



# Open Fractures

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# Objectives

## Open Fracture “Take-Home Points”

- Modern medicosurgical management has improved outcomes for patients with open fractures
- Open fractures, however, are infamous for complications
  - I.e., Infection, nonunion, malunion, chronic pain, physical and mental dysfunction
  - Increased risk with higher grade and compromised host
- Timely antibiotic administration, debridement, and fracture stabilization are of paramount importance
- Orthoplastic reconstruction is required for severe open fracture with soft tissue and/or bone loss
- Standard and innovative treatment strategies are required for limb salvage
- Amputation should be considered as part of the reconstructive armamentarium



# History, BUT... We have made progress

- Open fractures were associated with high (~40%) mortality rate due to sepsis (Billroth 1866). In his series of 93 open tibia fractures: 36 deaths, 28 amputations.
- Today, timely antibiotics, thorough fracture debridement, and orthoplastic reconstruction can yield successful limb salvage for severe open fractures
- Recent large database study showed that amputation rate for open tibia fracture between 2-3% (Mundy *Orthopedics* 2021). If mortality occurs after open tibia fracture today, often due to other injuries or medical complication.



Two young men with 3B open tibia fractures s/p orthoplastic reconstruction sharing their experiences of limb salvage

# Mechanism - Low Energy

- Frailty
- Poor skin quality
- Osteoporosis



- Geriatric open ankle fracture/dislocation (lateral malleolar insufficiency fracture & deltoid tear) with typical transverse medial wound
- Valgus moment on thin skin causing tearing and herniation of distal tibia

Geriatric open distal third tibia fracture requiring soft tissue coverage procedure for limb salvage



# Mechanism - High Energy

- Young or old patient
- I.e., MVA, MCA, ped vs motor vehicle
- Large zone of injury
- Devitalized bone and soft tissue



Open femur fracture after high-speed traffic accident with critical-sized bone defect and soft tissue loss after open fracture care



# Open Fracture from Lawn Mower

- Grossly contaminated
- Severe bone and soft tissue injury



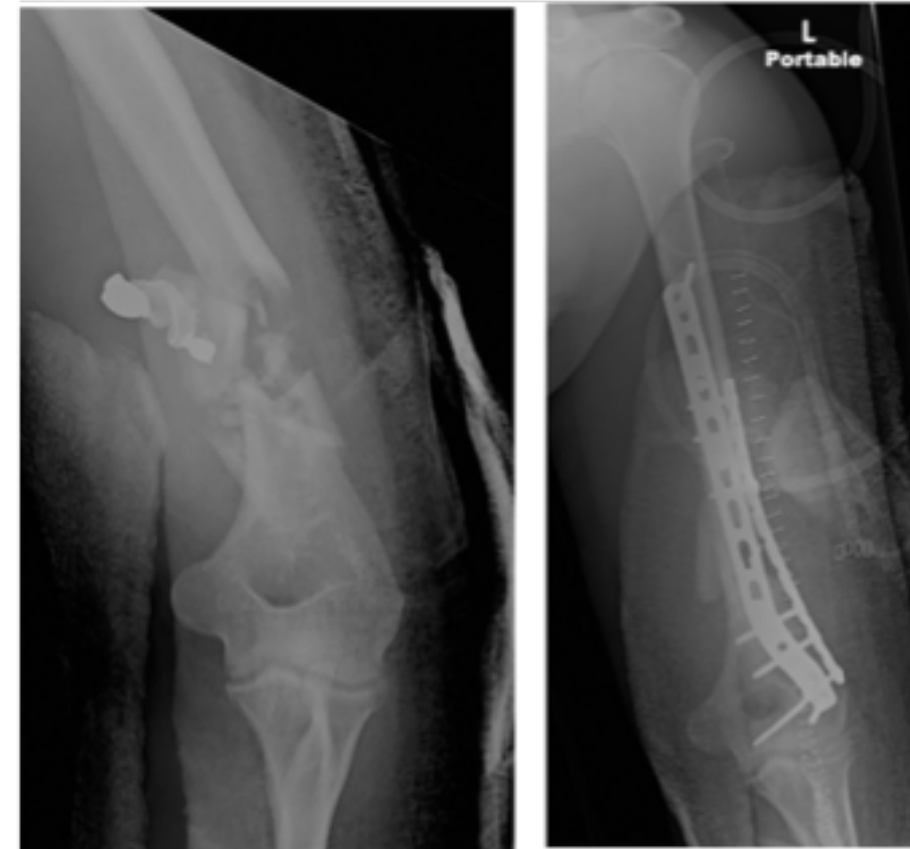
Open midfoot fracture/dislocation from lawn mower injury managed with serial I&D, limited internal fixation, trans-articular wire fixation, and hybrid ex fix

# Open Fracture from Gunshot Wound (GSW)

- Variable degree of bone and soft tissue injury based on energy/velocity of projectile

