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Trauma Call: How to Stay Out of Trouble at 2am

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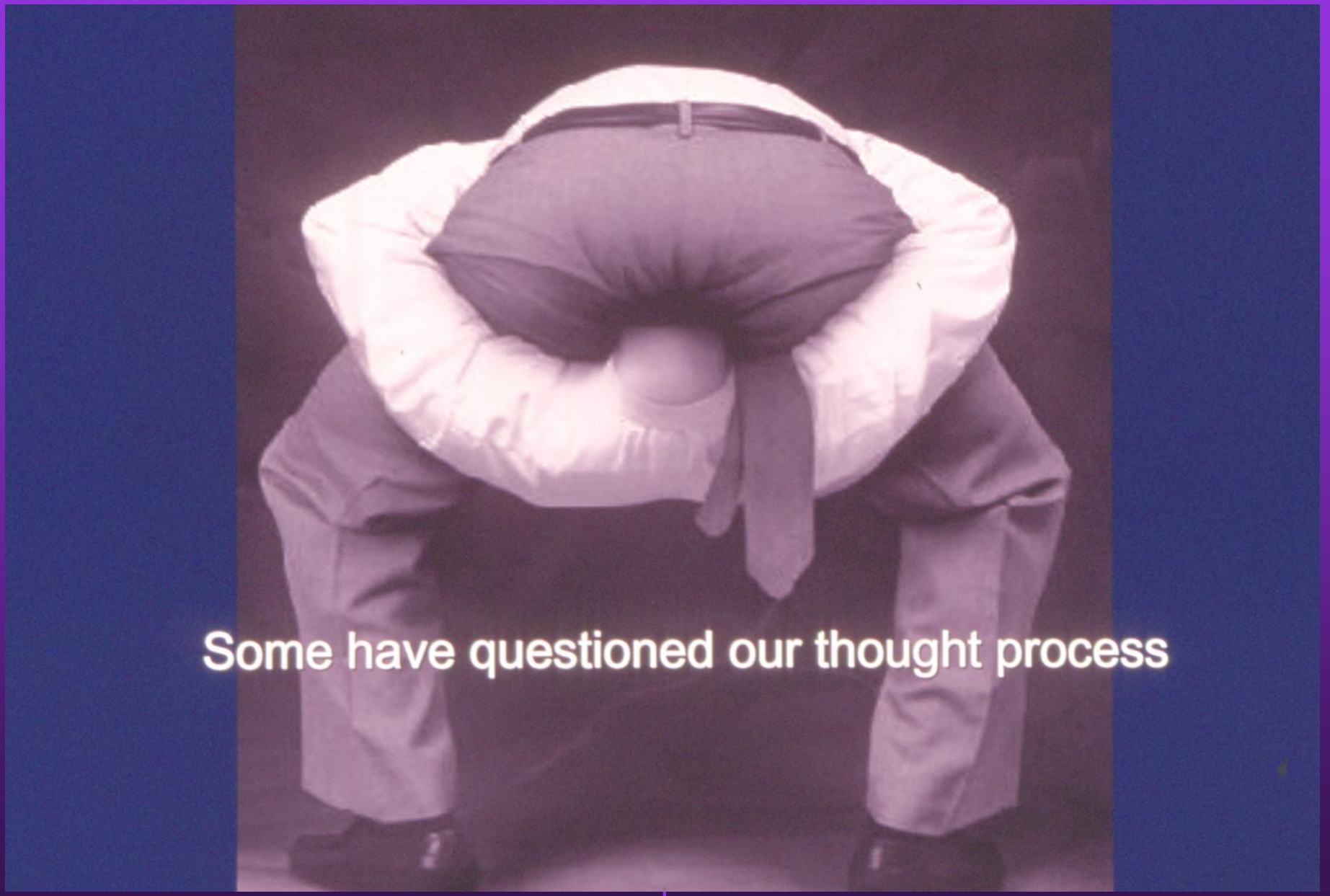
Legally versus Pateint Care

- PTSD – Not a Jury of Your Peer, A Juror said, " None of us thought you did anything wrong but we all thought he deserved some money." Justice system is not fair. A Risk we have to take.
- 95% of trauma done in the communities. At 2am be available and respectful


Some have questioned our thought process

Failure of Understanding

- The Goals
- The Biology
- The Mechanical Environment
- How to Refer

What can get me or the patient into trouble

- Open Fractures- Type 1 not Type 3
- Compartment Syndrome
- Unstable Fractures
- Infections
- Know hospital capabilities, referrals and call a friend


INJURY PREVENTION TEAM
Charity Hospital

Advice

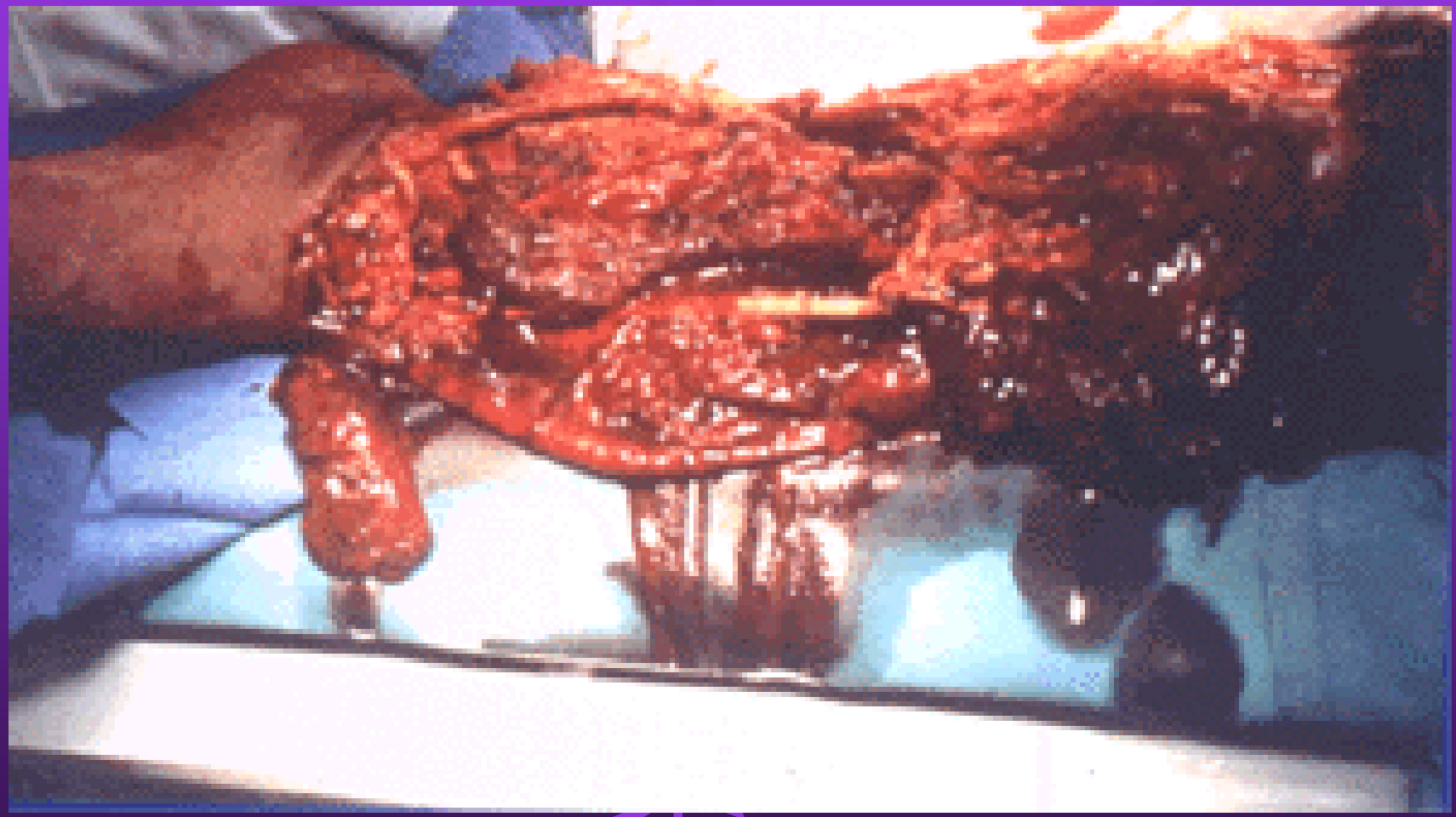
- The soft tissue injury component of any fracture is the major outcome determinant.Assessment, classification and treatment of the soft tissue injury is critical
- Ex fix always available and a good bail out
- Never miss a compartment syndrome!
- Error on the side of debridement

OTA 10/13/10

- Headlines of "USA Today"
- "High School Football Player Loses Leg"
- Grade I open tibia inadequately debrided

Visual Examination

- Contusion → avoid incision
- Pink or dusky → ABI > .9
- Pulses → Splint
- Palpate all fractured limbs, internal external rotation against resistance all normal limbs



Beware of Compartment Syndrome

Emergent Treatment

- One Look Exam
- Sterile Dressing
- No ER Cultures
  - Poor indicator of probability of infection and organism
  - expensive
- Realign and Splint

Open Fractures Principles

- Serially debride until surgically clean wound is obtained
- Stabilize fractures (preserve soft tissue and vascularity to the fracture)
- Soft tissue coverage
- Mobilize early

Do Not Delay Surgical Washout

Principles of Debridement

- Tumor surgery
- All devitalized tissue removed
  - –includes skin, muscle, and bone

Principles of I&D

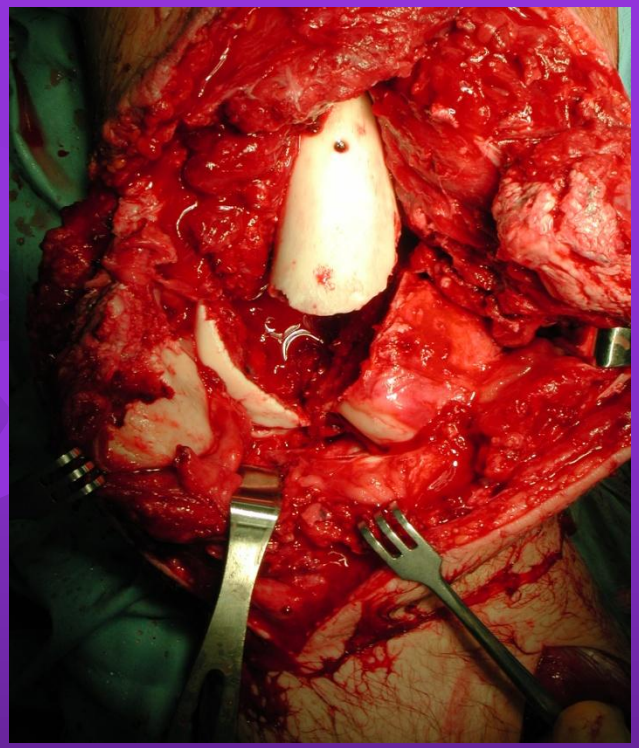
- Longitudinal incisions- extensile exposures
- Wherever the hematoma went
- Excise non viable tissue (loops)
  - Systematic and detailed approach
- Irrigation
- Stabilize fracture

I&D

- Systematic
  - Skin
  - Fascia and fat
  - Muscle: 4 C's of muscle viability
    - Contractility
    - Capacity to bleed
    - Consistency
    - Color

I&D

- Bone
  - Deliver, inspect and cleanse bone ends
  - Remove fragments without soft tissue attachment
  - Cleanse and retain all major articular fragments



Antibiotics Require Local Blood Supply to be Effective

Duration of Antibiotic Treatment

- Initial 72 hours
- 48 hours after each subsequent procedure

Tetanus Toxoid

Tetanus Toxoid 2.5 cc to all poly-trauma patients, otherwise:

IMMUNIZATION HISTORY	NON-TETANUS PRONE	TETANUS PRONE*
UNKNOWN	YES	YES
>3 IMMUNIZATIONS (<5 YEARS)	NO	NO

***Tetanus Prone: >6 hours old, complex soft tissue injury, wound >1 cm deep, missile, crush, burn, frostbite, devitalized tissues, soil contaminants, denervated, ischemic, early infection.**

Tetanus Immune Globulin

250-500 units IM:

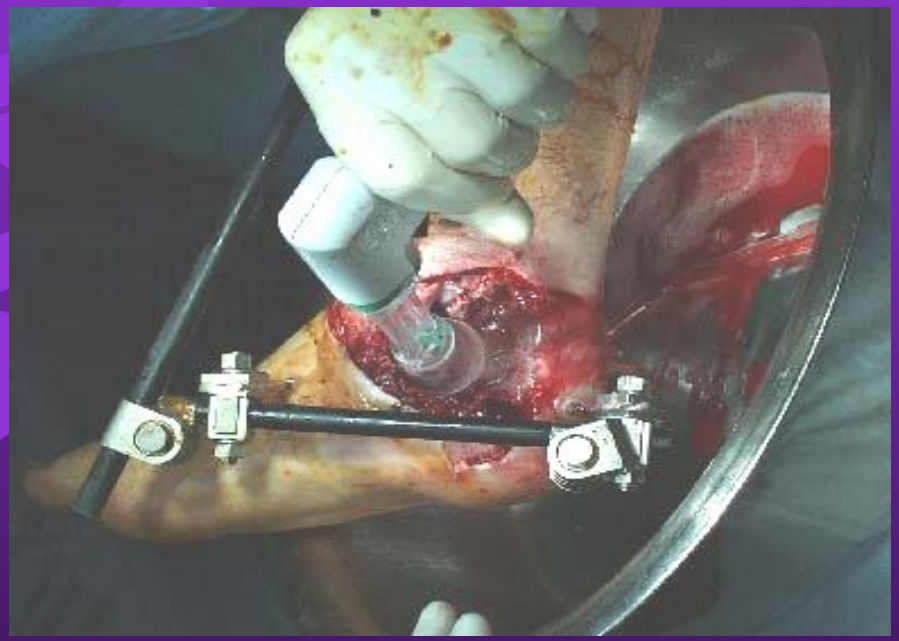
IMMUNIZATION HISTORY	NON-TETANUS PRONE	TETANUS PRONE*
UNKNOWN	NO	YES
>3 IMMUNIZATIONS (<5 YEARS)	NO	NO

Wound Irrigation

Petrisor et al (OTA 2007) – normal saline with low pressure (?antibiotics in irrigation)

I&D

- Pulsatile Irrigation
  - Copious volume
  - Pulsatile action reduces bacteria counts in tissue
  - Consider brush cleaning bone
  - Antibiotics in solution controversial
  - May impair bone healing



INFECTION

…92% (thirty-five) of thirty-eight open-fracture infections were caused by bacteria acquired while the patient was in the hospital…
…Most open-fracture infections are caused by gram-negative rods and gram-positive staphylococci…

Carsenti-Etesse H, Doyon F, Desplaces N, Gagey O, Tancrede C, Pradier C, Dunais B, Dellamonica P. Epidemiology of bacterial infection during management of open leg fractures.
Eur J Clin Microbiol Infect Dis. 1999;18:315-23.

INFECTION

…the administration of antibiotics after an open fracture reduces the risk of infection by 59% (relative risk, 0.41; 95% confidence interval, 0.27 to 0.63)…

Gosselin RA, Roberts I, Gillespie WJ. Antibiotics for preventing infection in open limb fractures. Cochrane Database Syst Rev. 2004;1:CD003764.

Lessons Learned from LEAP Study

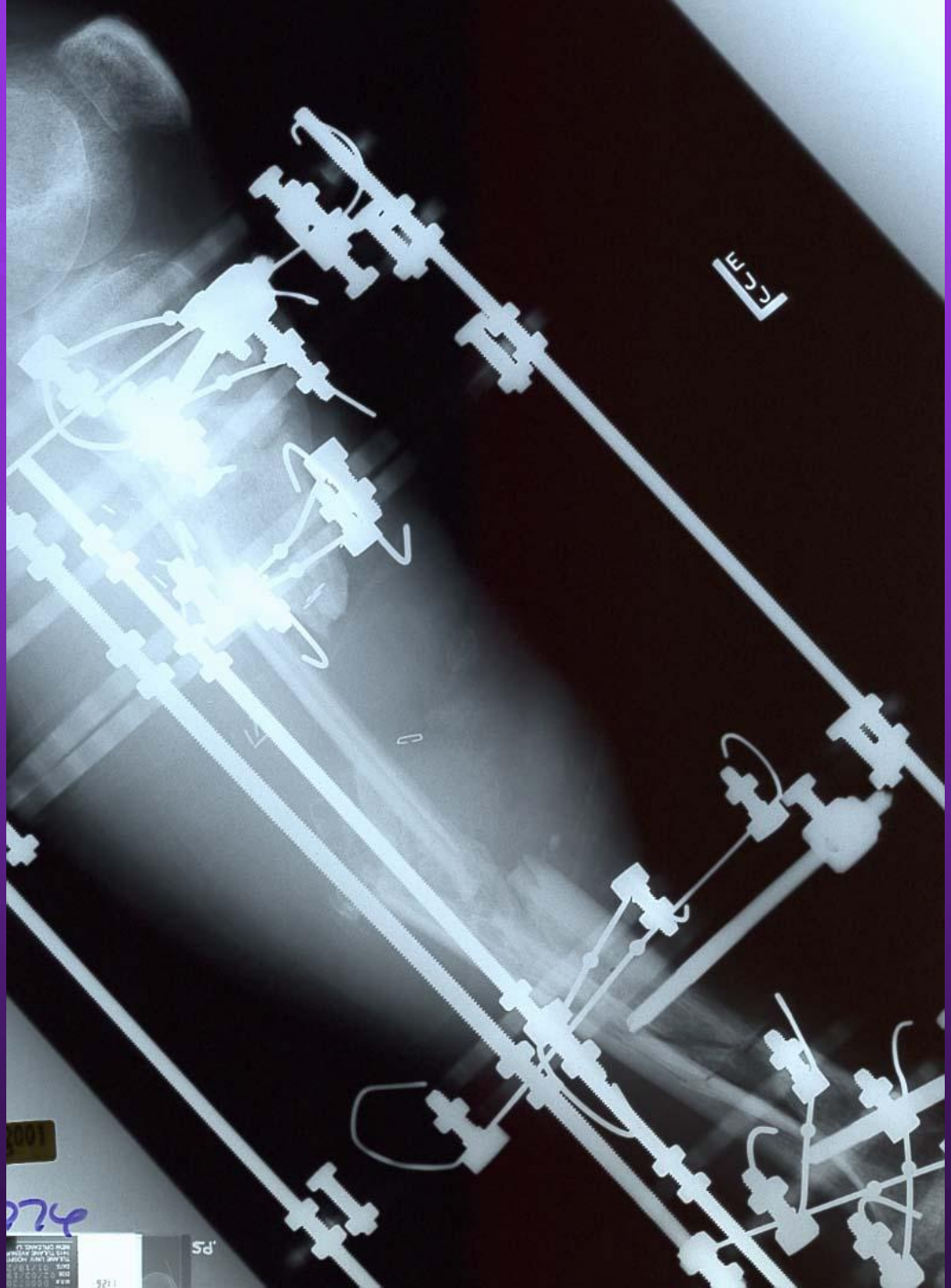
- No one does really well
- Scoring systems do not predict outcome
- Psycho-social issues play important role in long term outcomes
- Absent plantar sensation not an indication for amputation
- Avoid complications regardless of treatment path

