Management of Open Fractures

Choice of Definitive Treatment

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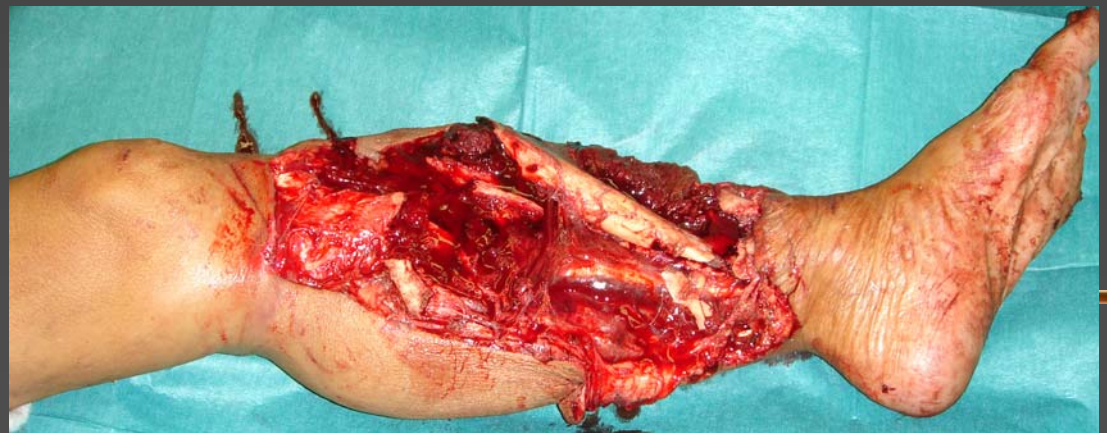
Open Fracture

- Fracture communicates through a traumatic wound to surrounding environment
- Resulting in contamination & soft tissue envelope disruption

Open Fracture

- High energy
- Outcome depends extent of soft tissue injury
- Treatment of soft tissue trauma with contamination ➔ Primarily important
- Treatment of skeletal injury ➔ Secondary



Classification: Gustilo & Anderson

Type	Size (cm)	Energy of trauma (Soft tissue crush & fracture comminution)	Infection rate (%)
I	<1	Low energy	0-2
II	1-10	Moderate energy	2-5
III	>10	**High energy**	**5-50**

Principles of Management

- **ATLS**: Save life first, then save limb
- **Prevent infection**: Wound debridement & lavage, IV / local antibiotics, Tetanus prophylaxis
- **Fracture stabilization**: Temporarily & **Definite**
- **Early soft tissue coverage**: Initial flap preservation, delayed 1° suture, secondary intention, skin graft, flap
- **Mx of bone defect**: Shortening, bone graft / transport
- **Rehabilitation**: to minimize disability & optimize functional recovery

Prevent Infection: Wound Debridement & Lavage

- Remove all devitalized tissue (esp. muscle), debris, loose fragments & foreign body
- NS / antiseptic irrigation:

  copious pulsatile lavage (6-10 L)

- +/- 2nd look debridement every 24-72 hrs until completely clean
- Wound left open & daily dressing

1st debridement

2nd debridement

Fracture Stabilization: Optimize Fracture Healing

- Fracture reduction
- Stable fixation
- Dynamize and weight bear at appropriate time
- Bone graft
- Bring in blood supply

Fracture Stabilization: Temporarily

Standard: External Fixation

- Quick & easy
- Minimal invasive
- Good stability
- Prevent infection

Temporarily stabilization

Early Soft Tissue Coverage

- Usually within 3 days to 1 week to prevent nosocomial infection (main source of infection in open #) and improve outcome
- “Very early fix and flap” protocol
- Balanced by soft tissue tension & infection
- Methods:
  - Delayed 1° closure
  - Skin graft (PTSG, full thickness)
  - Flap (local, free) bring in blood supply

Soleal flap

Fracture Stabilization: Definite

- Usually done after wound conditions (infection & coverage) stabilized
- Exchange from external fixation to internal fixation
- Timing & method depends on fracture pattern & wound conditions

➔

Choice of Definite Fixation

1. **Conversion from External Fixation to Internal Fixation** (Nailing/ MIS implants/ Percutaneous screw/ K-wire)
2. **Keep External Fixation** (Simple / Hybrid) as definite treatment
3. **Primary Internal Fixation** (Nailing / MIPO)
4. **Conversion from External Fixation to Casting**
5. **Amputation**

1. Conversion from External Fixation to Internal Fixation

Case 1: Conversion to Nailing

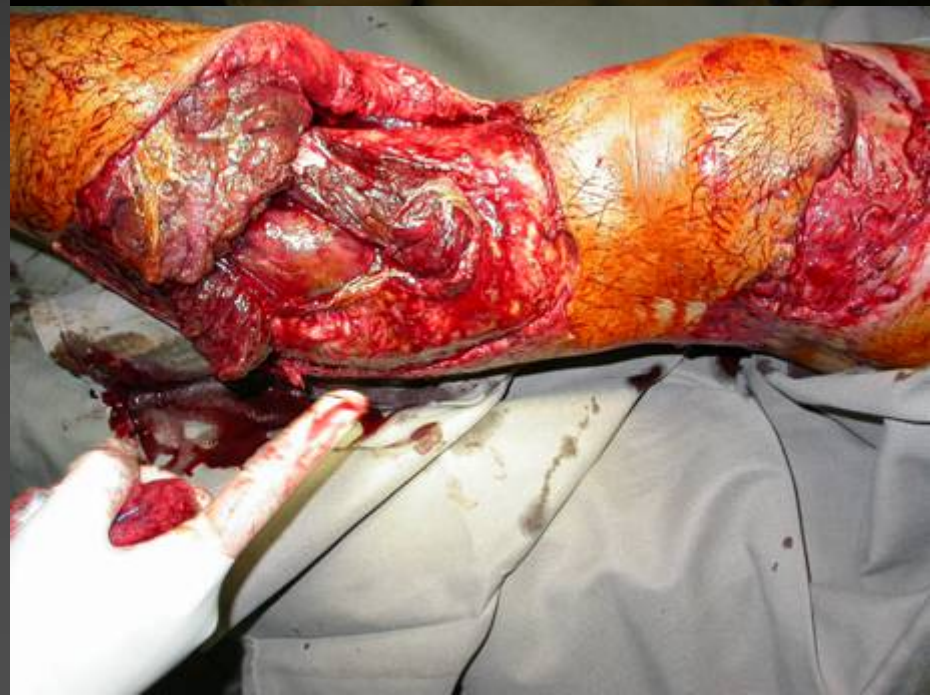
Case 2: Conversion to Plate & Screw

Conversion of Ext. Fix. to Reamed Nailing

- Tibia - generally not later than one week
- For I, II and IIIA #'s
- One stage (<3 wks) or "cooling" period (>3 wks)
- Better access for flap surgery
- Less prone to delayed or mal-union
- Generally more acceptable to patients
- Shorter hospital stay
- Only if fracture location and type amenable to nailing

Case 1: M/23

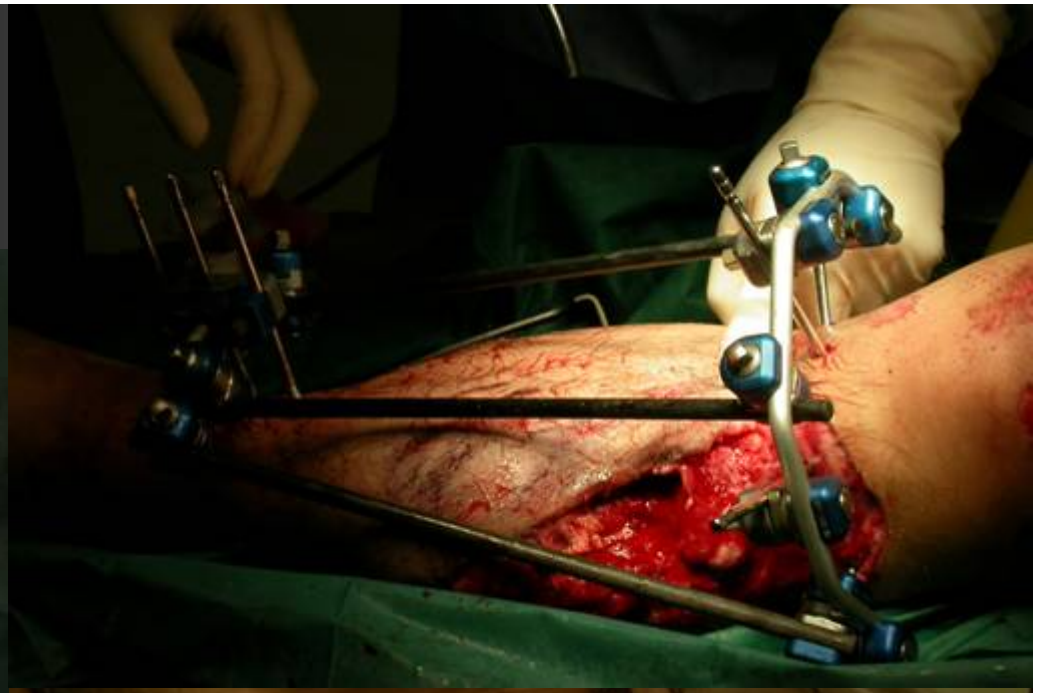
Open wounds at the left leg.