-Low-energy gunshot treated with local wound care/fracture stabilization

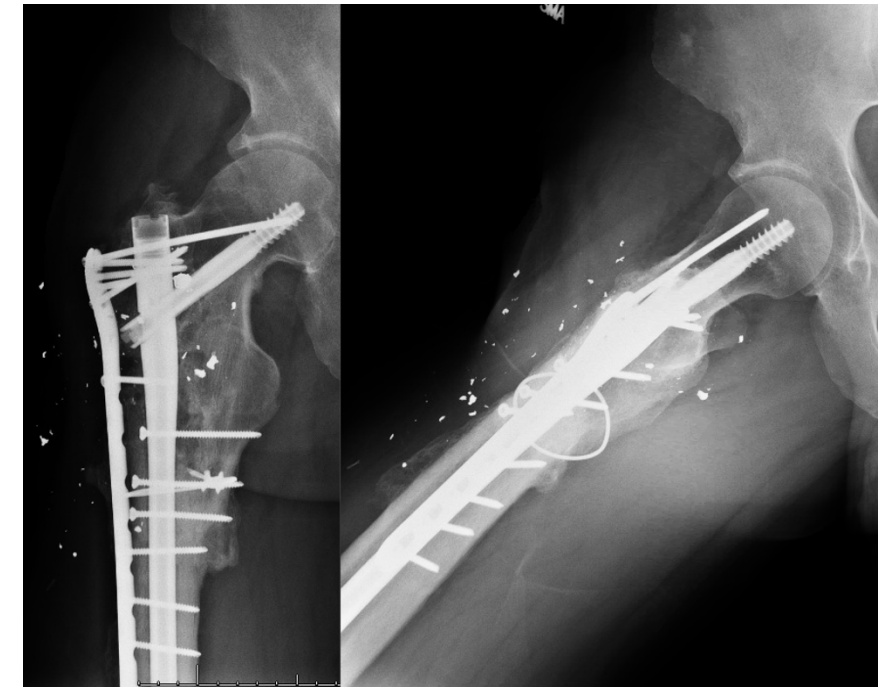
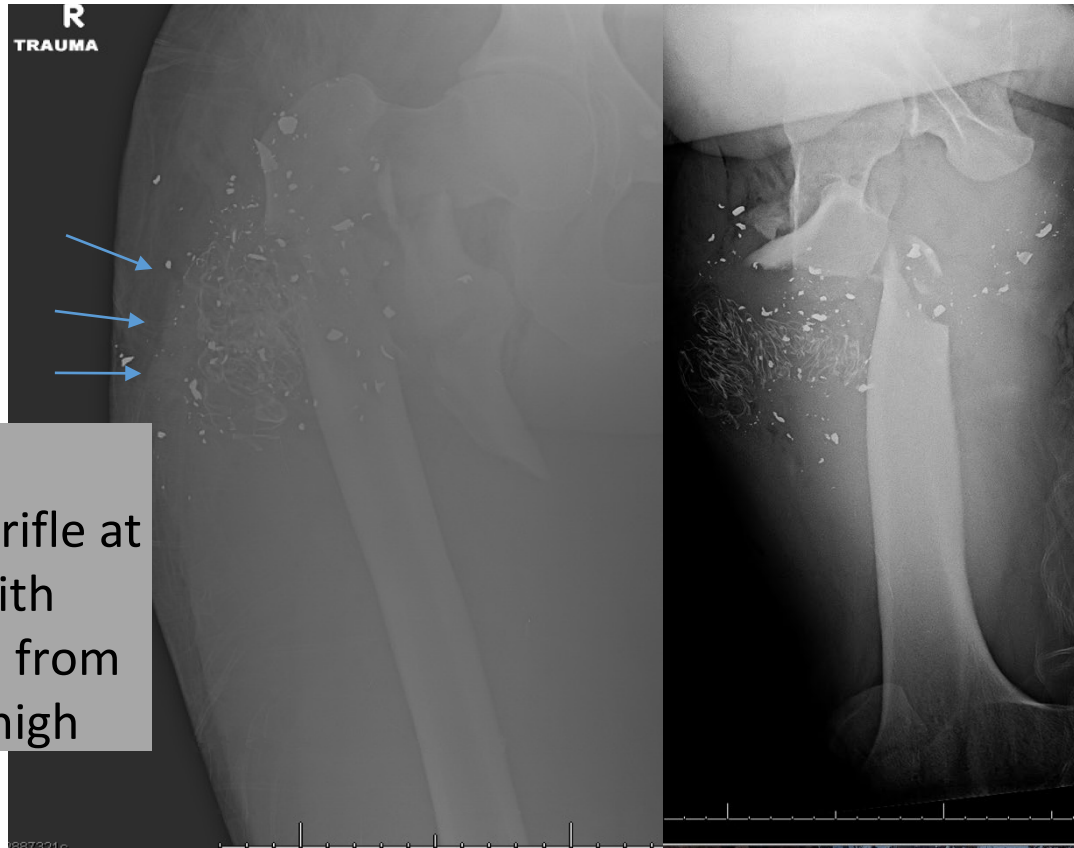
-High-energy gunshot treated with formal I&D with removal of all devitalized soft tissue and bone



**Fig. 4.** For unstable distal humerus fractures, such as this open variant with metaphyseal bone loss (a), dual column lateral plating is an alternative to exposure and instrumentation of the medial column (b).

# High-Energy GSW

35yo s/p high-energy GSW treated with **I&D (x3)**, nail, antibiotic beads  
Delayed autogenous bone grafting/supplemental plate fixation



50-caliber muzzleloader rifle at short range with sabot (plastic) from projectile in thigh



# Impending Open Fracture

Urgent reduction/fracture stabilization necessary to avoid open fracture

Skin buttonholed in proximal humeral fracture



Skin tenting from clavicle fracture can cause necrosis and open fracture



Open humeral shaft fracture after attempted closed management using Sarmiento brace in alcoholic



Wawrose, Tarkin et al. Temporizing external fixation vs splinting following ankle fracture dislocation. *Foot Ankle Int* 2020.



# Open Fracture Mechanisms

## Inside Out vs Outside In

Fracture displacement causes penetration of the soft tissue envelope and open wound

vs.

Environmental object directly penetrates skin and soft tissue sleeve causing fracture/wound



Inside out -  
Multiply co-morbid patient with low-energy open tibia fracture

Predisposition to injury based on poor bone and skin quality



Outside in -  
Dirt bike handlebar

# Epidemiology

- Open fracture mechanisms

(Weber et al. *Eur J Trauma Emerg Surg* 2019 & FLOW Investigators *NEJM* 2015)

- MVC ~30%
- Motorcycle ~20%
- Fall ~20%
- MVC vs pedestrian ~15%



Open fracture more common when subcutaneous bones involved (i.e., tibia, ankle)

# Classification of Open Fractures

Gustilo-Anderson (1976 & 1984) *“The Classic”*

- Type I – wound <1 cm, minimal contamination, comminution, soft tissue damage
- Type II – wound 1-10 cm, moderate soft-tissue damage, minimal periosteal stripping
- Type IIIA – severe soft tissue damage and contamination, coverage adequate
- Type IIIB – severe soft tissue damage and contamination, coverage inadequate
- Type IIIC – arterial injury requiring repair

(Okike et al. *JBJS* 2006)

- Meant to be applied after initial debridement!

# Disadvantages of Gustilo-Anderson Open Fracture Classification

- Meant to be applied after initial debridement!
- Interobserver reliability ~60%
- Only directly applicable to tibia fractures
- Does not consider degree of bone loss after open fracture care
- Does not consider host factors related to healing/immune response

Gustilo-Anderson Type???



# Gustilo-Anderson Type I & II Open Fractures

The difference in Type I vs II is not only wound size  
Type II injuries will have greater degree of soft tissue and bone injury



Type II open tibia fractures



Rate of complications such as infection and nonunion for Type I-II injuries, however, are significantly less than Type III Injuries

# Gustilo-Anderson Type III Open Fractures

High-energy injuries with significant damage to the soft tissue sleeve and bone  
Heightened risk of complication (infection, nonunion, chronic pain/dysfunction)

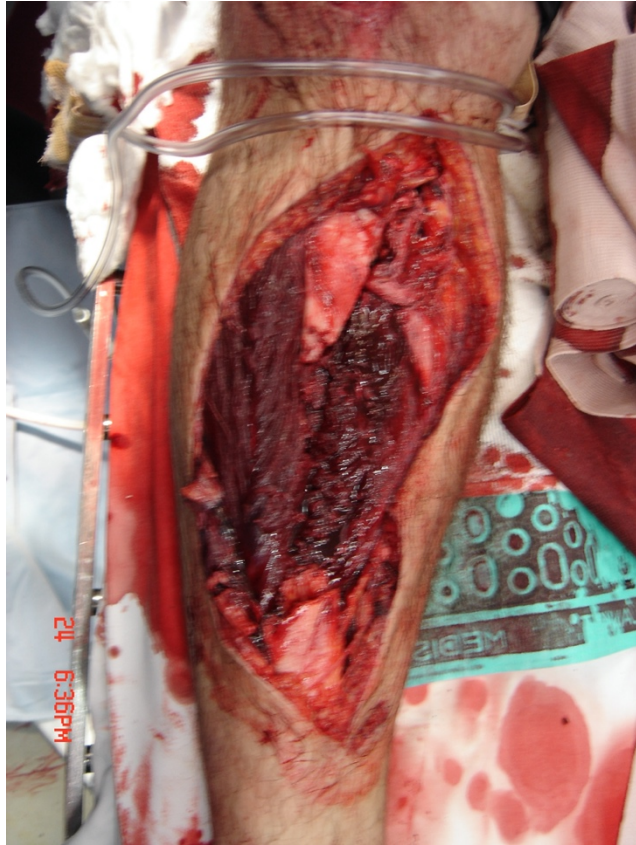


IIIA open tibia fractures will have sufficient soft tissue coverage

IIIB open tibia fractures will require soft tissue coverage, typically rotational or free flap

Significant debridement of crushed dysvascular tissue, particularly muscle, is typically the rule!

