Treatment of Complex Tibia Injuries San Francisco May 2024

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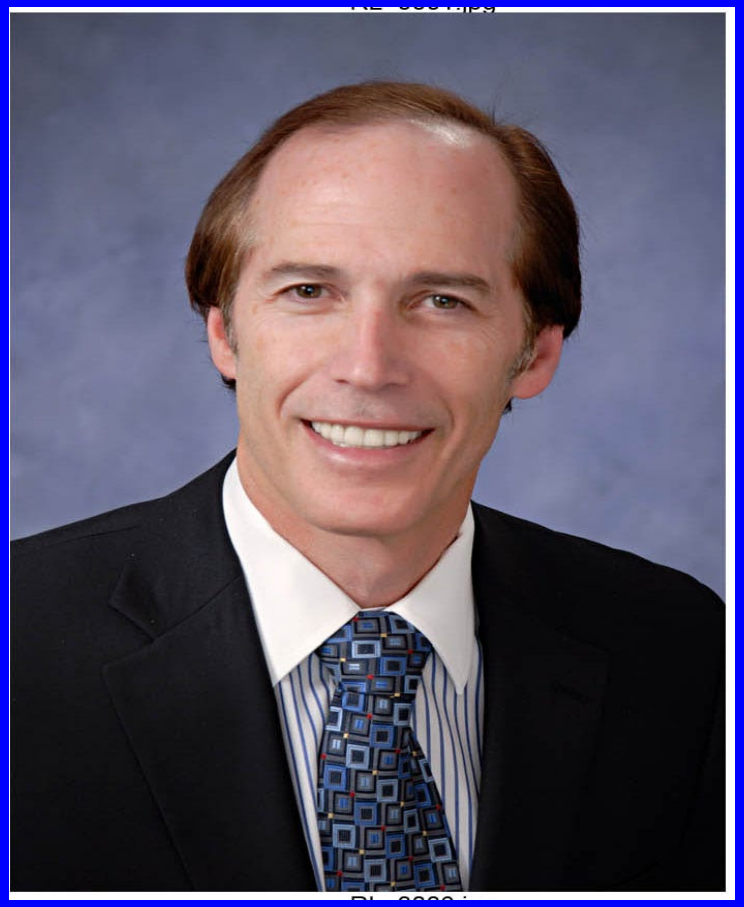
- Professor of Surgery
- Dalhousie University



Disclosure

I, Ross Leighton declare that in the past 3 years:

I have received support from the following companies:

- Etex Corporation
- Smith and Nephew
- Synthes
- Depuy
- Stryker
- Medtronic

I have/ done consulting work for the following companies:

- Etex Corporation
- Smith and Nephew
- Synthes
- Depuy
- Stryker
- Medtronic

I have done speaking engagements for the following companies:

- Etex Corporation
- Smith and Nephew
- Synthes
- Depuy

I or my family do not hold individual shares in the following:

Treatment of Complex Tibia Injuries

- TREATMENT OPTION
- Delayed definitive treatment is “risk free” as long as the soft tissues are addressed and stabilization of the environment has occurred
- better for the patient and the Surgeon
- Ross K. Leighton M.D.

10 hours from injury and now 2 AM

Delayed or Immediate OR

Classification of Open Fractures

- Type I
- Type II
- Type IIIA
- Type IIIB
- Type IIIC

Goals of Management of Open Tibial Fractures

- Early return to function
- Avoid complications

Complications

- Infection
- Malunion
- Nonunion

Emergency Room Management

- Assessment
- Reduction and splinting
- Wound care
- Tetanus prophylaxis
- Antibiotics

Emergent Operating Room Management

- Resuscitation
- Timing of Surgery- ASAP –within 24 hours??
- Trauma scrub
- **Debridement and irrigation—the most important by far**
- Skeletal stabilization- the next most important step
- Open wound
- Antibiotic bead pouch

Interesting info. to help truly appreciate the magnitude of the soft tissue injury

- Energy Transfer
  - Fall from curb
    - 100 ft-lbs
  - Skiing
    - 300-500 ft-lbs
  - High-Velocity GSW
    - 2000 ft-lbs
  - Automobile Bumper @ 20 MPH
    - 100,000 ft-lbs

Classification of Soft Tissue Injuries-Closed Fractures

- Tscherne Type 0:
  - Minimal soft tissue injury
  - Indirect injury mechanisms
  - Simple fracture patterns.

Classification of Soft Tissue Injuries-Closed Fractures

- Tscherne Type I:
  - Superficial abrasion or contusion (pressure from within)
  - Mild to moderate severe bony injury

Classification of Soft Tissue Injuries-Closed Fractures

- Tscherne Type II:
  - Deep, contaminated abrasions or muscle contusion
  - Impending compartment syndrome
  - Severe fracture pattern

Classification of Soft Tissue Injuries-Closed Fractures

- Tscherne Type III:
  - Extensive skin contusion or crush
  - Severe underlying muscle damage
  - Subcutaneous avulsion (degloving)
  - Associated major vascular injury
  - Severe, comminuted fracture pattern

Soft Tissue Management

- At least as important or MORE "important" than skeletal stabilization

Skin Antisepsis before Surgical Fixation of Extremity Fractures

The PREP-IT Investigators

*

—

- **CONCLUSIONS—6785 PATIENTS**
- **Among 5000 plus patients with closed extremity fractures, skin antisepsis with iodine povacrylex in alcohol resulted in fewer surgical-site infections than antisepsis with chlorhexidine gluconate in alcohol.**

