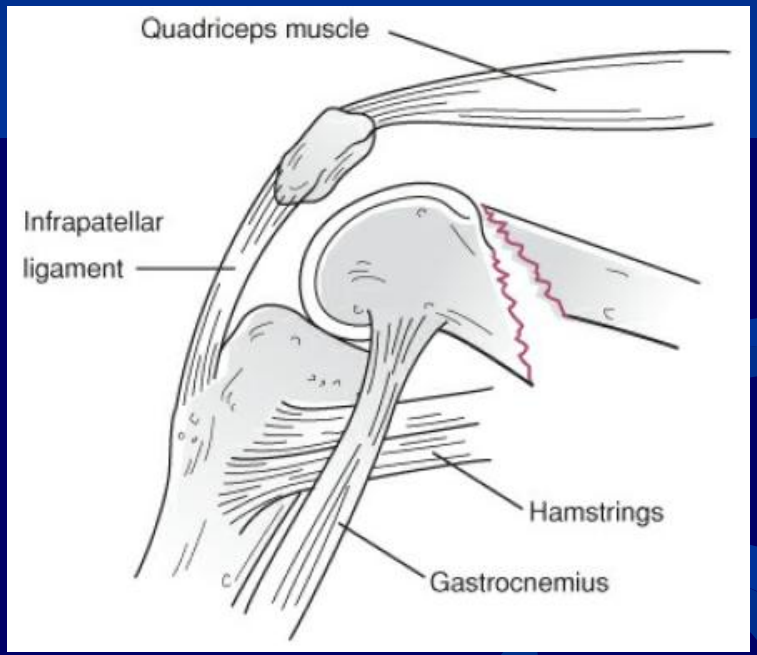


DUKE ORTHOPAEDIC TRAUMA

Trauma Institute
CO GENERAL HOSPITAL

Injury Considerations

- Mechanism of injury
  - Young patient: high energy (MVC, fall from height)
  - Elderly: low energy fall on flexed knee
- Deforming forces
  - Quadriceps → shortening
  - Hamstring → shortening
  - Gastrocnemius → apex posterior angulation, posterior displacement
  - Adductors → varus



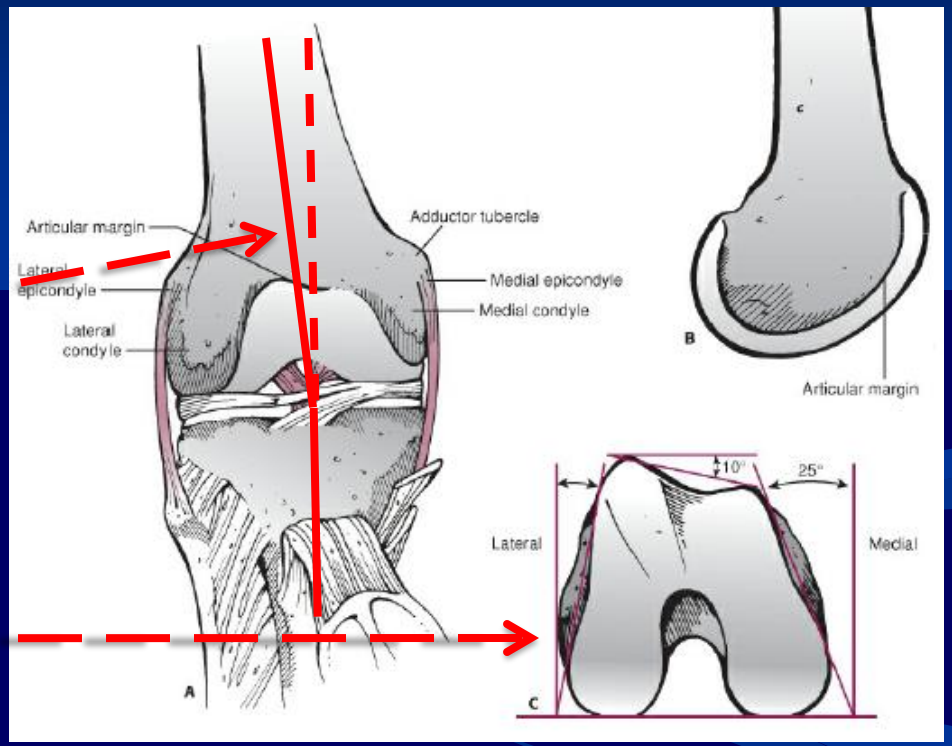
(Collinge CA, Wiss DA. Distal Femur Fractures. In: Tornetta P, Ricci WM, eds. *Rockwood and Green's Fractures in Adults, 9e*. Philadelphia, PA: Wolters Kluwer Health, Inc; 2019.)

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Osteology

- Shaft of femur aligned with anterior half of lateral condyle
- Anatomic axis 9° valgus (range 7-11°)
  - anatomic lateral distal femoral angle (aLDF) 81° (79°- 83°)
  - mechanical lateral distal femoral angle (mLDF) 87° (85° - 90°)
- Sectioned axially, distal femur is trapezoidal
  - Ramifications for:
    - Implant placement
    - Screw prominence



(Collinge CA, Wiss DA. Distal Femur Fractures. In: Tornetta P, Ricci WM, eds. *Rockwood and Green's Fractures in Adults, 9e.* Philadelphia, PA: Wolters Kluwer Health, Inc; 2019.)

DUKE ORTHOPAEDIC TRAUMA

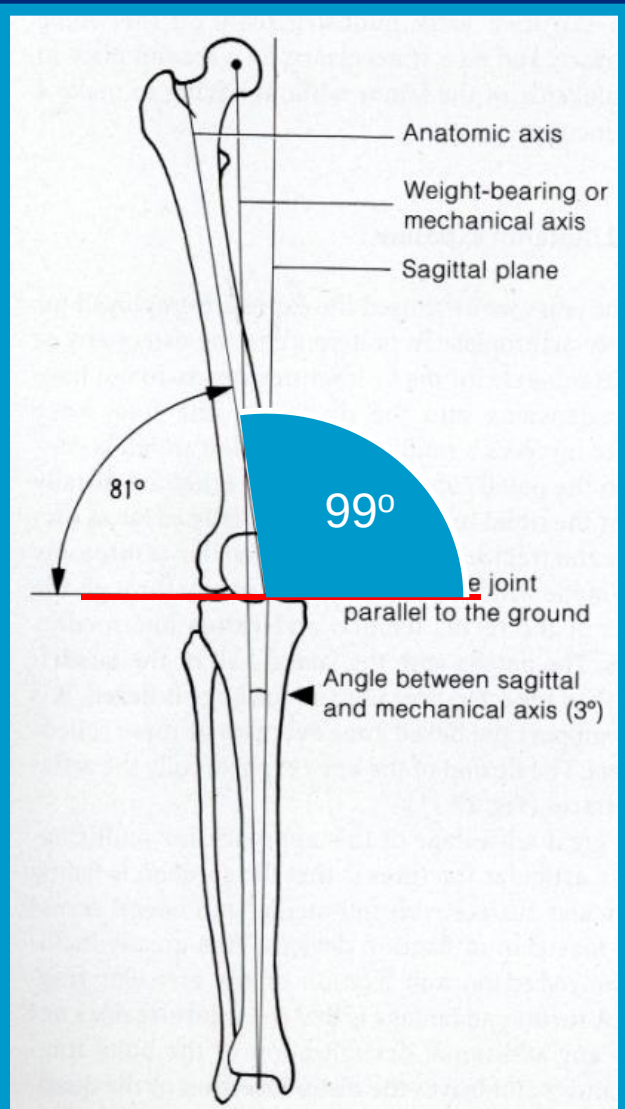
Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Planning Definitive Reconstruction – Distal Femoral Valgus

- The distal femoral articular surface has valgus of ~ 9° relative to the anatomical axis of the femur

So why are fixed angle implants made at 95° of Valgus?

To allow for 4 degrees of pre-stress at medial fracture line in non-comminuted fractures



DUKE ORTHOPAEDIC TRAUMA

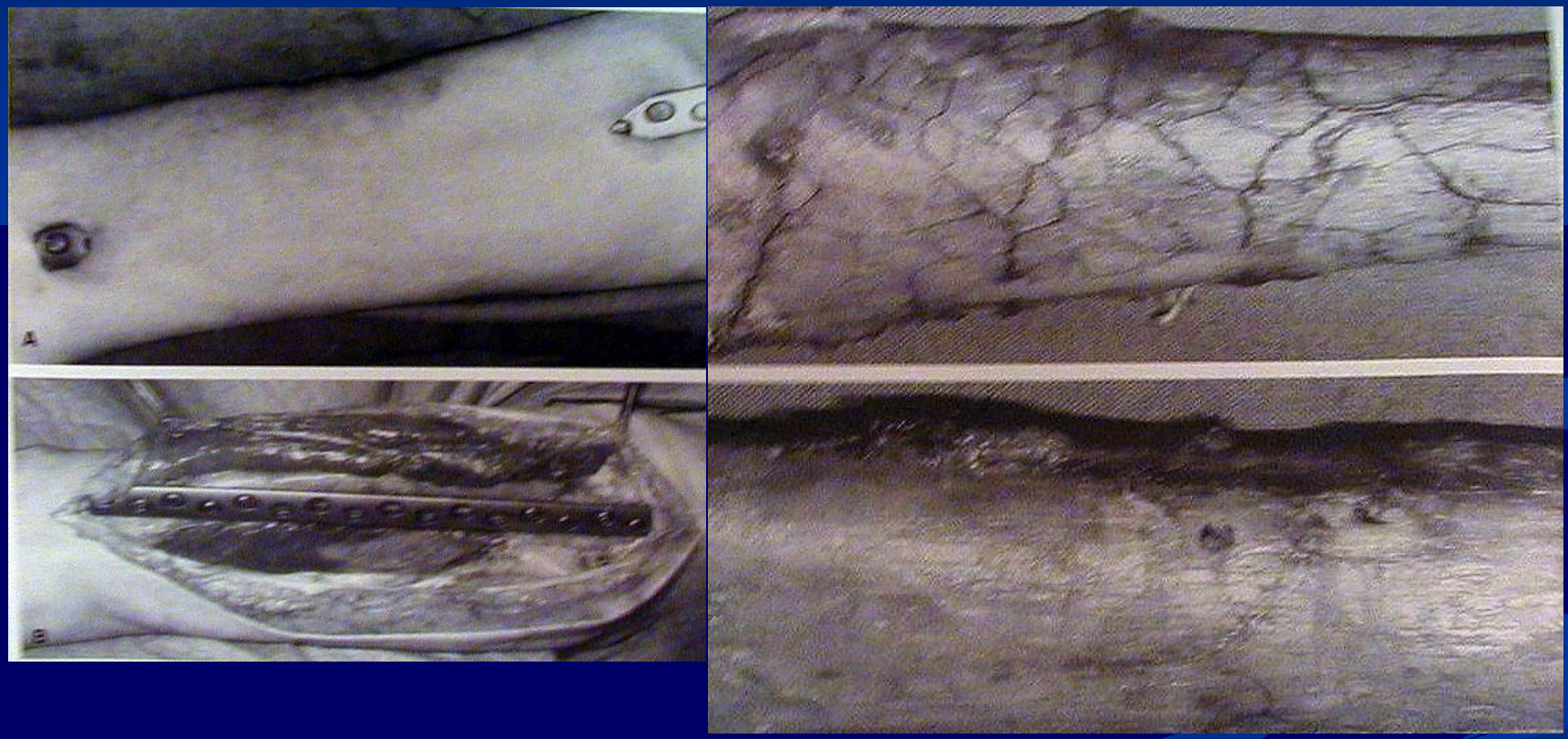
Modification of Fixation Constructs in my Career

- 3 conceptual changes occurred over a short time
- 95 degree fixed angle plates remain

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Top – Minimally Invasive Percutaneous Osteosynthesis (MIPO