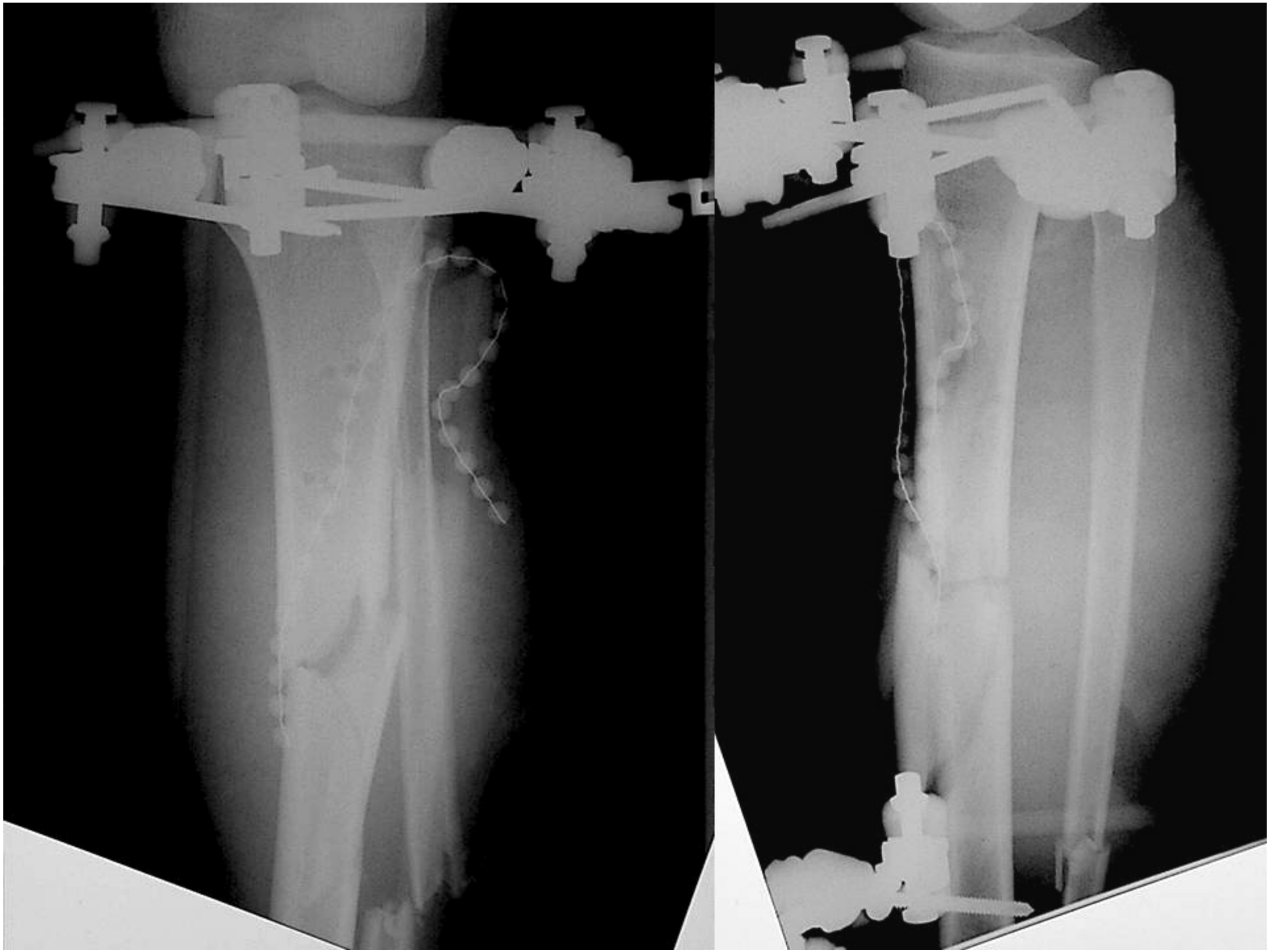


Initial debridement and Hoffmann II External Fixation

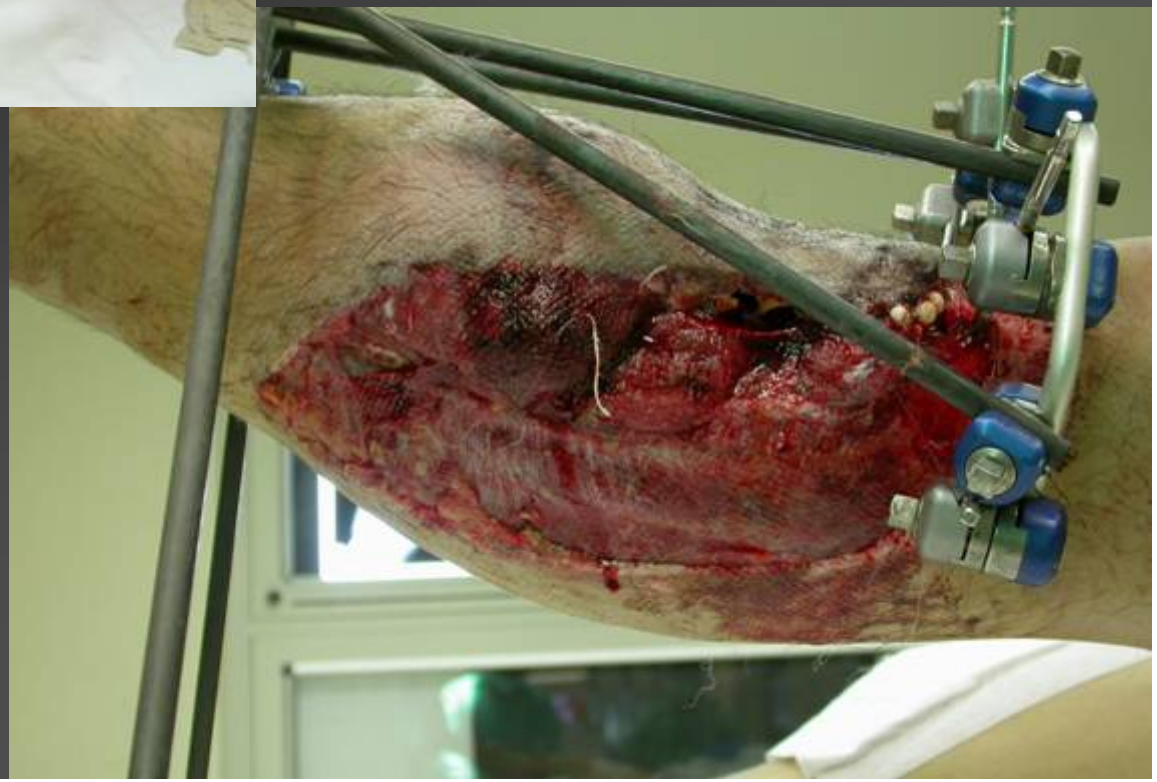
Before and after initial external fixation

Day 3, fixation revised





Injured limb supported and raised on the fixator frame to facilitate nursing care, surgery, and drainage.



Skin graft

4 weeks

Fixation removed (already the 9th operation). Pin holes “rested” for 4 weeks.

8 weeks after injury

IC Tibial nail inserted.

1 year after injury

2 years after injury

Case 2: F/68

Emergency Treatment

Wound Lavage +
Debridement +
External Fixation

Day 5

Debridement + PTSG + ORIF
Ext. Fix. kept for soft tissue injury

2 Months

2. Keep External Fixation (Simple / Hybrid) as Definite Treatment

Case 1: Comminuted Fracture

Case 2: Infection

Case 3: Severe Soft Tissue Injury

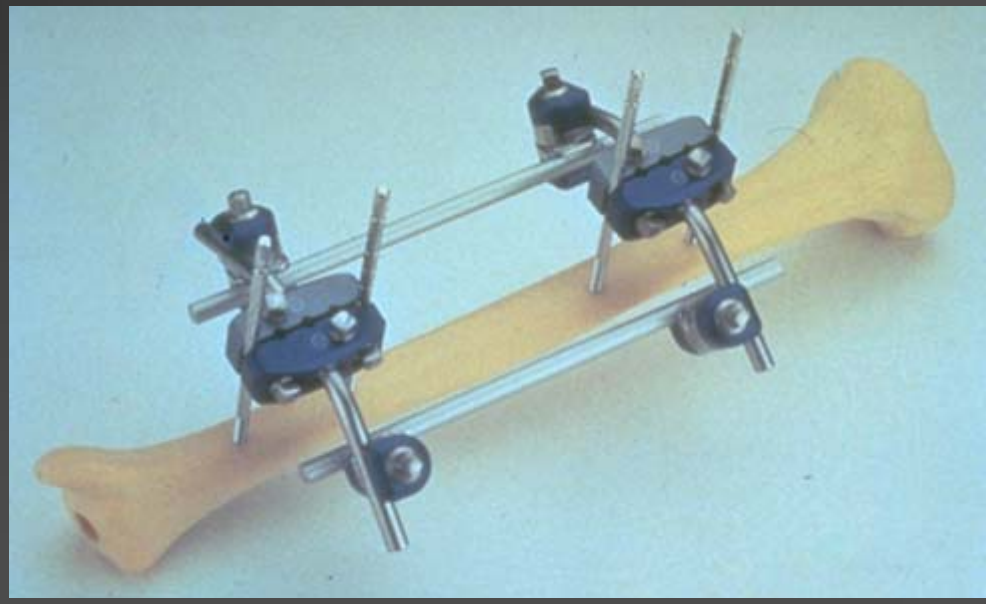
Case 4: Polytrauma with complex management

Pin Fixators

AO

Orthofix

Stryker: Hoffmann II



Ring & Hybrid Fixators

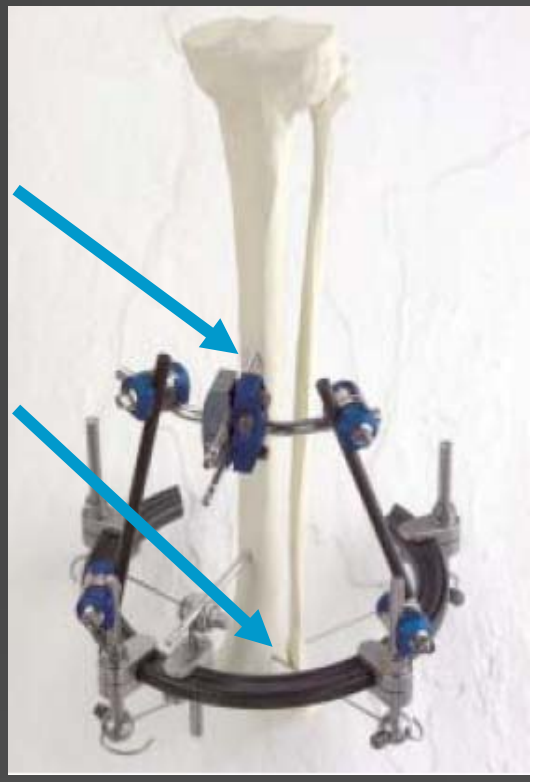
AO

Orthofix

Stryker: Tenxor

Half pin

Tensioned wire

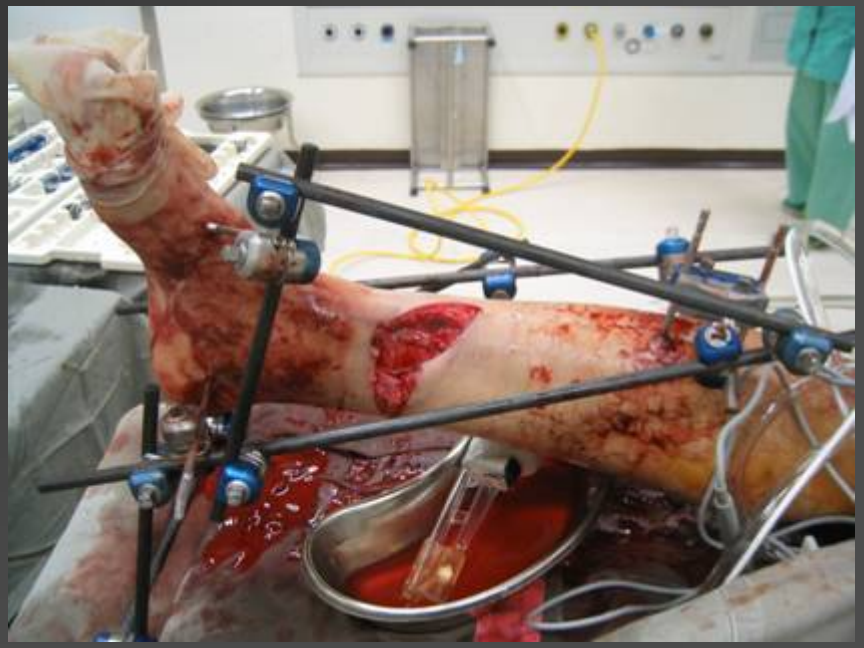


Case 1: Comminuted Open Fracture

- M/40

Emergency Treatment

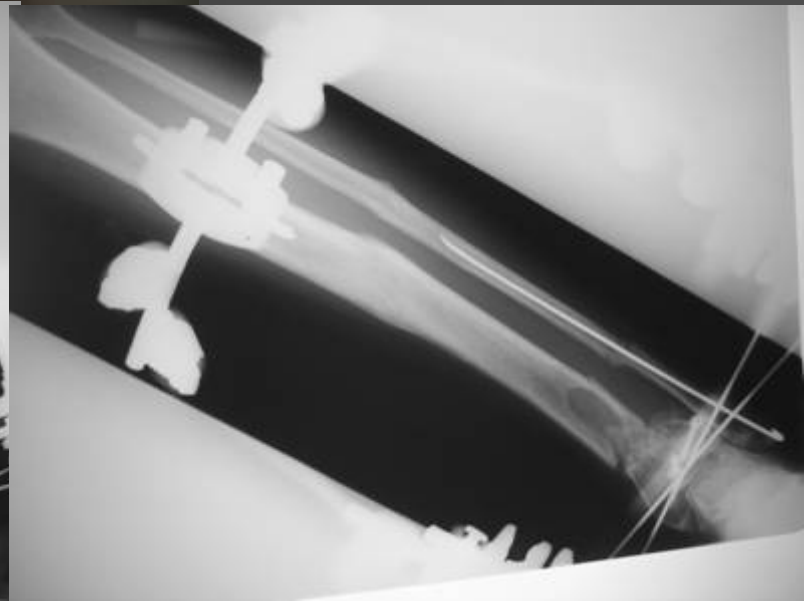
Wound Lavage + Debridement + External Fixation