- In patients with open fractures, 1700, the results were similar in the two groups. (Funded by the Patient-Centered Outcomes Research Institute and the Canadian Institutes of Health Research; PREPARE ClinicalTrials.gov number, **NCT03523962. opens in new tab**.)
- This was just not powered to show a difference but should be considered in prepping closed fractures and probabloy open fracture
- No skin compromise was seen with either agent in this peospective randomized study

OPEN WOUND MANAGEMENT

- LEAVE OPEN-- if above a grade two
- Do not close under tension
- IS THERE A ROLE FOR PRIMARY WOUND COVERAGE?—Probably
- But never can be wrong with a second look in 48 hours
- ANTIBIOTIC BEAD POUCH --if open
- Stimulan (Calcium sulfate beads) if you close the wounds

Reamed Nailing of Open Tibial Fractures: Does the Antibiotic Bead Pouch Reduce the Deep Infection Rate?

Keating JF, Blachut PA, O'Brien PJ, Meek RN and Broekhuyse HM

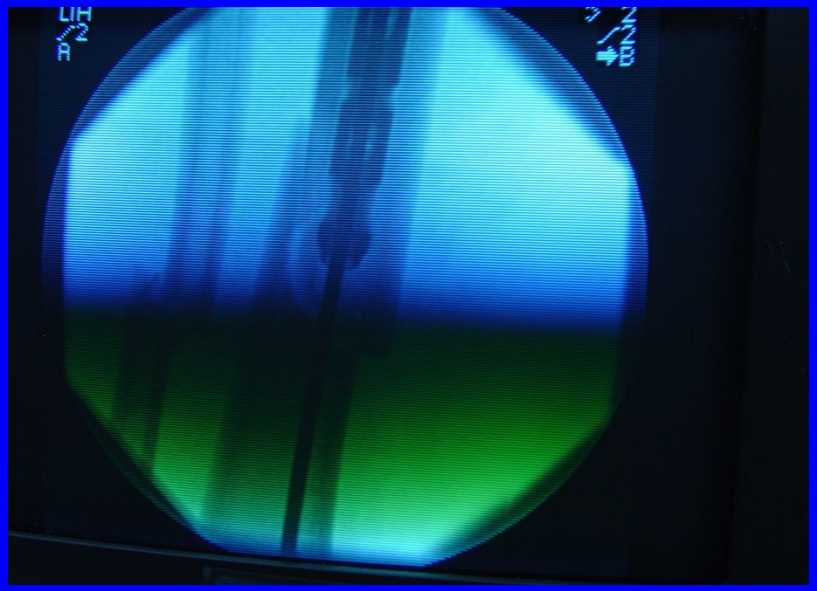
J Orthop Trauma 10(5):298-303, 1996

ANTIBIOTIC BEAD POUCH

- 81 OPEN TIBIA FRACTURES randomized to bead pouch and no bead pouch
- - INFECTION RATES
  - **–NO BEAD POUCH - 16%**
  - **–BEAD POUCH - 4%** VGH/UBC

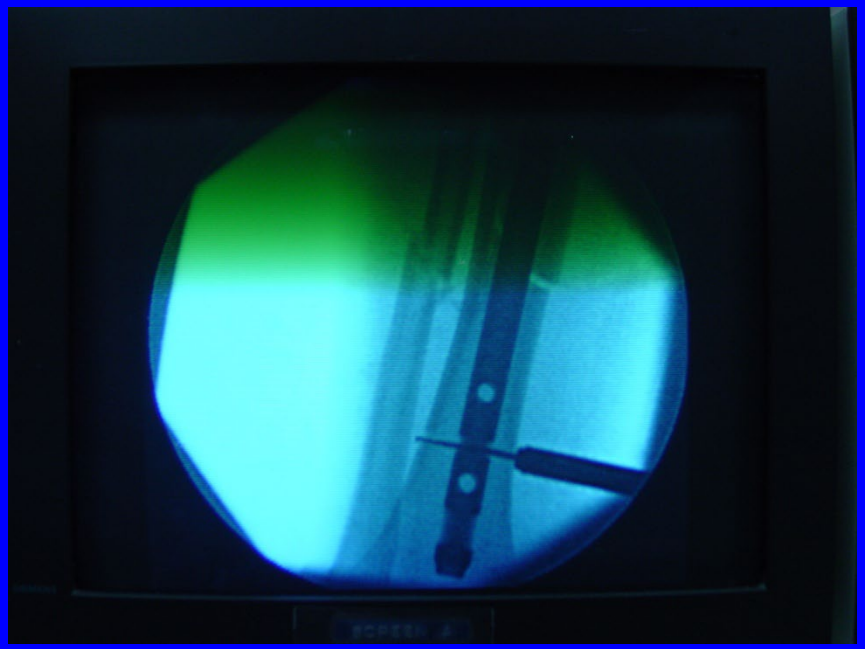
This is done on a radiolucent table

Nail Insertion



Lock Proximally

Lock Distally
Use bead pouch if left open, depot of antibiotics -Vancomycin or Stimulan if closed



Type II Open

- Hamilton (MacMaster) reviewed this 15-17 years ago in an effort to get more OR time
- They set out to prove that a delay would increase the infection rate
- No difference could be detected when comparing rapid verses delayed debridement

Chapman et al
UC Davis 1998

- Early versus delayed debridement

- No difference in outcome
- Conclusion—Treat with early gross clean up and splint in Emergency
- Cover with a dry dressing and splint the joint above and below the fracture
- OR –ASAP- when the team is ready
- Ie -- within 12 to 24 hours

Grade IIIC
Open Fractures

Open Fractures IIIC

- Amputation

vs.