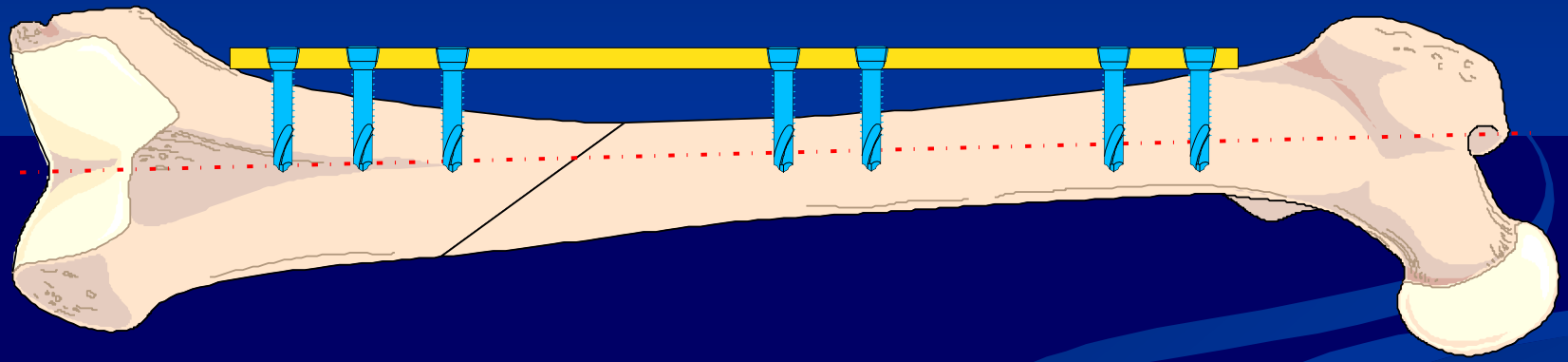
Bottom - Conventional Plating

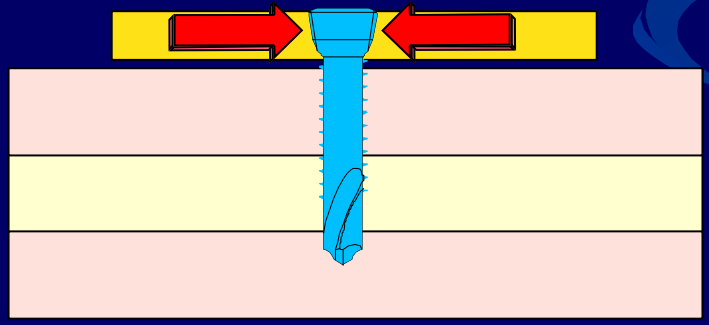
Krettek et al Injury 1997

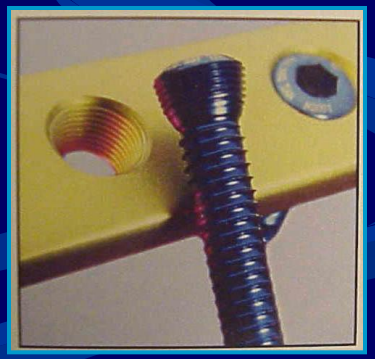
DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Osteosynthesis with Internal Fixator
"Locked Plating"



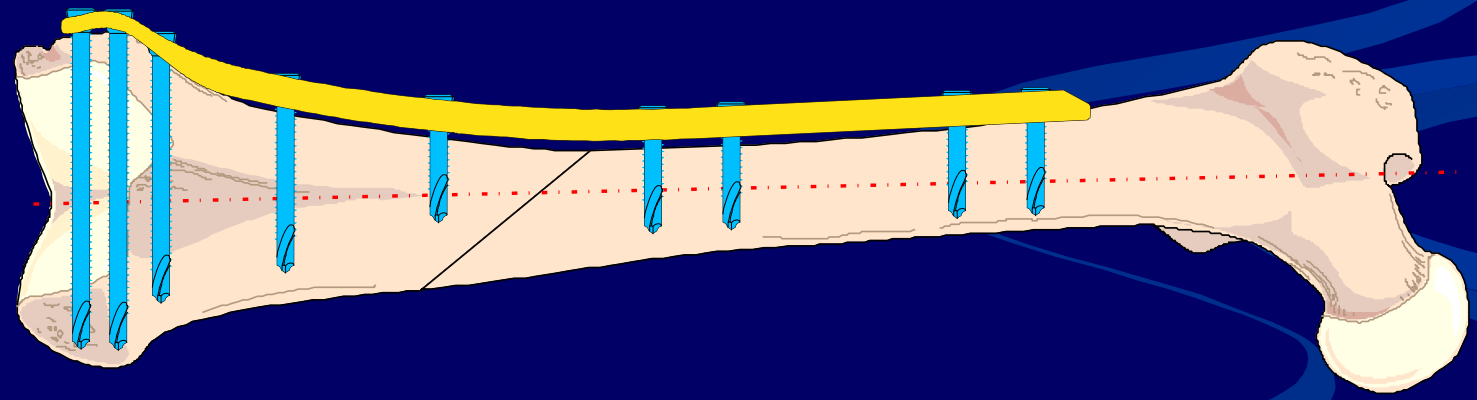




DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

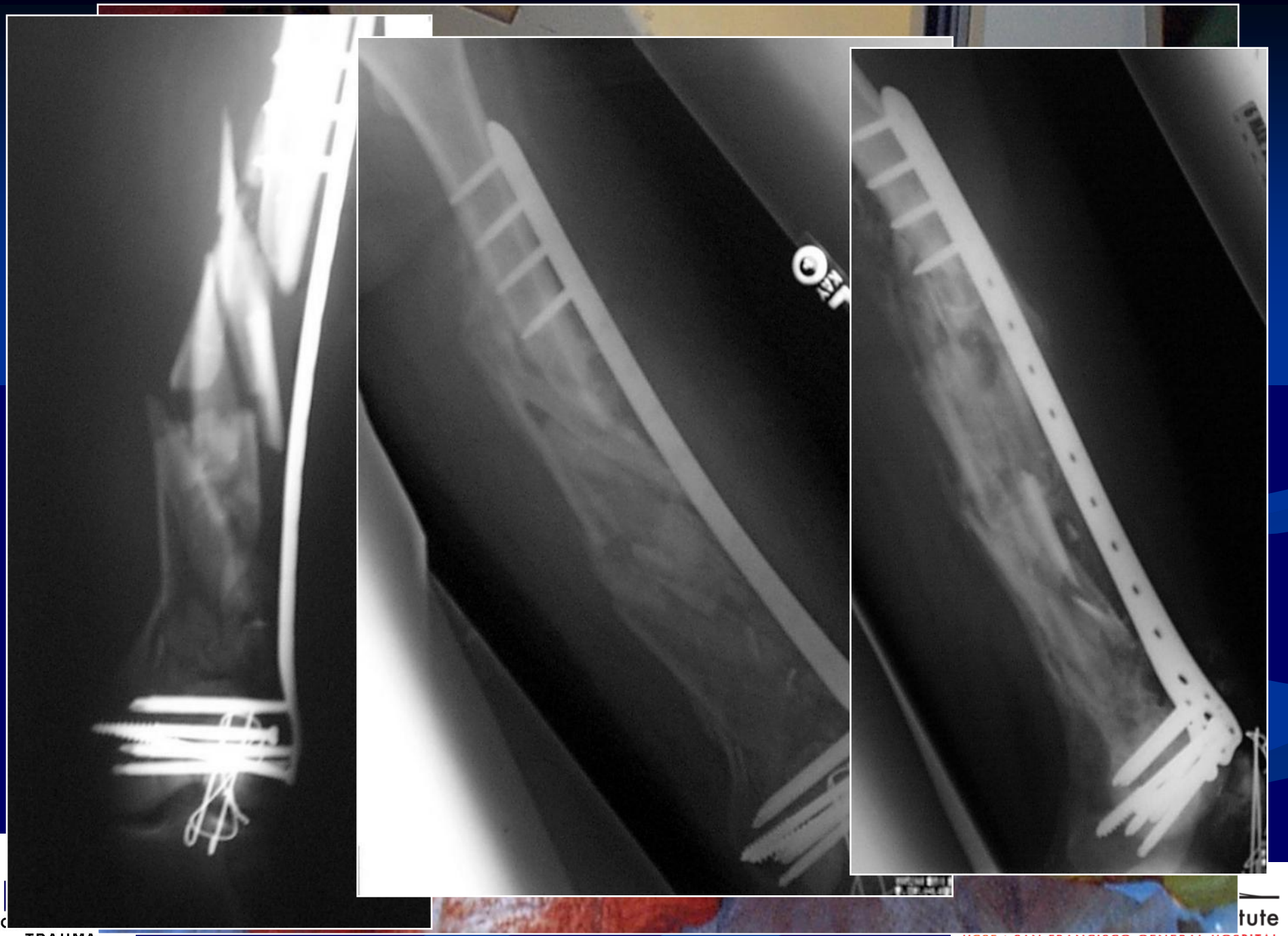
Anatomically Pre-contoured Plates



DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

My First LISS Case - 1999



Double-plating of comminuted, unstable fractures of the distal part of the femur

- 9 patients with Lateral and Medial plating of distal femur for severe comminution of distal OTA 33C.3 fractures
- 3 had ROM less than 90 degrees
- Recommend using fixed angle fixation rather than double plating