Definite Treatment

PTSG + Conversion to Hybrid External Fixation

16 Weeks



Case 2: Infected Open Fracture

M/50
Type IIIA

Conversion from Ext. Fix. to IM nail on Day 2

ORIF for calcaneal & navicular fracture on Day 11

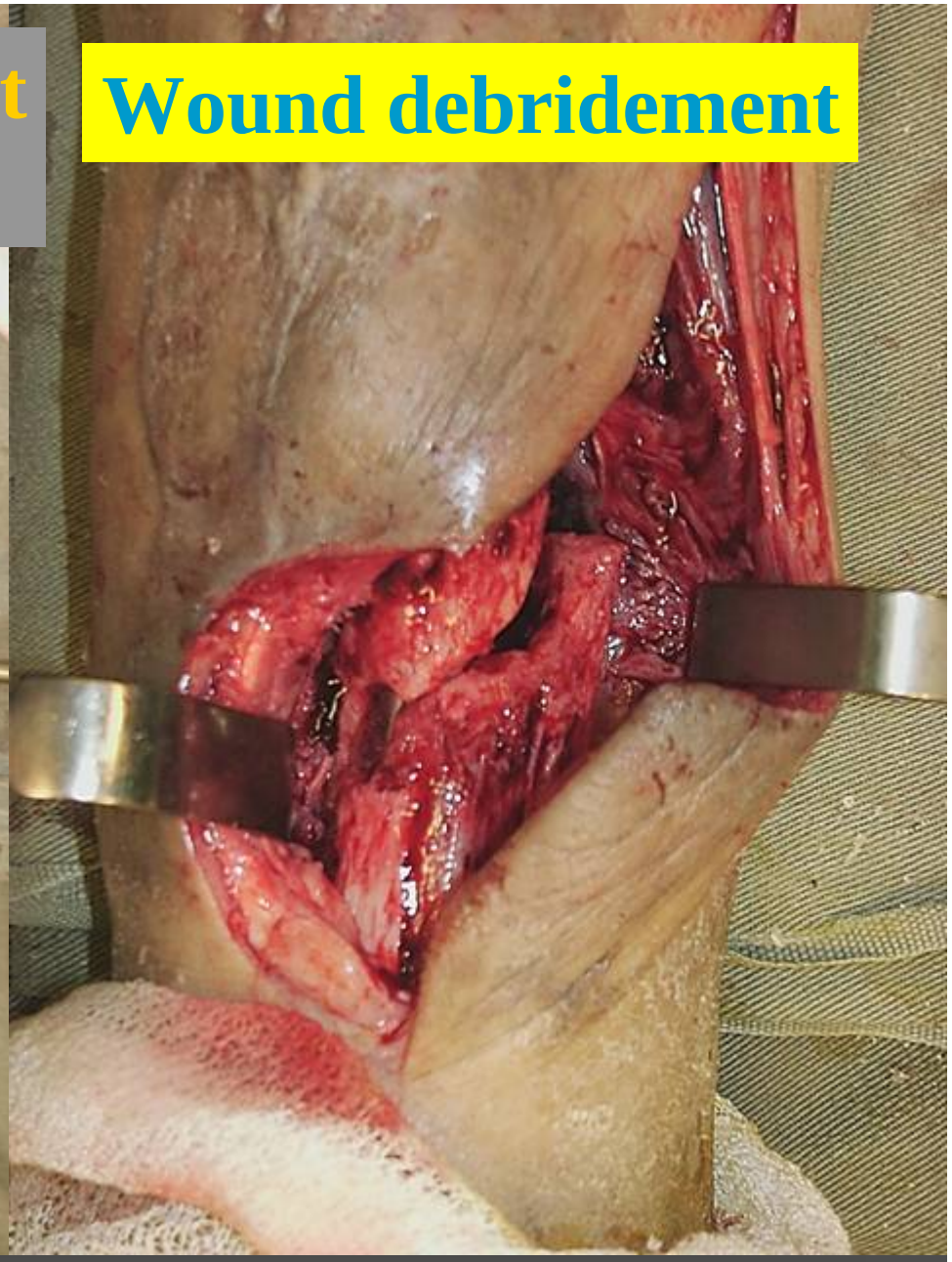
MRSA Infection: repeated debridement from 3 to 8 weeks

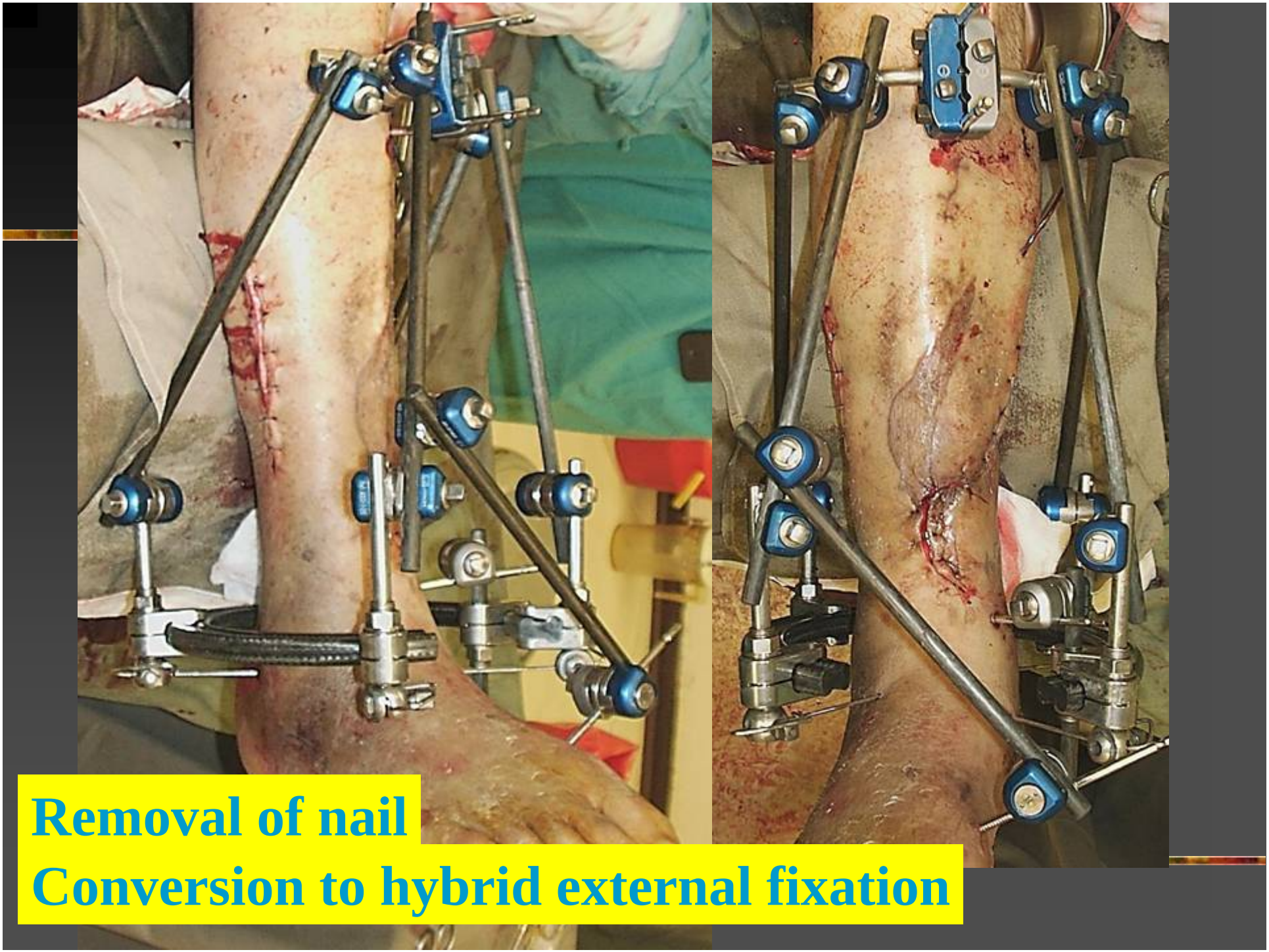
10 weeks

- Loosening of distal fixation detected, fracture went into valgus & recurvatum

Subsequent Management (11 weeks)