Salvage

Rest of Survey

- Chest, belly, pelvis are benign
- L lower extremity is badly injured below the knee
- Patient is unconscious
- No motor or sensory responses
- No pulses despite reduction of #s
- What to do? When?

LEAP STUDY

- RECONSTRUCTION OR AMPUTATION OF LOWER LIMB-THREATENING INJURY:
- 2 YEAR CLINICAL AND FUNCTIONAL OUTCOMES
  - BOSSE, MACKENZIE, KELLAM, ET AL
- OTA 2001

Leap Study

- Mean Time from Injury to Level 1 Trauma Center admission---**Significant difference if delayed**
- **No difference** –Mean time from Injury to first debridement---average time >13 hours

  -Mean time from admission to first debridement

  -Mean time from first debridement to coverage

Reamed Interlocking Intramedullary Nailing of Open Fractures of the Tibia

Keating JF, O'Brien PJ, Blachut PA, Meek RN and Broekhuyse HM

CORR 338:182-191, 1997

Open Fractures

- Tornetta, JBJS(B), 1994
  - Treatment of grade IIIB open tibial fractures (A prospective, randomised comparison of external fixation and non-reamed locked nailing)
  - Sprint study (2006) showed similar results for minimally reamed Im nails
  - **A compound fracture should now have a minimally reamed nail –just to get the nail to a diameter that accepts a 5 mm screw**

Study in The OTA

- Early Closure of compound fractures

- Of Note in the protocol they must go to the OR within 24 hours---Not 4 to 6 hours!!!
- No difference if no tension on the wounds!!

Open Fractures (II - IIIB)

- Delay is based on Team, Institution and ability to get guaranteed time the next am
- (When the Team is ready)
- Locked Minimally reamed IM nailing is treatment of choice

BUT

nonunion and infection are still a problem

Early debridement does not alter these problems

Proper debridement is the key and does alter the outcome

We are all trying to avoid this !!!!

What are the first steps in the workup of this patient?

- Inflammatory labs (ESR, C-RP, WBC)
- PET scan
- Bone Scan
- Magnetic Resonance Angiography
- Treat with antibiotics

- Discussion

Present Treatment of Open Fractures at Dalhousie University

- Limb and Life threatening injuries go to the OR AS soon as possible –----------Day or Night
- All others –cleaned of any debris and most importantly splinted with a long leg splint
- IV antibiotics Kefzol plus or minus Gentamycin and penicillin
- Usually taken to the OR during the day in the Orthopedic Trauma Waitlist Room
- In the OR-- they are adequately debrided and fixed with a minimally reamed locked IM Nail (95%)

  or an Ext Fix (5%)

Summary

- Locked IM nailing (2 screws proximal and distal) when the OR and the Team are ready,
- This is the treatment of choice for open (Grade II - IIIB) tibial shaft fractures
- Reamed and unreamed nails have similar results - infection 3-7%, nonunion - 10%
- Unreamed nails have a small increase in implant failures due to small screw diameter.

THANK YOU

THANK YOU

Halifax Waterfront

Thanks to the OTA and our course organizers for this Great Format and Wonderful Venue

Capital Health District
Orthopaedic Department

ARS --A 42-year-old male has a midshaft open tibia fracture with 11 cm of bone loss.

What is your initial treatment of this fracture?

1) Cast and send home
2) Splint and elevate for 2 weeks till swelling goes down then ORIF
3) Antibiotics and flexible nailing
4) Antibiotics, irrigation and debridement, and external fixation
5) Antibiotics, irrigation and debridement, and casting

Preferred Response -4

- DISCUSSION: The initial goal of treatment for open tibia fractures with a large bone defect is boney stability, soft tissue coverage, and avoidance of infection. One method to achieve these goals is to treat with antibiotics, debride and the externally fix the fracture.

- REFERENCE: (Apard, Bigorre et al. 2010; Hutson, Dayicioglu et al. 2010)

Reamed IM Nailing

- 112 open tibia fractures
  - Nonunion 8%
    (I-3%, II-5%, IIIA-13%, IIIB-17%)
  - Malunion 6%
  - Deep Infection 5%
  - Compartment syndrome 7%

Keating, et al

Open Fractures

	N	*Nonunion*	*Infection*
Grade I	**31**	**1 (3%)**	**0 (0%)**
Grade II	**38**	**2 (5%)**	**4 (10%)**
Grade IIIA	**23**	**3 (13%)**	**0 (0%)**
Grade IIIB	**20**	**3 (17%)**	**2 (11%)**
	112	**9 (8%)**	**6 (5%)**

Keating, 1997

Open Fractures

	Ext. Fix	*UTN*
Number	14	15
Deep infection	7%	7%
Malunion	14%	0%
Healing time	28 wks	23 wks
Bone grafting	79%	73%
Pin site infection	21%	-
Knee ROM	0-120°	0-130°
Ankle ROM	0-30°	0-35°

Tornetta JBJS(B), 1994

External Fixation or Interlocked Intramedullary Nail

Review of the Literature

- IM Nail
  - no difference in infection and nonunion rates
  - lower risk of malunion
  - fewer secondary procedures
  - better patient compliance
  - early functional return
  - technically simpler

ARS

- A 21-year-old male has a midshaft open tibia fracture with 10 cm of bone loss and need for a free flap for anteromedial soft tissue coverage. You initially debride the wounds and then place an external fixator and a negative pressure dressing. The patient then is treated with an anteromedial free-flap 7 days after injury.