# Type IIIC - Open Fracture with Vascular Injury



Critically ill polytrauma patient s/p MCA with 3C open contaminated tibia fracture with significant bone loss, profound degree of nonviable muscle, and pulseless foot secondary to vascular injury

Amputation performed as definitive reconstructive option using multi-disciplinary decision-making process



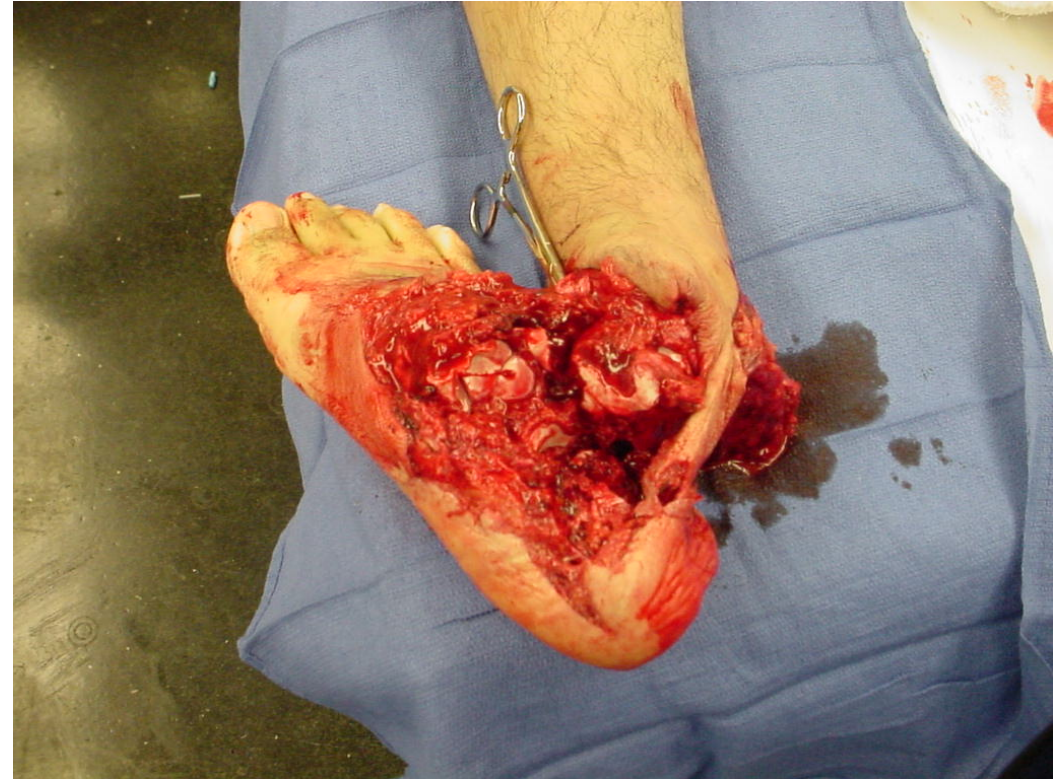
# Classification of Open Fractures (OTA)

## OTA classification

(OTA Study Group- *JOT* 2010)

• Based on 5 categories:

- 1) Skin injury
- 2) Muscle injury
- 3) Arterial injury
- 4) Contamination
- 5) Bone loss

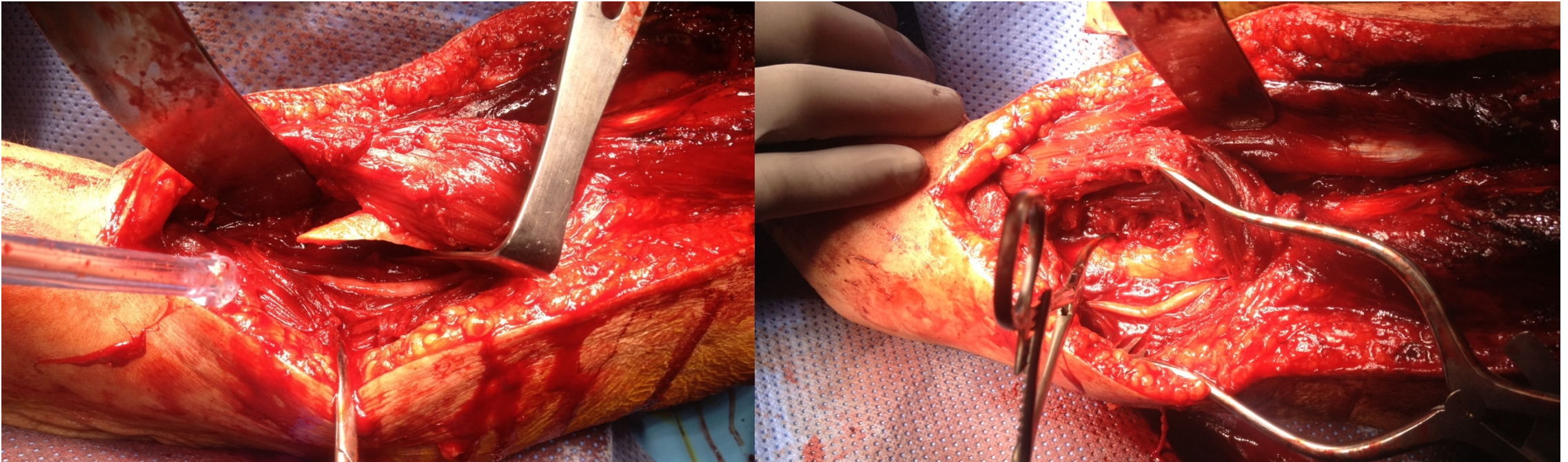


May be superior to Gustilo-Anderson in predicting outcomes (Hao et al. *JOT* 2016)

# Open Fracture-Associated Conditions

## Nerve Injury

Peripheral nerves are vulnerable to injury, with greater fracture displacement typically seen with open fractures secondary to direct injury and/or stretch