Time to Definitive Treatment Influences Incidence of Infection After Open Lower-extremity Trauma

- **Pollak et al (LEAP Study Group) OTA Paper 2003**
- Retrospective multicenter of 315 patients (40% transferred from other hospitals)
- Overall infection rate 27%
- Mean time to debridement 11.4 h
- Not significant predictors of infection:
  - time to debridement, time to coverage
- Time to admission to trauma center was significant:
  - <6 h infection rate 22%
  - >6 h infection rate 39%

CM-11-30-00

CM-1-18-01



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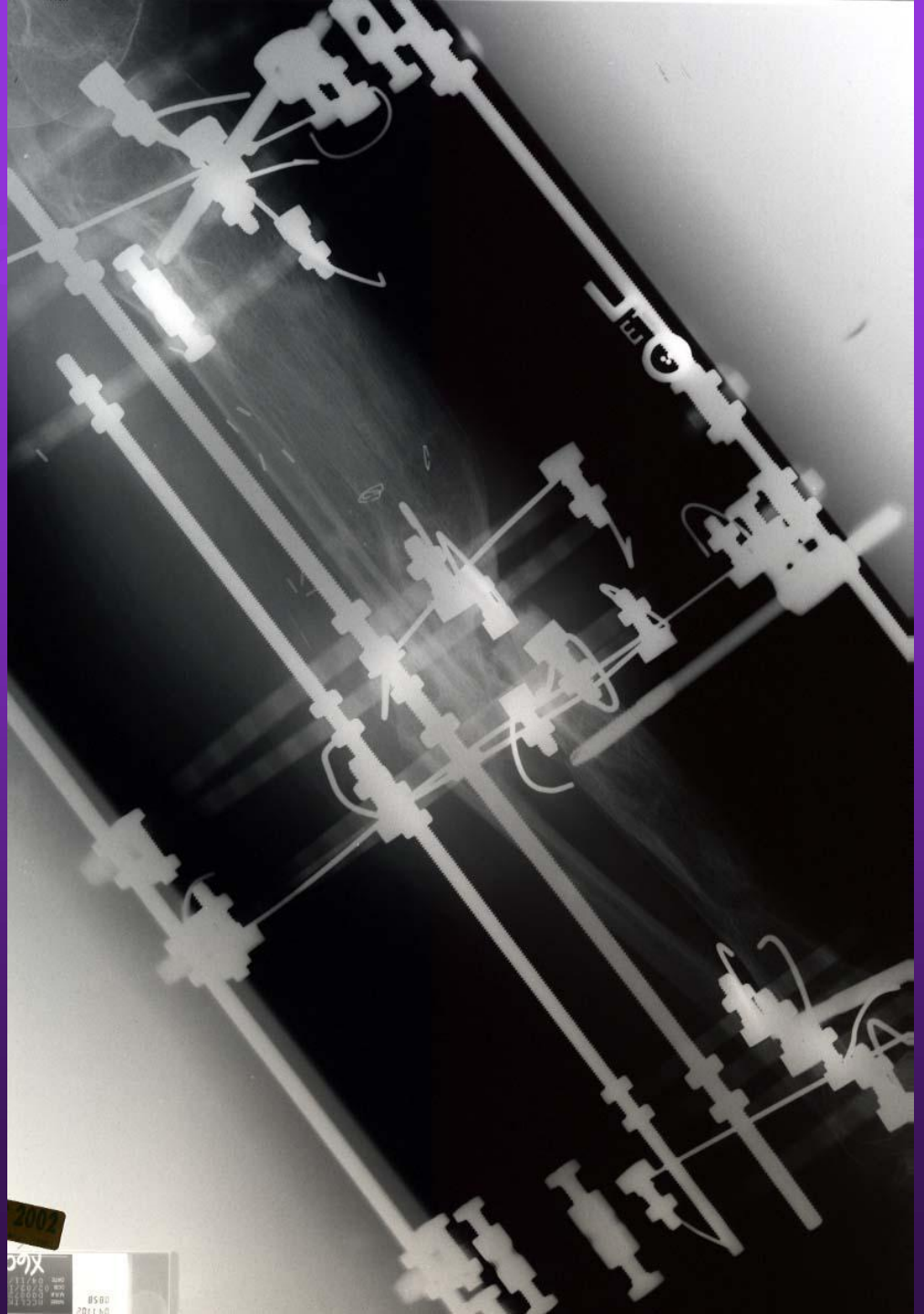

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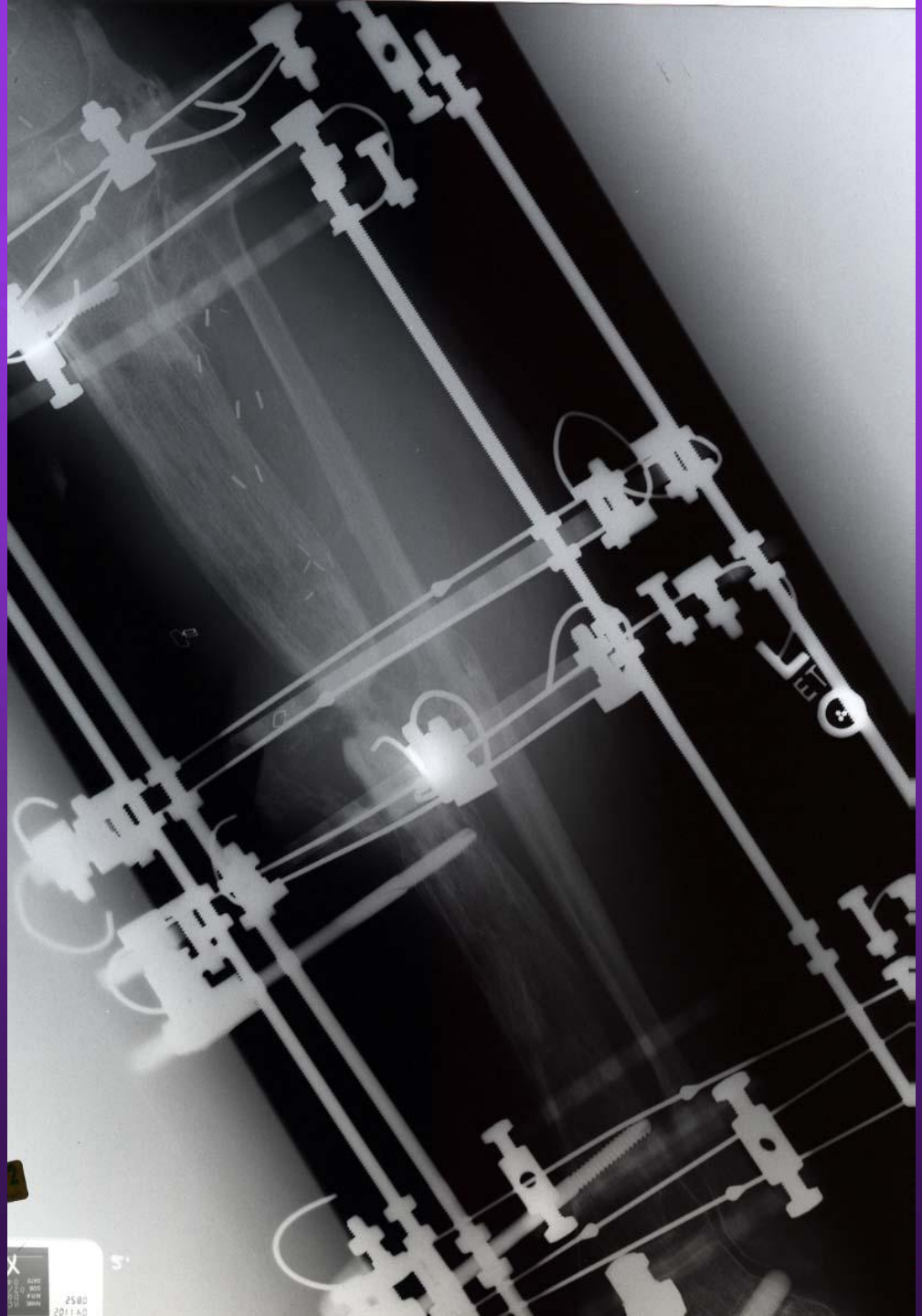
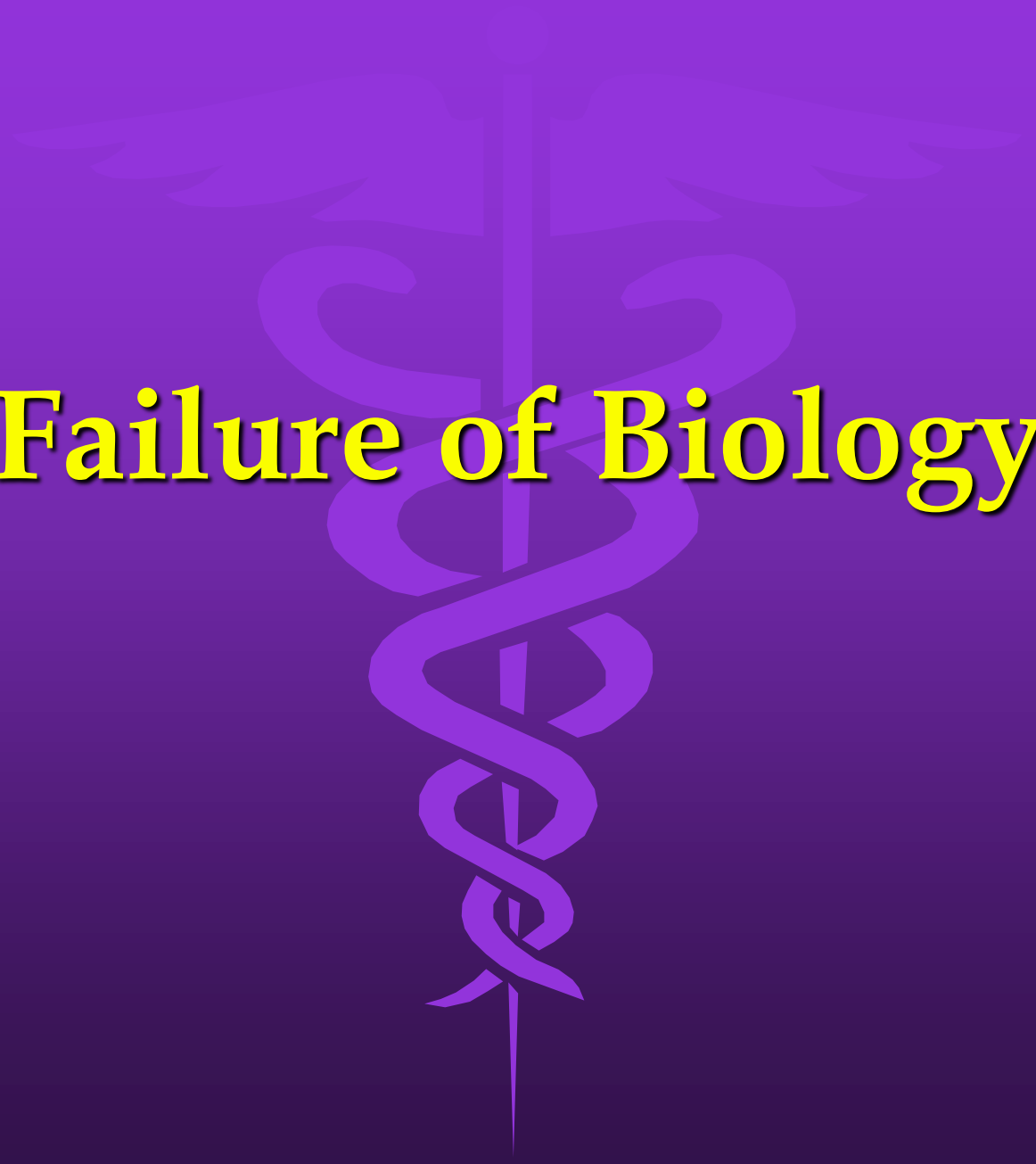


CM-7/22/04

Failure of Biology




rd


CF


CF


CF
W 2500
C 500


HEAD
Ref scan 4
Ref TP -167
CF
RT. TIBIAL FX


CF
R


CF


100 ML
80
60

Negative Pressure Wound Therapy

- VAC Devise (KCI Inc)
  - After I&D
  - Infected wound after I&D
  - Dead Space
  - Over STSG
  - Exposed tendon, bone, joint
  - Webb, JAAOS 2002