What is the next surgical treatment for this patient if there is no infection?

1) Percutaneously inject aspirate from the iliac crest
2) Elevate the flap and insert bone morphogenic protein
3) Bone transport
4) Elevate the flap and insert calcium phosphate
5) the flap and insert platelet rich plasma

Preferred Response -3

DISCUSSION: The treatment of massive bone loss can be fraught with complications. However, bone transport after flap coverage of bone defects has been shown to be a relatively safe and effective procedure for reconstitution of bone loss of the tibia.

- REFERENCE: (Minehara, Yokoyama et al. 1998

ARS

- A 25-year-old male has a midshaft open tibia fracture with 5 cm of bone loss and need for a free flap for anteromedial soft tissue coverage. You initially debride the wounds and then place an external fixator and a negative pressure dressing. The patient is then treated with an anteromedial free-flap 7 days after injury

What is the next surgical treatment for this patient if there is no infection?

1) Place calcium phosphate in the defect
2) Elevate the flap and insert BMP
3) Plate tibia, place a polymethylmethacrilate (PMMA) block into defect at time of flap and then bone graft in 6 weeks
4) Plate and bone graft at time of placement of flap
5) Elevate the flap and insert platelet rich plasma

Preferred Response-3

- DISCUSSION: There are several ways to approach treatment of open tibia fractures with a bone defect of 5 cm. One of these is to plate the tibia, insert a PMMA block into the tibial defect, and then bone graft 6 weeks later. All of the other options are not recommended at this time.

- REFERENCE: (Taylor, French et al. 2012)

Discussion case

- A 53-year-old smoker has a history of an open proximal tibia fracture treated with an intramedullary nail 2 years ago. The patient is complaining of pain and has a draining sinus with hypertrophic nonunion. He is physiologically stable


L

Preferred Response but lots of answers

DISCUSSION: The initial assessment of patients with a draining sinus and a previous tibial fracture includs inflammatory labs and x-rays. Bone scan has a low sensitivity and specificity. MRI may be useful to assess the extent of the infection if needed. Evaluation for medical comorbidities such as diabetes and smoking are also essential.

- REFERENCE: (Patzakis and Zalavras 2005)

Case - St. Elsewhere

- 38 F

- Motorcycle hit by car 27/10/2010
- Comminuted left tibia (Gustillo IIIC)
- Fractured Left patella
- Right comminuted patella (closed)


+6mAs
+35msec
kV:80
Femur/AP
PORTABLE
REX#462
Left
LgM:1390
AP FEMUR
Exp Index:
EI:


+6mAs
+35msec
kV:75
Tib/Fib Lat
PORTABLE
REX#738
Left
LgM:2454
LAT TIB/FIB
Exp Index:
EI:


Ankle Lateral
PORTABLE
Left

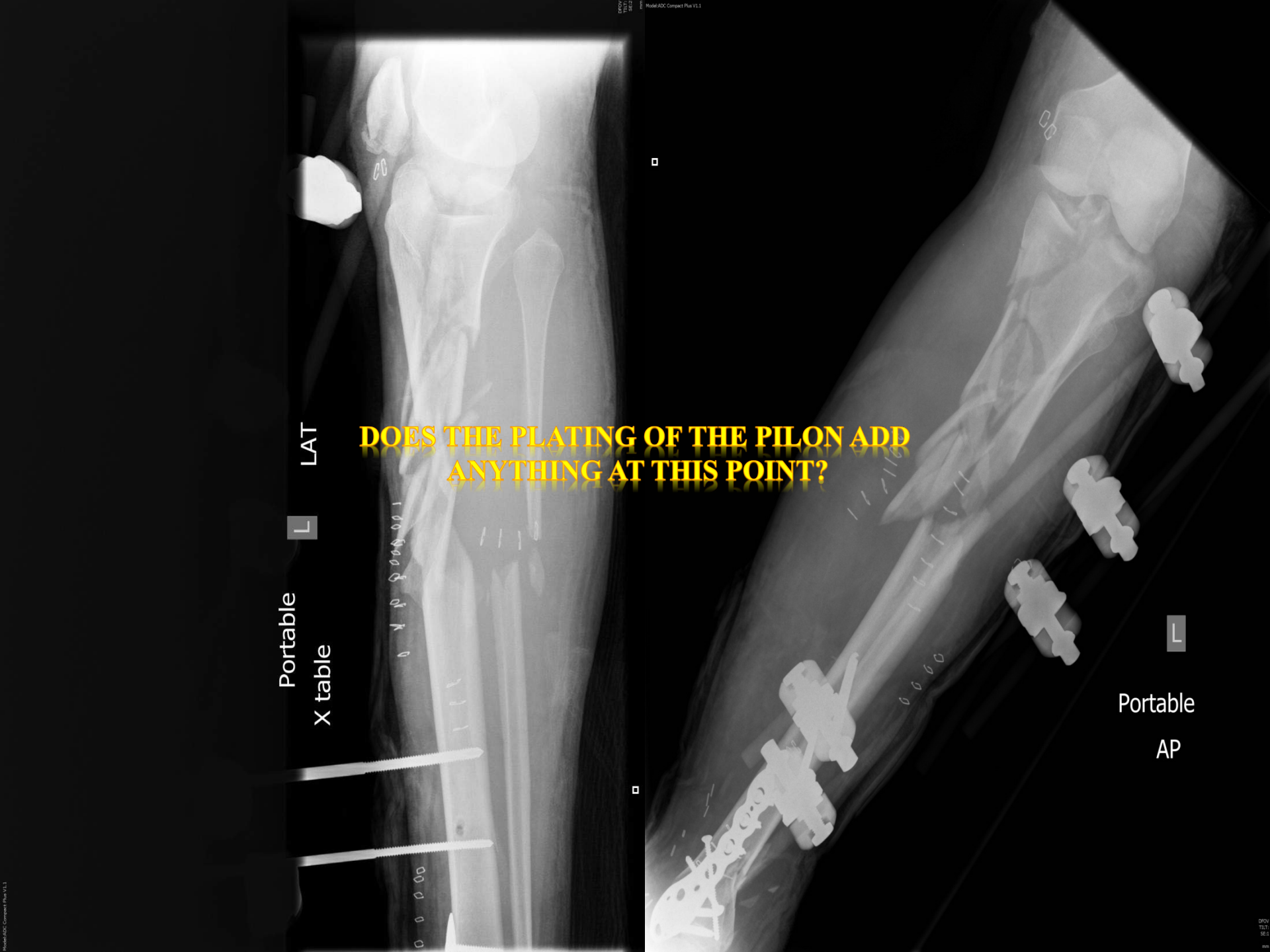
Initial management of open fractures?