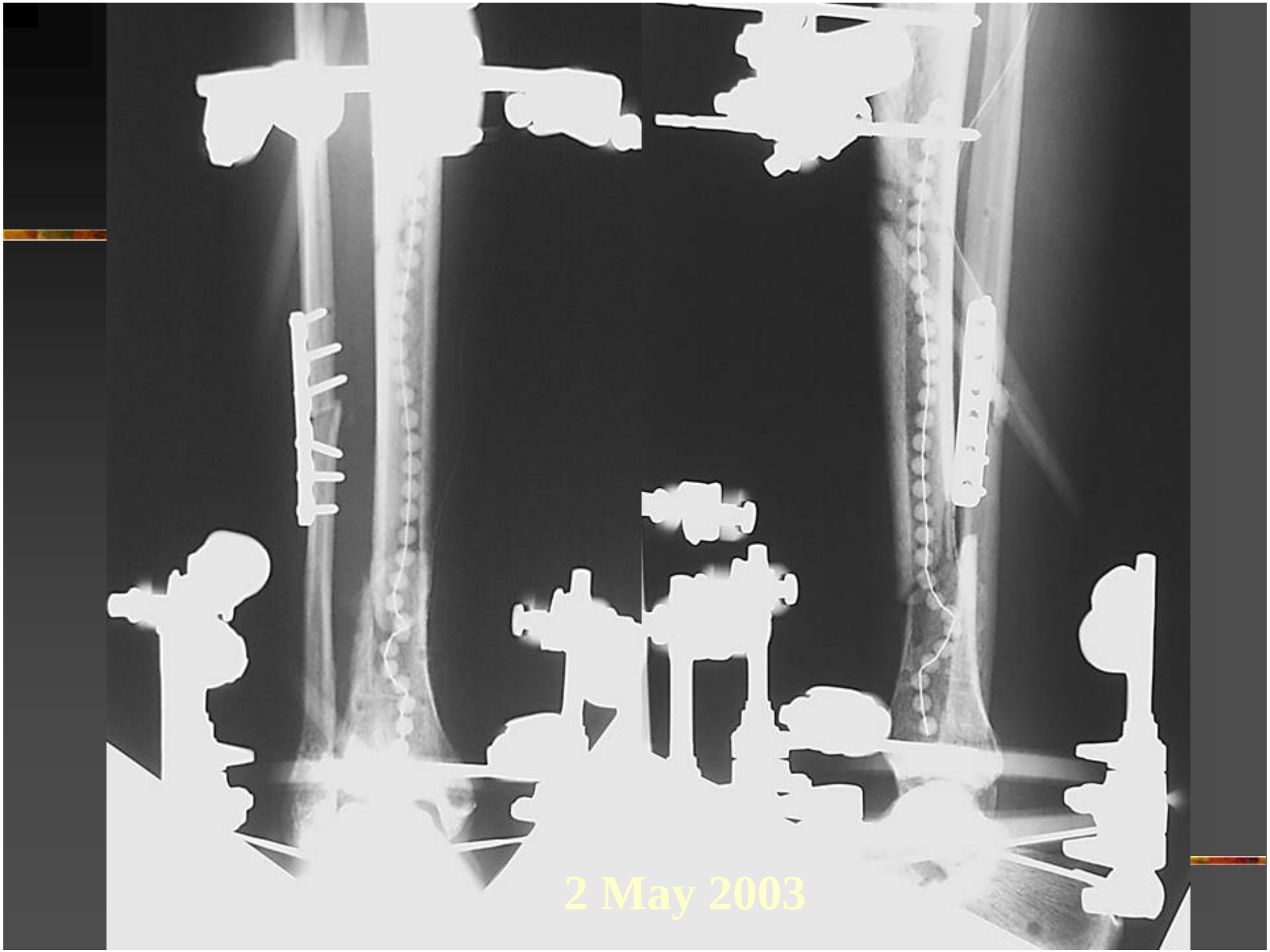
Wound debridement





Removal of nail

Conversion to hybrid external fixation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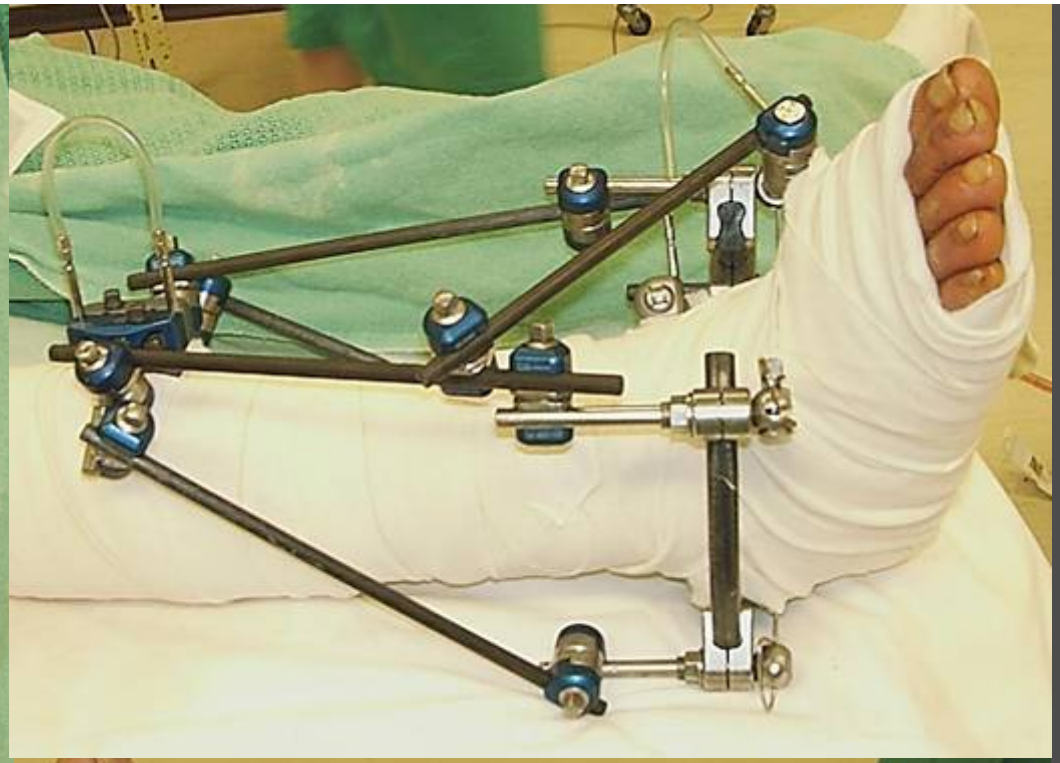



14 weeks

14 weeks

Then Ext.
Fix removed
on 17 weeks


43 weeks from hybrid fixation
13 months after injury
Stick walking 30 min, unaided 10 min

Case 3: Severe Soft Tissue Injury

F/75

Emergency Treatment

Wound Lavage +
External fixation

2 Weeks

Debridement + PTSG + Limited Percutaneous Internal Fixation

4 Weeks

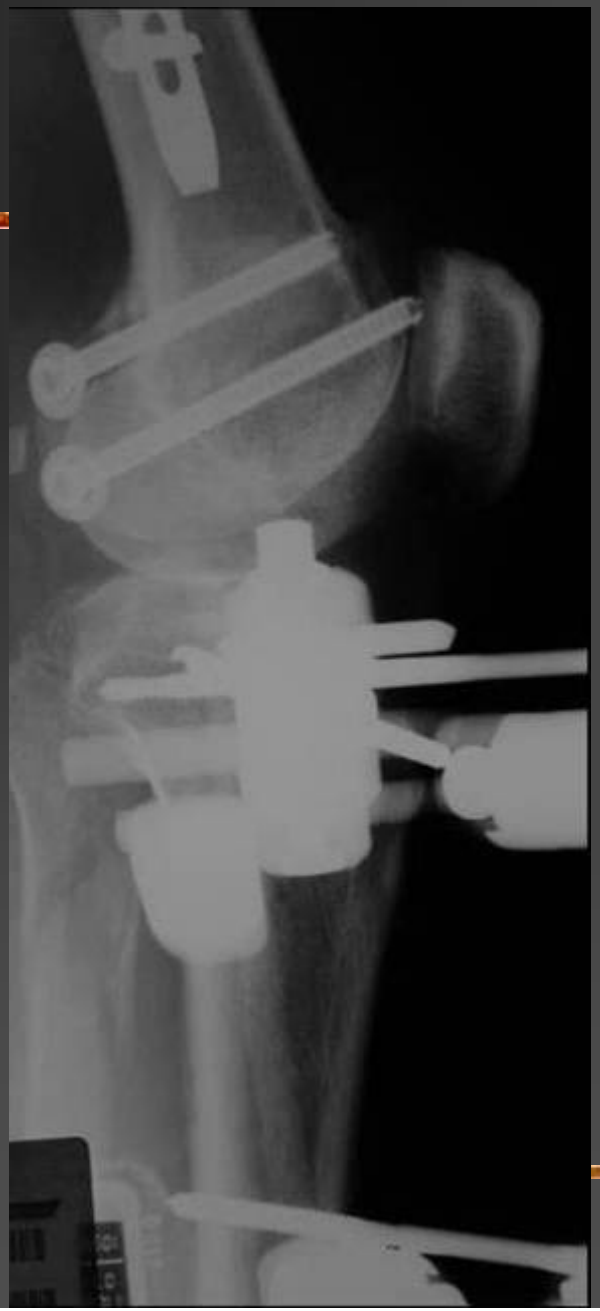
Fracture Healed Up

Case 4: M/57 Polytrauma

Right Forearm

Right Femur

Right Knee



Right Tibia

Requires
Bone Grafting

Left Side

- Stellate wound at front of knee
- Shattered patella
- Shattered distal femur – intercondylar and lower shaft

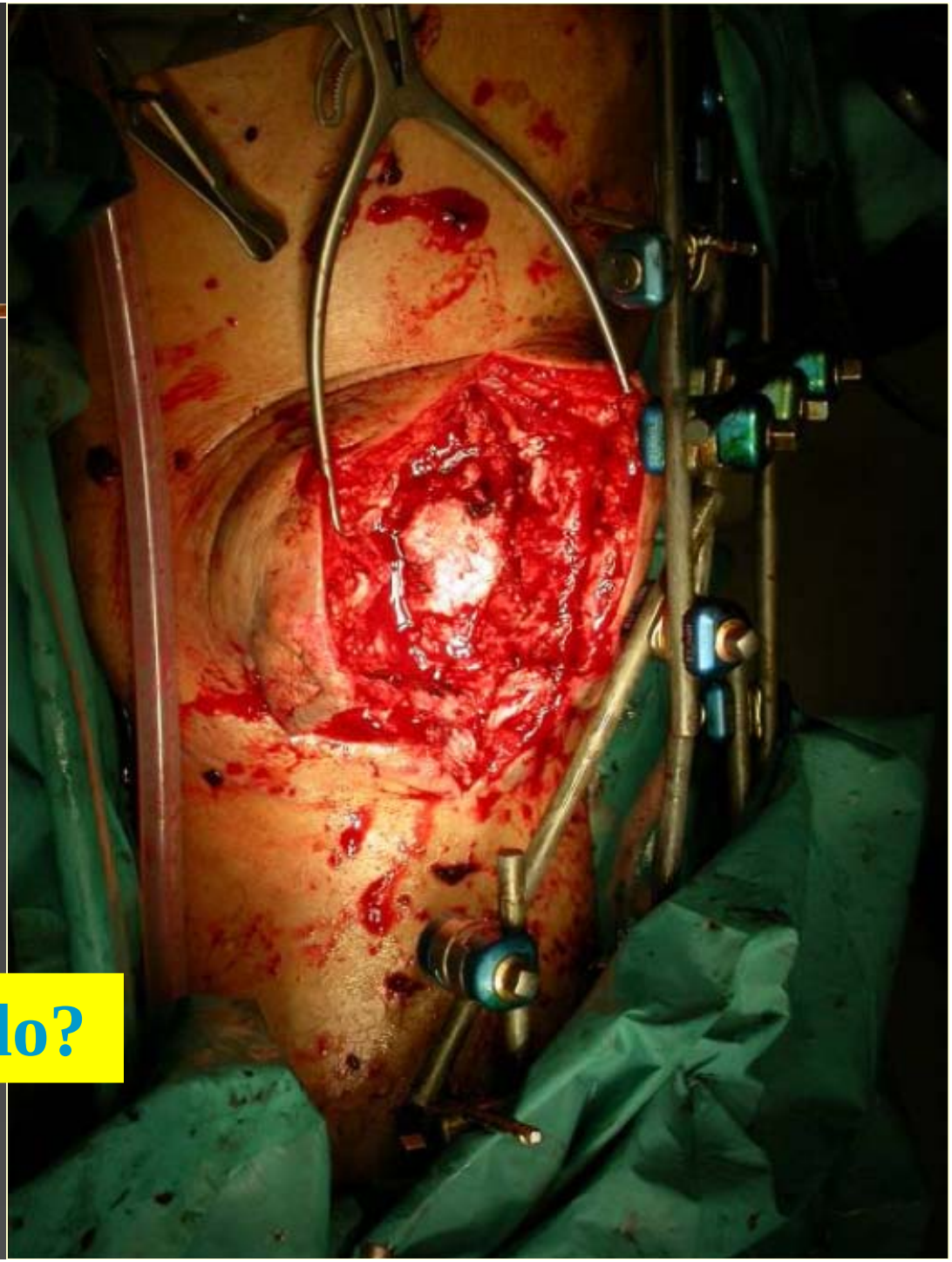
Left Knee – after 1st Debridement

Left Knee – after 2nd Debridement

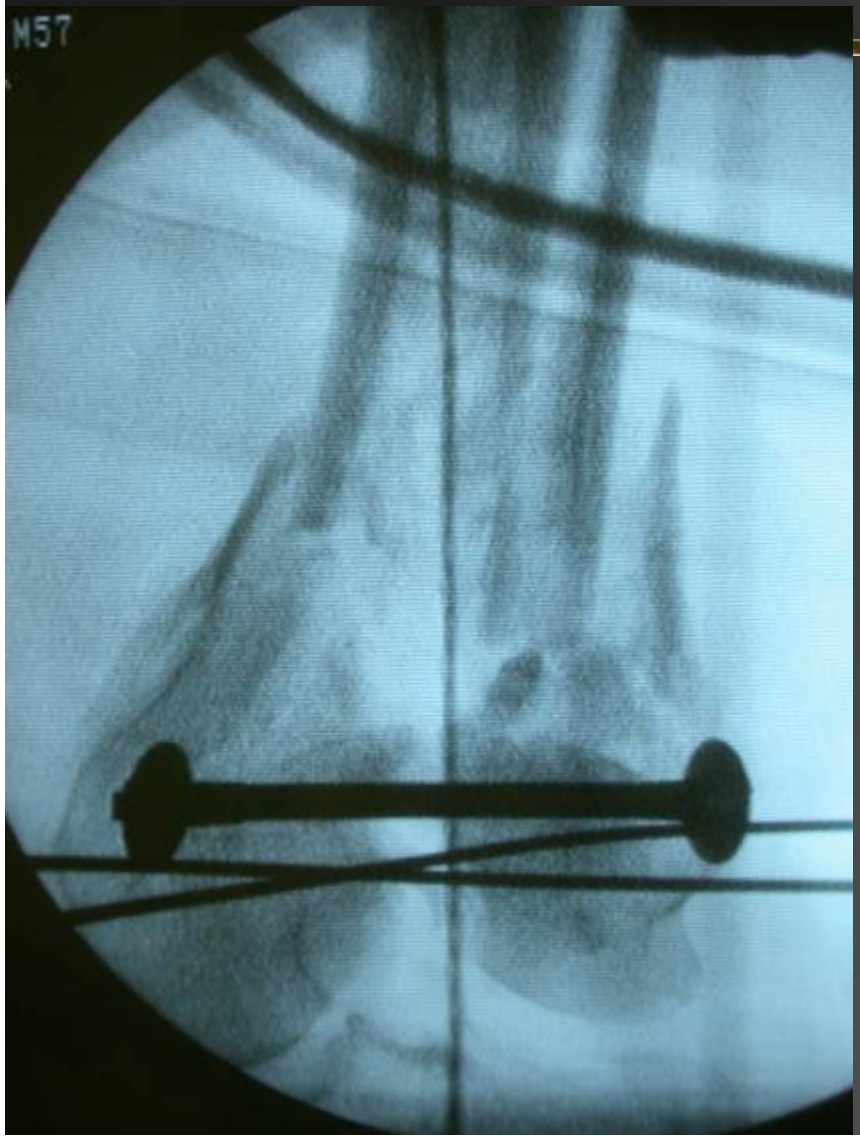
Followed by MRSA infection and multiple debridement