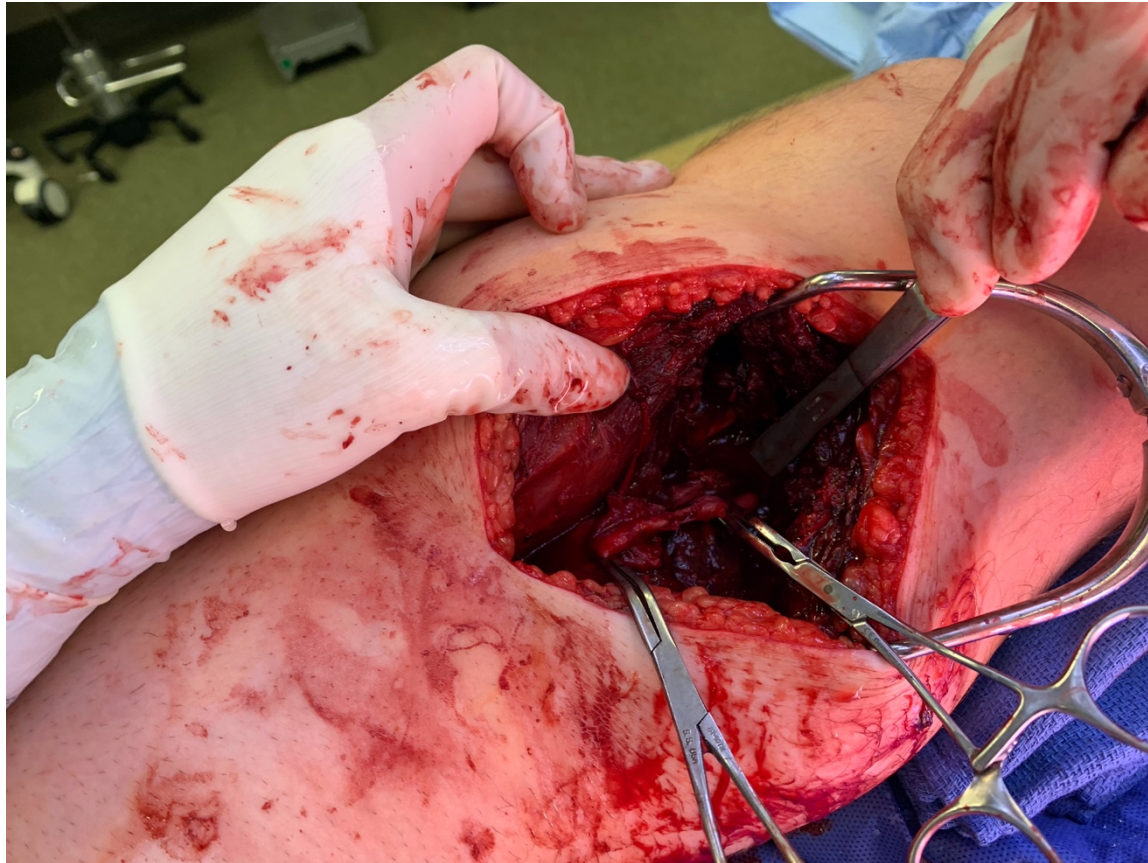


Type I open segmental humeral fracture associated radial nerve neuropraxia

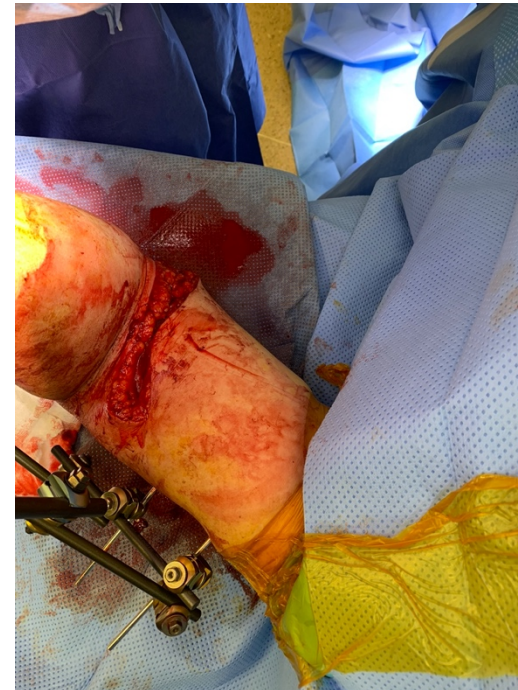
Radial nerve injury infamously at risk with distal 1/3 fractures (Holstein-Lewis)

# Open Fracture-Associated Conditions

## Vascular Injury



Reverse saphenous vein graft for arterial injury after open elbow fracture/dislocation



# Open Fracture-Associated Conditions

## Tendon and Ligament Injuries

- Beyond critical neurovascular structures, optimal functionality predicated on uneventful healing of tendon and ligament injuries
- Either acute or delayed reconstruction indicated to promote best outcomes



# Open Fracture-Associated Conditions

## Compartment Syndrome

Open fractures are at increased risk for CS necessitating fasciotomy —especially high-energy cases

Necrotic muscle from delayed compartment release in open tibia fracture



Low threshold to perform fasciotomy in case of high-energy open fracture to avoid compressive ischemia of traumatized muscle

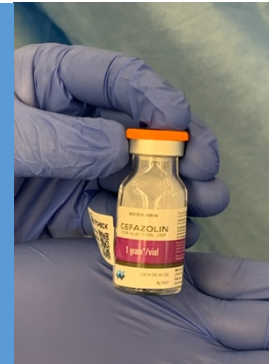


Floating knee (open fractures of the femur and tibia) managed with I&D of open wounds, retrograde femoral nail, antegrade tibial nail, and fasciotomies of the thigh and leg for associated compartment syndrome

# Antibiotics – Timing & Type

- Crucial to start antibiotics early
- Obremskey et al. *JOT* 2014 – 86% of orthopaedic trauma surgeons responded that <1 hour to antibiotics is optimal after open fracture

- Antibiotic determined by severity of fracture
- Ancef for Type I & II (clinda/vanc if penicillin allergic) (Garner et al. *JAAOS* 2020)
- Gentamicin can be added for Type III, though fallen out of favor given concerns for kidney toxicity
- Zosyn appropriate alternative to Ancef+Gent (Redfern et al. *JOT* 2016)



Grossly contaminated Type IIIA open distal femur fractures with traumatic knee arthrotomies received Zosyn within 1 hour of presentation. Tetanus was up to date.

# Antibiotics - Duration

24 hours adequate for Type I and II open fractures (Hoff et al. *J Trauma* 2011)



Longer for Type III (72 hours?), though length is controversial (Chang et al. *JBJS Rev* 2015)

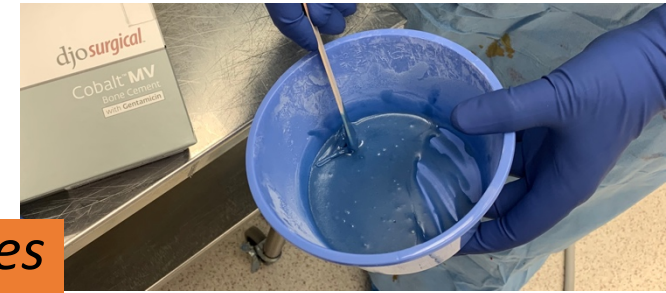
Contaminated Type III fractures of distal femur, proximal tibia, and tibial pilon given Zosyn within 1 hour of presentation and continued for 72 hours

Judgment!... Duration of therapy dictated on host and injury factors (ie severity of wound, patient co-morbidities)