Sanders et al JBJS Am 1991

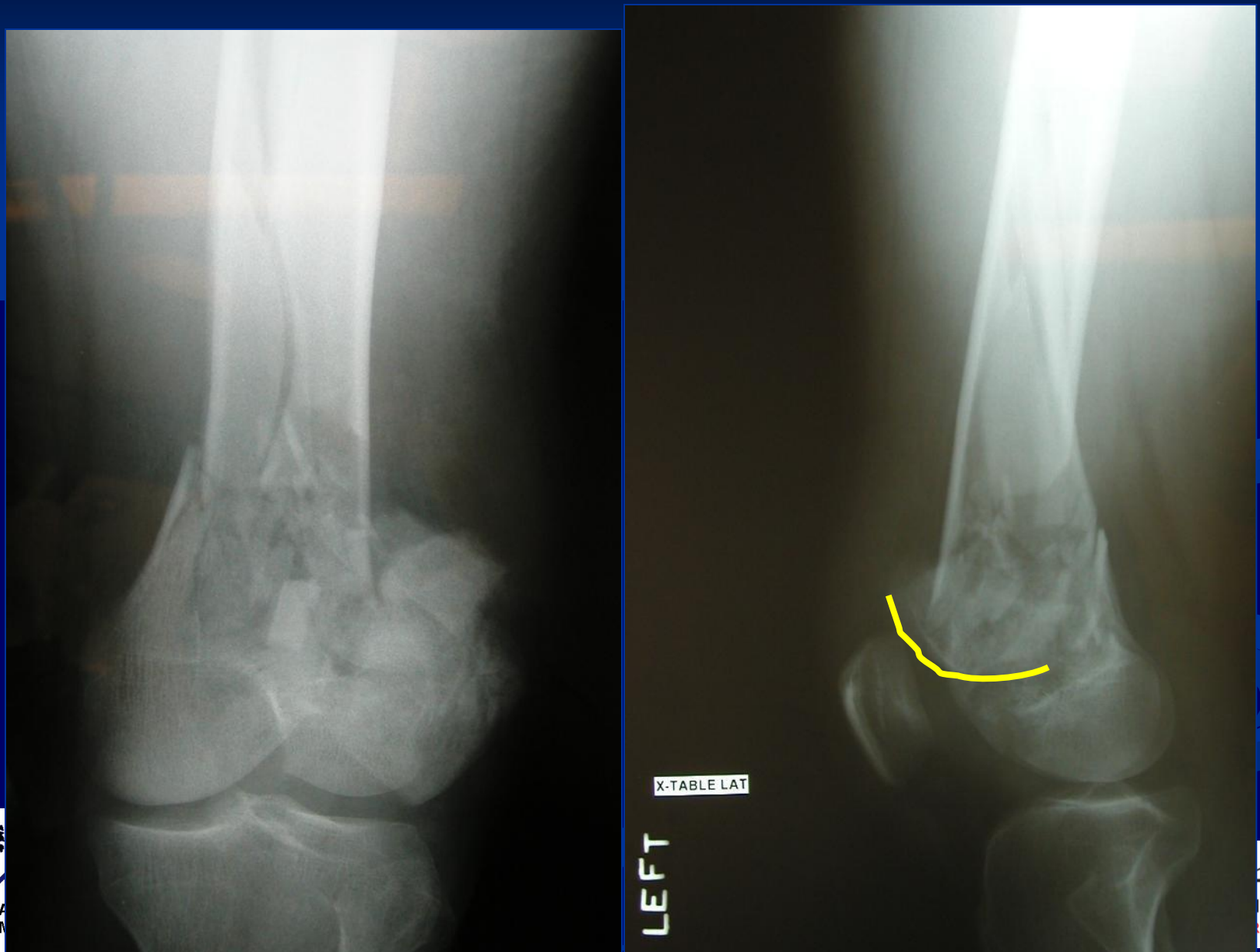
DUKE ORTHOPAEDIC TRAUMA

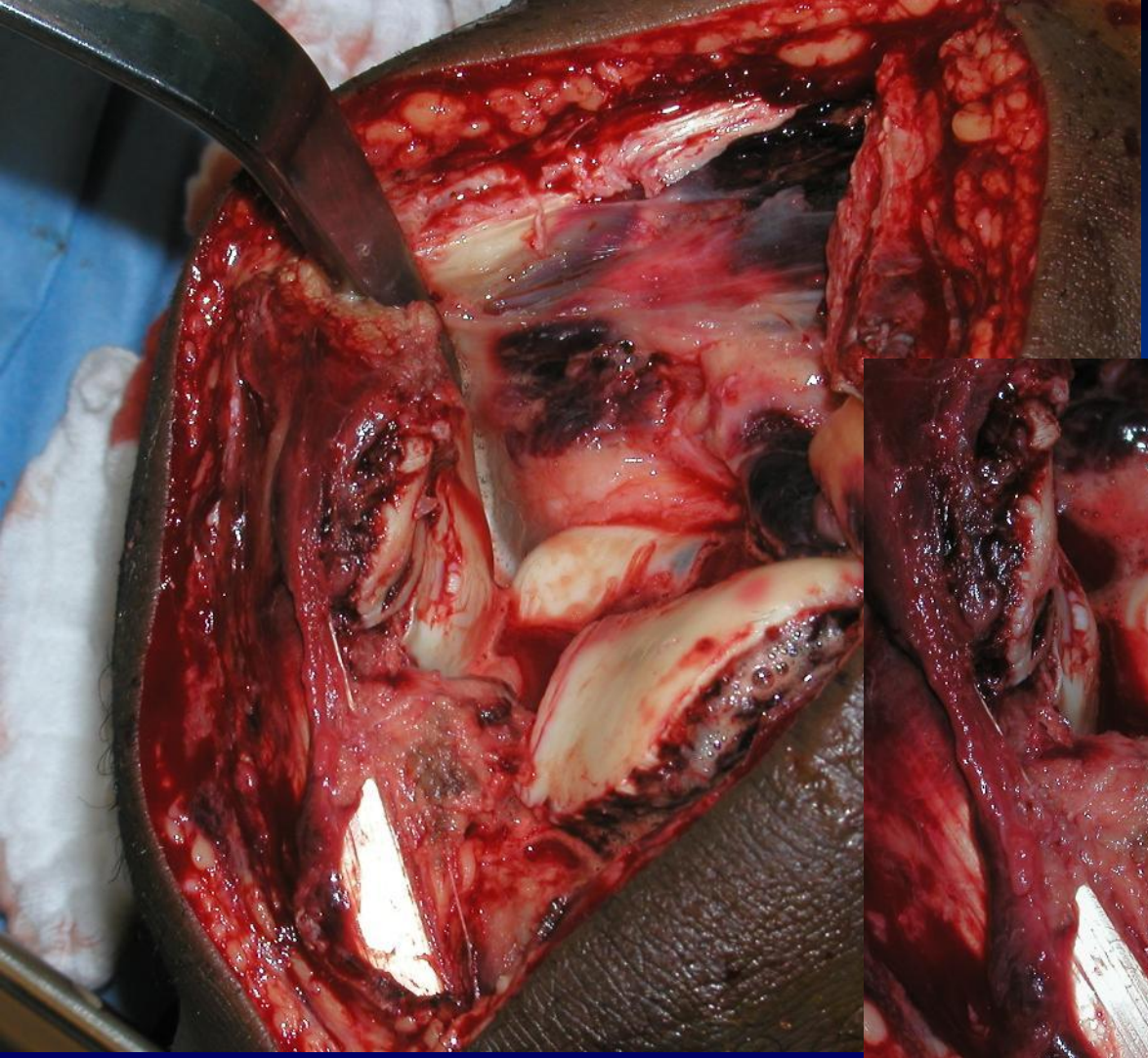
Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

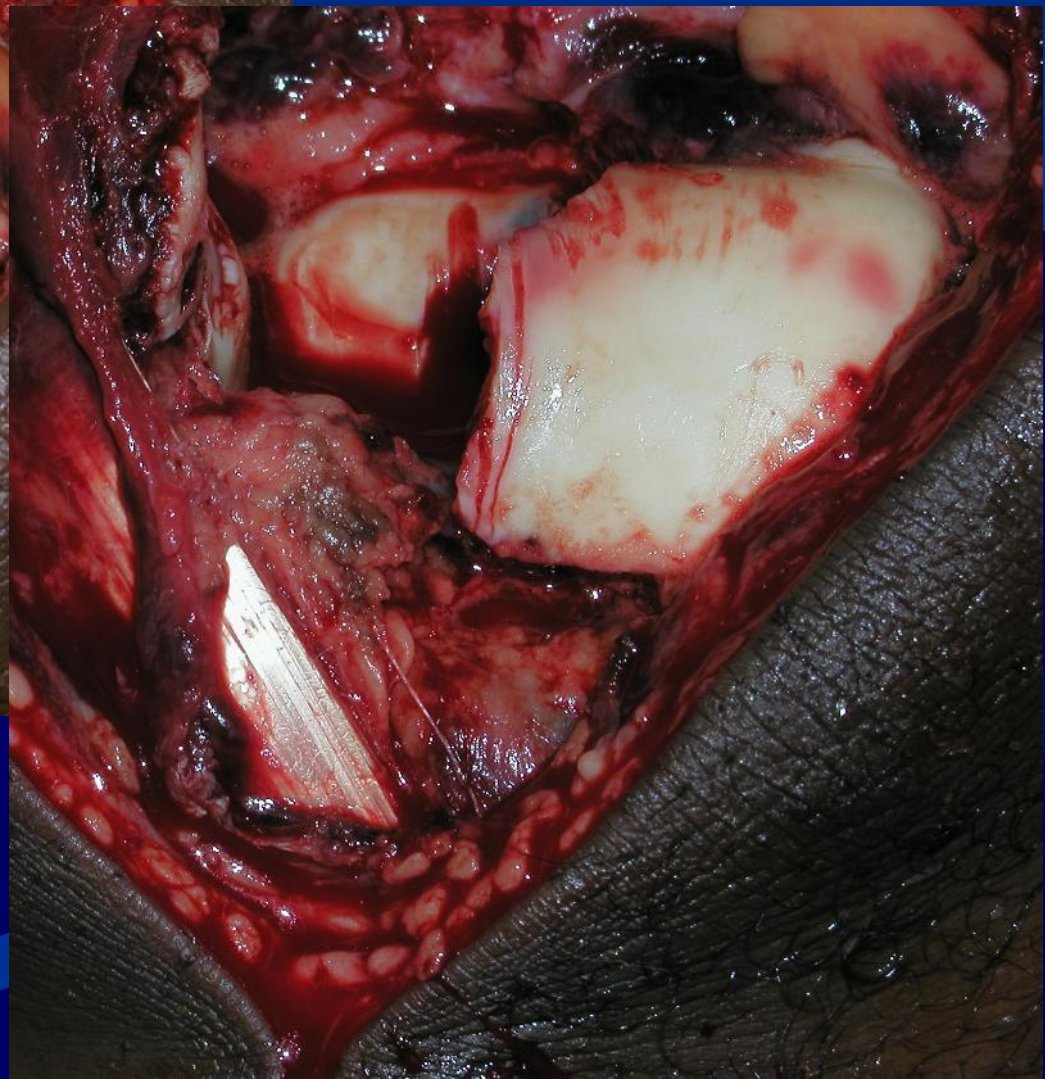
DUKE
ORTHOPAEDIC
TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