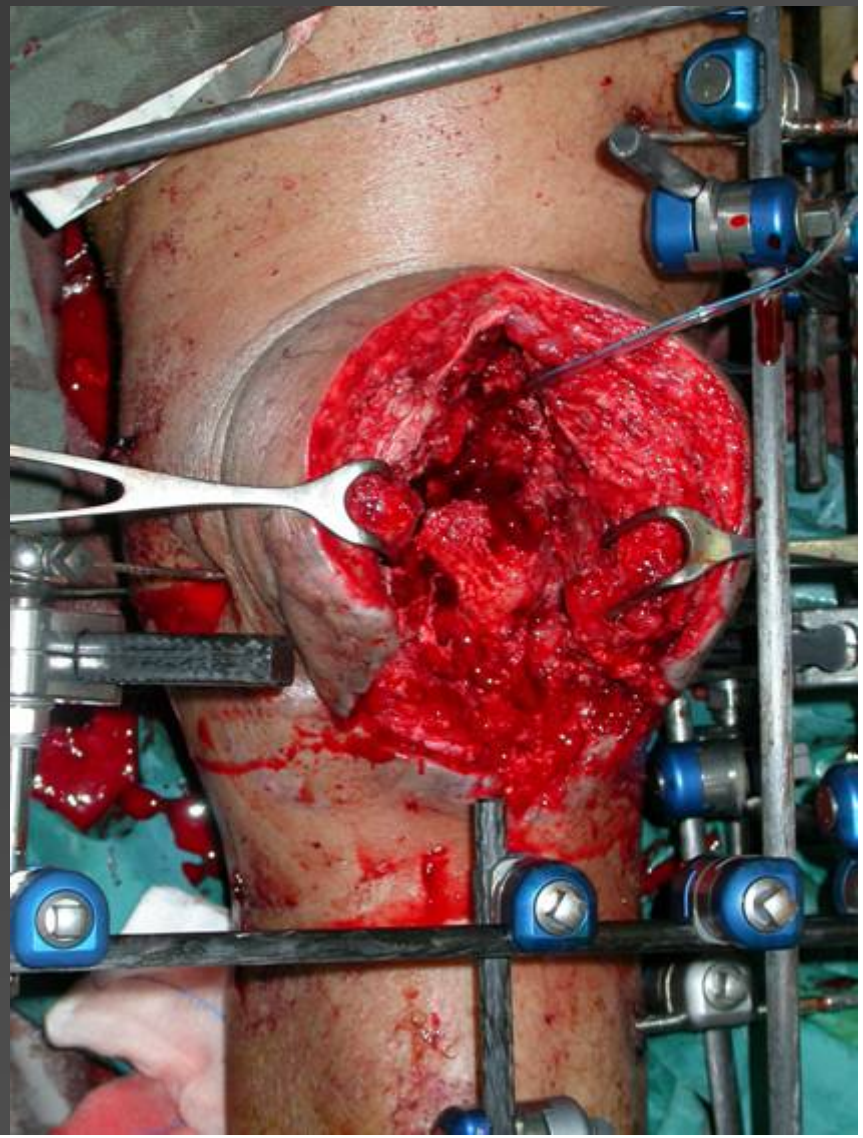
Left Knee (12 weeks)

What to do?

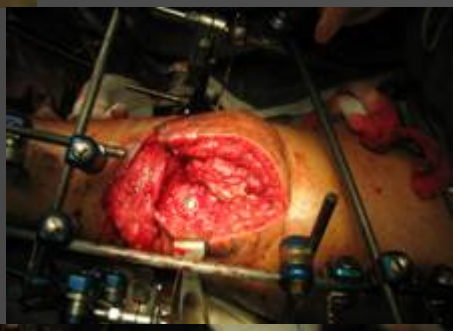


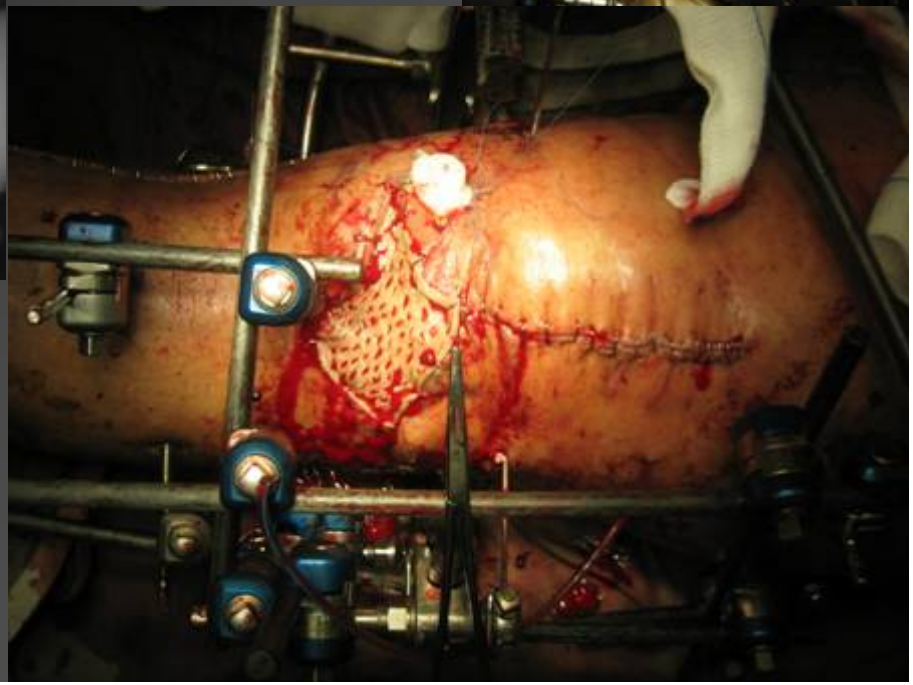
Intercondylar screw fixation with limb shortening at 13 Week