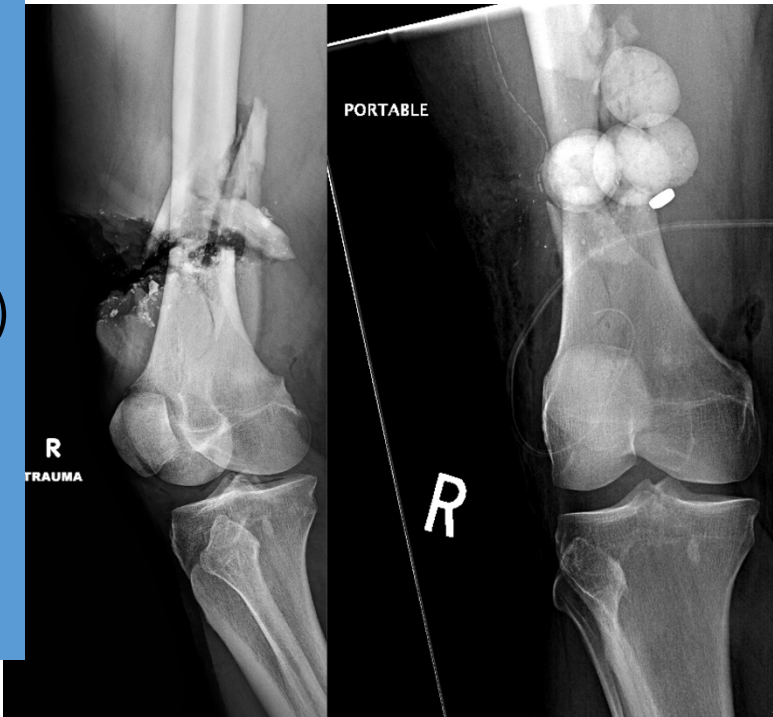
# Antibiotics - Local

May be role for local antibiotics as well (Morgenstern et al. *Bone Joint Res* 2018)

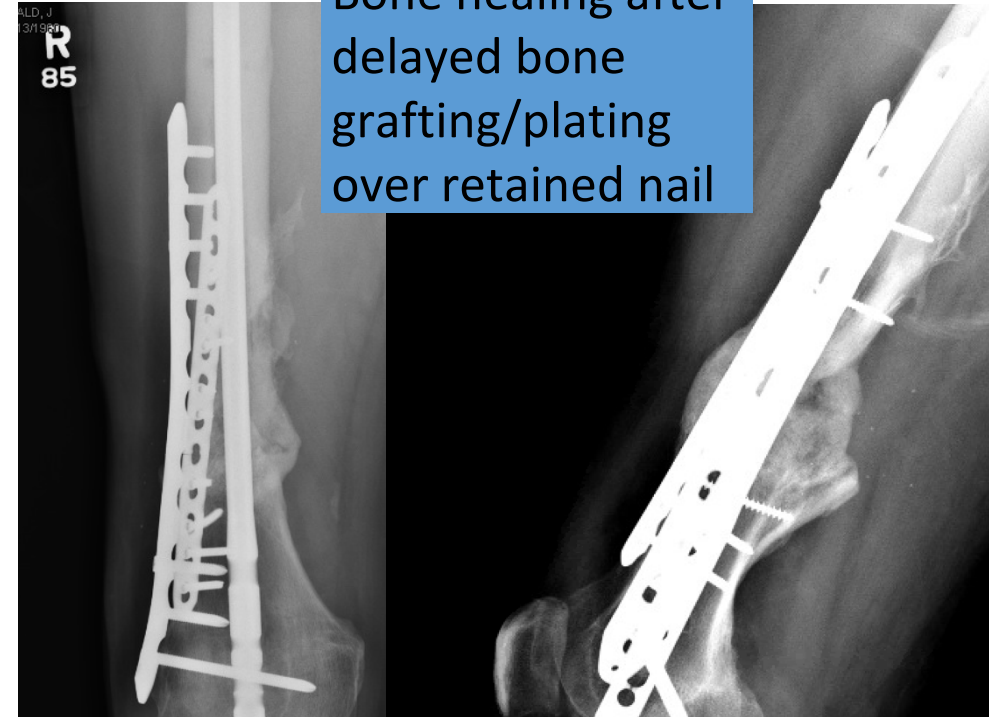
Can be with or without carrier (e.g. beads/spacer)



Open femur fracture from industrial grinder accident (grossly contaminated with bone defect) Staged by on-call surgeon with cement beads in bone defect as antibiotic carrier



Bone healing after delayed bone grafting/plating over retained nail





# Initial Care in Emergency Department

- Antibiotics! Tetanus, betadine/saline gauze, temporizing immobilization (splint, skeletal traction, external fixation)



Type I???  
Determine after debridement!



Field splint by EMS  
with traumatic  
wound covered  
with betadine-  
impregnated gauze

**“Halt the Cycle of Injury!”**

Mehta et al 2010 JAAOS

# Timing of Operative Debridement

Earlier the better! from the “Journal of Common Sense”

As long as competent resources are available and patient physiologically stable

## The Science

- “6-hour rule” - based on guinea pig study in 1898
- No difference in infection rates between early and late debridement (Schenker et al. *JBJS* 2012)
- However, no argument that highly contaminated wounds should go to OR ASAP



# Principles of Open Fracture Wound Care

- Extend the traumatic wound to appreciate zone of injury/facilitate comprehensive debridement
- Preserve vascularity to the traumatic wound
- AVOID sharp angles when extending wound (<90 degrees)
- Optimize base width of skin flap to maximize vascularity from subdermal plexus



# Debride Open Fracture Through Surgical Wound

- Extension of traumatic wound commonplace for open fracture care
- However, if wound over exposed bone and cannot be closed primarily or delayed, flap coverage necessary

Alternative- close traumatic wound(s) over exposed bone and make surgical wound to debride open fracture, which typically will require a split-thickness skin graft (STSG)



# Debridement of Open Fracture

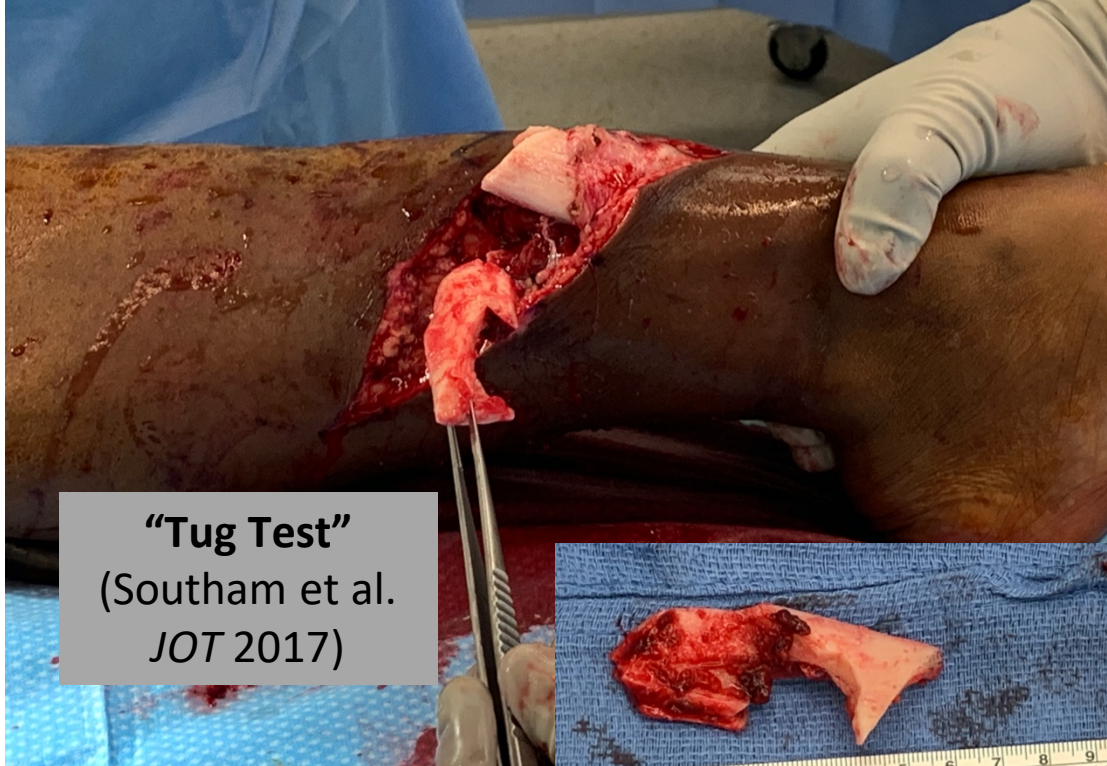
Remove any dysvascular, nonviable tissue that will ultimately serve as nidus for infection (skin, subcutaneous tissue, MUSCLE, and bone)