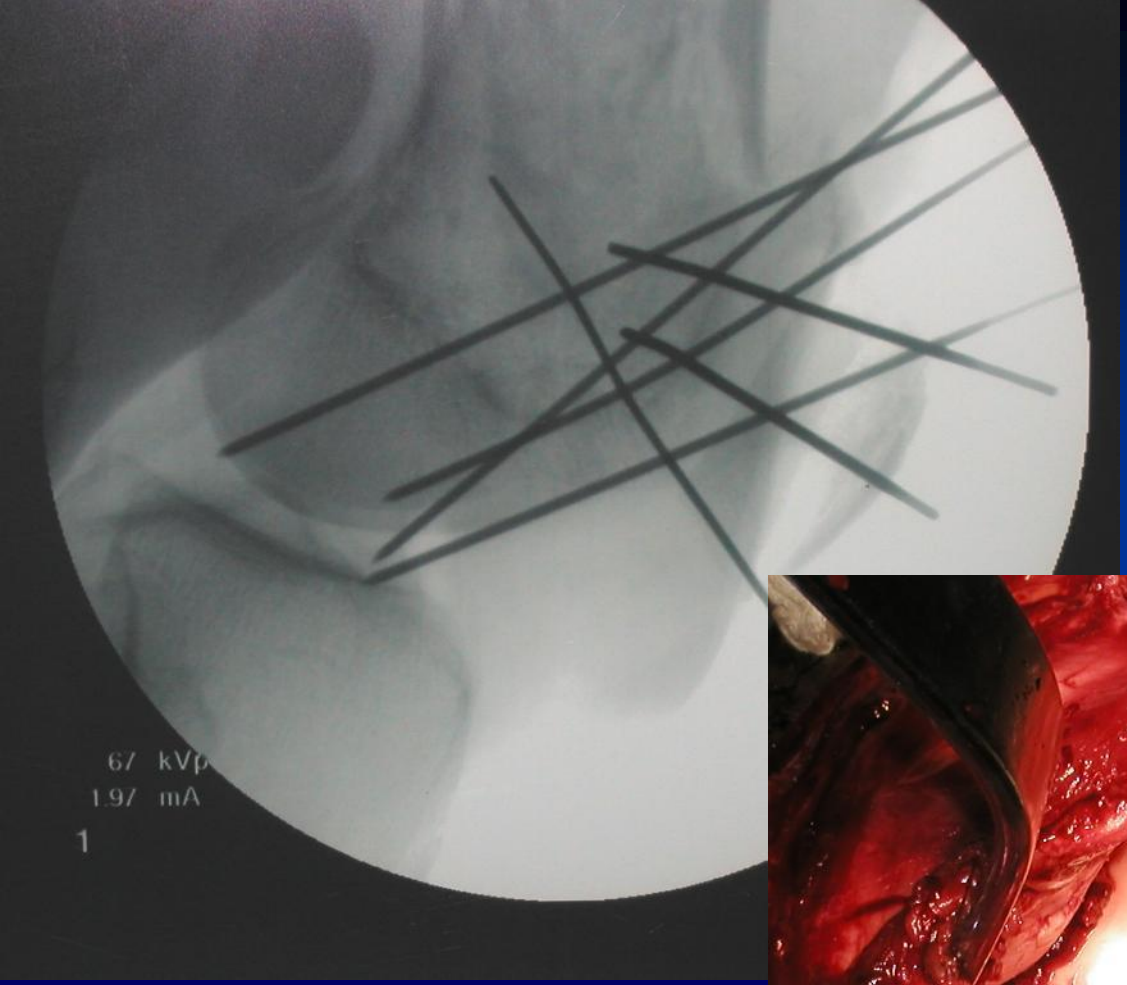
Technique Review OTA 33C3

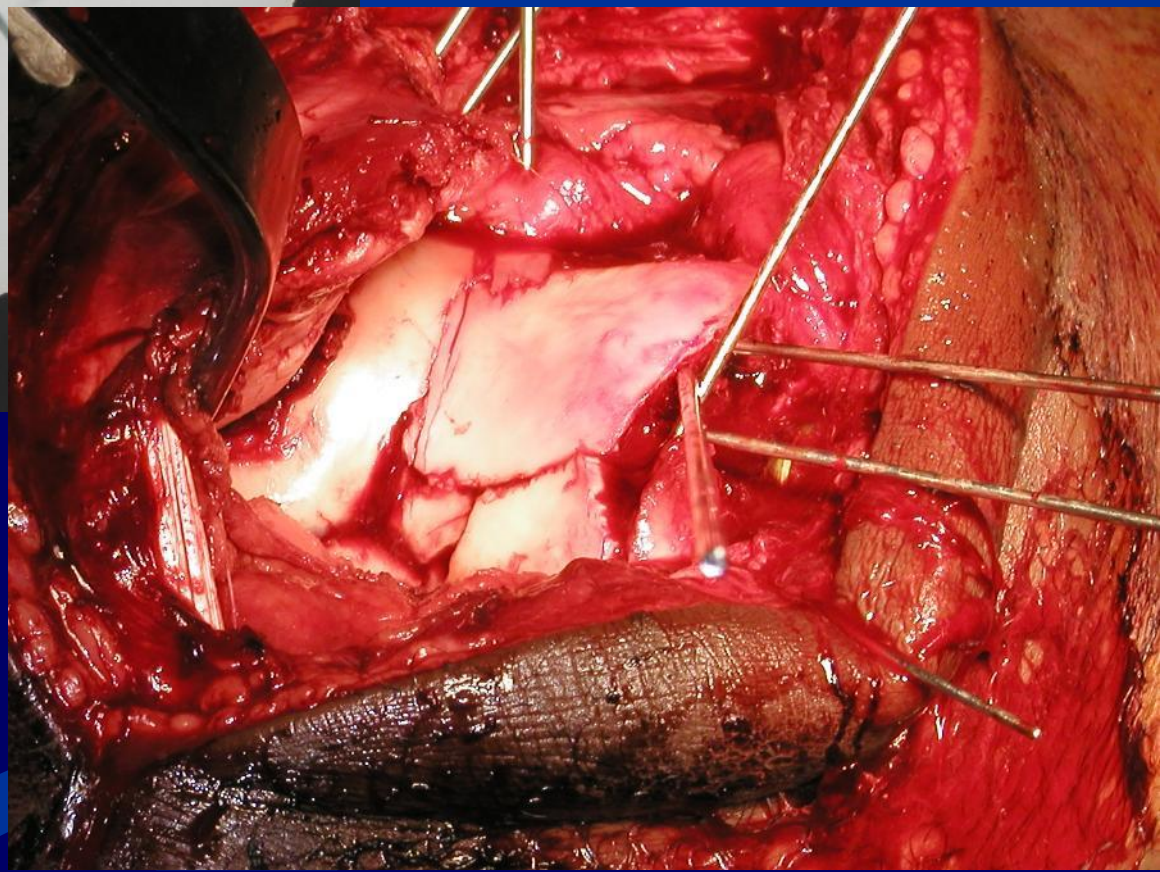






DUKE
ORTHOPAEDIC
TRAUMA





DUKE
ORTHOPAEDIC
TRAUMA

Nothing New Under the Sun

- 1st edition 1951!

THE
CLOSED TREATMENT
OF
COMMON FRACTURES

BY

JOHN CHARNLEY

B.Sc., M.B., F.R.C.S.

Orthopædic Surgeon, Manchester Royal Infirmary; Orthopædic Surgeon, The Park Hospital, Davyhulme; Orthopædic Surgeon, Wrightington Hospital; Honorary Lecturer in Orthopædics, Manchester University; Late Hunterian Professor, Royal College of Surgeons.

THIRD EDITION
(*REPRINT*)

Master Pad of Charnley

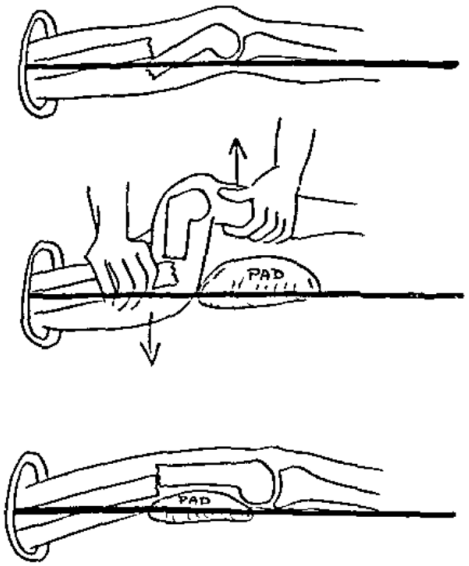


FIG. 145

Technique of reducing a transverse fracture in the lower third if longitudinal traction fails. Note that the master sling with its superimposed pad is applied to the splint *before* this manœuvre is executed because it is an important fulcrum in the *actual manipulation.*

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

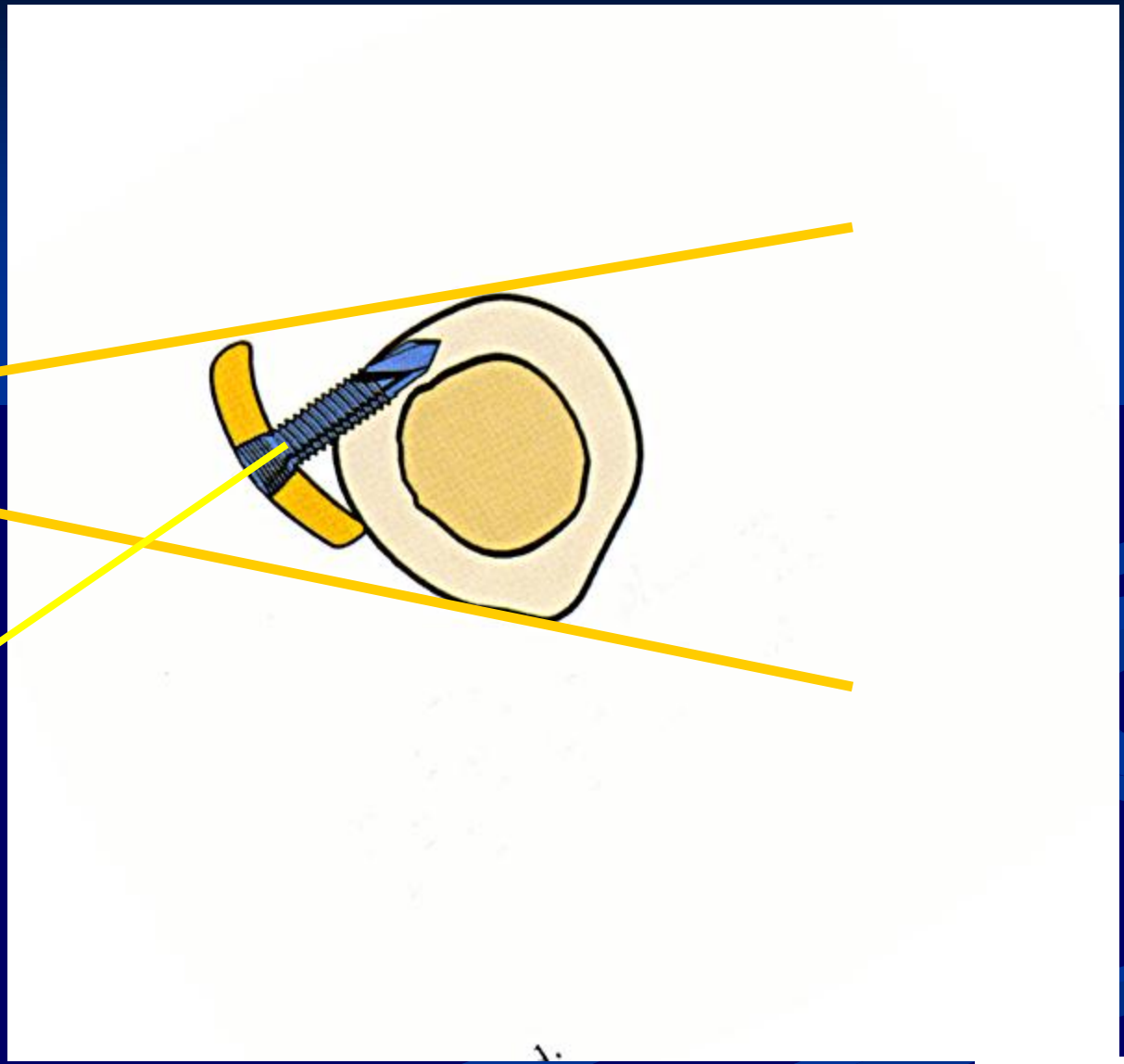
Bump from Rolled Towels

DUKE ORTHOPAEDIC TRAUMA

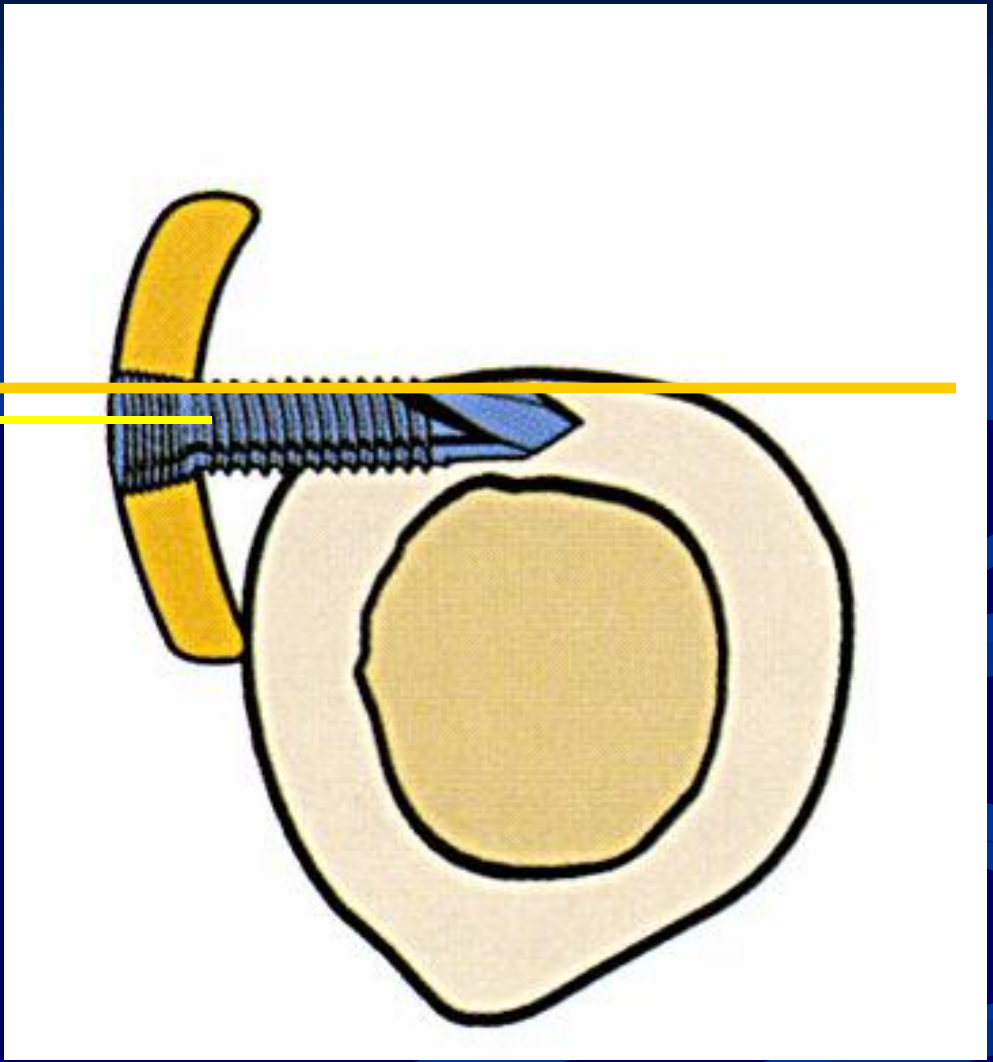
Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Implant Position on Shaft

- X-Ray appearance
- Use long 2.5mm drill/pin and feel 2 cortices and canal
- Incision to palpate plate and bone
- REMEMBER: femur is a round bone