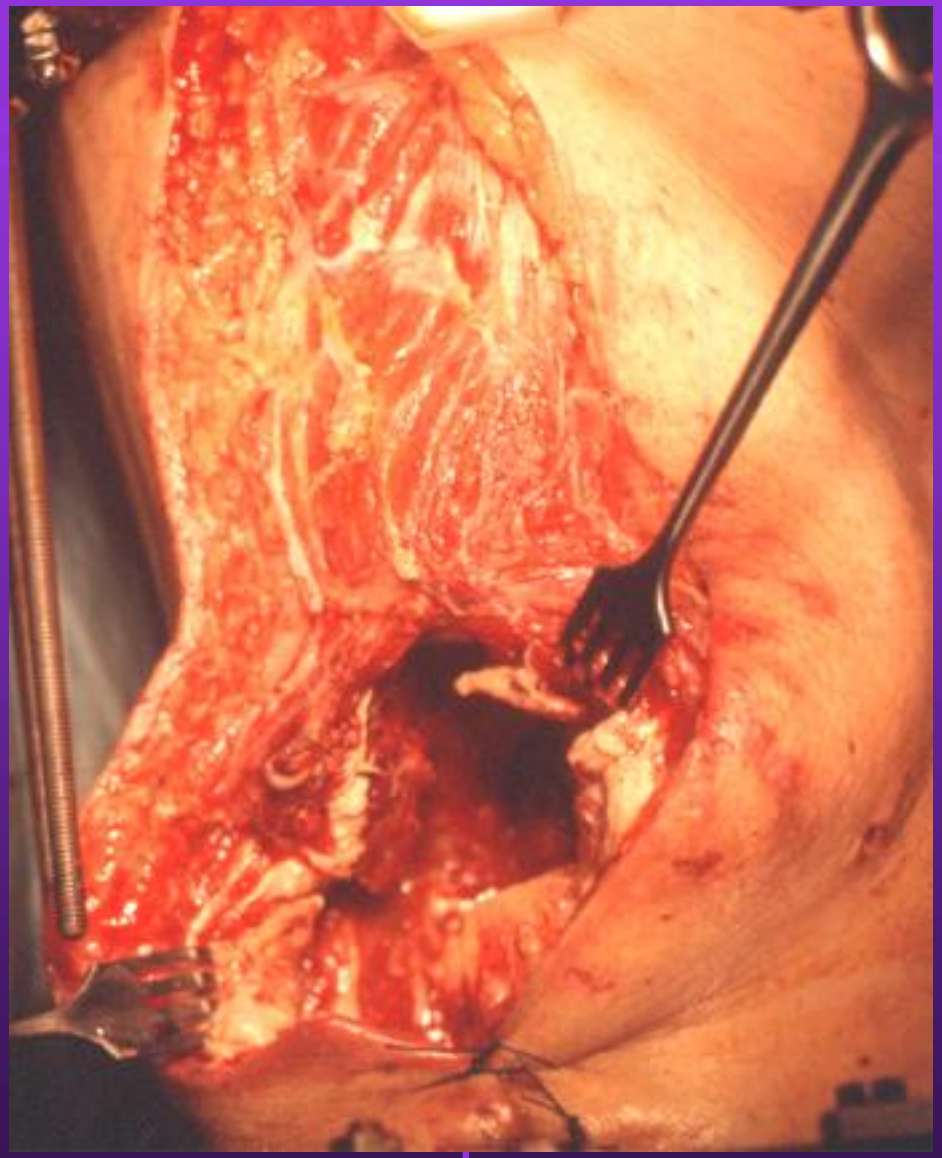
Amputation

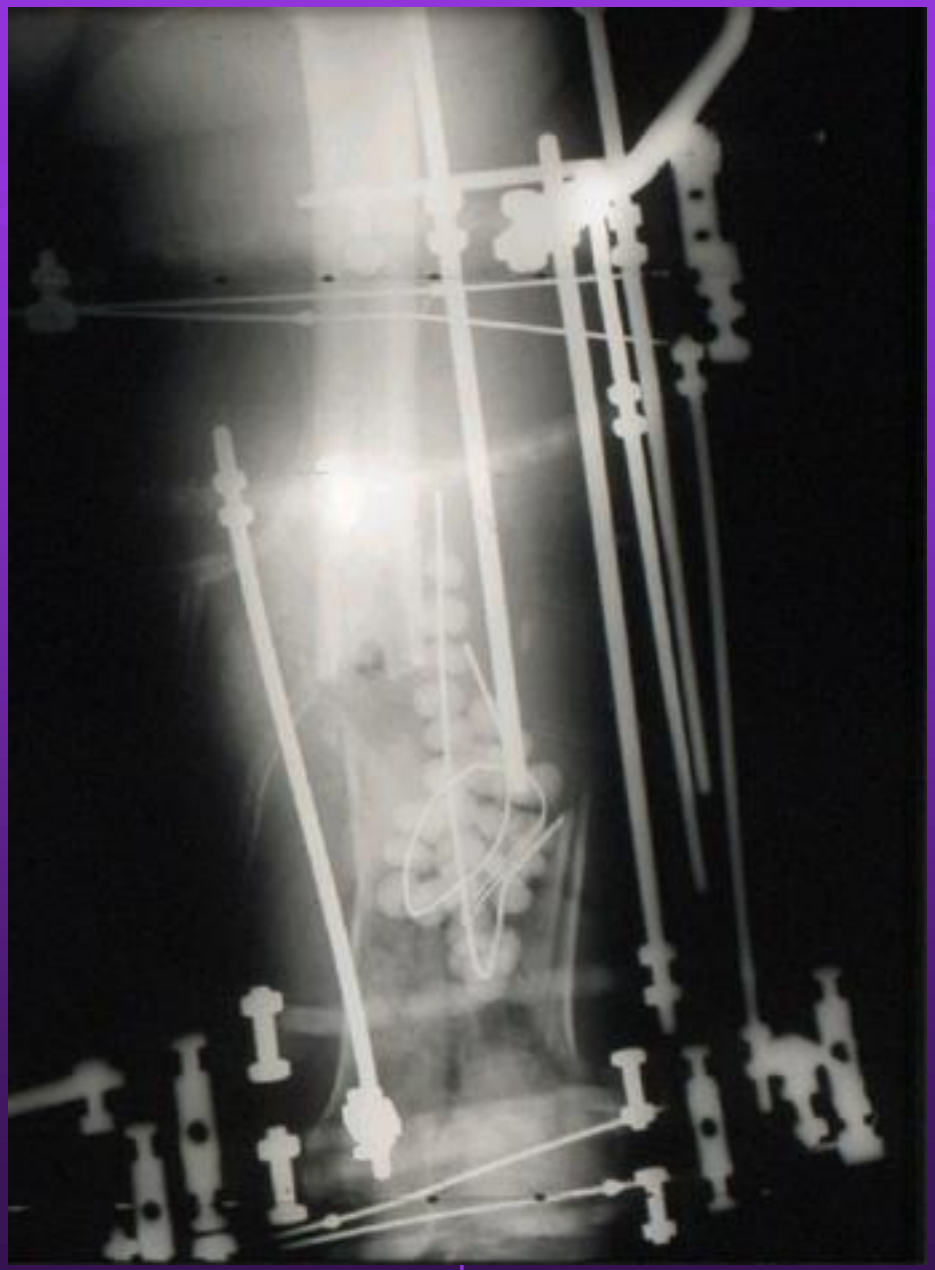
- > 6 to 8 hours warm ischemia
- Transection of tibia nerve
- Crushing injury to leg or foot


R
PORTABLE


R
PORTABLE


THOIR






188.2
20.0cm
56 M 720523
NOV 27, 2000
512
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3
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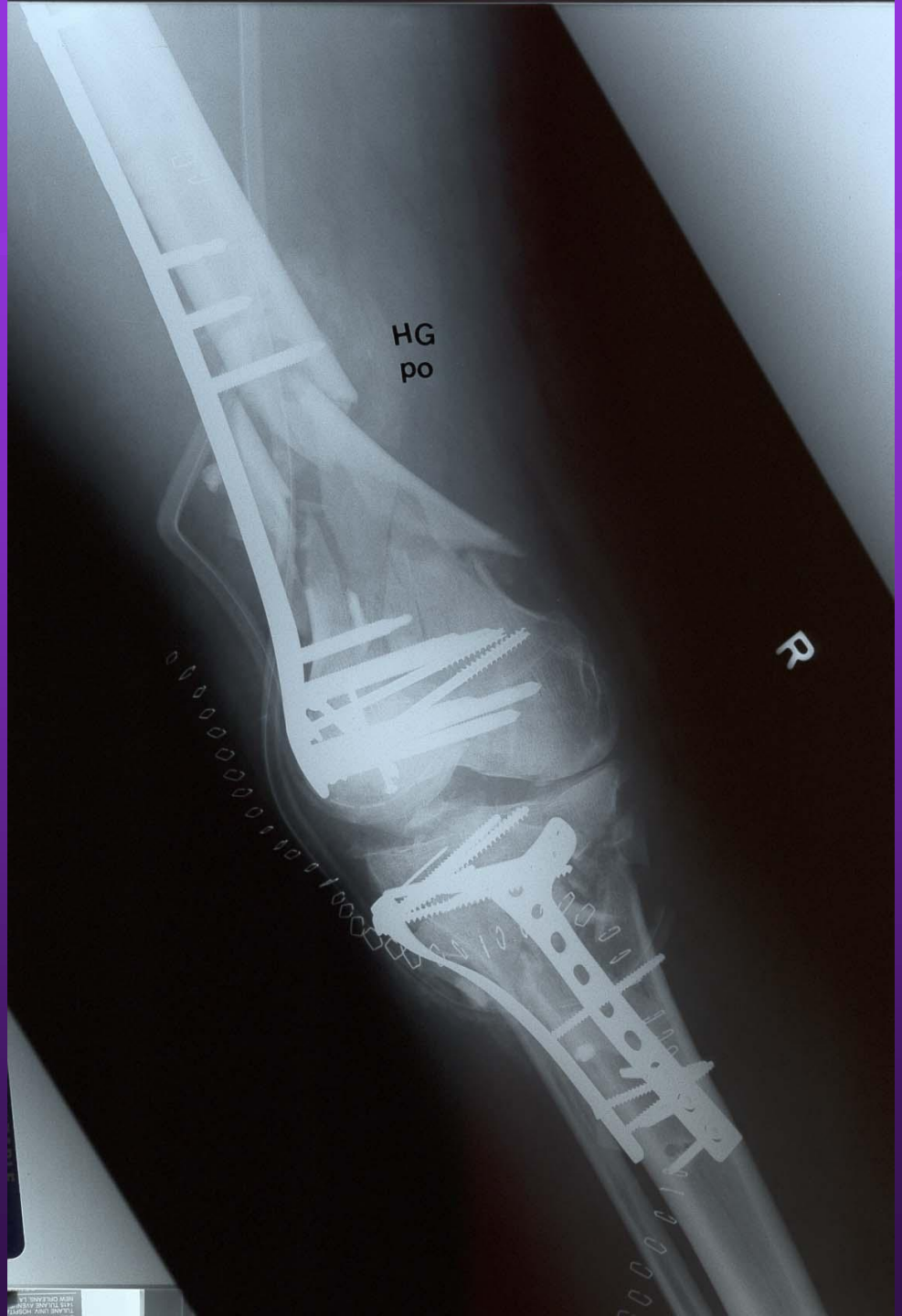
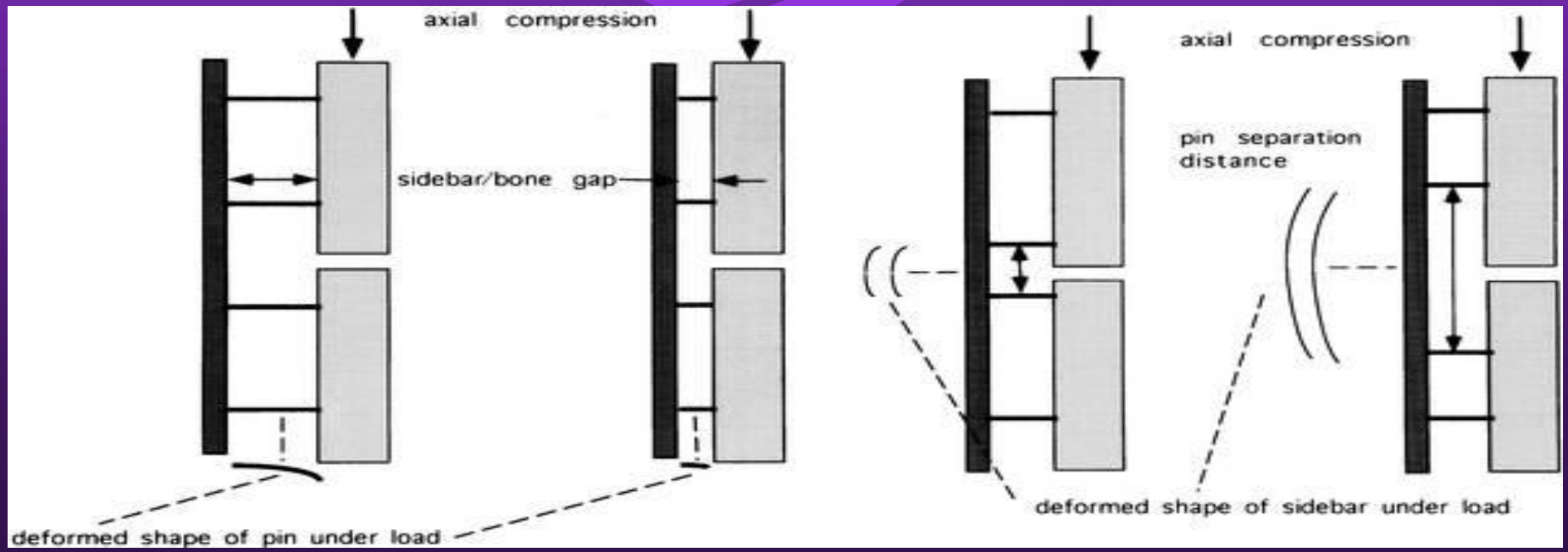
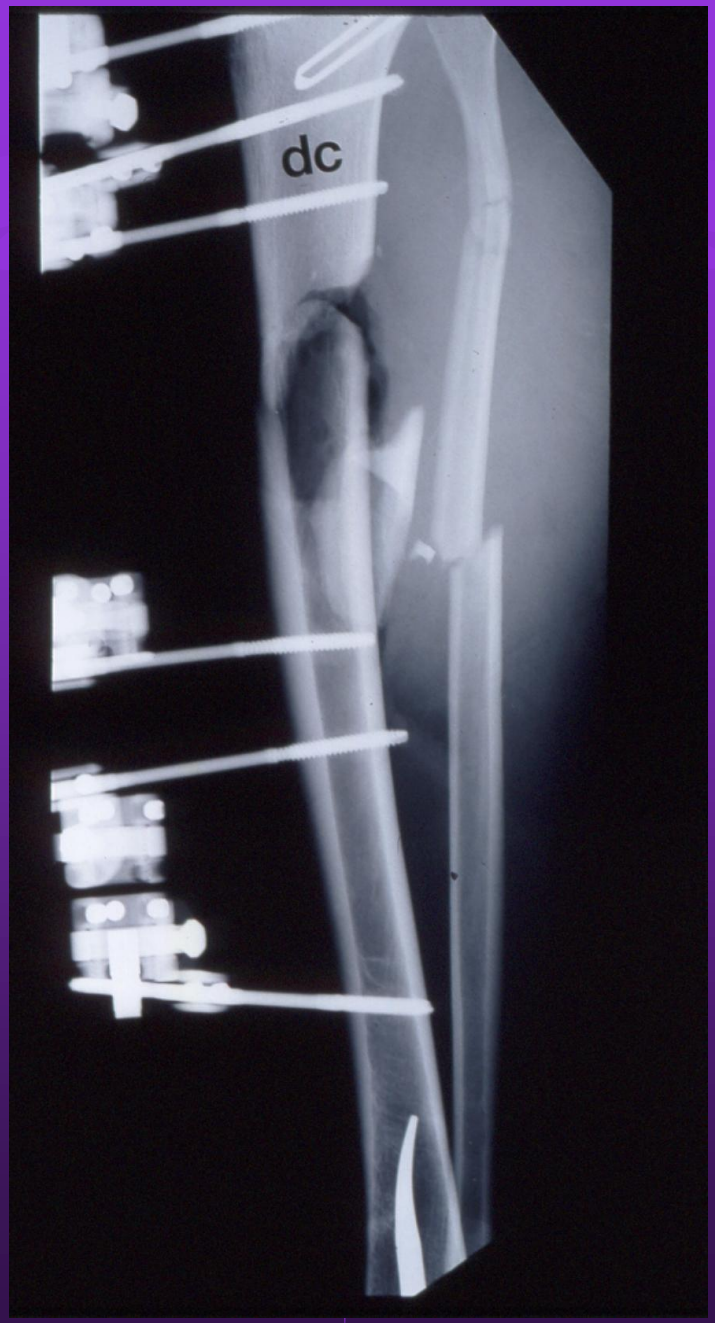

HG
po
R


HG
4M

Principles of Stability

- Closer to the bone
- Greater pin spread
- Additional planes of fixation (double bar,trangular) and pins
- Increase diameter of the pin
- Pin placement- predrill, release skin, anatomy, size matters



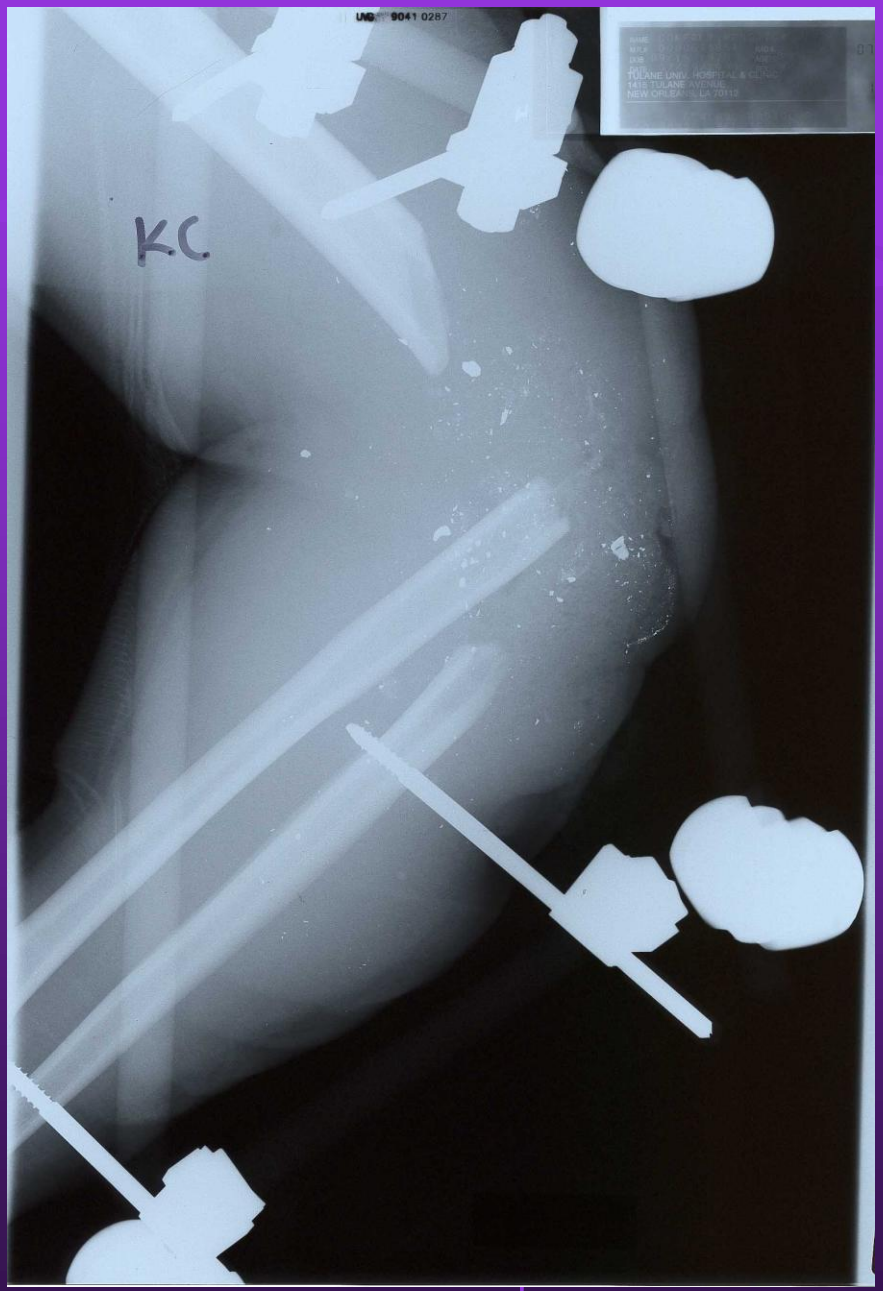

dc

Spanning External Fixator

- Rest soft tissue (temporary traveling – traveling vs. definitive treatment)
- Emergent stabilization
- Can return and look at the bone ends

Principles of Spanning Ex-fix

- Put pins away from your eventual incision and fixation (plan to use as femoral distractor
- Stability (pin clamps less stable)
- Don't put in hardware