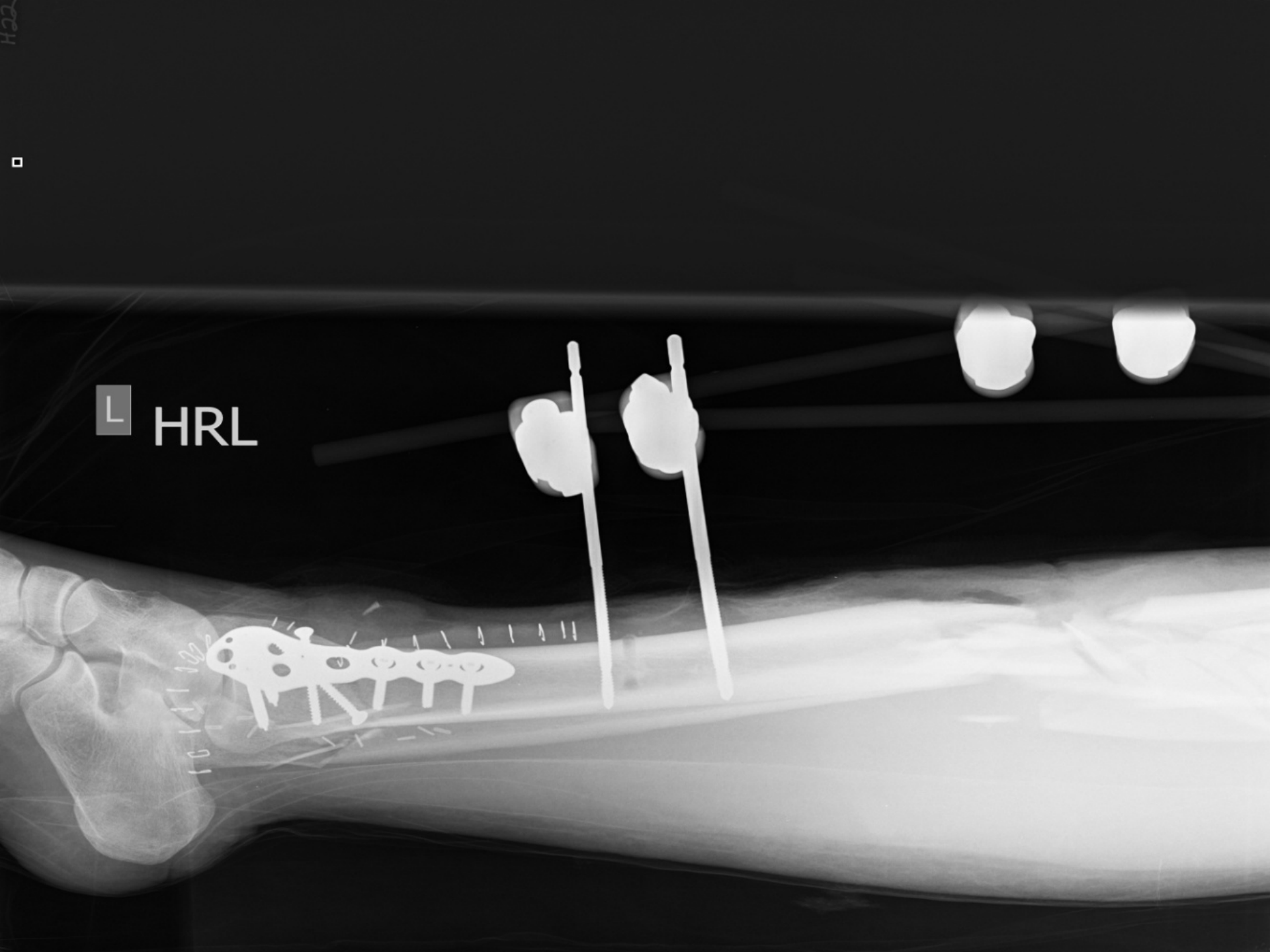
(ATLS) protocol

- Immobilization?
- Analgesia?
- Antibiotics?
- Tetanus prophylaxis?
- Photography?
- Dressing?