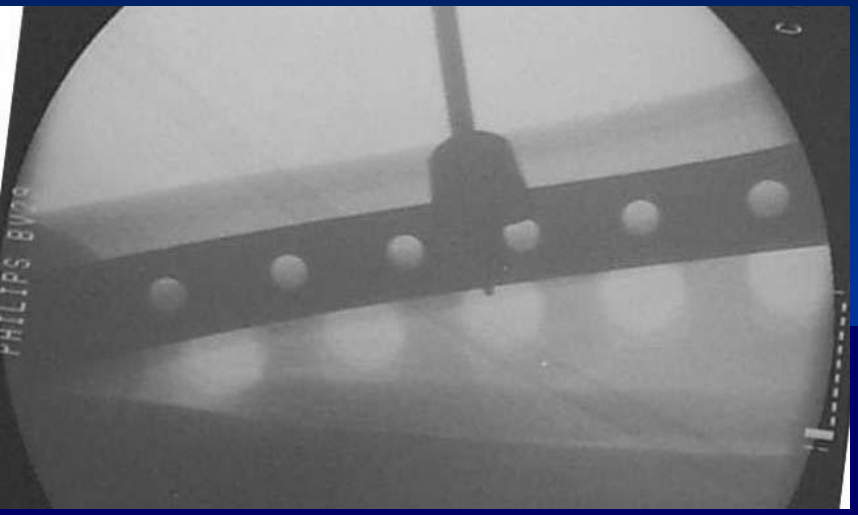
Guide



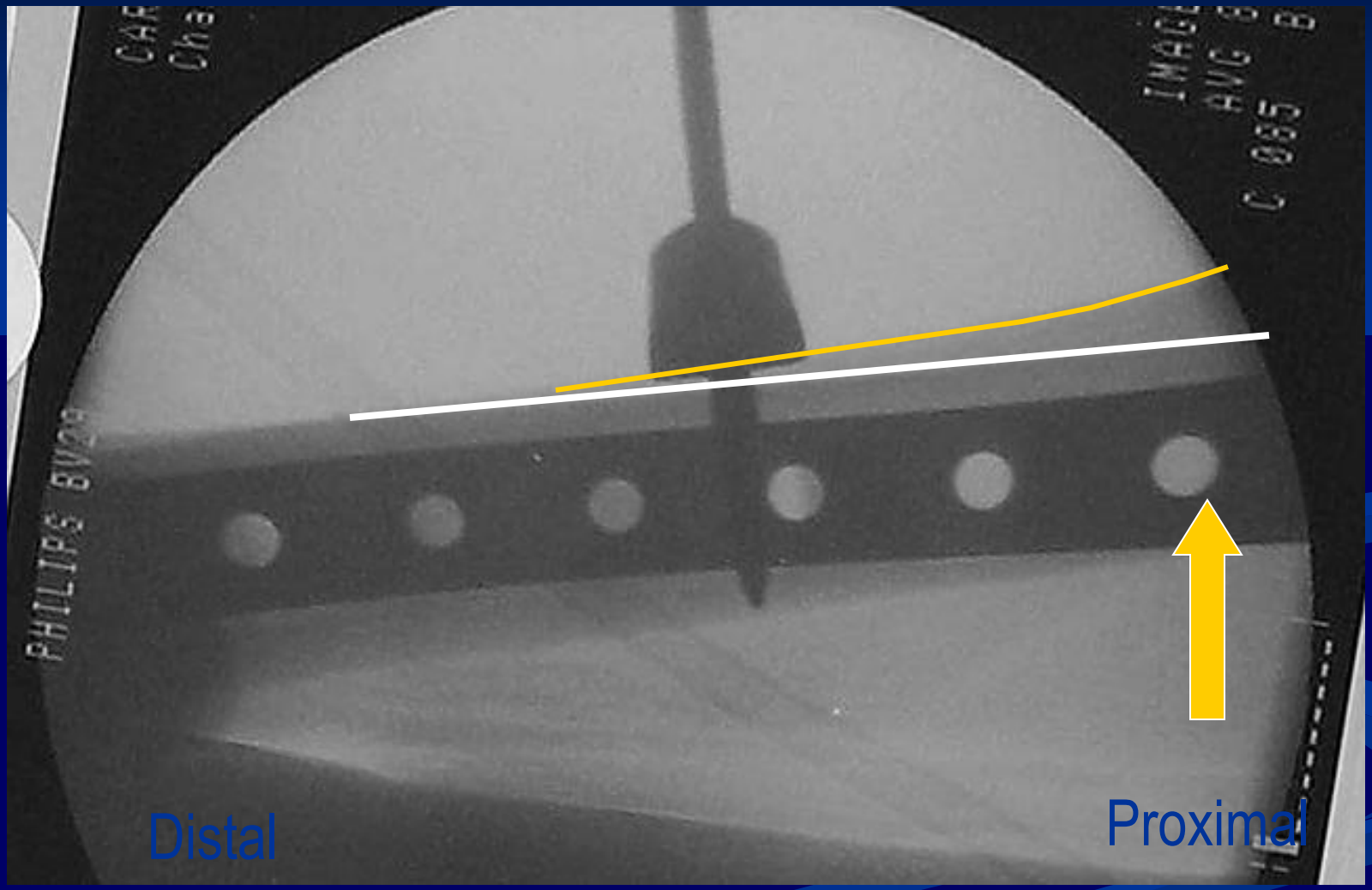
DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Ensuring Correct Position of Plate



Guide centered over fixator



DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

DUKE
ORTHOPAEDIC
TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

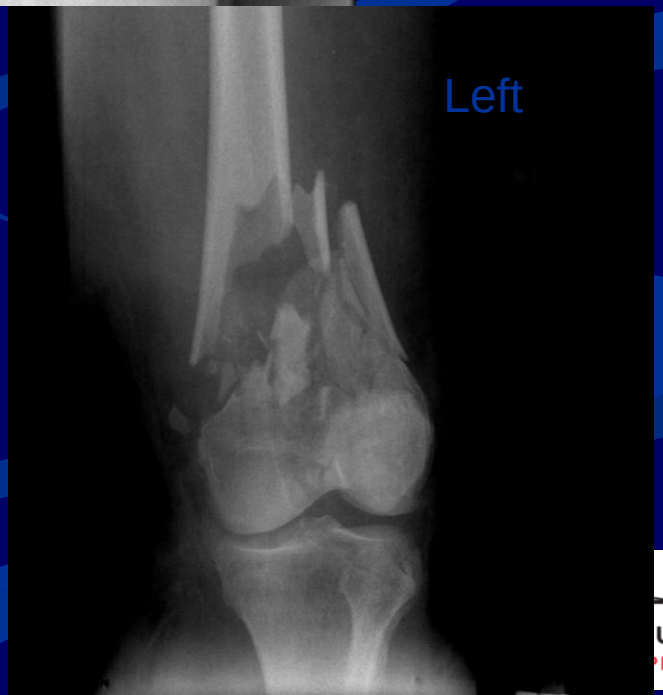
Case 1—Distal Femur Fractures

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

C

- 67 Female
- Head on MVA
- Bilateral Femoral #
  - Grade II open suprapatella
- Open Pilon #
  - Grade IIIB
- Head Injury



What now??

DUKE ORTHOPAEDIC TRAUMA

- Any concerns?
- What next?

DUKE ORTHOPAEDIC TRAUMA

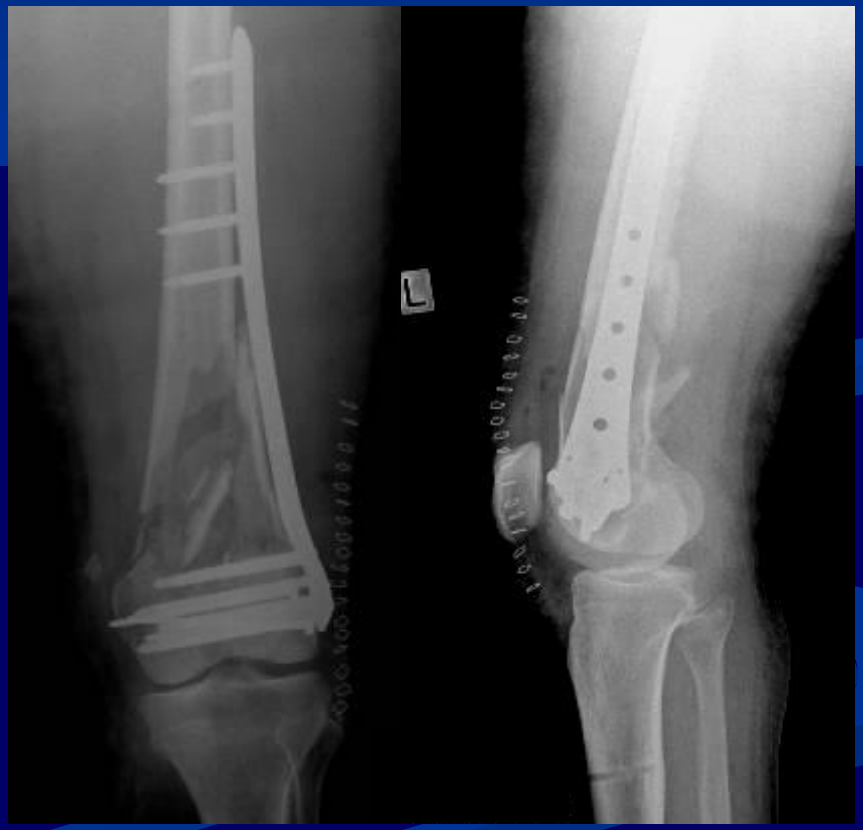
Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

- CT shows
- Bilateral intercondylar fractures
- Right has lateral Hoffa, minimal displacement
- Metaphyseal comminution bilat.

- Further treatment?
- When?
- Reduction techniques?
- Open, closed?
- Implants?

Delayed LISS fixation

Day 6



Day 10

- Post-op plan?
- When to WB?
- Bone graft?
- Bone graft needed if MIPO and locked plate?

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

United—1year, no bone graft
Walking well, full extension and bilat flex >100 deg

DUKE
ORTHOPAEDIC
TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Case 2 - Closed distal femur
What additional imaging if any do you want?

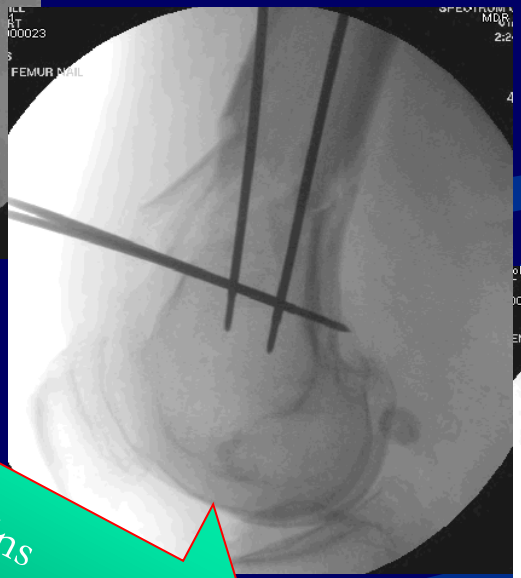
Plan of treatment

- Is operative fixation needed?
- Assume distal femoral block is intact – OTA 33C1
- What approach? What Implants?