KC

KC.
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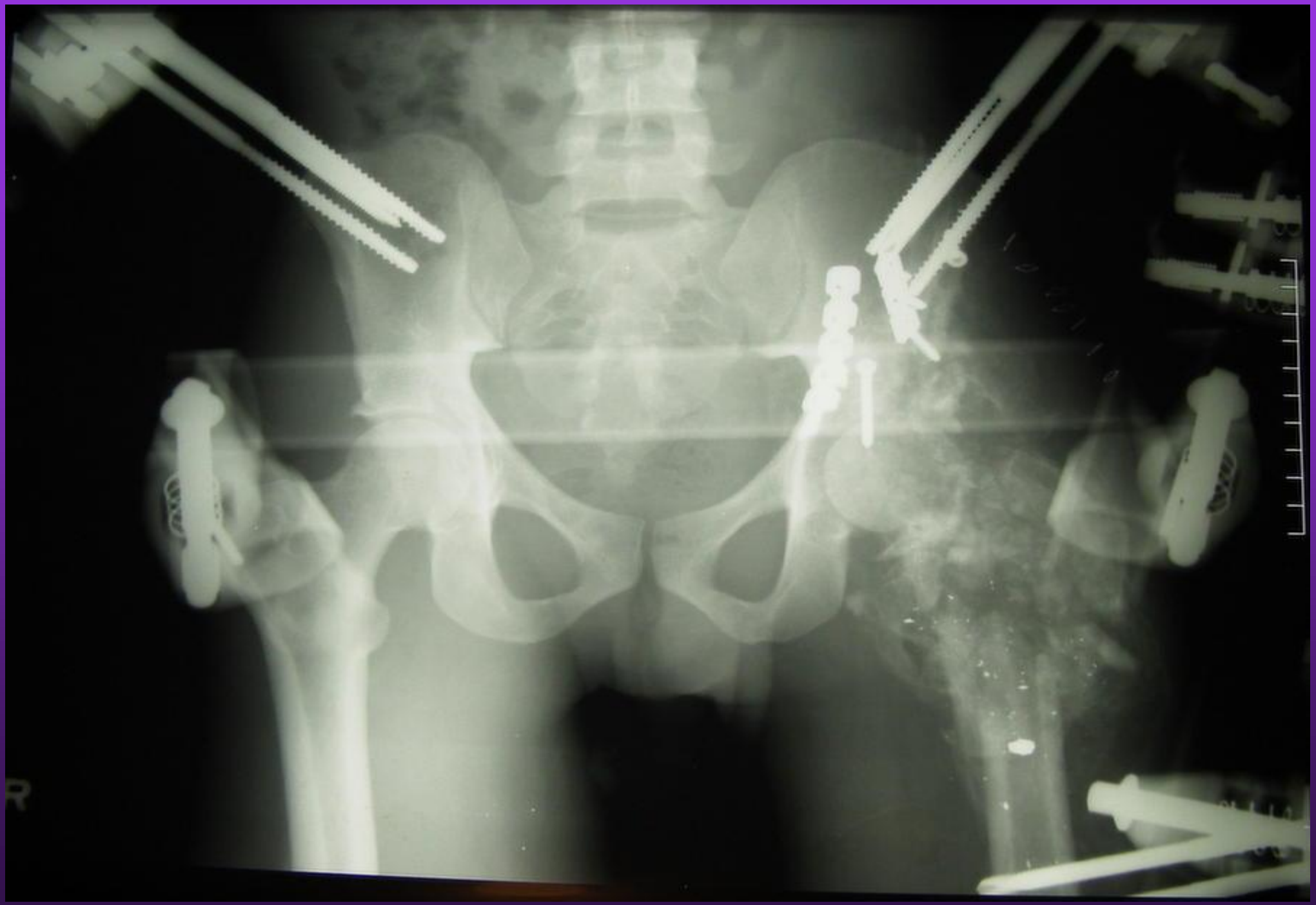
TULANE UNIV HOSPITAL & CLINIC
1415 TULANE AVENUE
NEW ORLEANS, LA 70112



Summary

- Obtain proper stability for the goal of treatment
- Proper technique for placement of external fixation to prevent infection
- Excellent option for "damage control orthopaedics", plafonds, segmental bone loss, and infected nonunions

Soft Tissue

- Closed Injuries
  - Impending compartment syndrome
  - Skin degloving

MOREL – LAVALLE' LESION (Skin Degloving)

- Infected in 1/3 of cases
- Require thorough debridement prior to definitive surgery

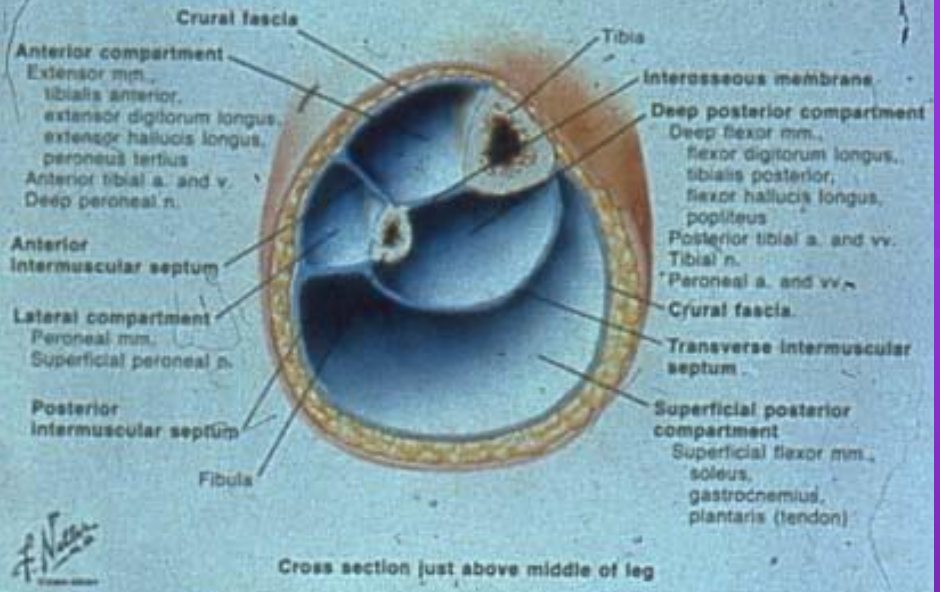
Compartment Syndrome

- increased pressure within an enclosed osteofascial space that reduces the capillary blood perfusion below a level necessary for tissue viability
  - two mechanisms: an increase in volume within an enclosed space (ex: SWELLING), and a decrease in size of the space (ex: CAST)

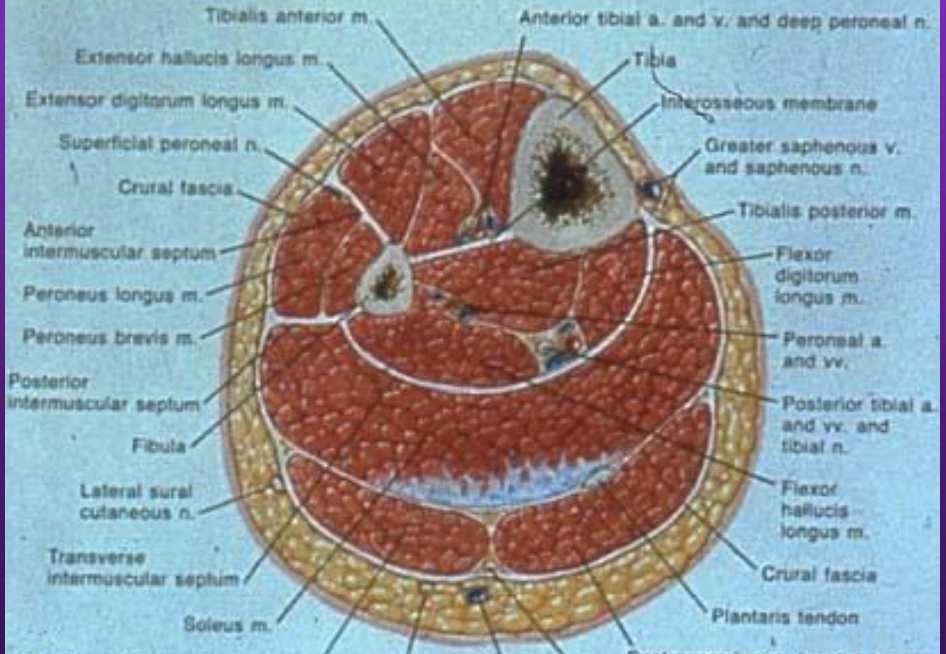
"Ischemic Muscle Paralysis and Contractures"
Richard von Volkmann, 1881
Volkmann R. Die ischaemischen muskellahmungen und kontrakturen. *Zentralbl Chir* 1881;8:801.

A picture is worth…

Fascial Compartments of Leg



Cross section just above middle of leg



Coagulopathy 2º Cirrhosis

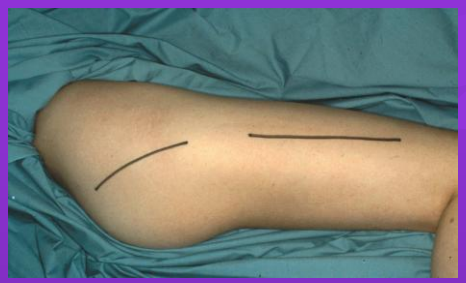
Compartment Syndrome

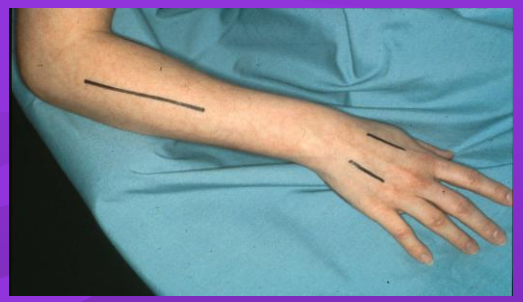
Average Settlement ¼ - ½ Million Dollars

Pathophysiology

- Increased local tissue pressure
- Increased pressure with in intra-compartmental blood vessels
- Decrease local A-V gradient
- Decreased local blood flow (capillary blood perfusion)

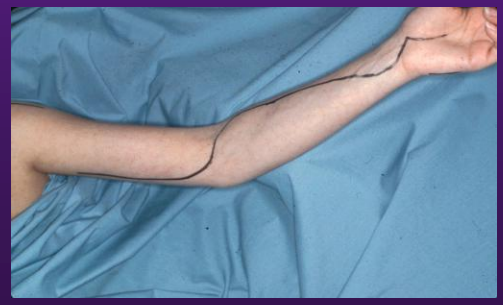
Compartment Syndrome





- Low Extremity
  - Gluteal
  - Thigh
  - Lower Leg
  - Foot

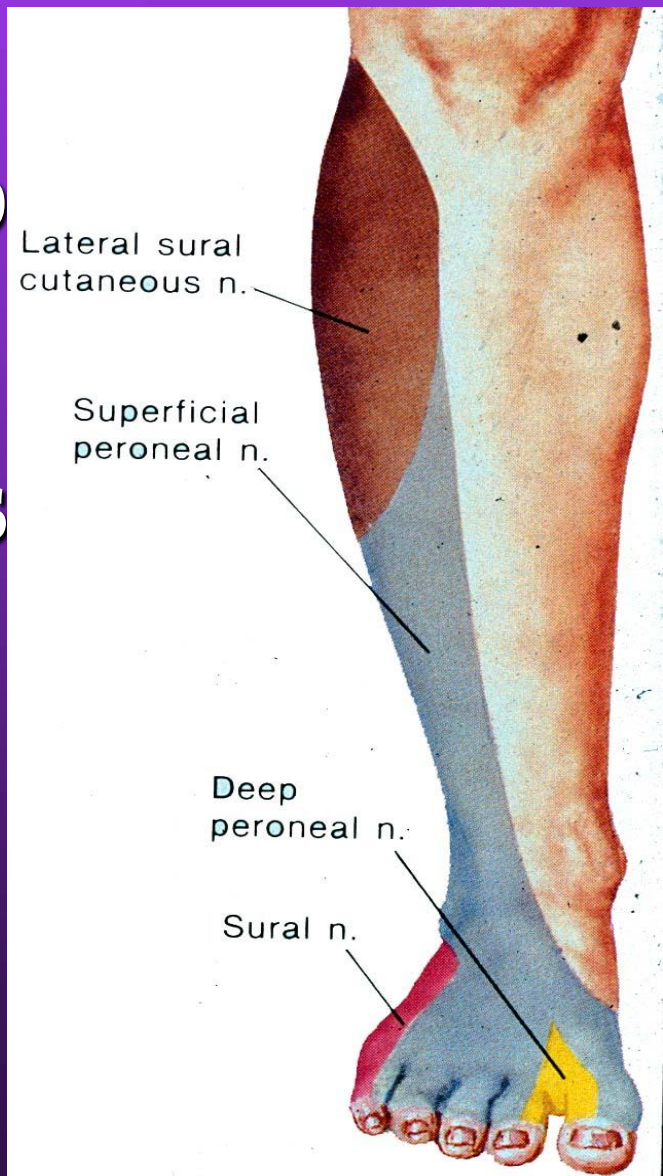
- Upper Extremity
  - Deltoid
  - Arm
  - Forearm
  - Hand



Compartment Syndrome

- Clinical diagnosis
  - –Pain out of proportion to the injury
  - –Numbness / Paresthesias
  - –Weakness (inability to flex and extend)

PAIN



Compartment Syndrome

- Physical Exam

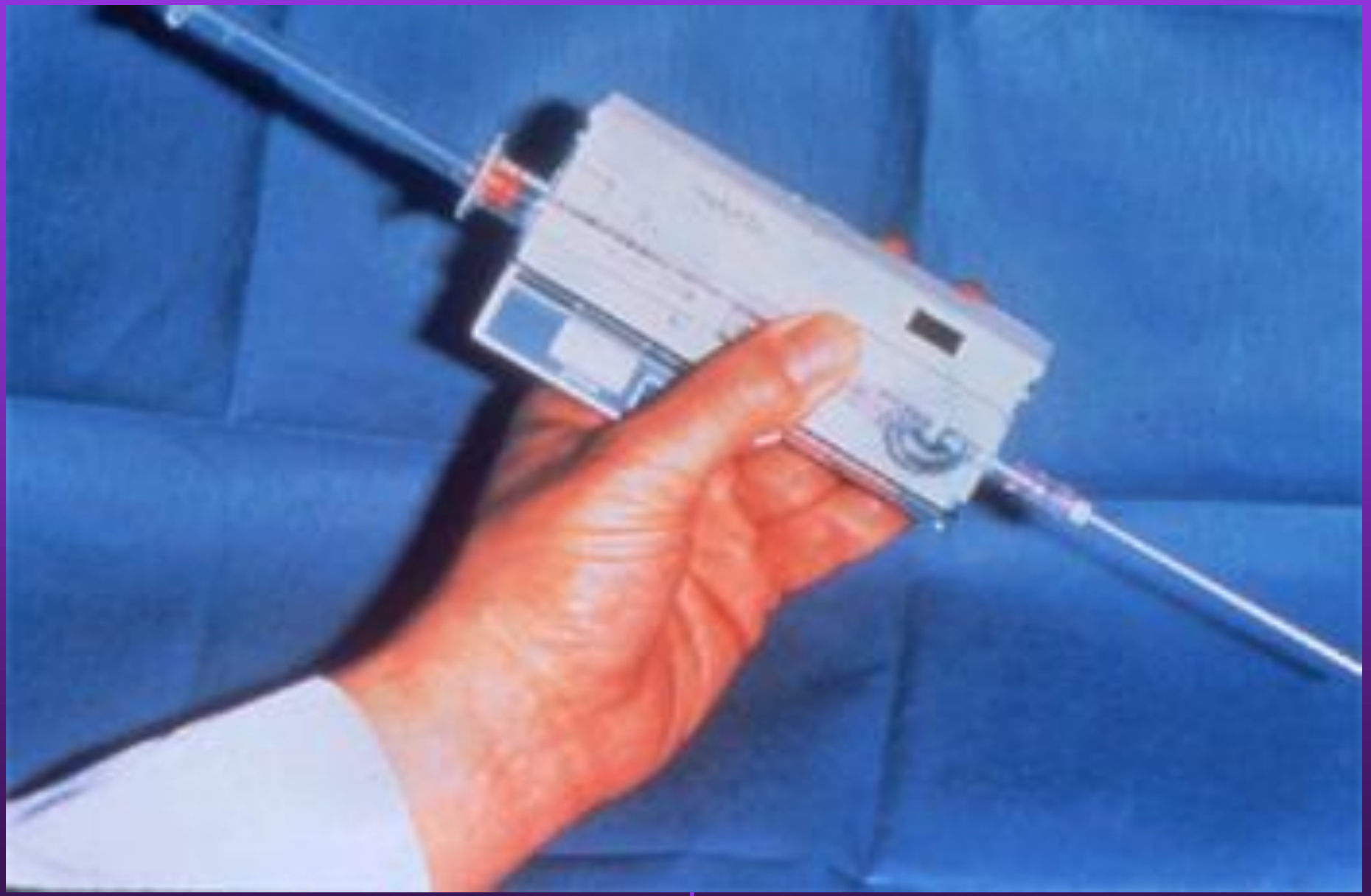
  Firm compartments

  – unreliable

  ~~Loss of pulses~~

  – occurs late or never

  Pain on passive stretch



Compartment Pressure Measurements

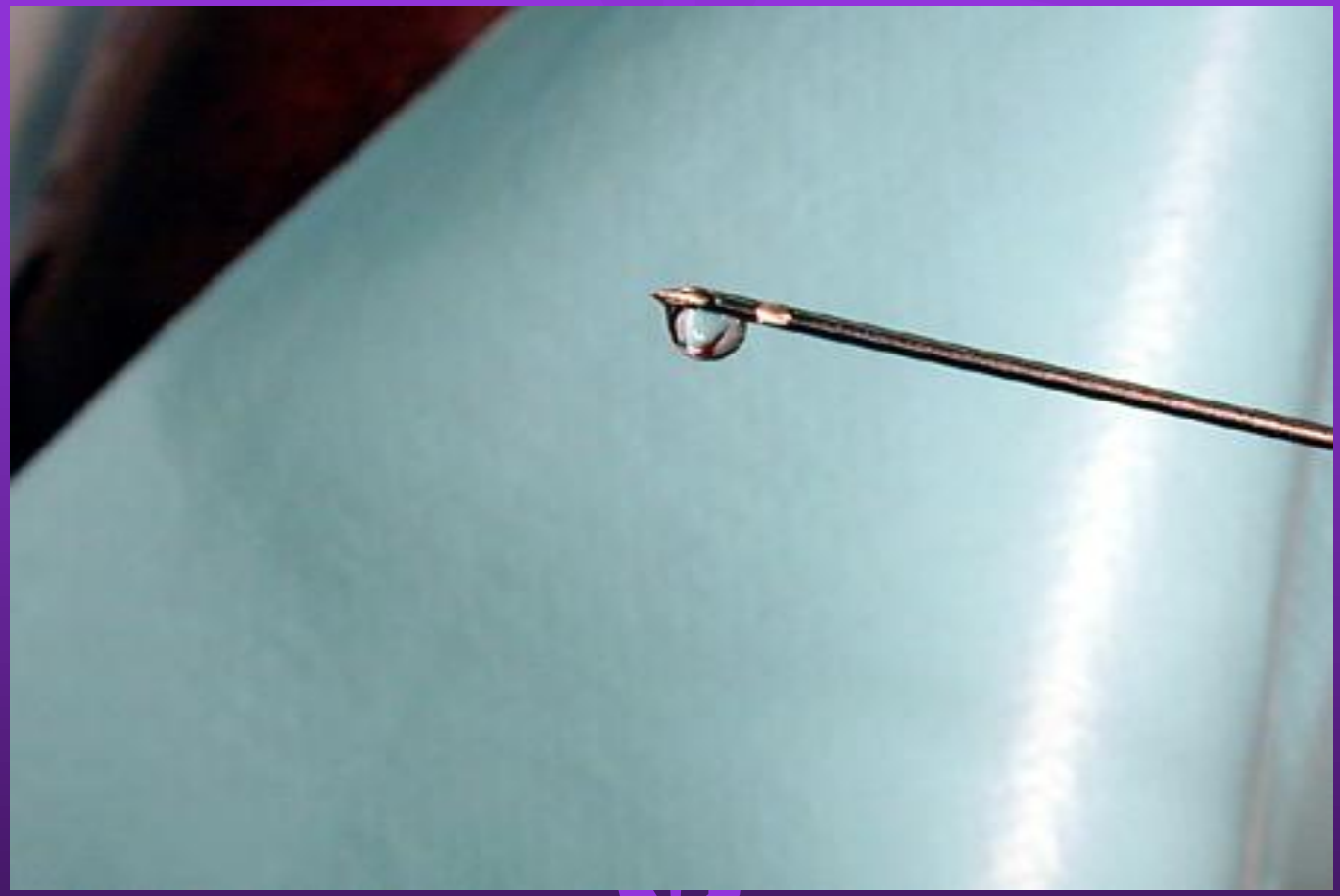
- Comparison Slit Catheter, Side-Ported Needle, and Simple Needle (Moed *JBJS* 1993)
  - no statistical difference between slit catheter and side-ported needle (mean 1.4 mmHg)
  - simple needle ($p<0.001$)
    - 18.3 mmHg higher than slit catheter
    - 19.3 mmHg higher than side-ported needle (Stryker)

Stryker Technique:

Rockwood & Green, 5th ed

* held parallel with the floor
* arterial line measurement: transducer must be at the level of the examination.