Gastrocnemius Flap with BG & PTSG 3 days later





Post-Flap 2 week

9 Months

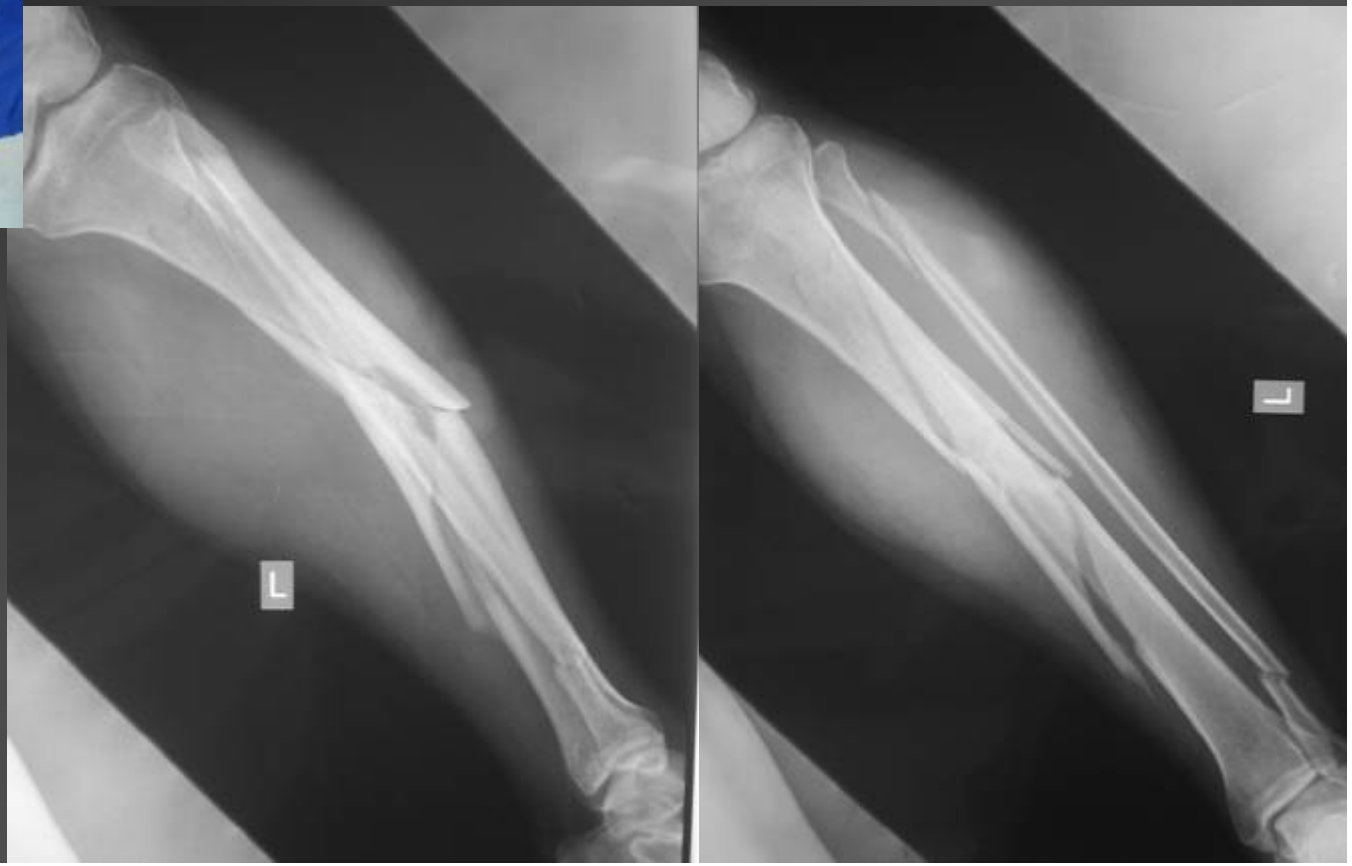
3. Primary Internal Fixation

Case 1: Nailing

Case 2: Nailing

Case 3: MIPO

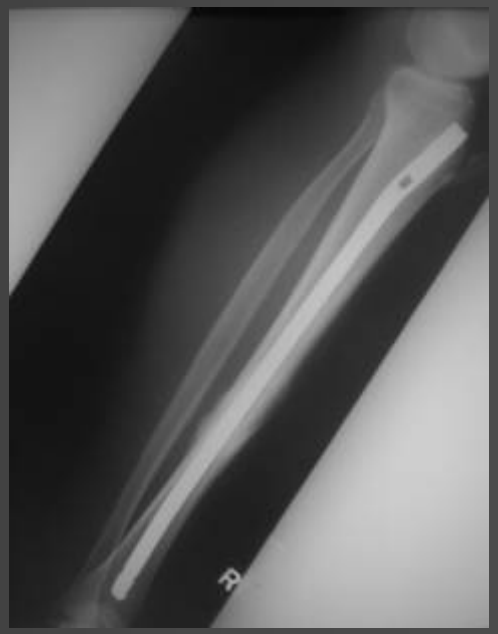
Case 1: Type I Open Fracture M/53

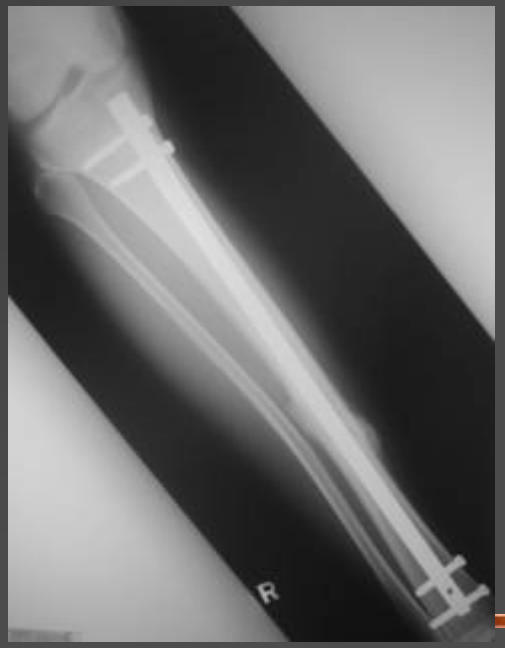


Wound debridement + Primary Nailing

Case 2: Type I Open Fracture

M/24

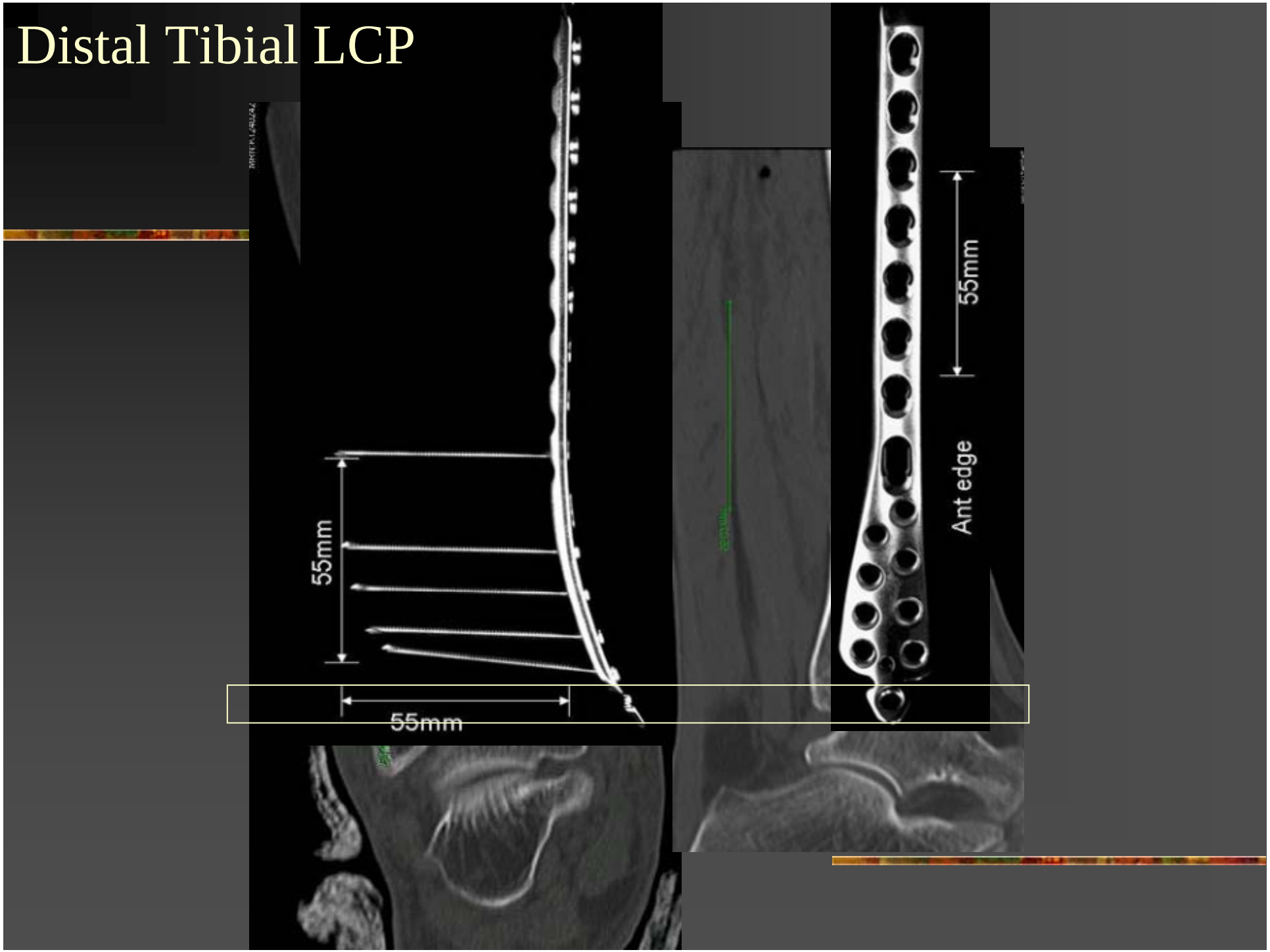




Case 3: F/53

- Type I wounds on medial aspect
- CT done, fracture extended very distally. Too distal for Distal Nailing.

Distal Tibial LCP



Day 1

4. Conversion from External Fixation to Casting

Case 1: Minor Open Wound with osteosporosis

F/74

Limited Internal Fixation + Pin & Cast

5. Non-salvagable Limb ➔ Amputation

Case 1: Delayed Amputation

Case 2: Primary Amputation

Amputation: Guideline

- Nonviable limb
- Nonfunctional limb
- Life-theatening limb
- Too extensive & prolonged reconstruction
- MESS >7

Amputation: MESS

MESS for limb salvage

- <4 → good prognosis
- >7 → poor prognosis

(100% predictive value for amputation)

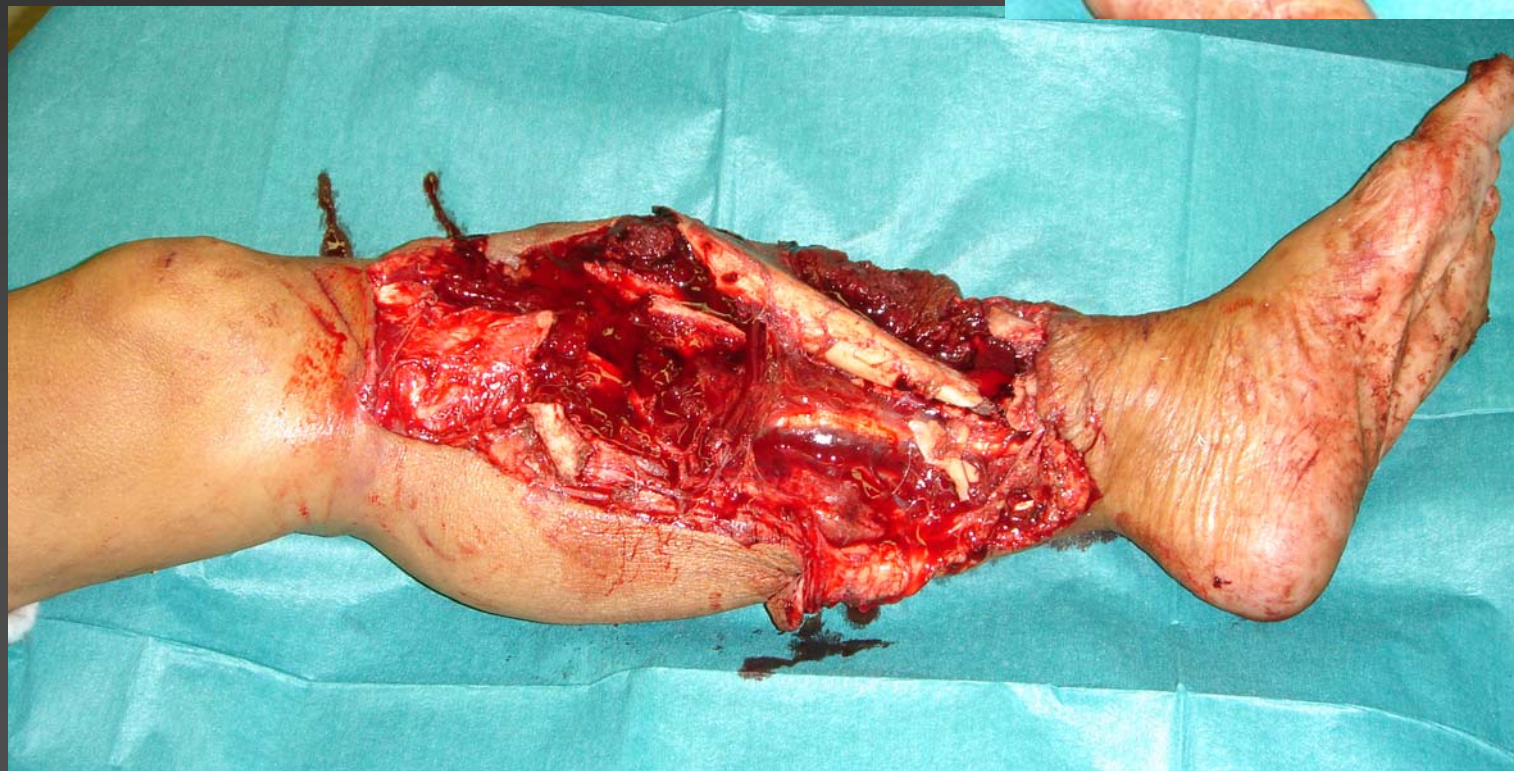
Mangled Extremity Severity Score

Criteria	Score
Energy of Injury	
Low	1
Medium	2
High	3
Massive	4
Ischemia*	
No ischemia	0
Decreased pulses	1
Thready pulses	2
No pulses	3
Shock	
Normal	0
Transient	1
Prolonged	2
Age	
<30 yrs	0
30–50 yrs	1
>50 yrs	2

*Ischemia score doubles when warm ischemia time >6 hrs.