Healthy muscle will contract with electrocautery stimulation  
-less reliable after muscle has produced granulation tissue in response to NPWT



# Osseous Debridement

Remove bone without meaningful soft tissue attachment



“Tug Test”  
(Southam et al.  
*JOT* 2017)



Critical-sized bone defect after debridement

Debride IM canal (hidden environmental contamination)



Novel Technique- Lindvall E  
*JOT*. 2015 Dec;29(12):558-62.

# Debridement and Irrigation

FLOW Investigators *NEJM* 2015 -RCT

- Low-pressure irrigation an acceptable alternative to high flow.
- Reoperation rate lower in saline group (vs soap)



Pendulum has swung toward low-pressure irrigation due to concerns about...

- Bone damage (Bhandari et al. *JOT* 1999)
- Damage to soft tissue envelope (Boyd et al. *CORR* 2004, Chiramonti et al. *JBJS* 2017)
- Propagation of bacteria into soft tissue with high-pressure irrigation (Hassinger et al. *CORR* 2005)

Traditional Teaching

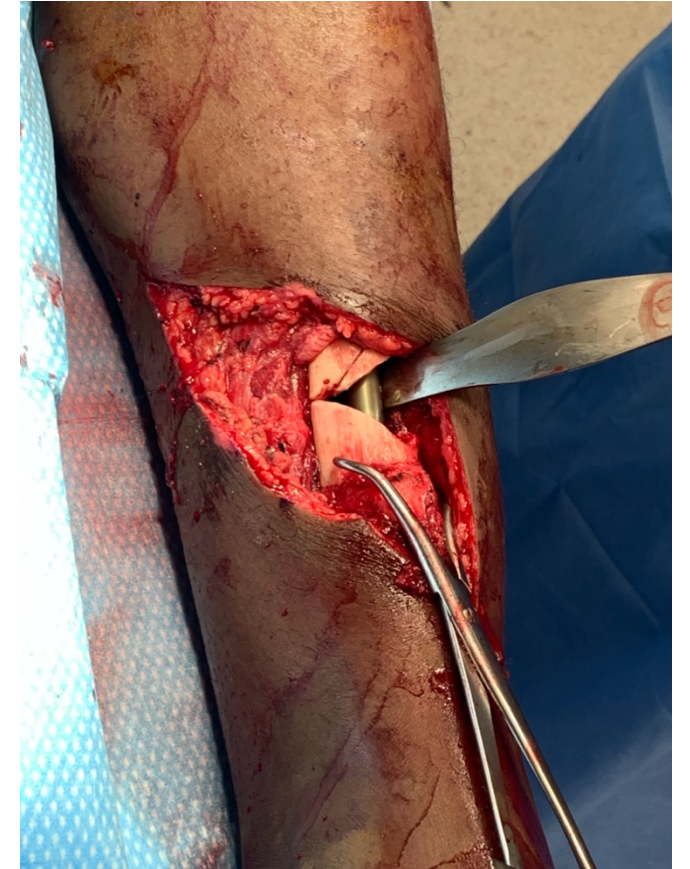
3L for Type I

6L for Type II

9L for Type III

# Fracture Reduction

Take advantage of traumatic wound to obtain fracture reduction





# Traumatic Wound Care

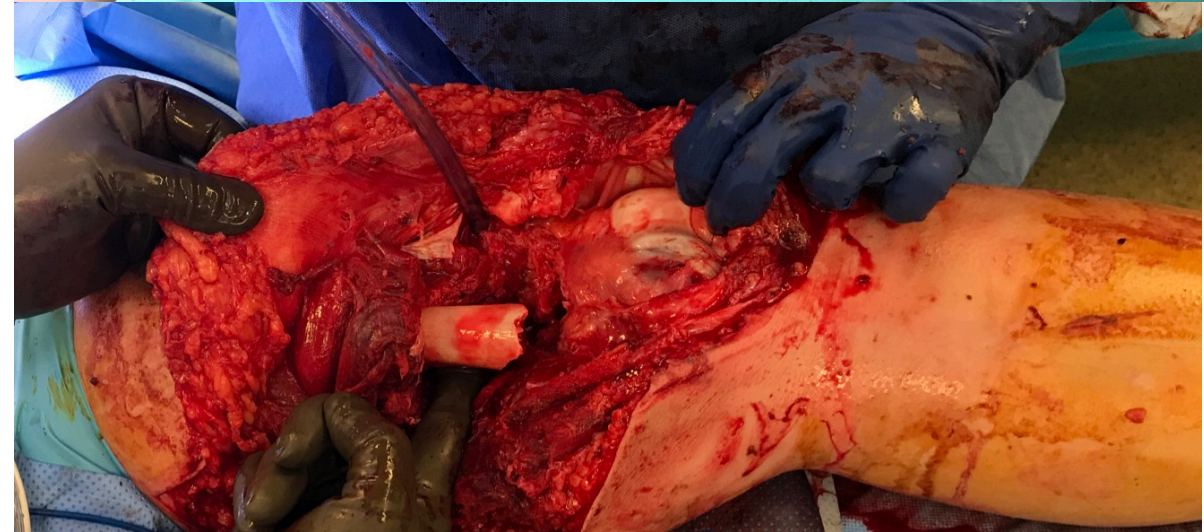


Primary closure preferred if skin edges are free of significant tension after suture repair (Scharfenberger et al. *JOT* 2017)

# Zone of Injury

## Case 2

- Open femur fracture/traumatic knee arthrotomy in young woman after MCA
- Traumatic wounds extended to appreciate extent of bone, joint, and soft tissue injury
- Organized debridement to remove all devitalized soft tissue and bone
- Bone ends delivered to debride IM canal



# Principles of Open Fracture Care

Nonviable tissue (including bone) serve as a nidus for infection and should be excised



Type IIIA open distal femur fracture after MCA

- Bone without meaningful vascular attachment removed

Level of aggressiveness debatable BUT... “When in Doubt Take It Out”

Dugan, Tarkin, et al. Open supracondylar femur fractures with bone loss in the polytraumatized patient—Timing is everything! *Injury* 2013.