Stryker Technique



The syringe is filled with fluid…

Stryker Technique

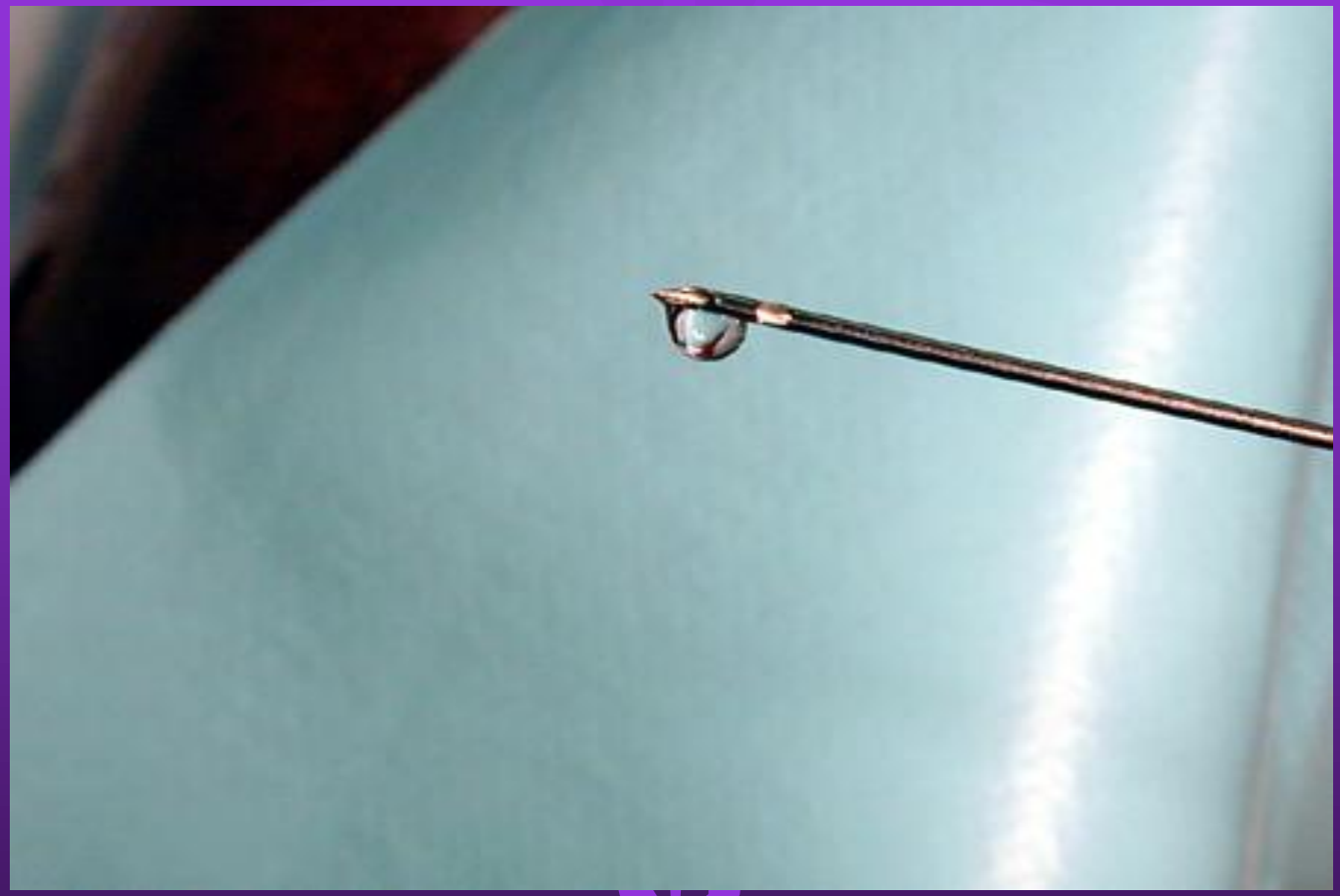
and then zeroed

Stryker Technique:

Rockwood & Green, 5th ed

* held parallel with the floor
* arterial line measurement: transducer must be at the level of the examination.

Stryker Technique

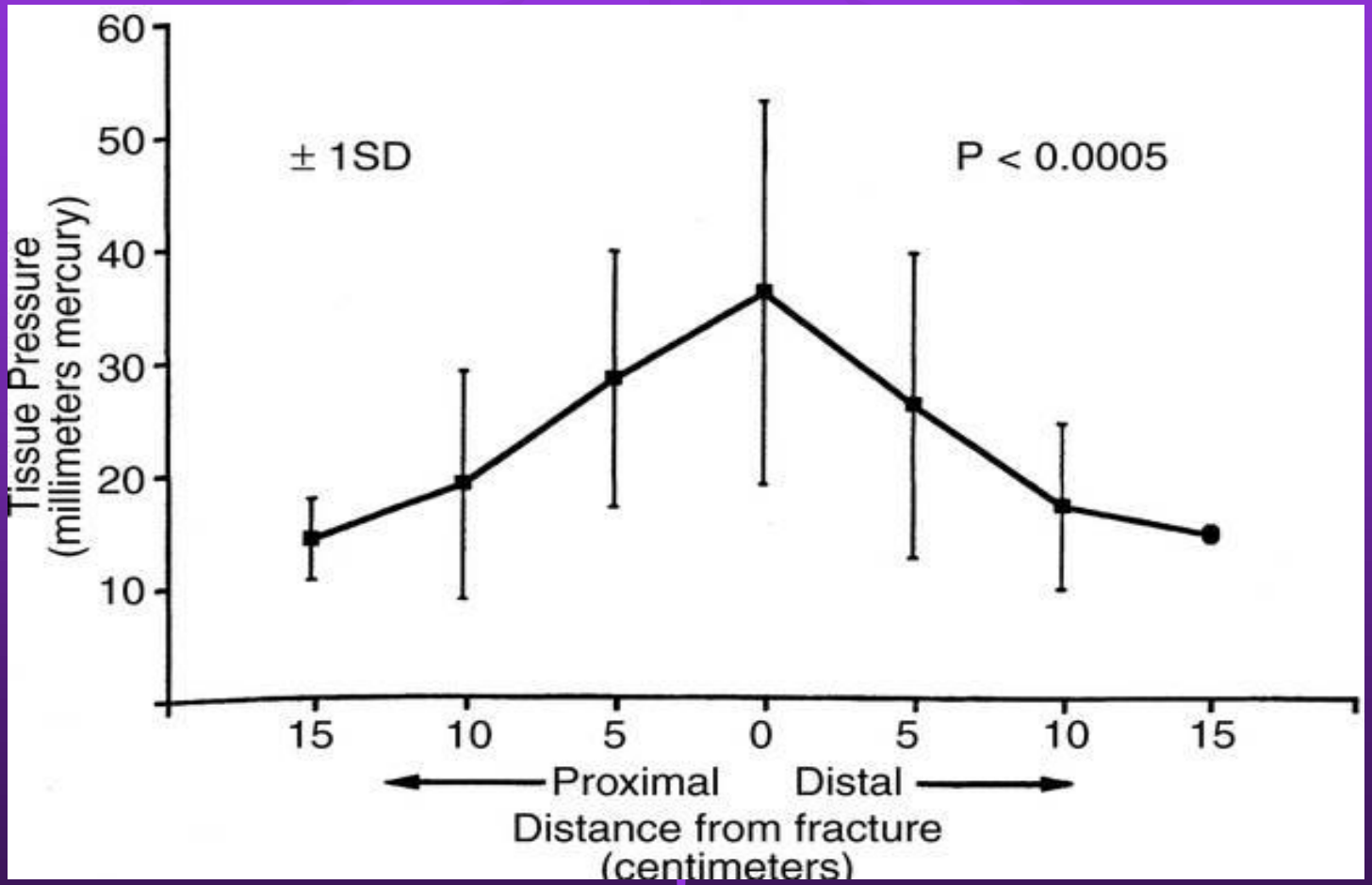


The syringe is filled with fluid…

Stryker Technique

*location relatively close to the fracture site
-More accurate (increased) readings.

Measure near fracture "Zone of Injury"



Heckman MM, Whitesides TE Jr, Grewe SR, et al. Compartment pressure in association with closed tibial fractures: the relationship between tissue pressure, compartment, and the distance from the site of the fracture *J Bone Joint Surg* 1994;76:1285–1292

Must Measure within 5 cm of Fracture site

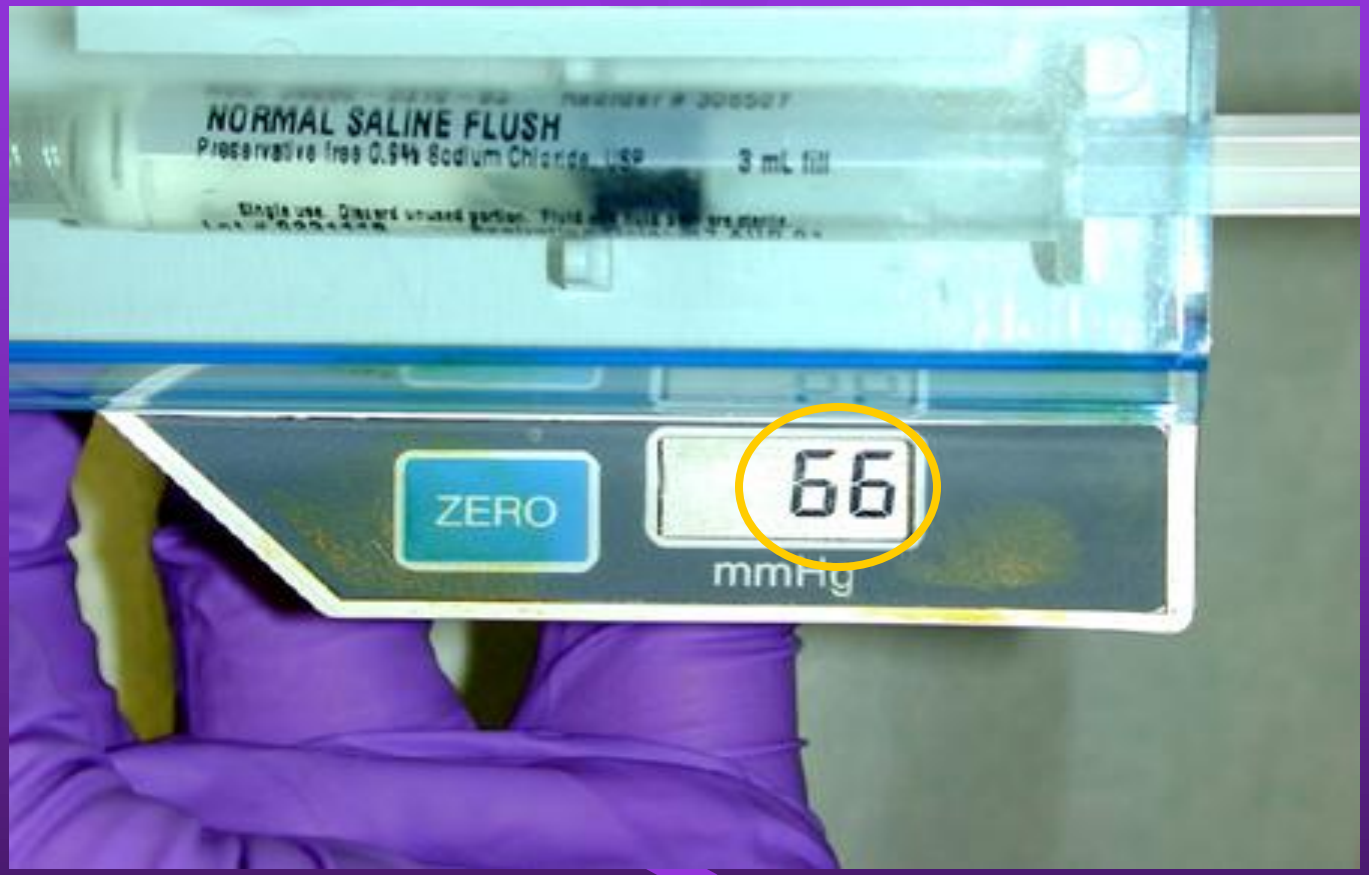
Stryker Technique

*location relatively close to the fracture site
-More accurate (increased) readings.

Stryker Technique

* Anterior compartment

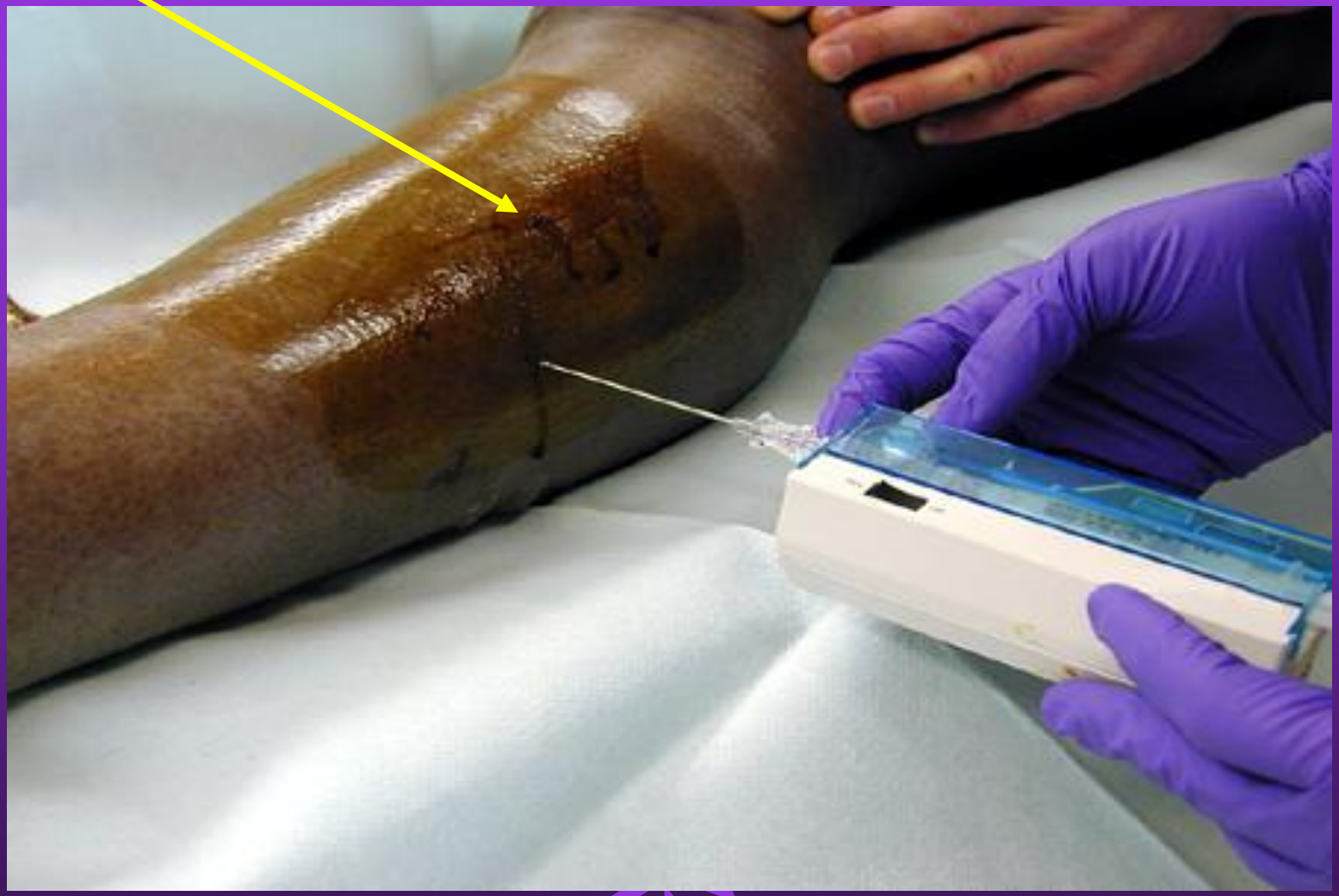
Stryker Technique



diastolic pressure of 74mm of mercury.
Thus a compartment syndrome was diagnosed in the anterior compartment ($\Delta P = 74 - 66 = 8$).