St. Elsewhere 27/10/2010

- ***27/10/2010 I and D left leg and external fixation***
- ***ABI=0.9 poor muscle function due to nerve injury***
- ***Transfer to your center 28/10/2010***


DOES THE PLATING OF THE PILON ADD ANYTHING AT THIS POINT?
Portable
X table
LAT
L
Portable
AP
L


L
HRL

You see at 9 Am with the following findings 30 hours after injury

- O/E
- Insensate foot, no motor function
- No pulses but flow with doppler– warm foot
- Swollen very firm leg--globally

Management?

- What now???

28/10/2010

- Fasciotomy
- Exploration
- Debridement of devitalised tissues
- ORIF ?
- Tendon of tibialis anterior left free by the ankle
- Anterior frame to support patella tendon
- Cement beads/Ioban drape/large dressing
- Doppler of TP+--- good flow

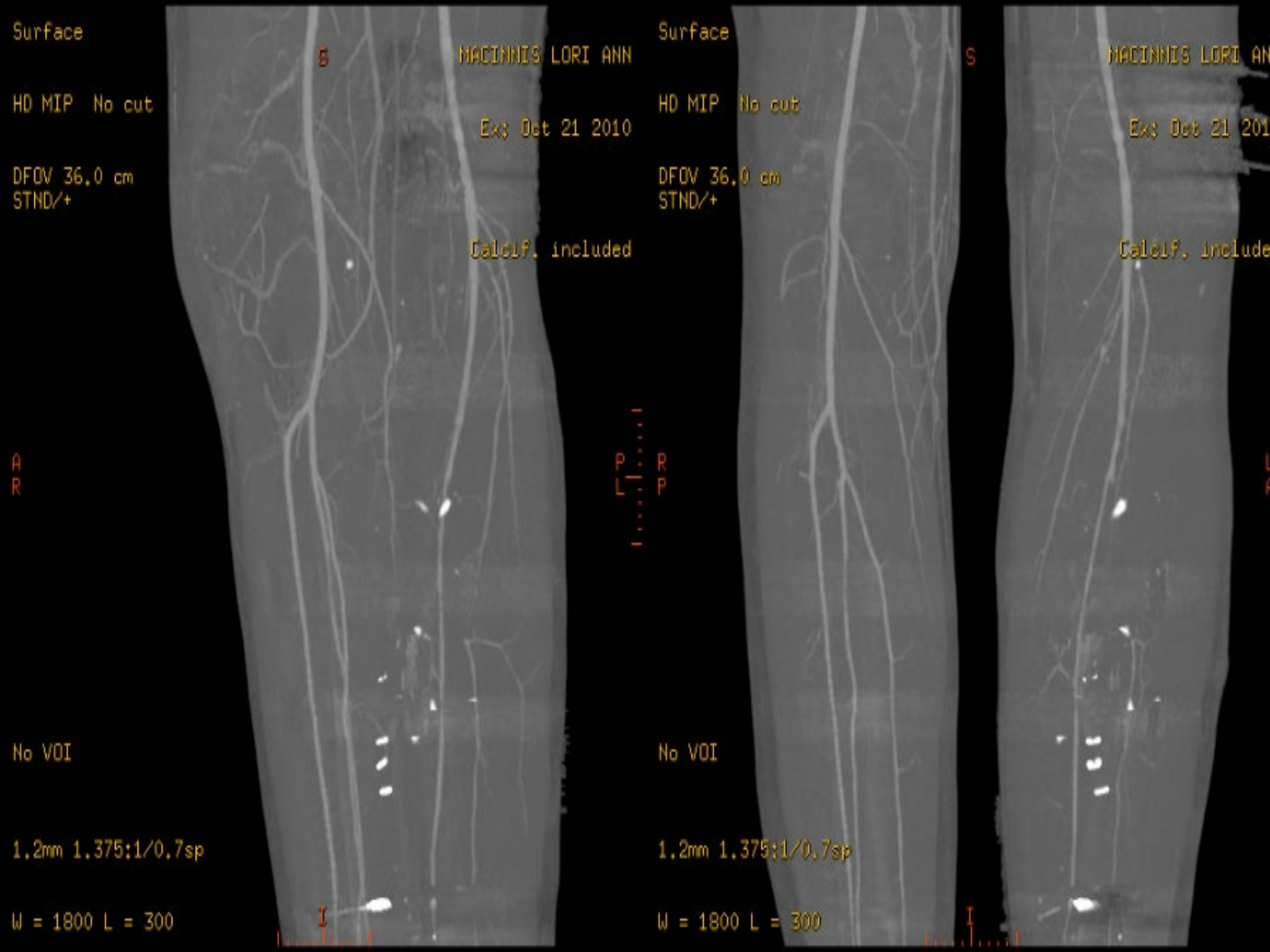
Assessment?

- What next ??

Assessment?