Ricci et al. A comparison of more and less aggressive bone debridement protocols for the treatment of open supracondylar femur fractures. *JOT* 2013.

# Remove Environmental Contamination



- Extent of contamination may not be obvious
- The entire zone of injury needs to be explored to remove environmental debris in addition to nonviable tissue
- IM canals need to be exposed and debrided as well

# Skeletal Stabilization of Open Fracture - External Fixation

- Polytrauma - damage-control orthopaedics (DCO)
- Complex peri-articular fractures

- Critically ill, under-resuscitated polytrauma patient with multiple open fractures
- Rapid I&D/ex fix as temporizing skeletal stabilization

Pape, Tarkin et al. Timing of fracture fixation in multitrauma patients: the role of early total care and damage control surgery. *JAAOS* 2009.

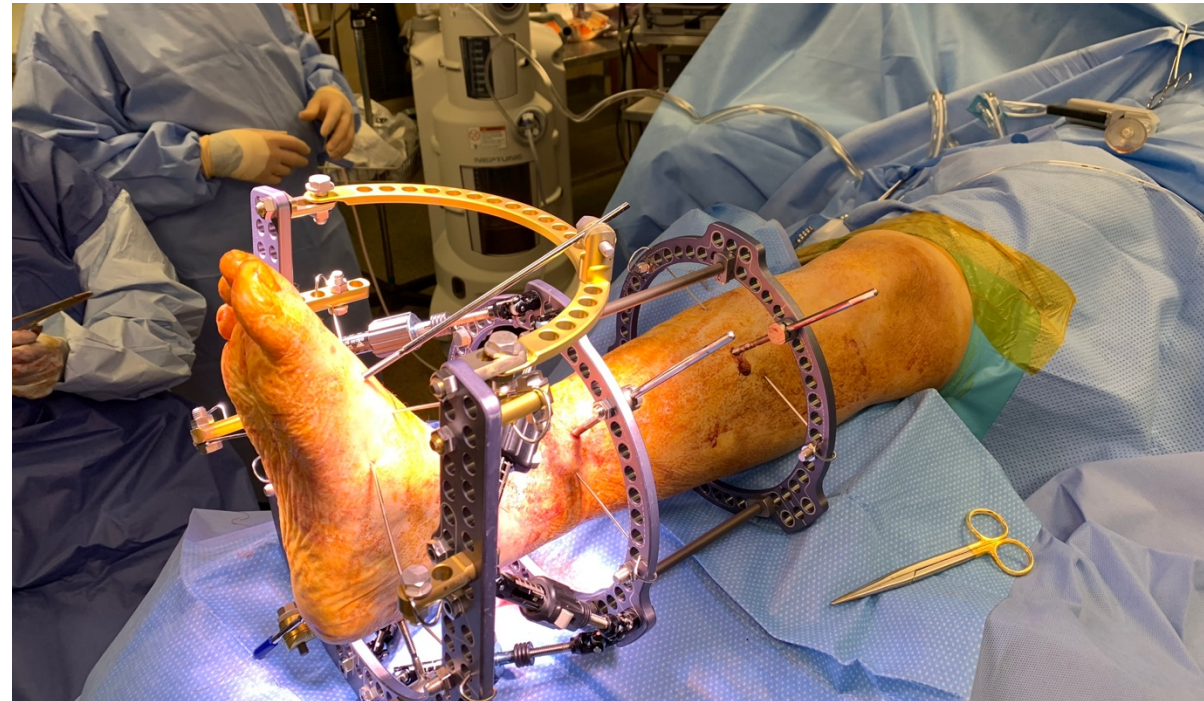


# External fixation

Definitive skeletal stabilization for severe open fracture

## Indications:

- Gross environmental contamination
- Contraindication to internal fixation present
- Anticipated need for lengthening procedure



# Internal Fixation for Open Fracture

- If a clean wound bed achievable after open fracture care, definitive fixation is INDICATED at index procedure
- Intramedullary nailing is the “workhorse” for most open diaphyseal and extra-articular meta-diaphyseal cases of the lower extremity
- Plate osteosynthesis is typically employed for open peri-articular cases

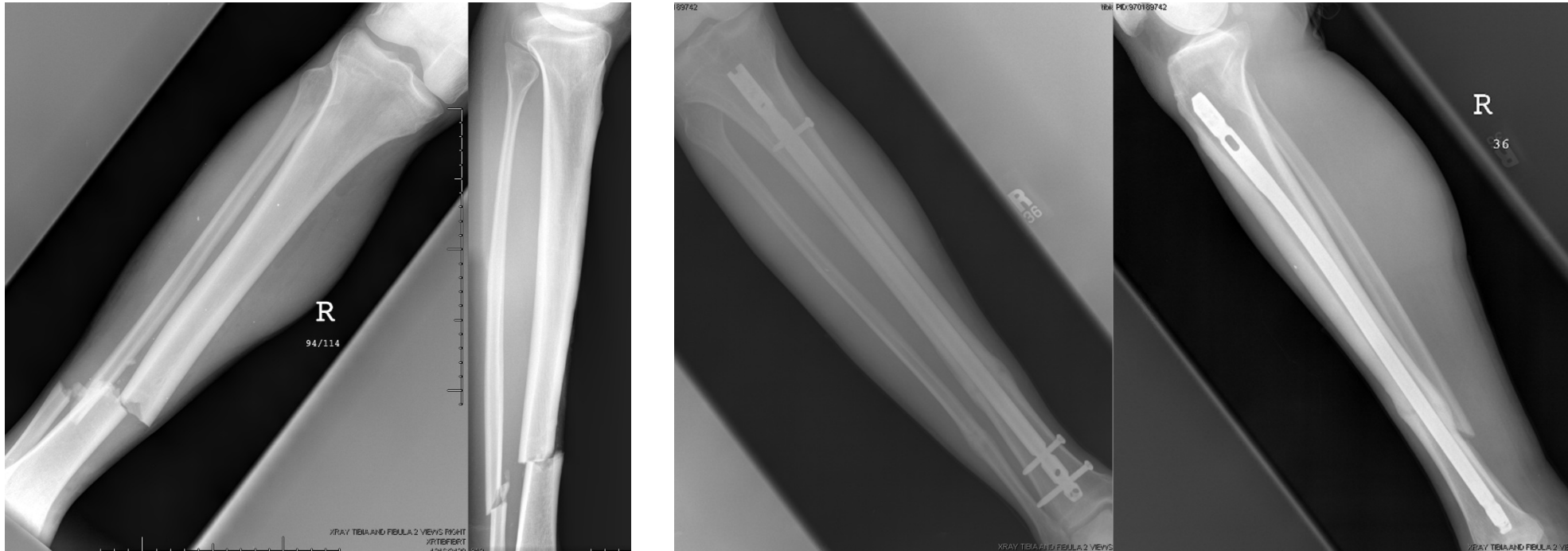


Exact reduction of intra-articular fractures is of paramount importance for best outcomes