DUKE ORTHOPAEDIC TRAUMA

Ort UCSF

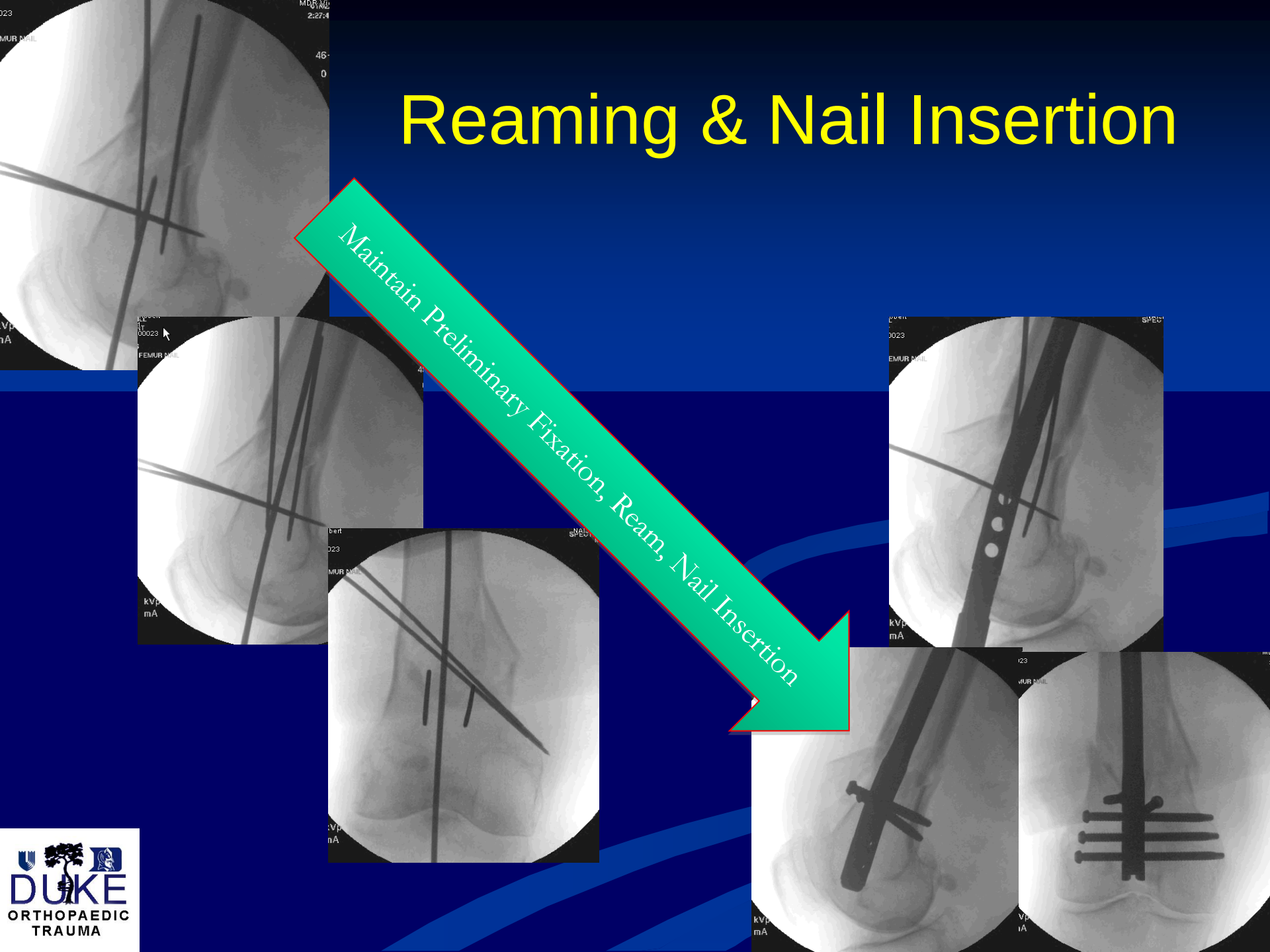
Fixation Technique



Preliminary Fixation, Blocking Pins

DUKE
ORTHOPAEDIC
TRAUMA

Reaming & Nail Insertion



DUKE
ORTHOPAEDIC
TRAUMA

Final Result

Critiques?

DUKE ORTHOPAEDIC TRAUMA

Trauma Institute
SAN FRANCISCO GENERAL HOSPITAL

DUKE
ORTHOPAEDIC
TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Case 3—Severe open distal femoral injury

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

- Female 53
- Motorcyclist knocked off bike
- On vacation in 3rd world country!
- Pelvic fracture
- Wrist fracture
- Open distal femur fracture
- No other injuries
- Open wound debrided, closed, placed in skeletal traction
- Transferred stable day 3

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

on arrival

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Pt stable, what now?

on arrival

DUKE ORTHOPAEDIC TRAUMA

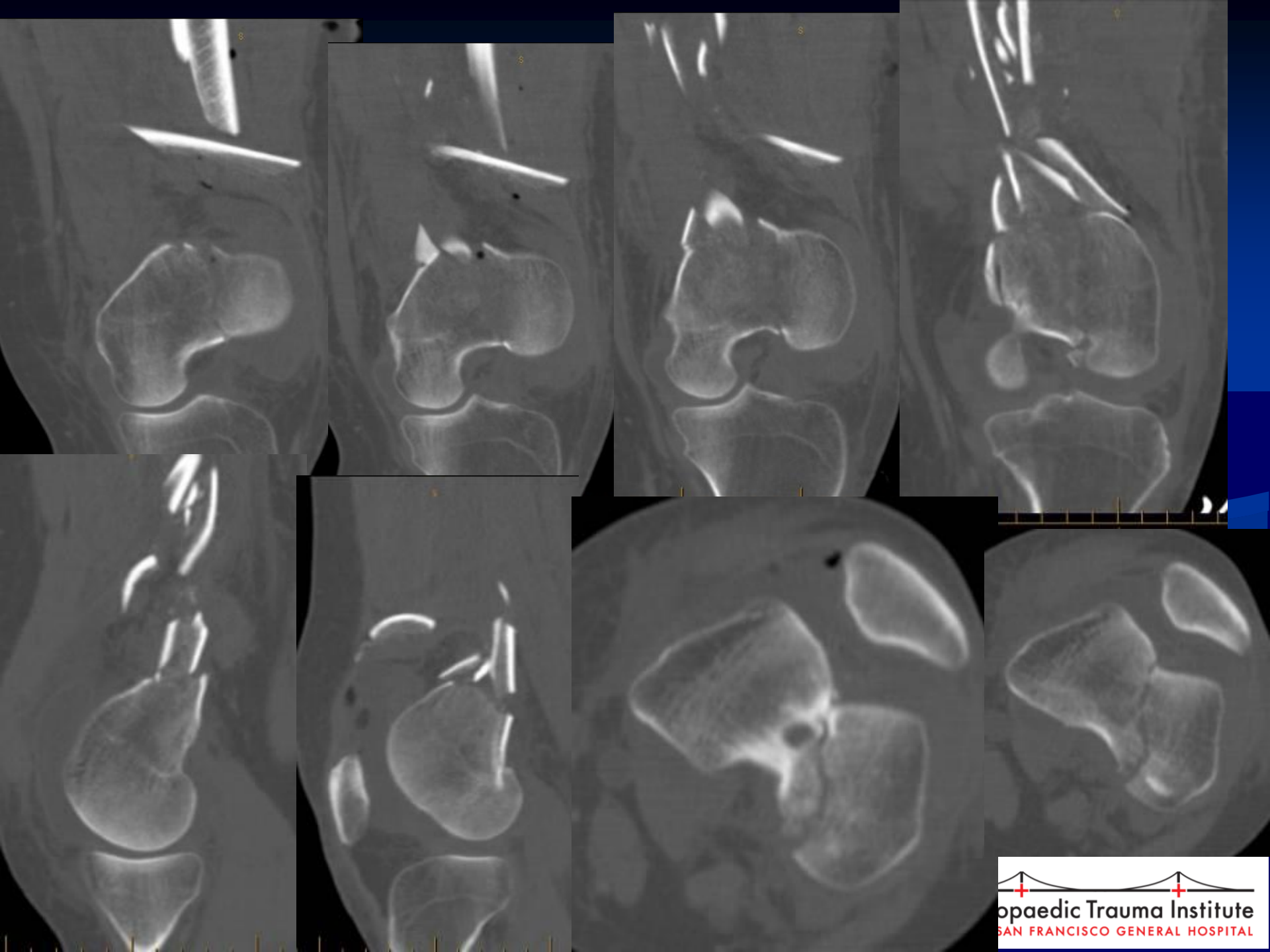
Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

- Wound re-opened
- Clean, no infection
- **But**, most comminuted fragments **devitalised** of all soft tissue
- Therefore excised
- Antibiotic beads inserted
- Bridging ex fix applied
- Alternatives?

after debridement

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL


opaedic Trauma Institute
SAN FRANCISCO GENERAL HOSPITAL

- What next?
- When?
- Management of bone loss?

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

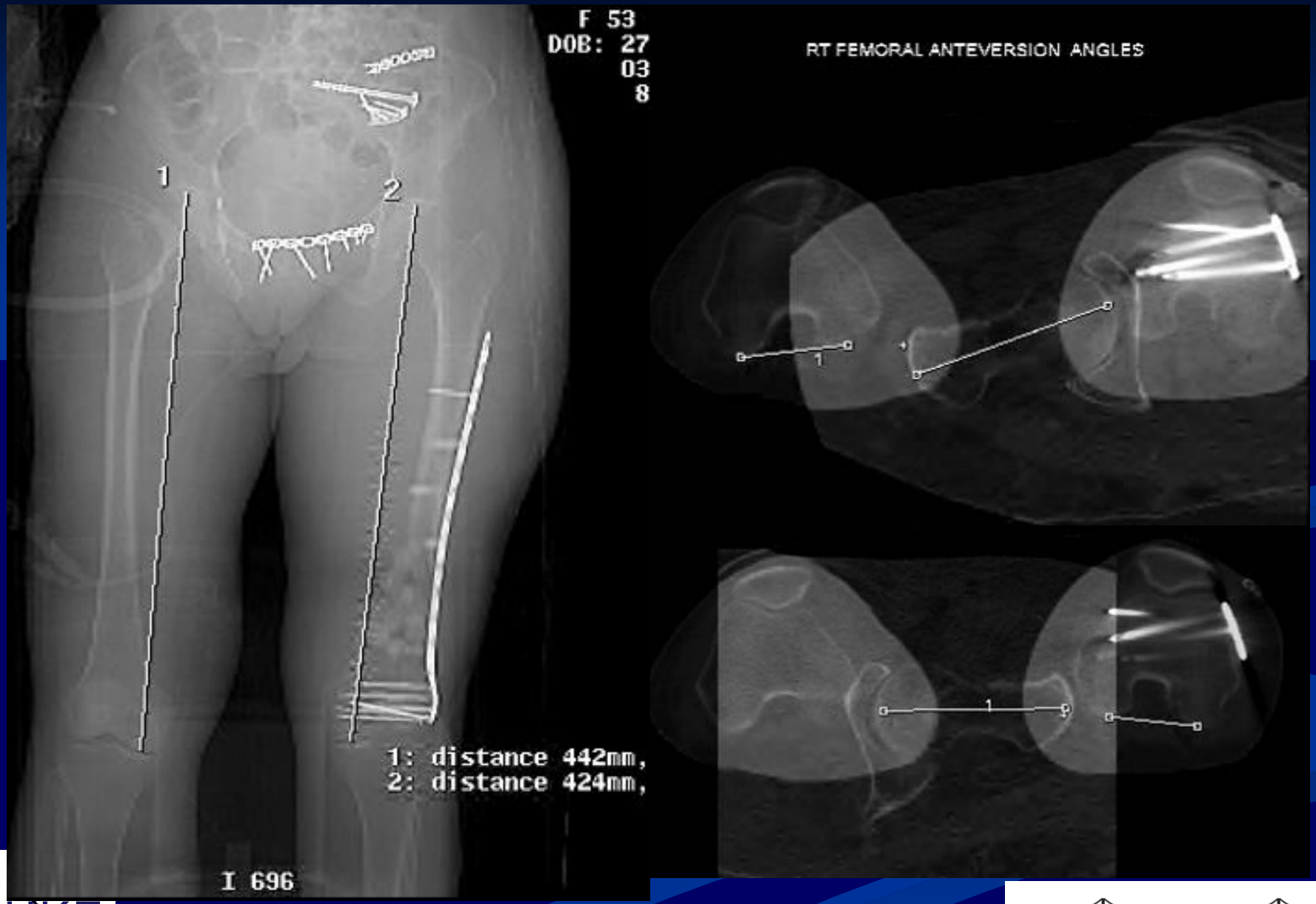
Intraoperative x-rays at 12 days

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

- 10–12cm bone defect
- Options for management?
- Any further imaging helpful?

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL



18 mm short and malrotation

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

3 months after

Vasc. fibula and autograft

LISS adjusted

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

nths

ORTHOPAEDIC TRAUMA

rthopaedic Trauma Institute

UCSF + SAN FRANCISCO GENERAL HOSPITAL

onths

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

DUKE
ORTHOPAEDIC
TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

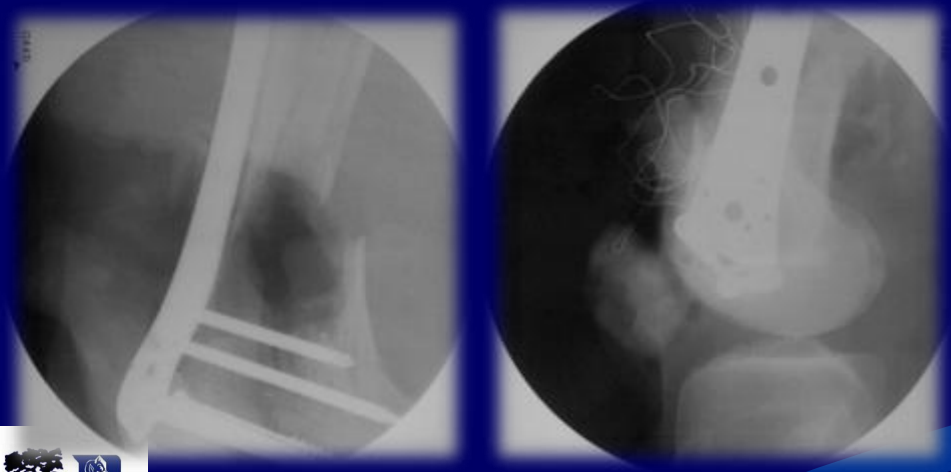
Case 4 —infected distal femur fracture

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

- 28-year-old male
- High speed MVA
- Isolated open distal femur fracture
- Neurovasc intact
- Managed initially in another hospital!