Stryker Technique

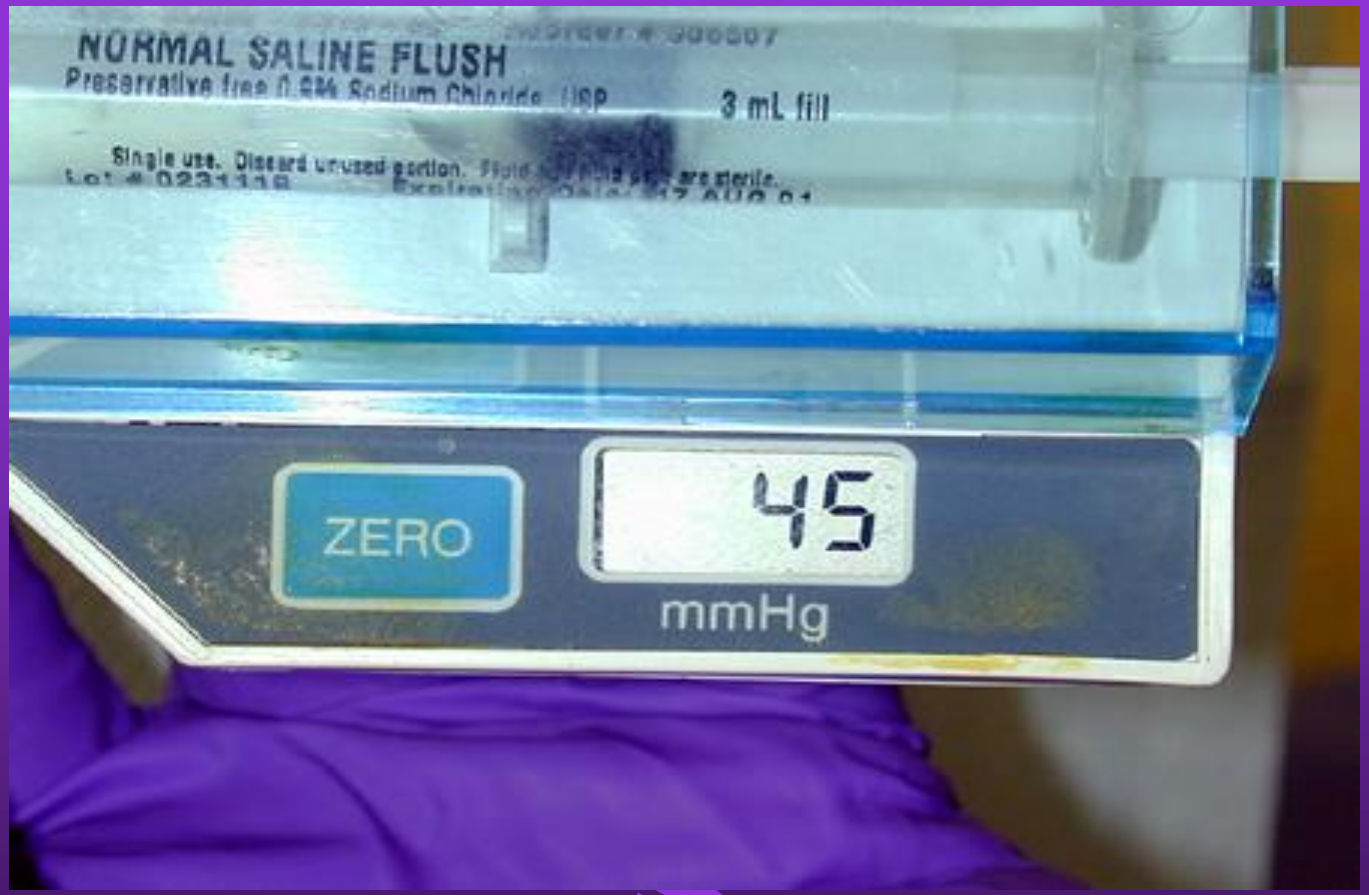
ANTERIOR PRESSURE MEASURED HERE



*lateral compartment

-directly over or posterior to the fibula

Stryker Technique



Stryker Technique

posterior compartments: posterior to the tibia medially, allowing measurement of first the superficial, and by farther advancement, the deep compartment.

Stryker Technique

Peripheral Nerve Conduction Block

Critical Level = 30 mm Hg x 6 – 8 hours

Increased Pathological Changes at Higher Intracompartmental Pressures

Compartment Pressure

Threshold

- $\Delta P < 30$mmHg
  - Diastolic BP - compartment pressure = ΔP
  - No sequelae in monitored tibia fracture patients when $\Delta P > 30$, even when compartment pressures exceeded 45 mmHg ***McQueen et al, JBJS-B, 96***

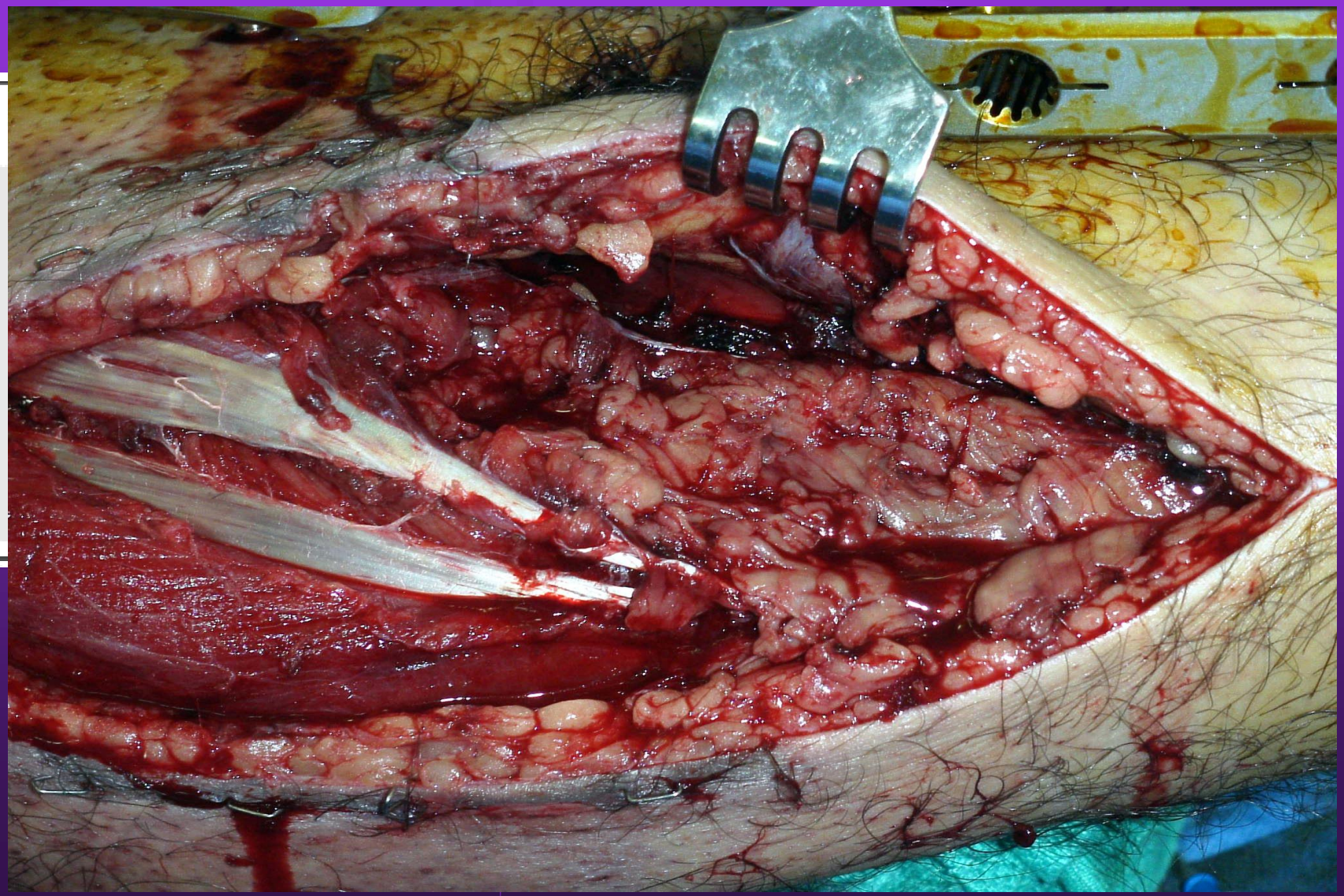
Diastolic pressure – compartment pressure < 30mm Hg = compartment syndrome

C.P. > 30mm Hg = C.S.

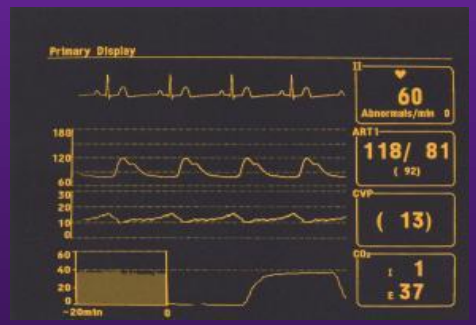
Debride non-viable muscle

TABLE 10-5.

Color
Consistency Capacity to bleed
Contractility



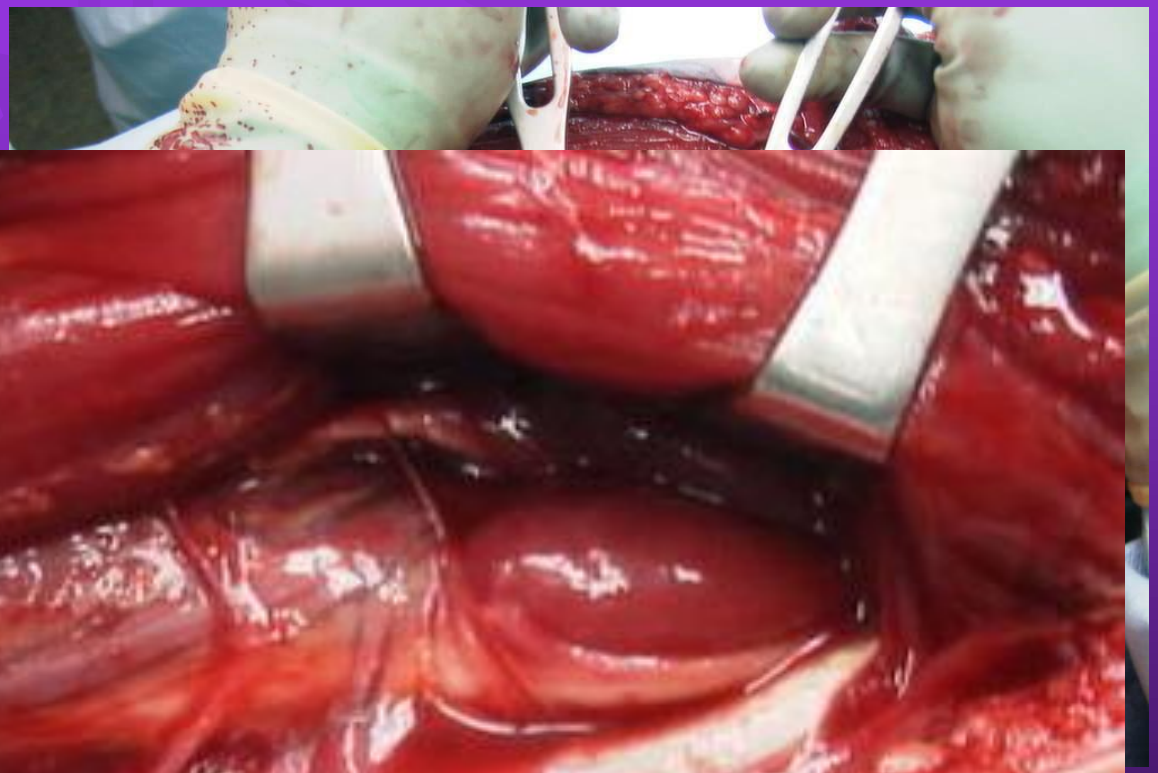
Check adequacy of release



19.3 millimeters of mercury higher than side-ported needle ($p < 0.001$)

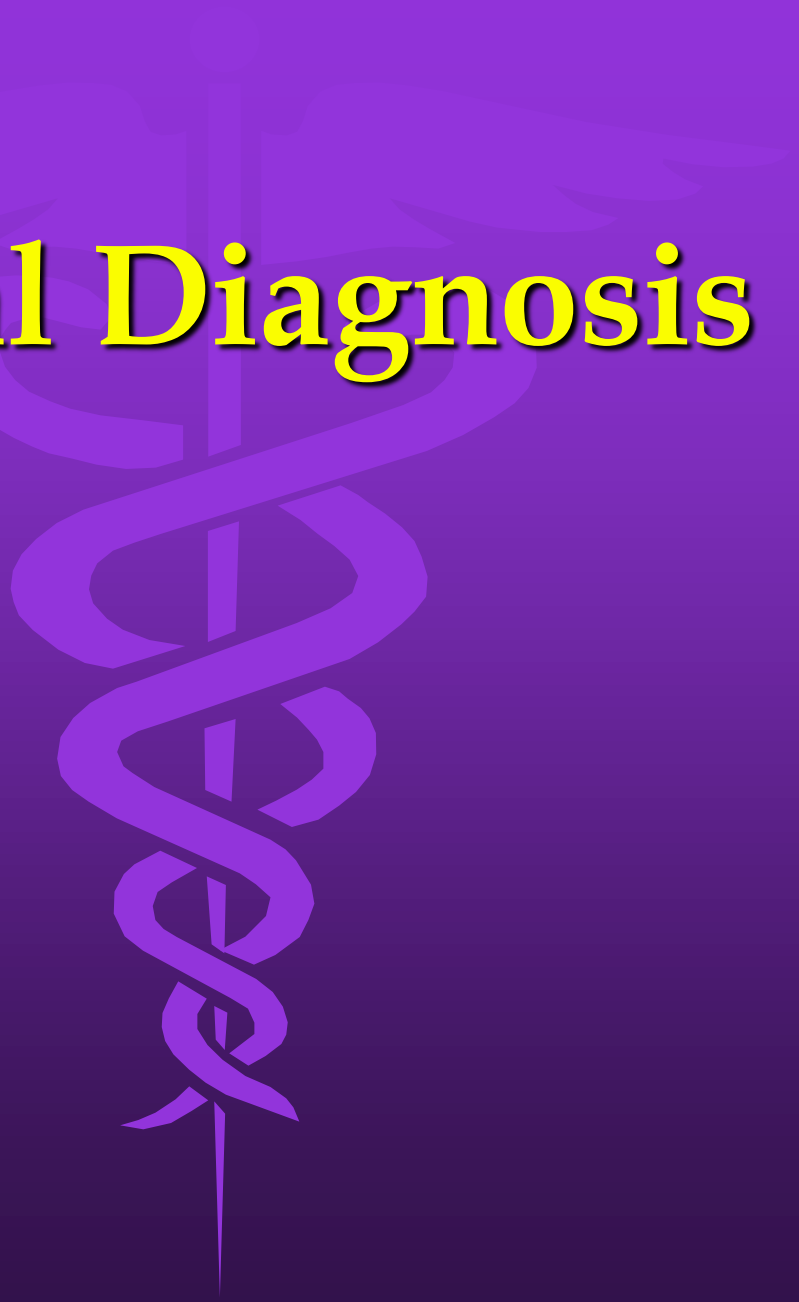
(Moed BR, Thorderson PK JBJSA 1993 Feb;75(2):231-5)

? More extensive release necessary



Common in forearm

Clinical Diagnosis



Physical Findings

- Pain out of proportion
- Pain with passive stretch
- Tight compartments

Physical Findings (cont.)