Case 1: M/54

- Knocked down by a car
- MESS=7

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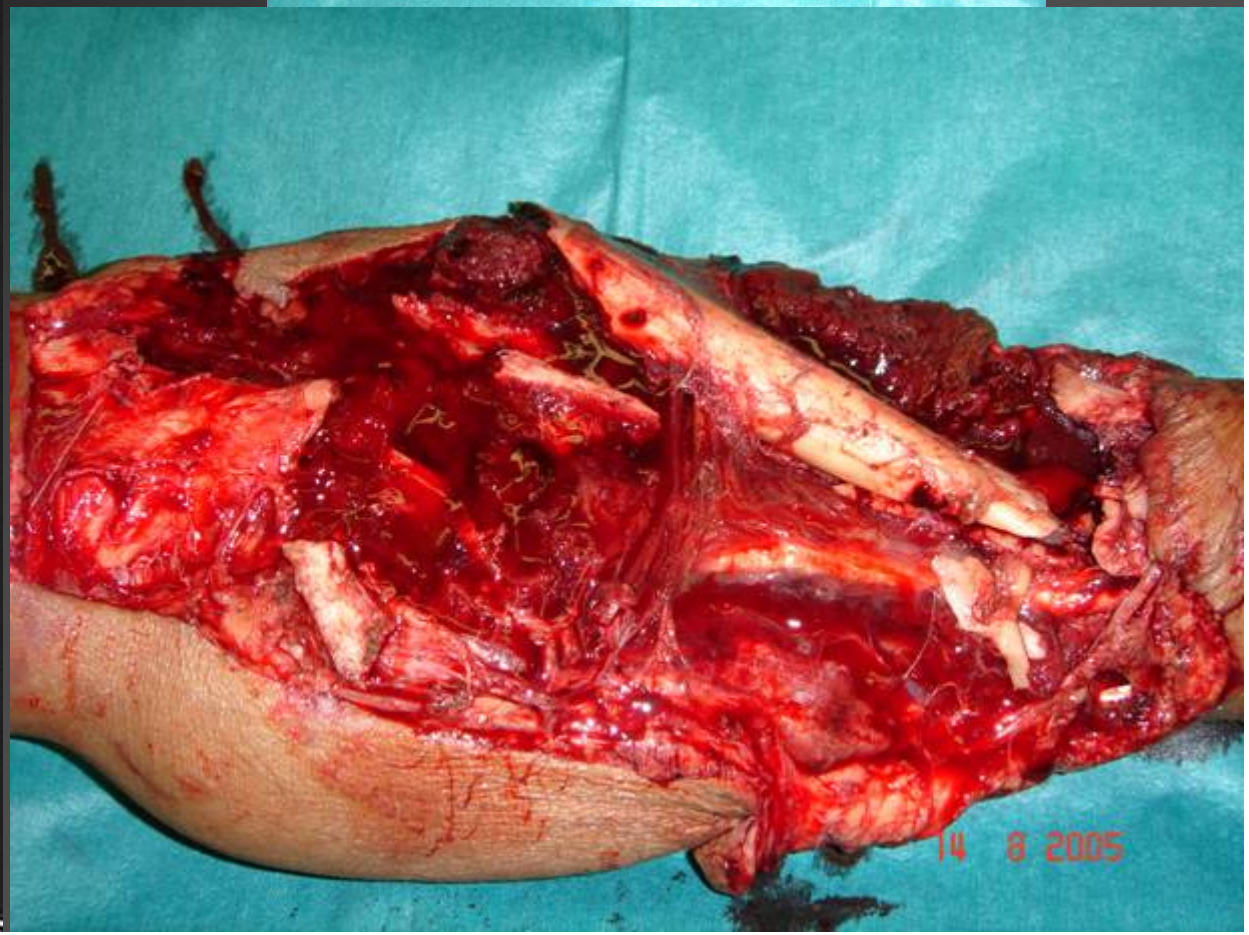
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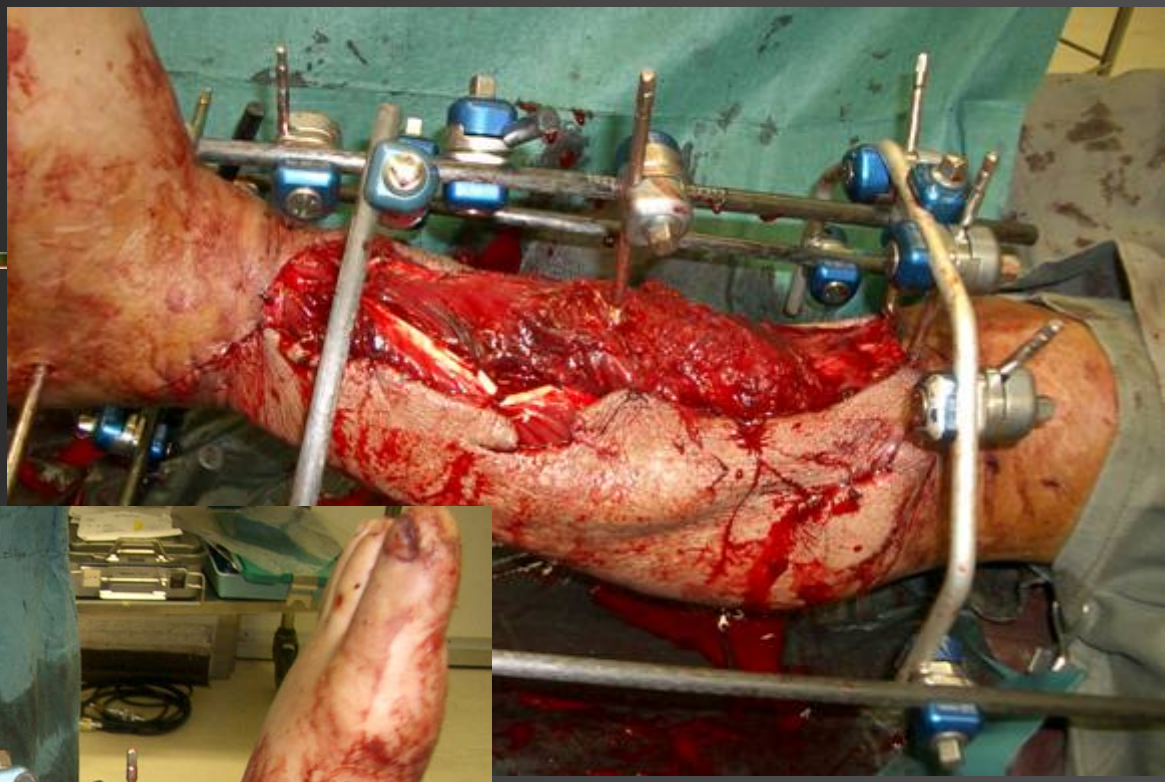
Day 1, 2nd Debridement



MESS

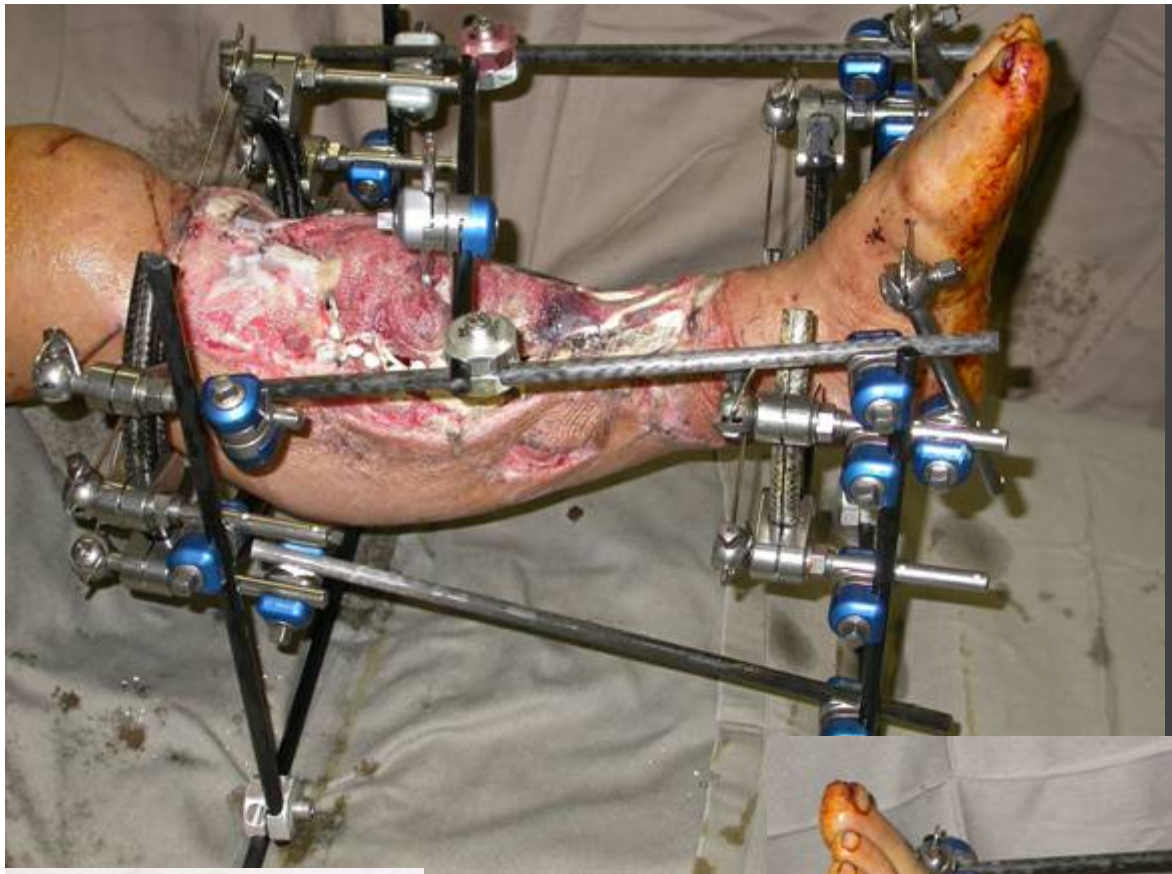
- Very high energy : 4
- Age 54 : 2
- Transient shock : 1
- Limb ischaemia : 0

- Total: 7 / 14
- Amputation recommended for score of >= 7.

What next ?

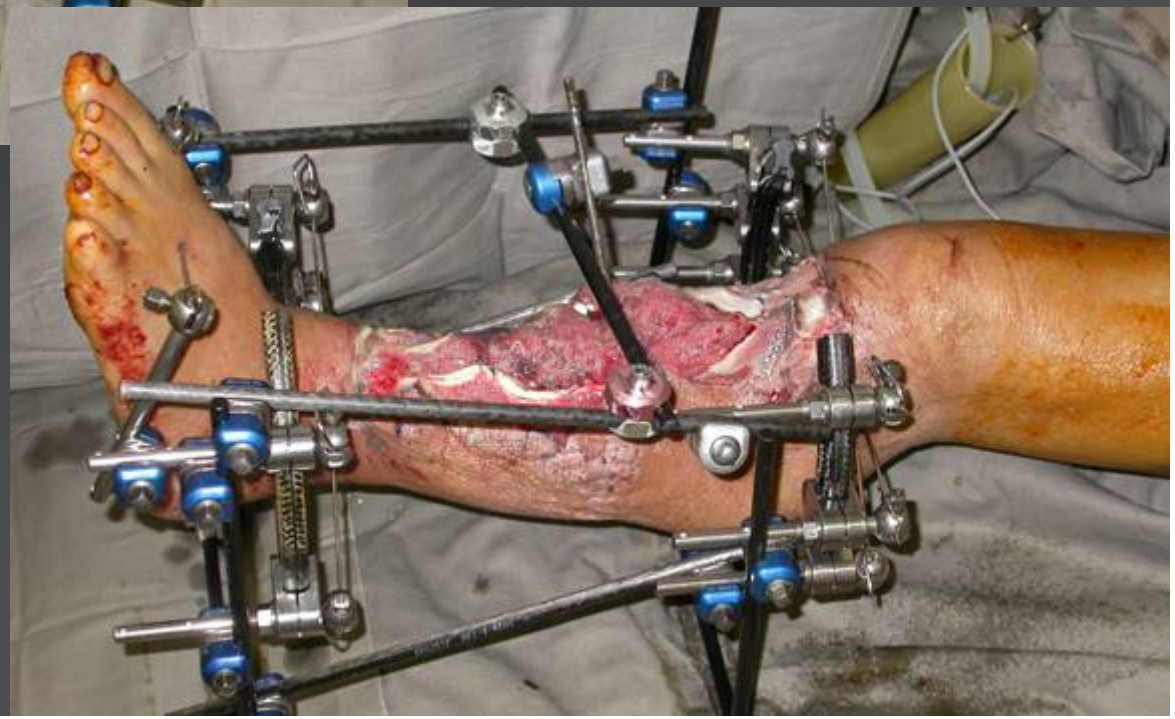
- Keep fixator, skin graft, wait for bone healing
- BKA