IIIA open distal femur fracture
Initial bridging fixation



Changed to internal fixation **plus bone graft** on day4

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

- Day 9
- Referred to you with acute infection
- Pseudomonas and enterobacter
- What now?

- Repeated debridement x 4
- Gentamicin beads
- IV ciprofloxacin + gentamicin

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

2 months later...

Chondrolysis on XR

MRSA

What now?

Plate removed, frame applied

Debridement and vancomycin cement block

One more debridement and cement block change

What next?

Lab Results after 2nd spacer

	D0	D14	D32	D48	D60
CRP	5.42	1.24	0.82	0.52	0.72
ESR	91	59	32	14	10

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

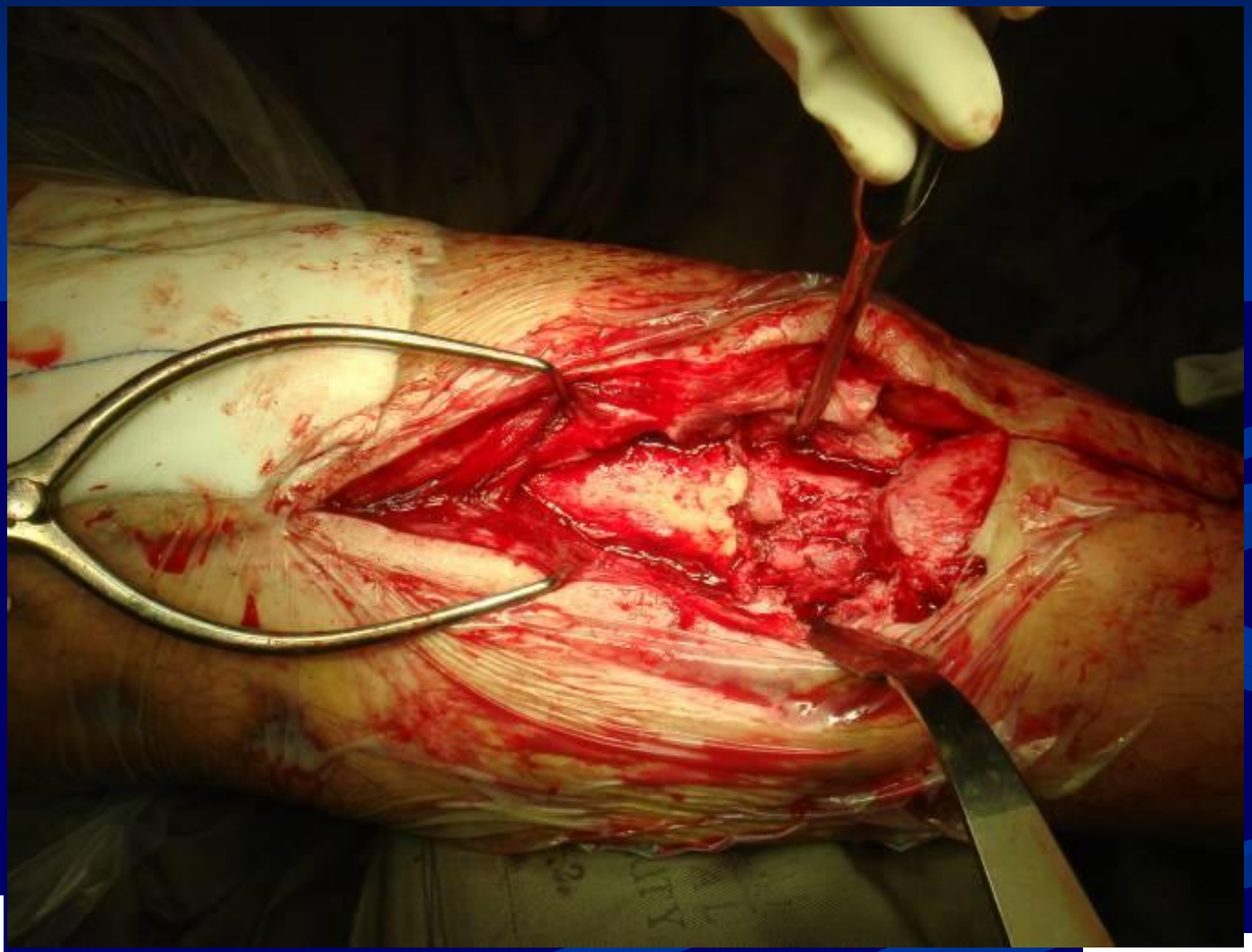
2 months

- removal of cement
- autologous bone grafting

DUKE ORTHOPAEDIC TRAUMA

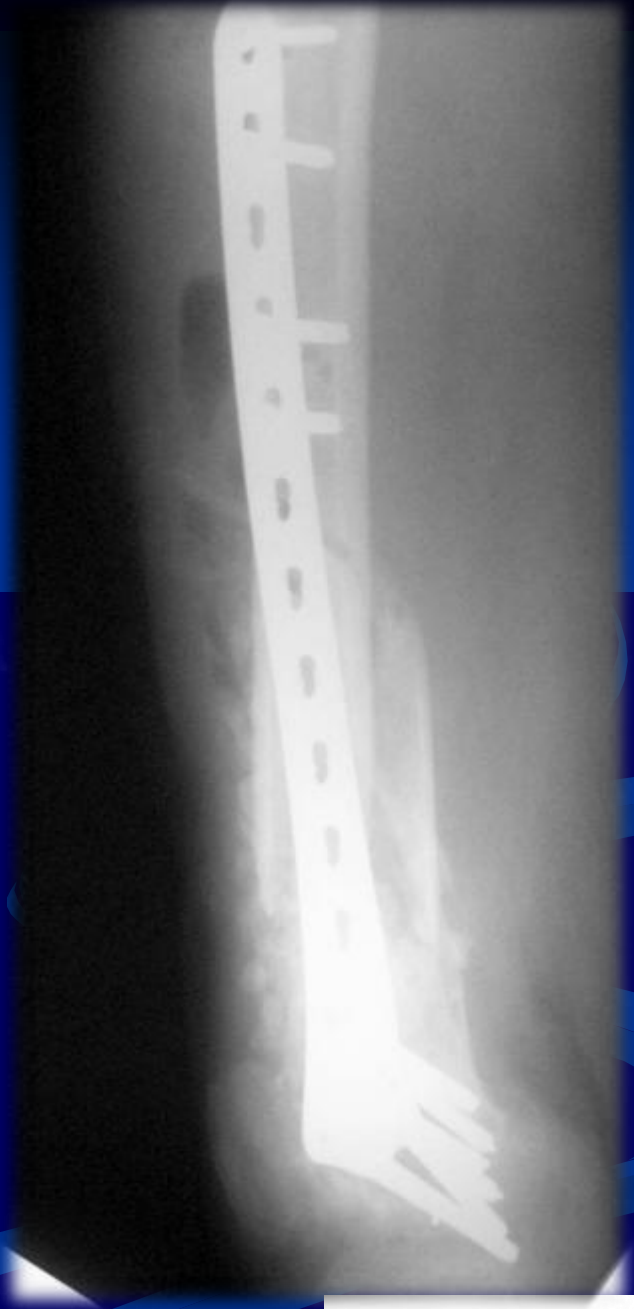
Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Internal fixation after a further 6 weeks



DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL



Follow-up x-ray

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Use of cement

- Provides stability to fracture
- Eliminates dead space and fills up bone defect
  - Prevents collection of haematoma
- Can deliver local antibiotics (gentamycin / vancomycin)

Masquelet technique

- Cement spacer induces membrane formation, creating a pocket for subsequent grafting
- Membranes - rich capillary network, high conc. of growth factors (vascular endothelial growth factor and TGF-beta-1) and osteoinductive factors (BMP-2)
- Prevents graft resorption, barrier to outward diffusion of growth and osteoinductive factors & source of stem cells and vascular cells supporting revascularization and osseous consolidation.

DUKE
ORTHOPAEDIC
TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Case 5 —severe distal femur fracture, floating knee

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

- Male 34
- Motorcycle v car
- Isolated L leg injury
- Gustillo Gd 3A open distal femur fracture, patella fracture
- Gustillo Gd 3B open segmental tibial fracture
- Compartments ok
- NV intact

DUKE
ORTHOPAEDIC
TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

- Initial treatment
- Priorities
- Order of surgery

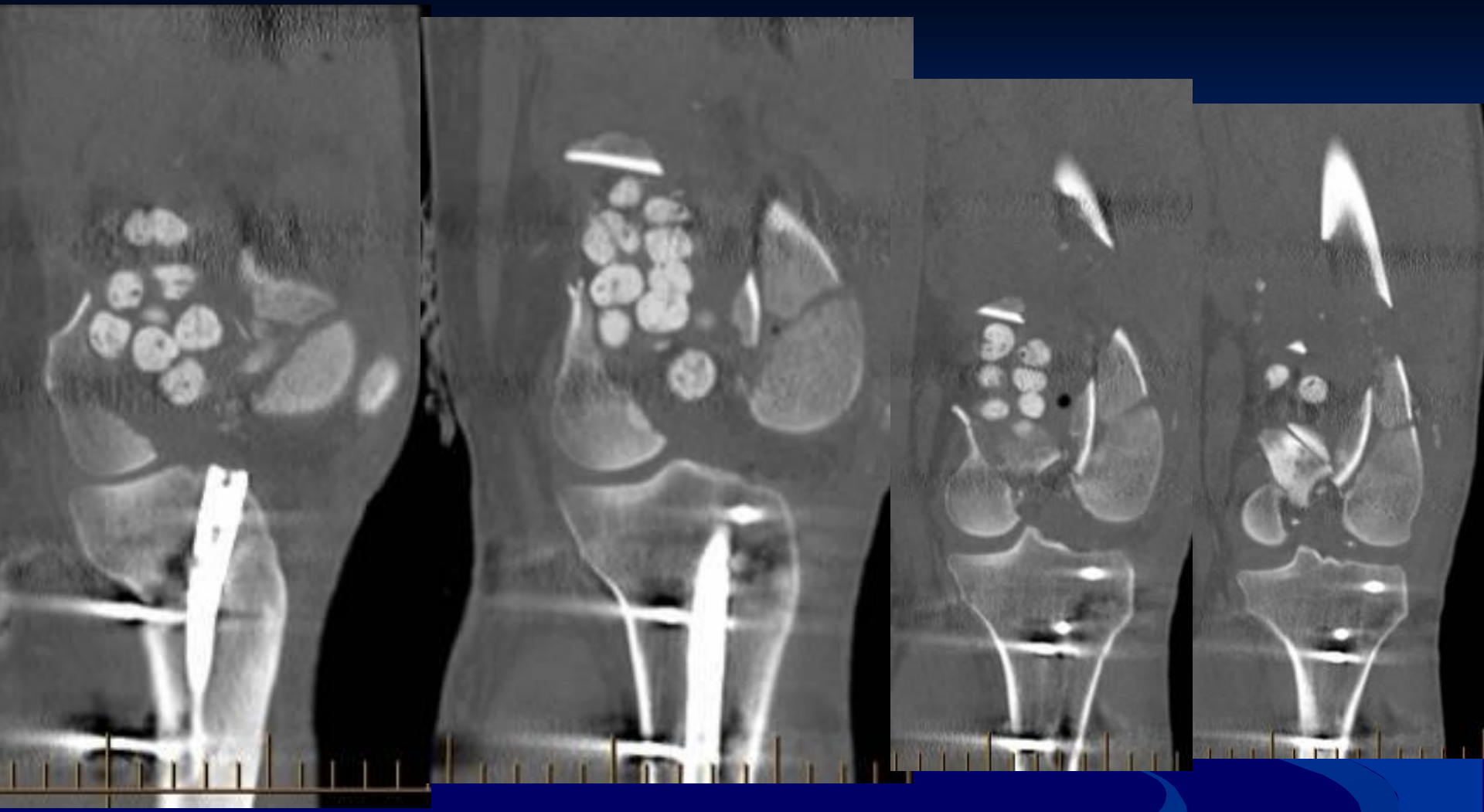
- Wounds debrided
- Femoral wound contaminated
- Vac dressing tibia, beads
- Ab beads distal femur, partial closure
- IM nail tibia
- Bridging ex. fix