- Angiography/Arteriogram

- Occluded tibial peroneal trunk
- Significant stasis peroneal artery
- Left anterior tibial artery good run off
- Psseudoaneurysm above ankle joint
- Abrupt termination of main trunk of PTA very low down
- 2 vessel run off


Surface
S
MACINNIS LORI ANN
HD MIP No cut
Ex: Oct 21 2010
DFOV 36.0 cm
STND/+
Calcif. included
A
R
P
L
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No VOI
1.2mm 1.375:1/0.7sp
W = 1800 L = 300
I
Surface
S
MACINNIS LORI AN
HD MIP No cut
Ex: Oct 21 201
DFOV 36.0 cm
STND/+
Calcif. include
No VOI
1.2mm 1.375:1/0.7sp
W = 1800 L = 300
I

30/10/2010

- Major debridement
- Plastics surgeons present
- Loss of all lateral and anterior muscles. Loss of lateral head of gastrocnemius. Soleus OK.
- Dessicated bone 8 cm, mid tibia stripping
- Foot warm doppler pulse biphasic at posterior tibia, ABI 0.9
- Bead pouch designed over large anterior defect

01/11/2010

- Further I and D
- No motor or sensory function distally
- Viability in question
- Gentamycin beads changed

12/11/2010

- Bone defect 3.5 cm in length
- Soft tissue defect over entire tibia
- Plastic surgeons performed an anteromedial thigh flap and SSG (Difficult anastomosis)


HRL
L
HRL
L

19/11/2010

- Removal of failed flap and BKA through bone and plate
- Catheter up tibial nerve to reduce neurogenic pain and prevent phantom pain
- Compression dressing and POP shell


5mAs
10msec
kV:65.9
2011/03/30
11:01:21
R
LgM:409
T Knee AP/PA
Exp Index:
EI:


2mAs
4msec
kV:65.9
2011/03/30
11:01:21
R
LgM:207
T Knee LAT
Exp Index:
EI:

ARS Question

- 48-year-old male has a midshaft open tibia fracture with 4 cm of bone loss and need for a free flap for anteromedial soft tissue coverage. You initially debride the wounds and then insert a nail and cover the open wound with a negative pressure dressing . The patient then is treated with an anteromedial free-flap 3 days after injury without complication

What is the next surgical procedure for this patient??

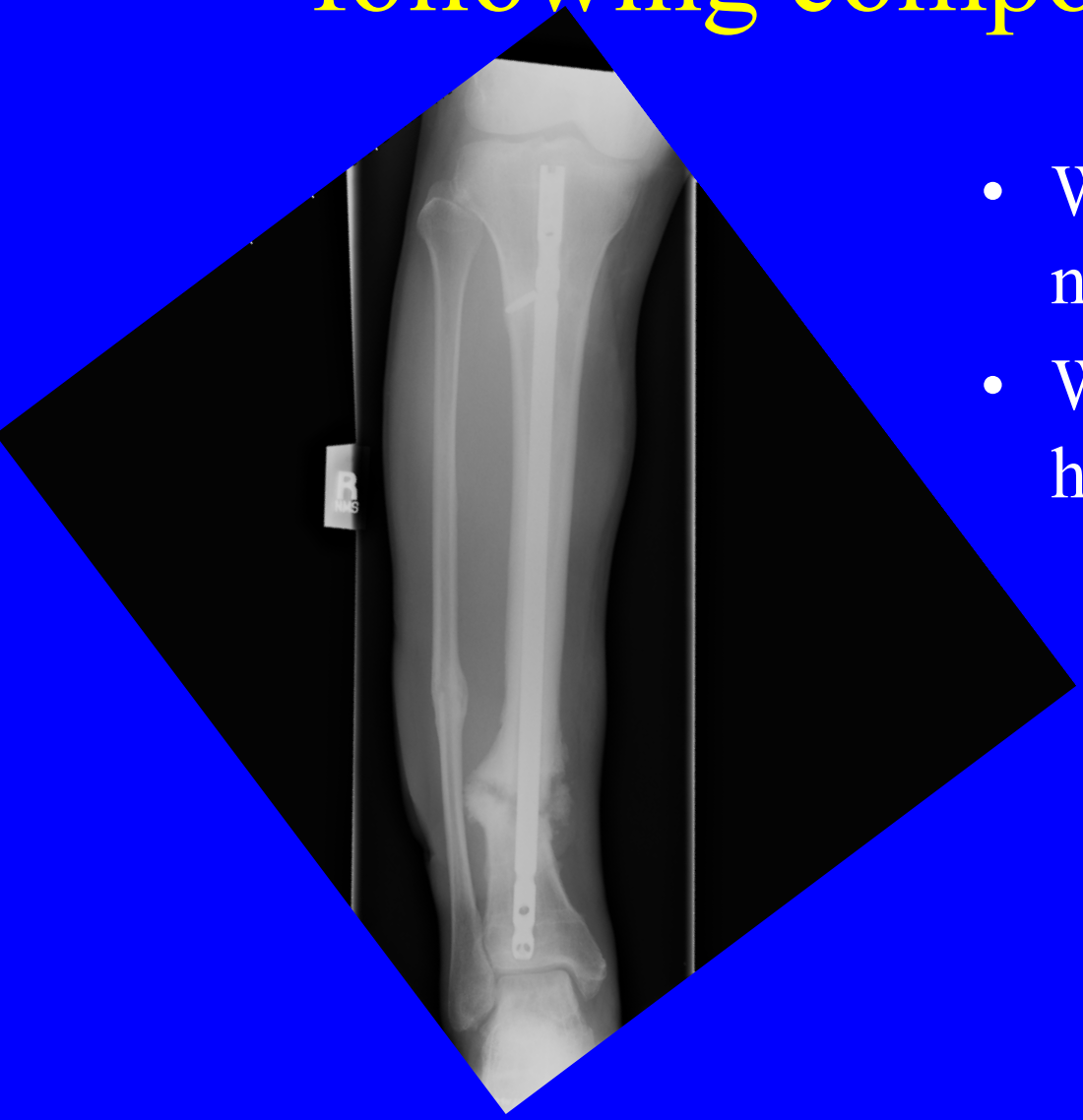
1) Percutaneously inject aspirate from the iliac crest
2) Percutaneously inject BMP
3) Elevate the flap and insert iliac crest bone graft
4) Elevate the flap and insert calcium phosphate cement
5) Percutaneously inject platelet rich plasma