- ↓ sensation
- Weakness
- Inability to flex and extend ankle

Compartment Syndrome Myths

- Lose pulses
- Elevate leg
- Will not evolve

Special Attention

Uncooperative and unreliable patients

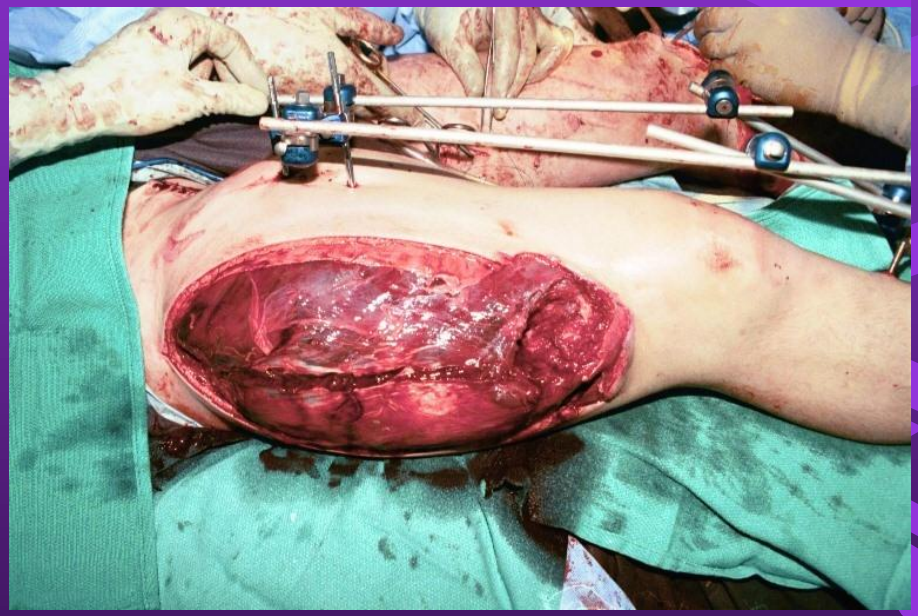
Unresponsive patients

Peripheral Neuropathies

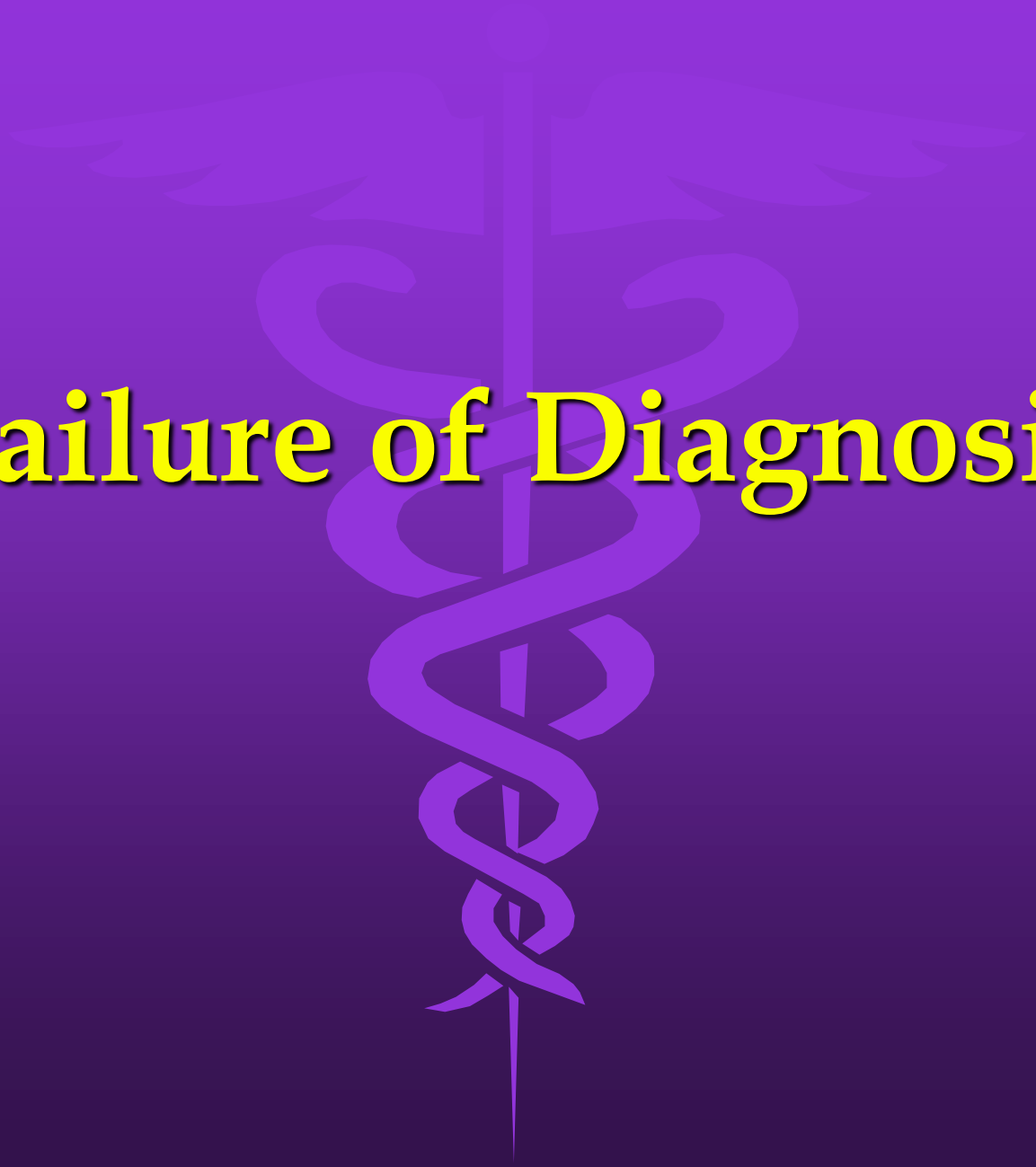
Skin Closure

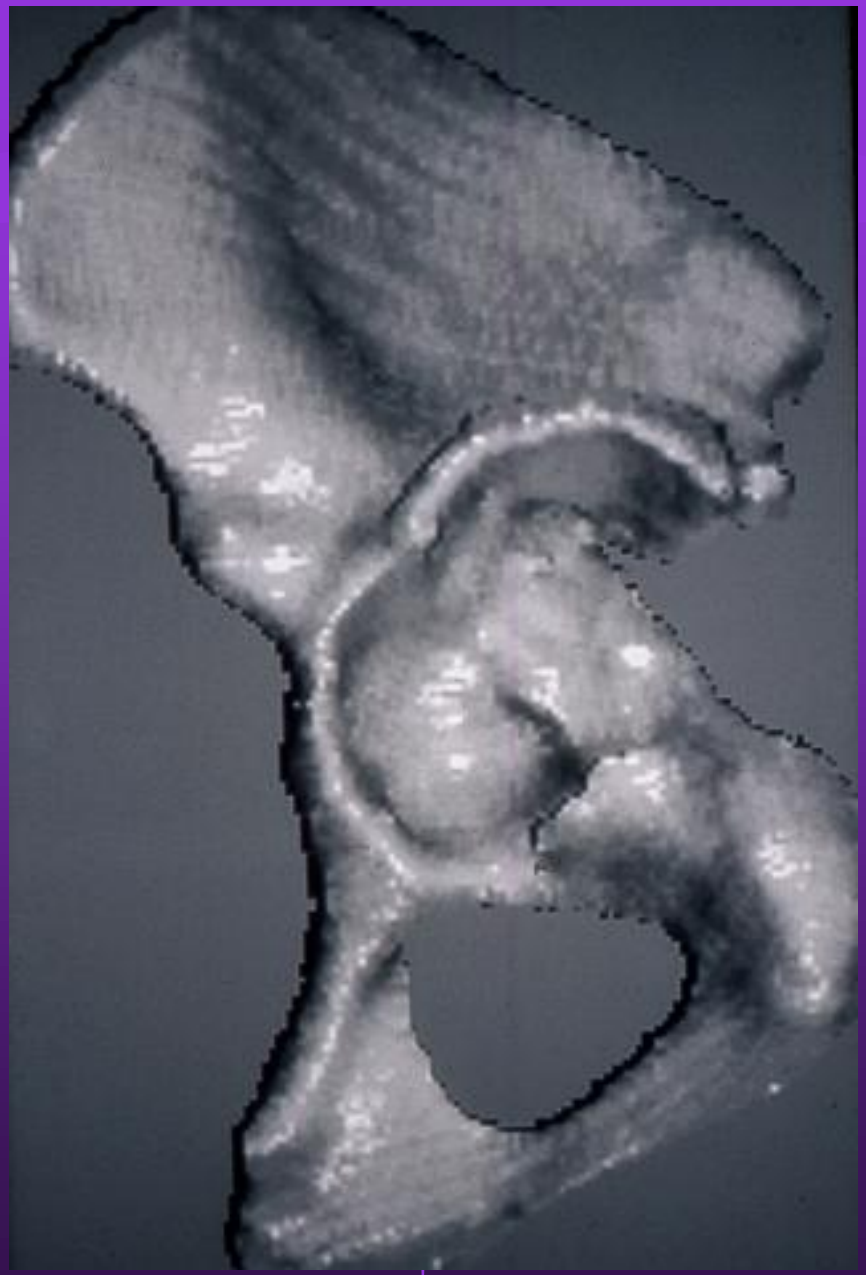
- may require STSG
- close medial wound first – at expense of lateral wound if necessary
  - lateral wound can be closed with STSG
  - medial might require muscular flap coverage
- prevent retraction of skin edges with gently tensioned vessel loops weaved through staples at skin edges
  - may obviate need for skin graft

Negative Pressure Wound Therapy

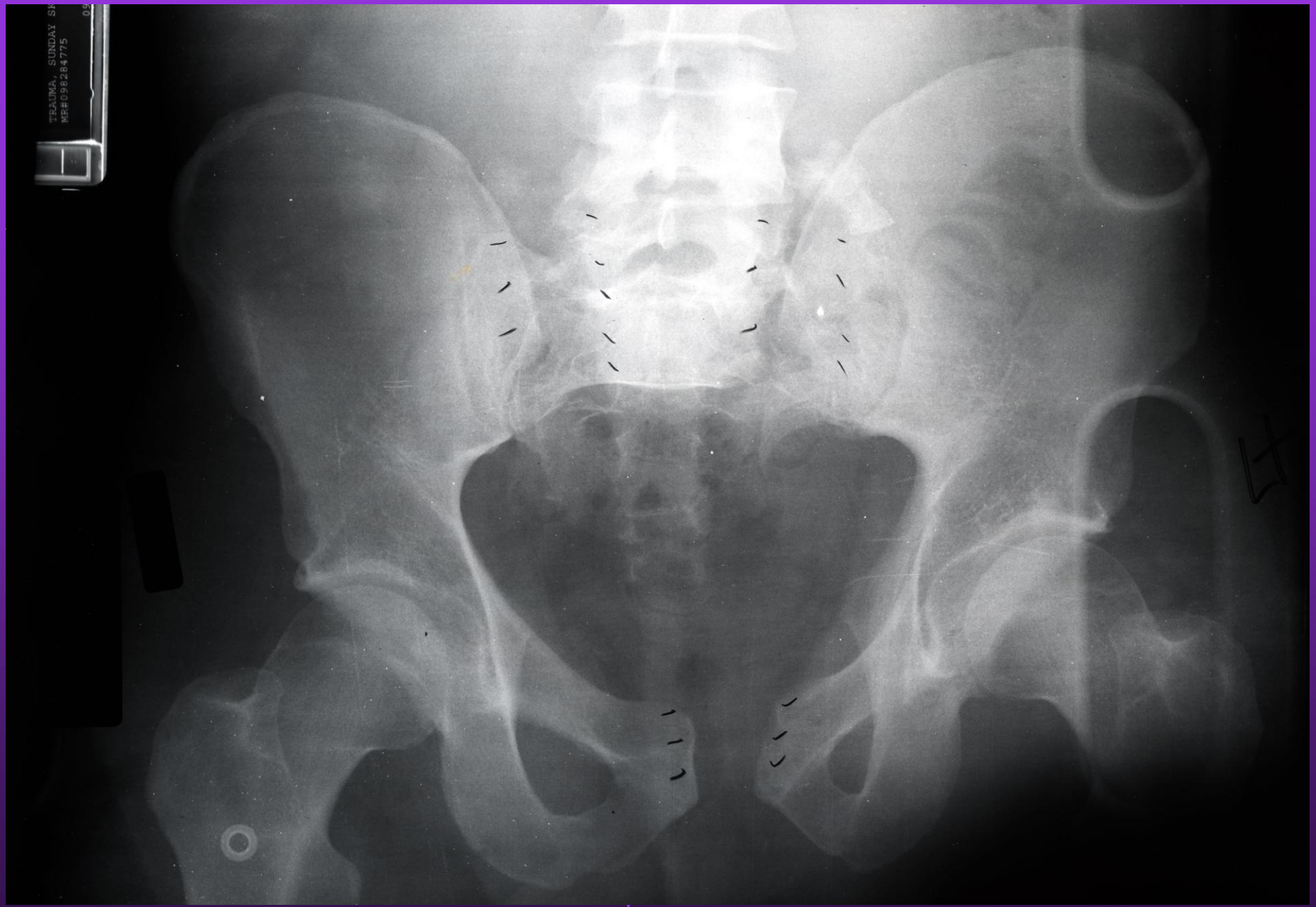


Failure of Diagnosis

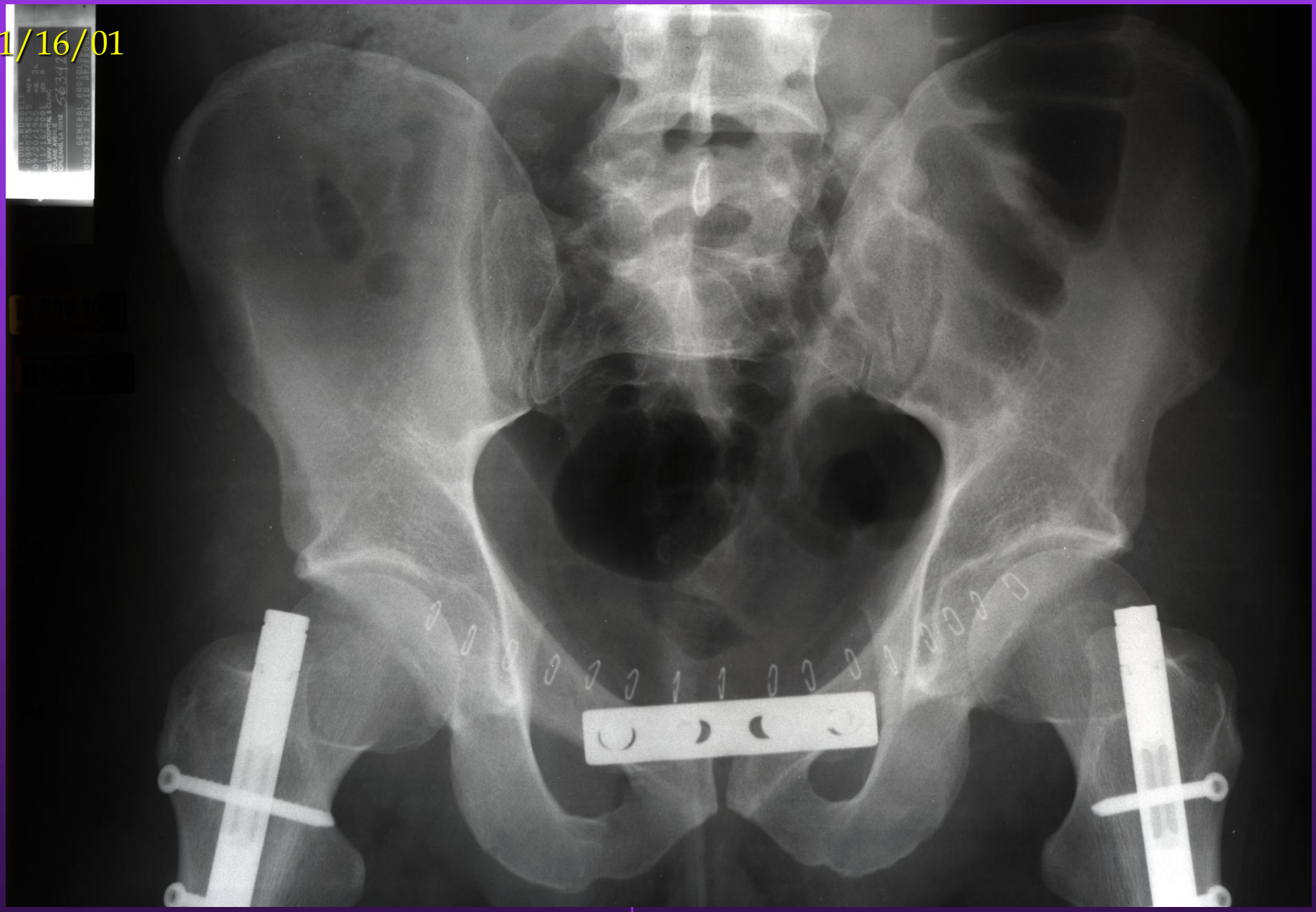




RL



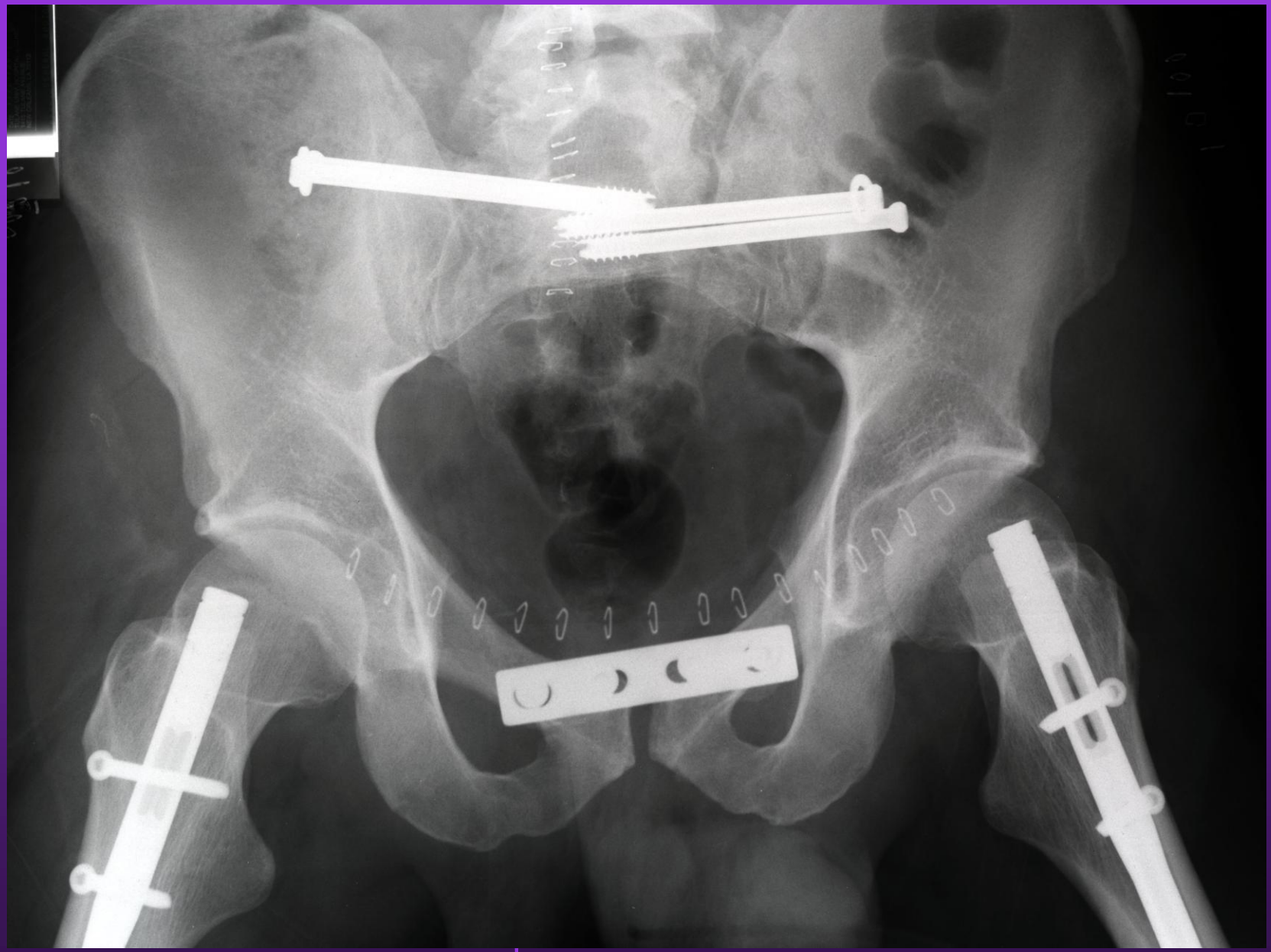
RL 11/16/01



RL 11/16/01


Reformat 29
Ex: 3169
Se: 2
L: 38.6 (coi)
S
Tulane Univ. Medical Center
LOUK,RUSSELL
M 36 D754535
Nov 16 2001
DFOV 15.0 cm
BONE
A
R
P
L
0.7/
kv 120
mA 330
1.9
3.8 mmHQ/1.9sp
Tilt: 0.0
07:49:20 PM
W = 2000 L = 350
I
A
R
L
P