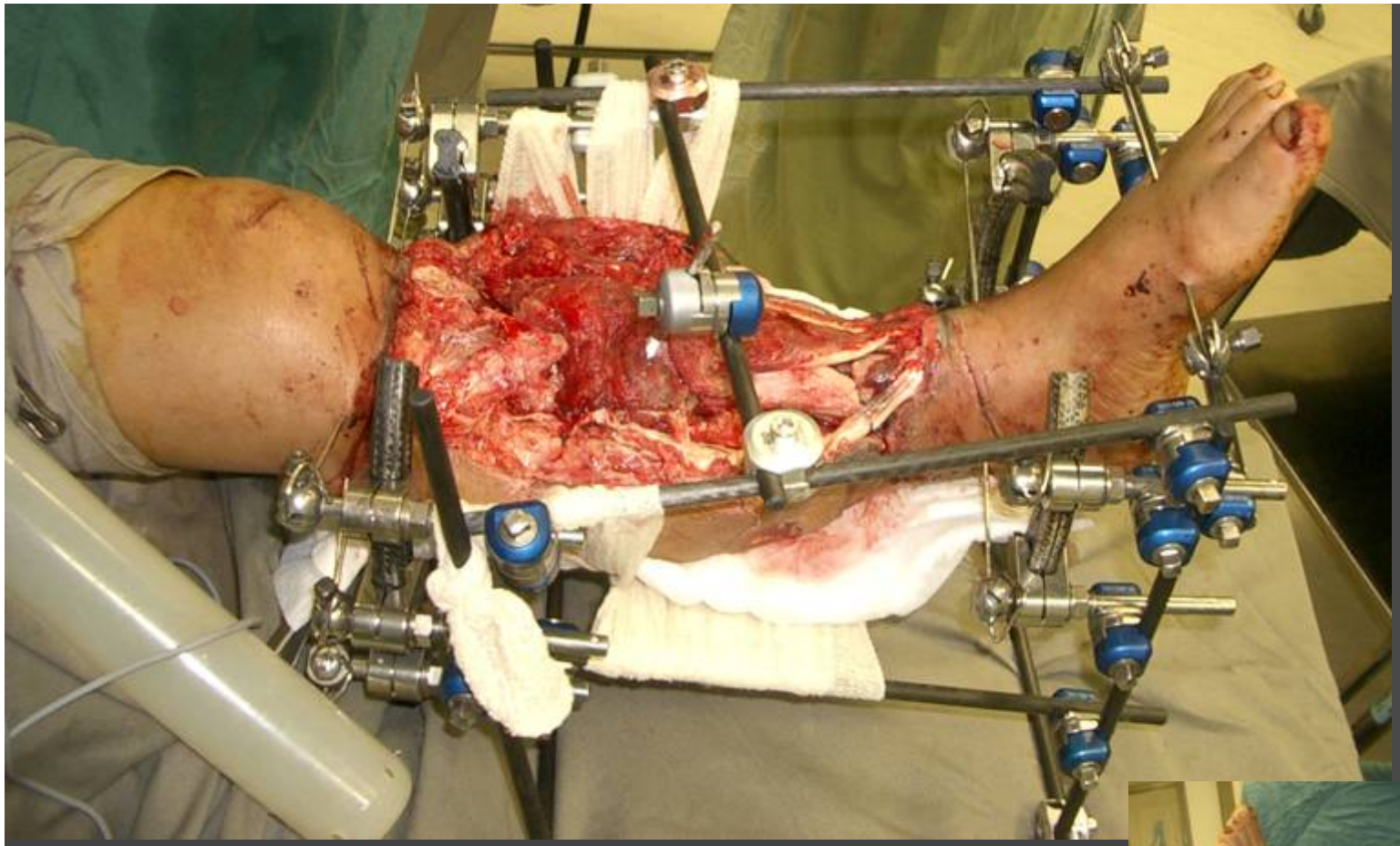
- Change to Ring Fixation to buy more time



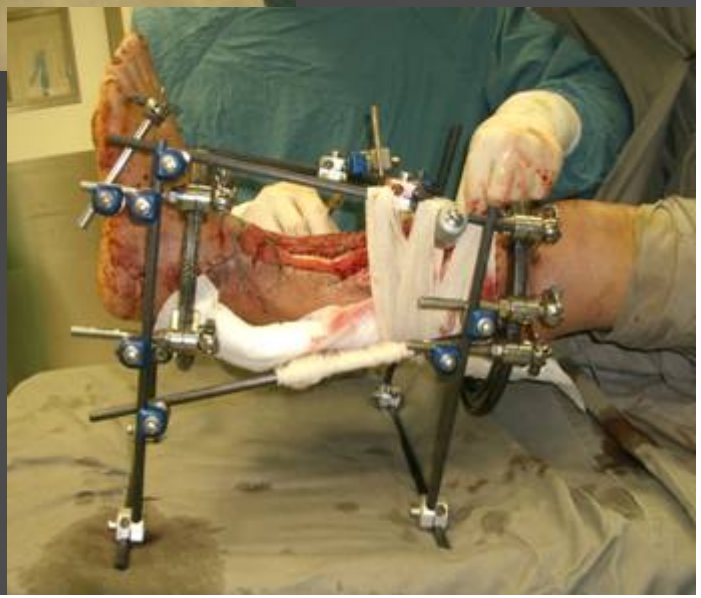
Day 3

Hybrid Fixator with tensioned wire





Soft tissue defect anticipated!




Local antibiotics:
Gentamicin beads
Bone defect also anticipated!

Day 10: Complicated with Infection despite Repeated Debridement

- Agreed to BKA

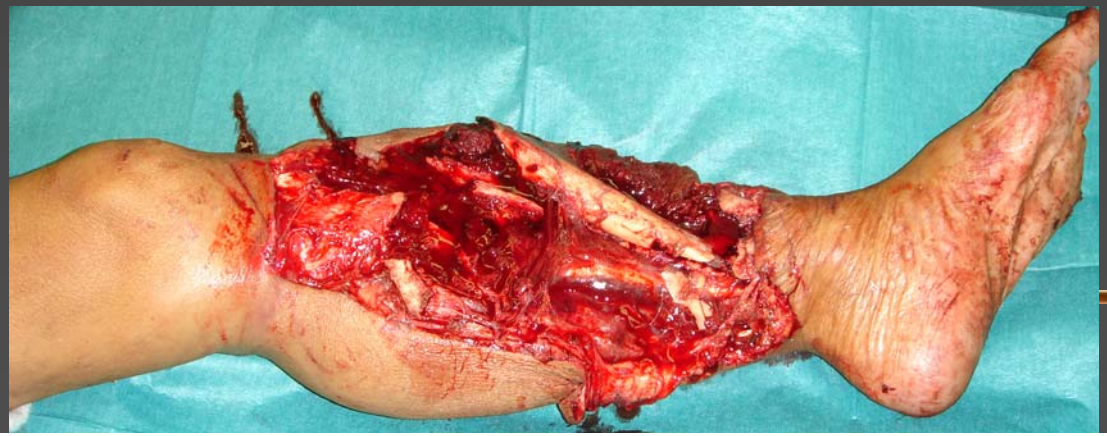
Salvaged limb ≠ Functional limb
Never forget prosthesis

Case 2: Jump Railway

Primary Amputation

Open Fracture

- High energy
- Outcome depends extent of soft tissue injury
- Treatment of soft tissue trauma with contamination ➔ Primarily important
- Treatment of skeletal injury ➔ Secondary



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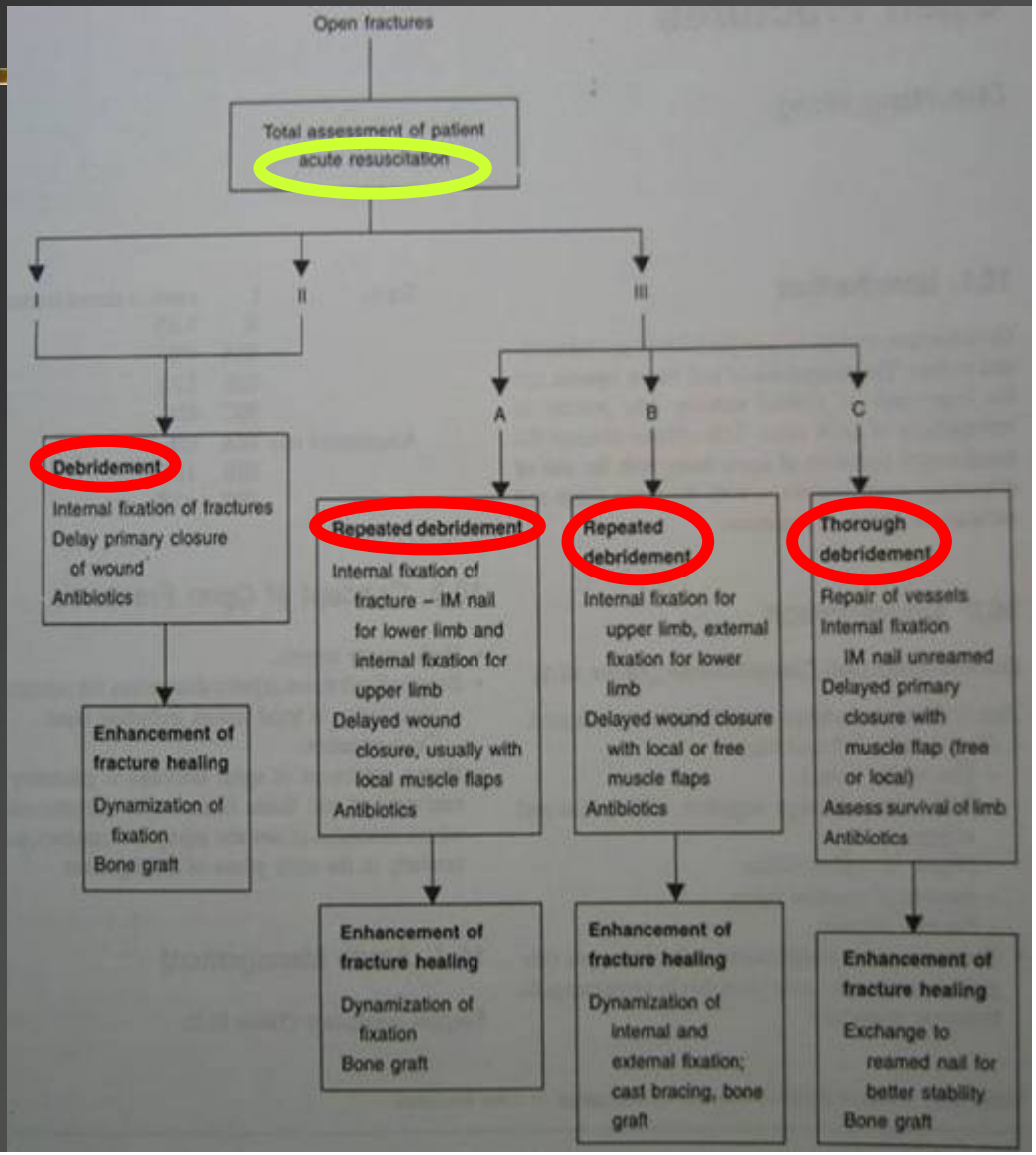
- **Mx of bone defect**: Shortening, bone graft / transport
- **Rehabilitation**: to minimize disability & optimize functional recovery

Management Protocol

Adequate debridement is the single most important factor in minimizing infection with open fracture !



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2. **Keep External Fixation** (Simple / Hybrid) as definite treatment
3. **Primary Internal Fixation** (Nailing / MIPO)
4. **Conversion from External Fixation to Casting**
5. **Amputation**

Complications

- Infection
- Delayed union
- Non-union

Thank You

The End