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

DUKE
ORTHOPAEDIC
TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

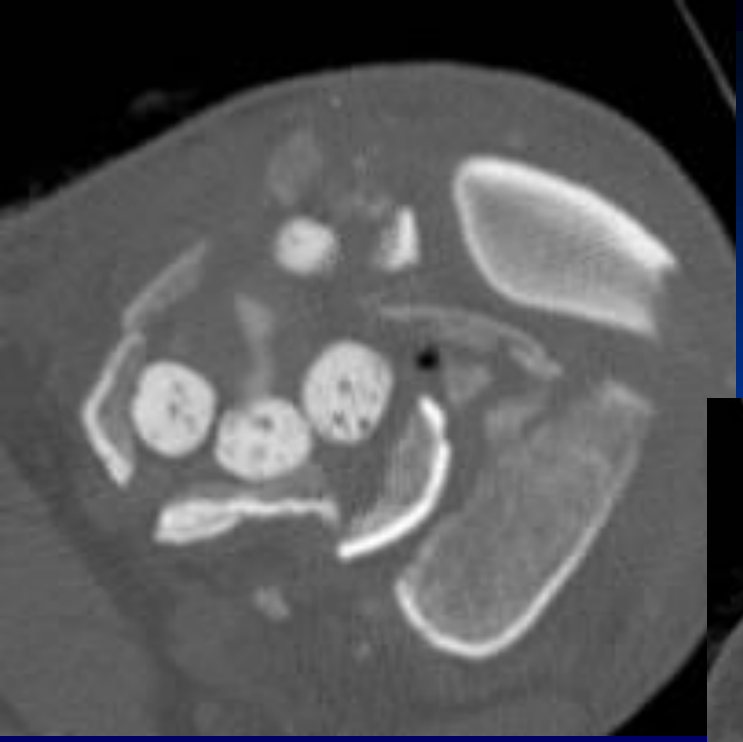


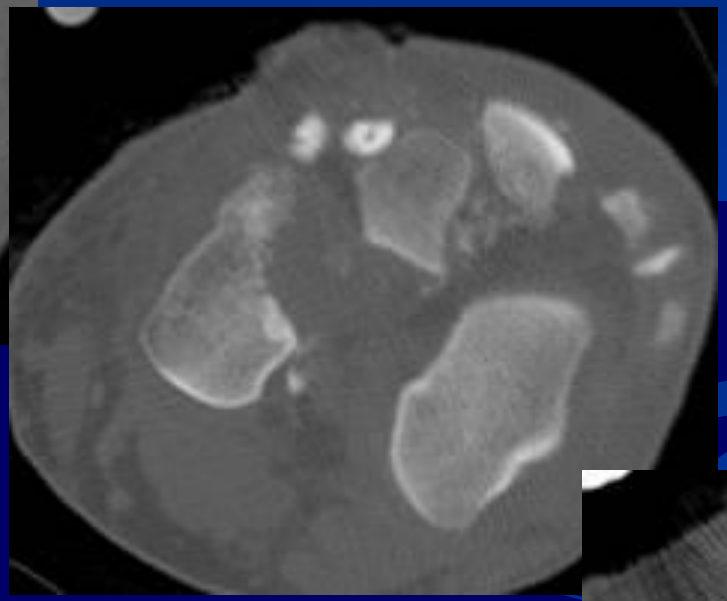
DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

DUKE ORTHOPAEDIC TRAUMA

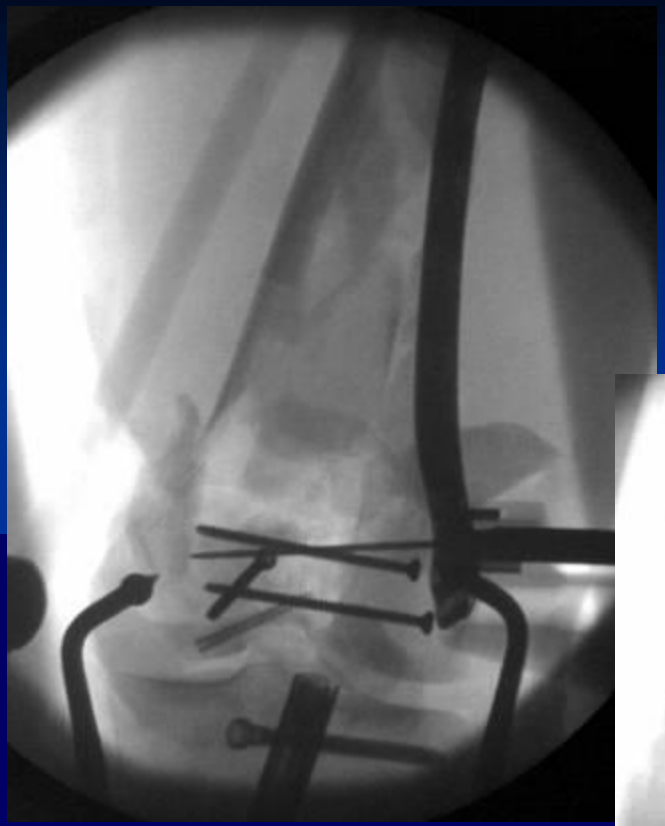
Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

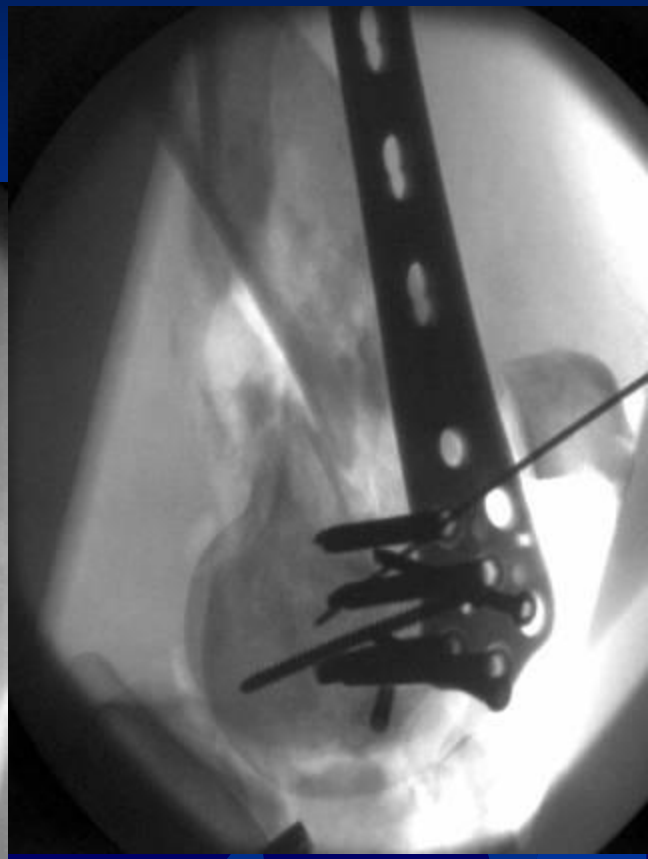




DUKE
ORTHOPAEDIC
TRAUMA

- What next?
- 3 further washouts, debridement
- At final washout (day 6), free flap to tibia and closure femoral wound after definitive fixation
- Definitive fixation femur how?
- Take cultures?





DUKE
ORTHOPAEDIC
TRAUMA

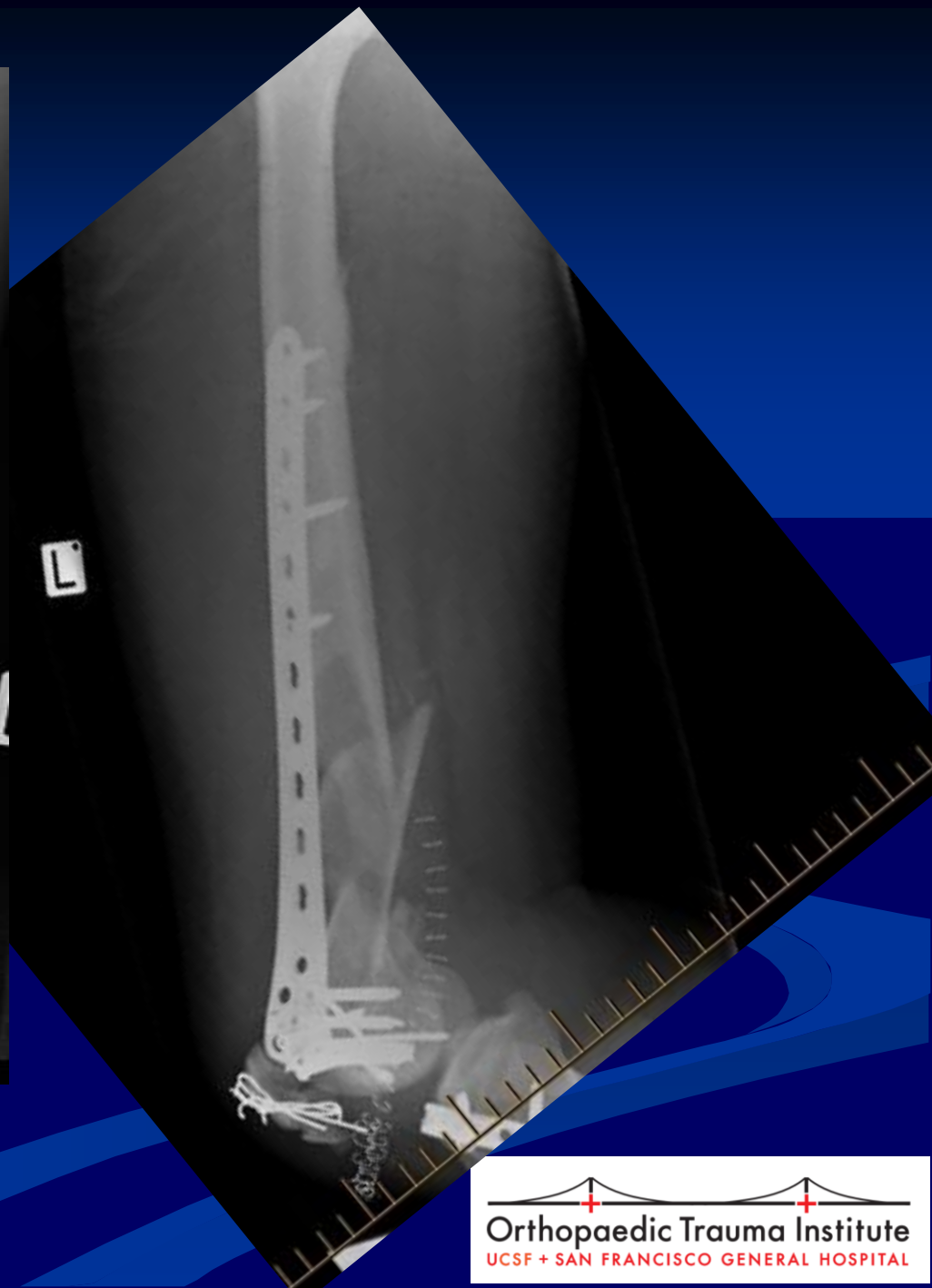
Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

- Open wound anteriorly used for reduction
- Lag Screws and counter sunk screw to articular surface
- Distal femoral LCP introduced through open wound
- Plate secured to articular block and then shaft reduced to plate

- Operative cultures femur positive Staph Aureus
- What now?
- IV ab’s via PICC line for 6 weeks

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL



DUKE
ORTHOPAEDIC
TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL





hs

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

- 8 months, tibia healed
- ESR, CRP normal
- Off Ab's
- Wires tenting skin
- Painful thigh WB
- Anything to do?
- Wires removed and defect distal femur bone grafted

nths

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

WB no pain, knee ROM 10-90 deg

Returned to work as labourer

1 months

DUKE ORTHOPAEDIC TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL

Thank You

DUKE
ORTHOPAEDIC
TRAUMA

Orthopaedic Trauma Institute
UCSF + SAN FRANCISCO GENERAL HOSPITAL