RL 11/24/01

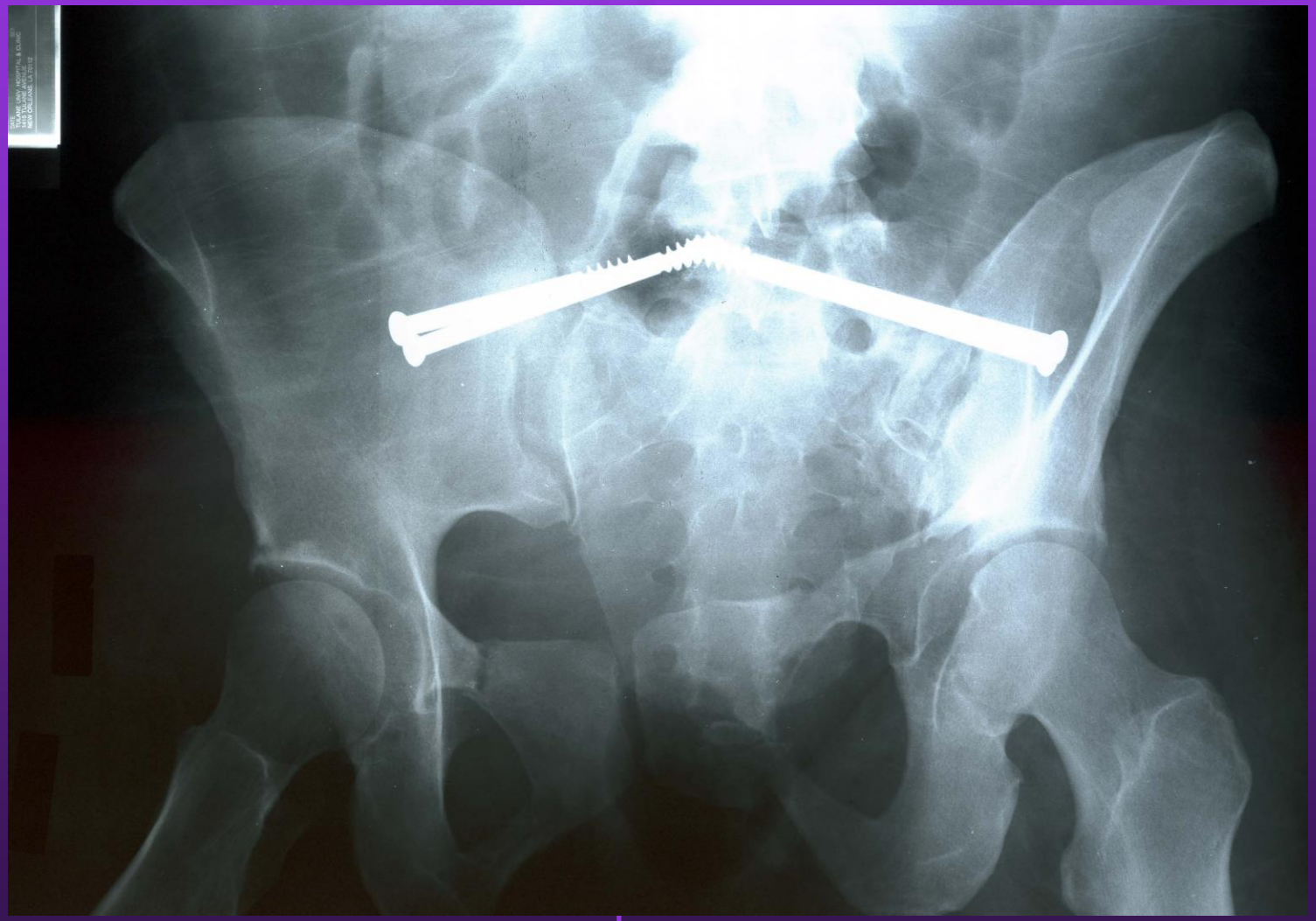


GV-11-11-02

GV-11-12-02


Se: 2
IC I516.28
Im: 67
DFOV 36.8cm
BONE
F 36 788894
DOB: Jul 15 1966
Nov 12 2002
512
R
1
3
3
L
2
3
5
kV 120
mA 300
Large
1.25mm/3.75 HQ
Tilt: 0.0
1.0s /HE 02:49:23/22.00

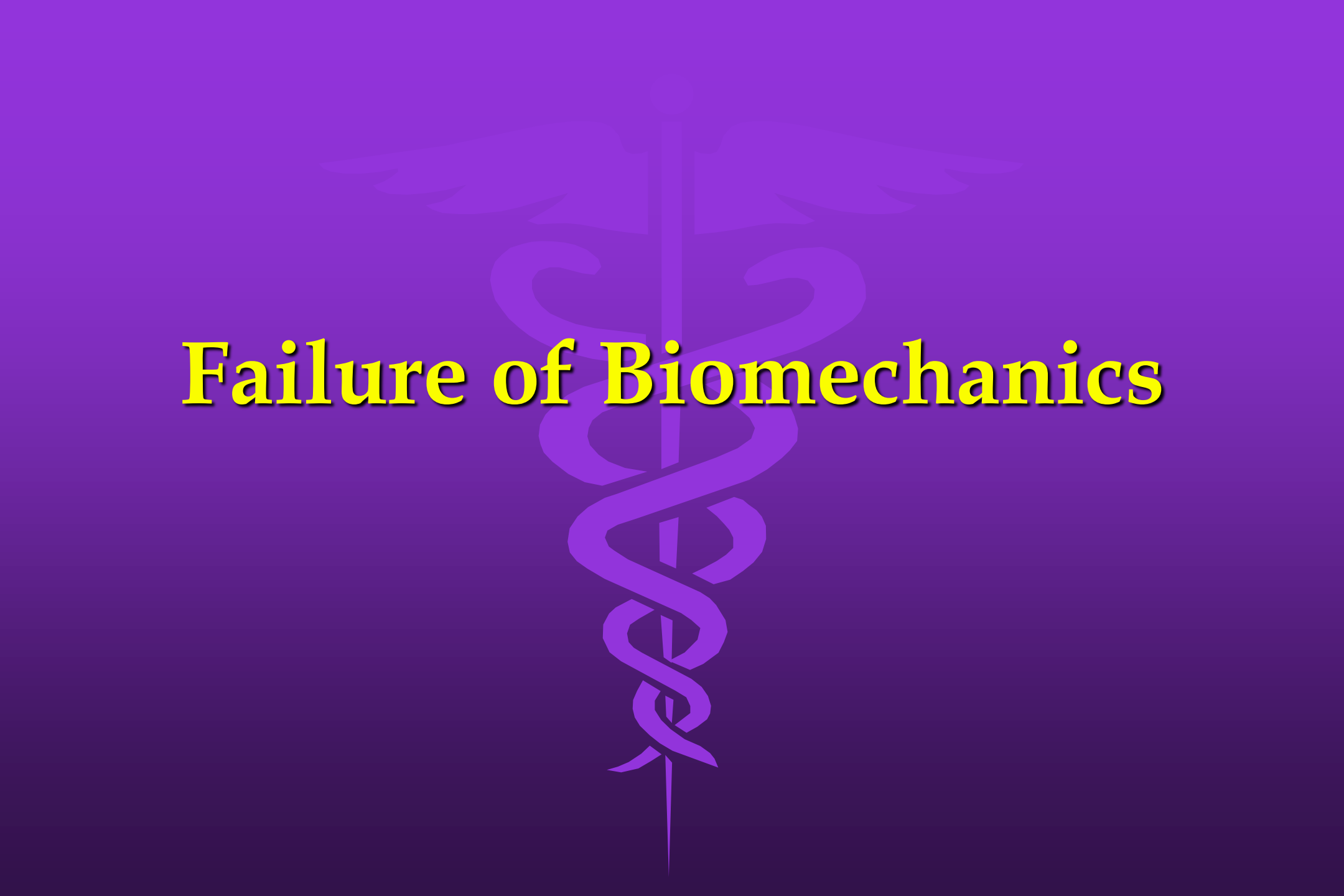
GV-11-21-02



GV-1-15-04

GV-6-17-04

Failure of Biomechanics



Schizophrenic Fixation

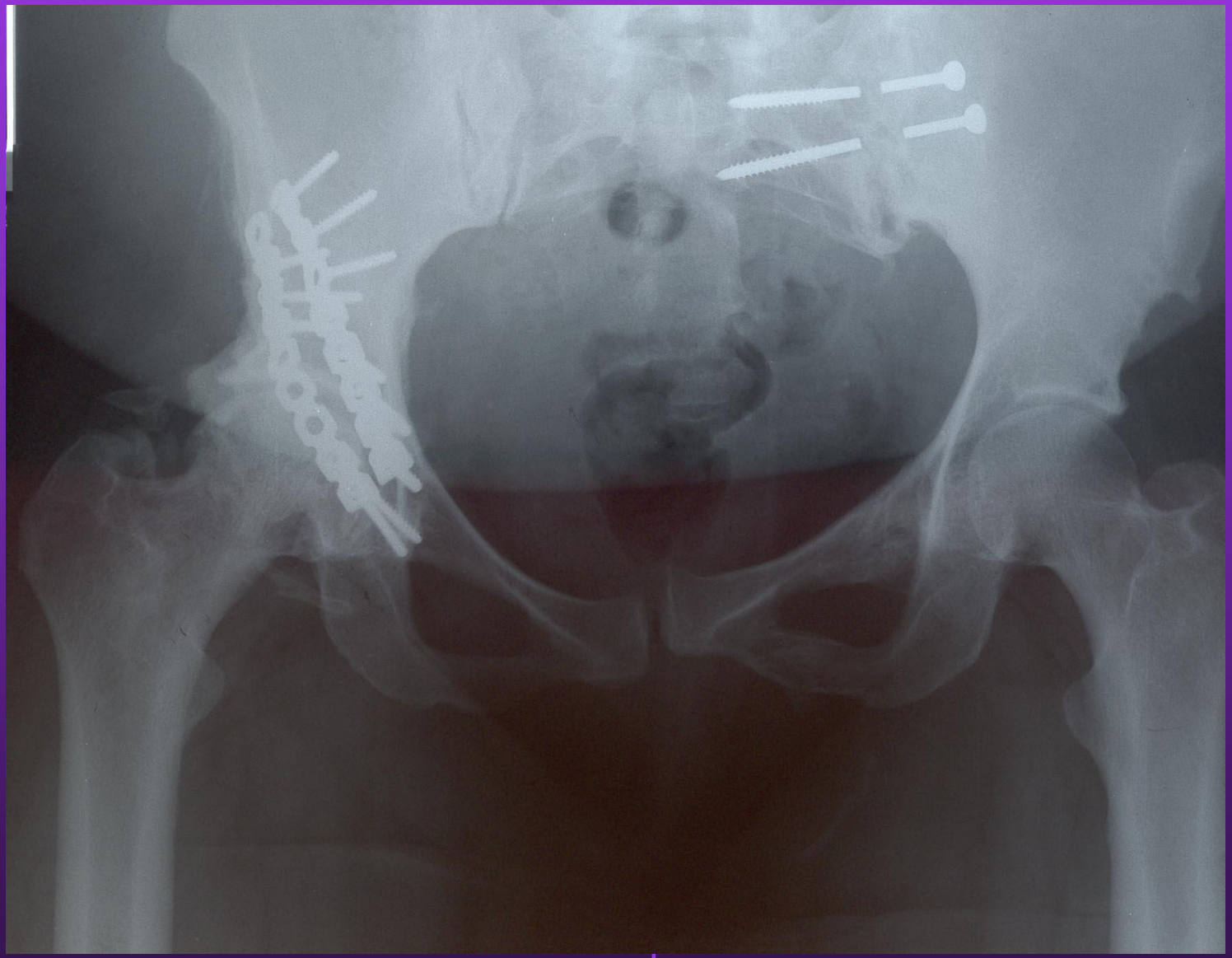
- Combining absolute fixation with relative fixation


NW


NW

NW
4 MO
R


SL
R

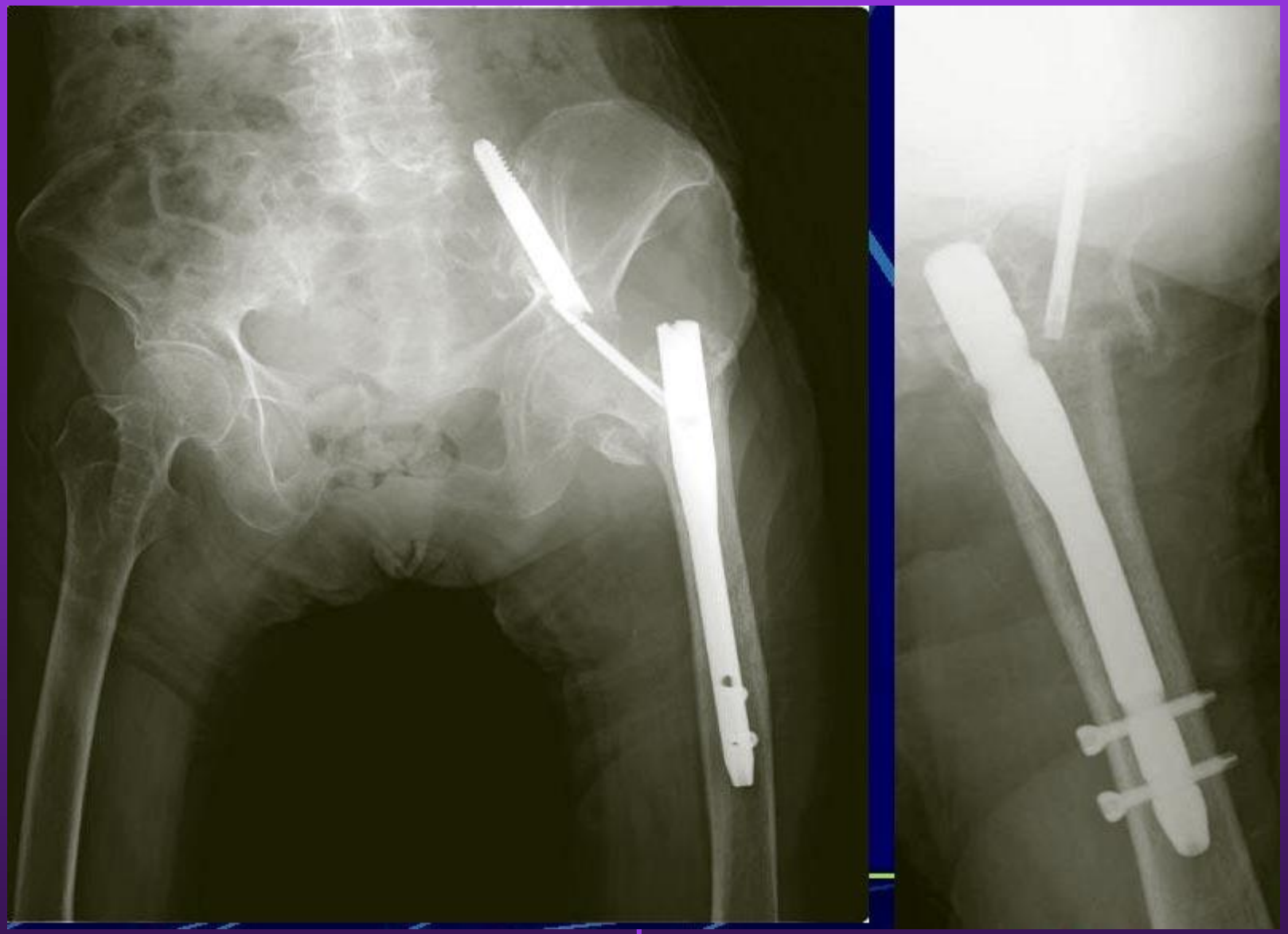


Know the Literature

i.e. 3.5 DCP for forearm fractures not 1/3 tubular


RC


RC



"A FOOL WITH A TOOL IS STILL A FOOL"

Infection


MESSAGE
02 11:12am
43515
85807
INTE MAIL
CLPK
42724
43513
HOLD
1
ABC 2
DEF 3
GHI 4
JKL 5
MNO 6
PRS 7
TUV 8
WXY 9
OPER 0
MUTE
SPKR
Security/85531
Emergency/55555
Royal

…Nature has her own doctor in every limb; therefore every surgeon should know that it is not he, but Nature, who heals

Paracelsus (1493-1531)