Preferred Response- 3

- DISCUSSION: The initial treatment goals are to stabilize the soft tissues and bone. After this is done, the defect is treated with bone grafting to achieve union. Calcium phosphate is used to fill metaphyseal defects that need structural support. Injection of platelet rich plasma, BMP, and iliac crest aspirate have not been shown to be effective.

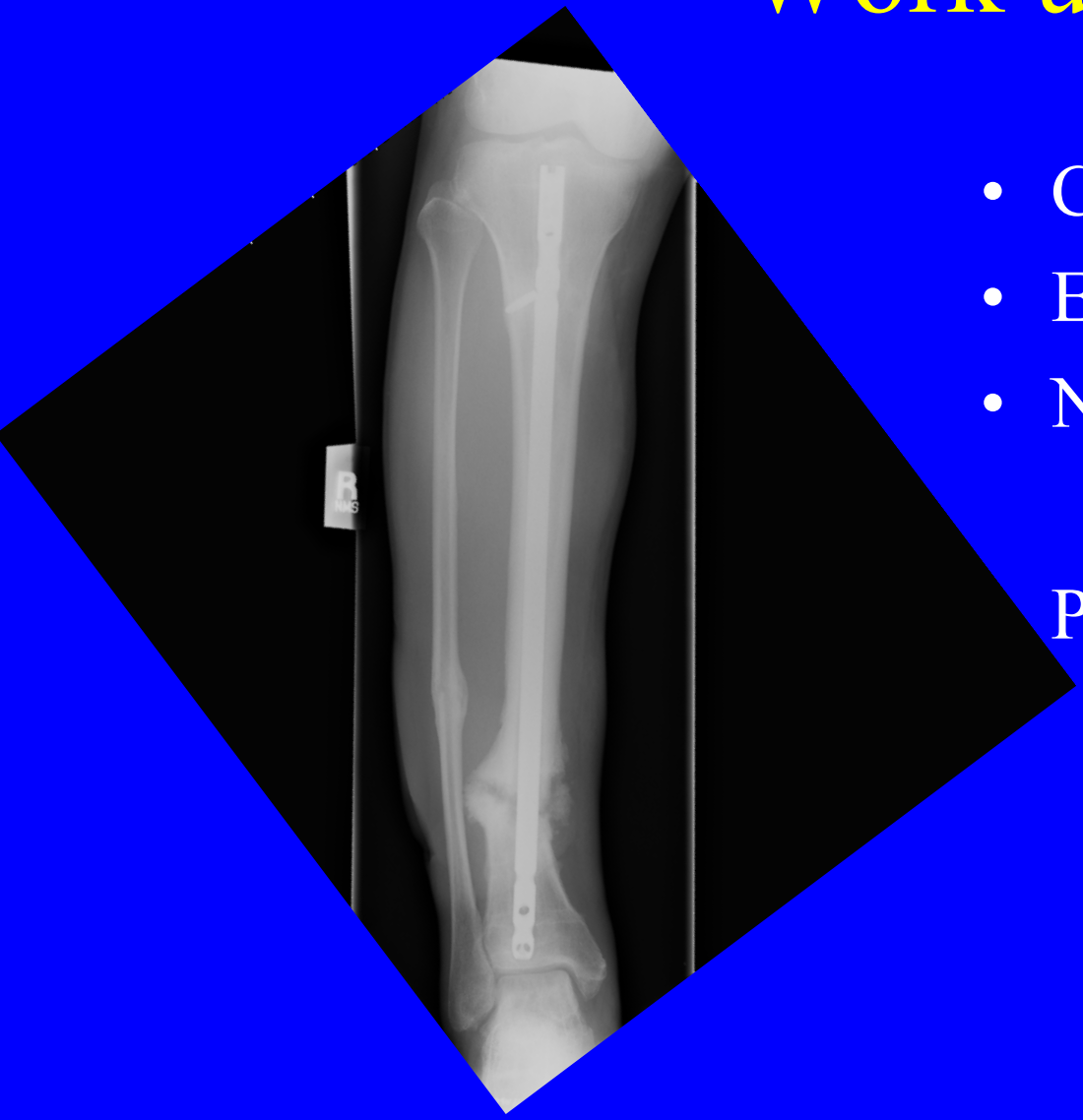
- REFERENCE: (Apard, Bigorre et al. 2010; Sohn and Kang 2011)

53 Y o male with a non union following compound injury



- What would you do now??
- What does this need to heal???

Work up



- CRP= Normal
- ESR=2
- No systemic signs

Plan???

Compression plating
Other Plans to gain union???