# Intramedullary Nailing for Open Fracture

Nailing limits surgical exposure necessary for fracture stabilization - “biologic fixation”  
Avoids tension on soft tissue sleeve (vs plating), thereby facilitating traumatic wound closure

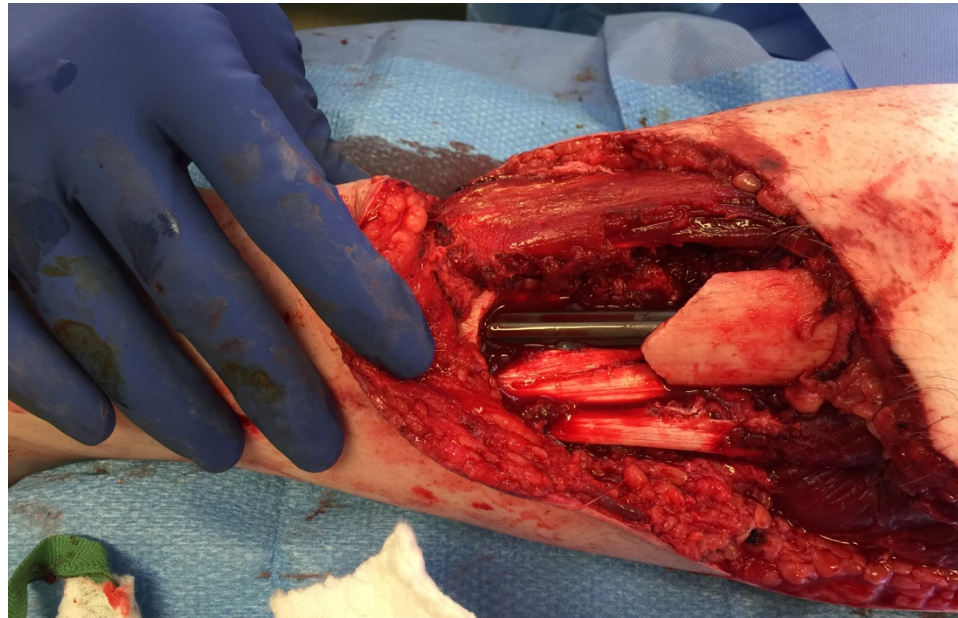


42yo with Type II open tibia fracture after MCA  
Traumatic wound closed primarily after I&D with reamed nail



# Intramedullary Nailing for Open Fracture

Excellent bridging device for open diaphyseal fractures with bone loss



# Intramedullary Nailing for Open Fracture

Positioning plate as adjunct in open tibia

Reduction with open manipulation through wound



# Segmental Open Tibia Fracture

## Nailing adjuncts



- Small fragment plate used as preliminary reduction tool prior to nailing
- Plate prevents segmental piece from “spinning” during reaming process
- Increases construct rigidity

# Nailing for Open Femur Fracture

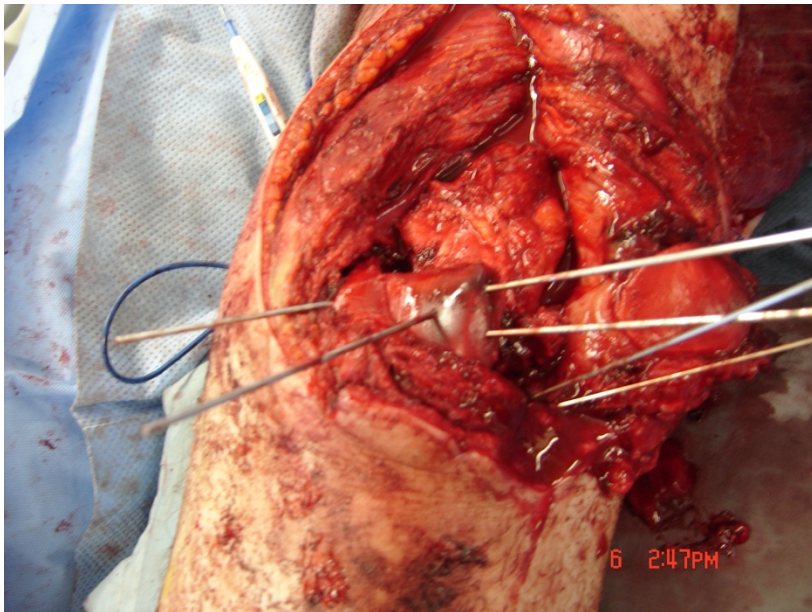


18yo polytrauma patient with Type I open femur fracture after MVC  
s/p retrograde IMN with uneventful healing

- Retrograde nail is an effective and efficient technique for open femur fracture in the polytrauma patient
- Zone of injury is explored through extension of traumatic wound
- Nonviable skin, subcutaneous tissue, fascia, MUSCLE, and bone excised
- Bone ends harvested and IM canals debrided

# Open Peri-Articular Fracture - Goals of Care

- Anatomic joint reconstruction (with intra-articular involvement)
- Alignment of reconstructed articular block to shaft
- Restoration of length, alignment, rotation of articular block to shaft



# Managing Bone and Soft Tissue Defects after Open Fracture

- Early primary closure should be attempted if soft tissues allow
- Soft tissue coverage should be obtained within 7-10 days (Melvin et al. *JAAOS* 2010) if critical-sized soft tissue defect
- Bone grafting strategies should typically be performed delayed once soft tissue envelope has healed/revascularized without signs of infection



# Open Fracture Wound Management

- Early primary closure of the traumatic open fracture wound preferred
- Healing the traumatic wound integral to avoiding infectious complications
- Caveat - Skin edges vascularized and closure without excessive tension



# Negative Pressure Wound Therapy (NPWT)

Temporizing option for critical-sized soft tissue defect associated with open fracture

- Protects/seals open fracture wound from environmental contamination (nosocomial infection)
- Negative pressure applied to traumatic wound promotes neovascularization/wound granulation and removes deleterious edema fluid
- Prepares tissue bed for soft tissue coverage (e.g., flap)

- 3B open tibia fracture in polytrauma patient
- Wound vac/ex fix used as temporizing measure as part of damage-control orthopaedics

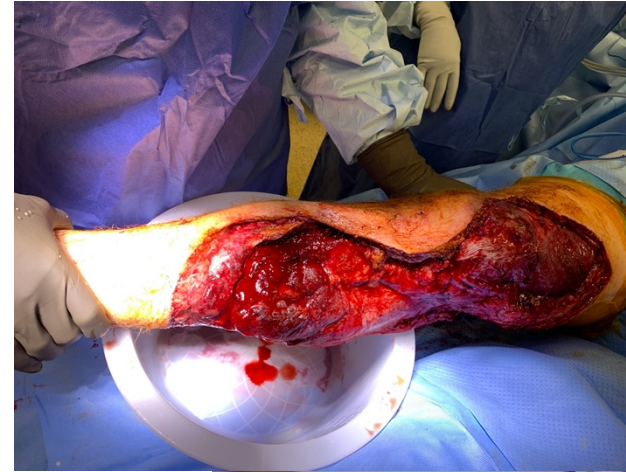


Tarkin. The versatility of negative pressure wound therapy with reticulated open cell foam for soft tissue management after severe musculoskeletal trauma. *JOT* 2008.



# Soft Tissue Coverage after Open Fracture

- Options depend on location of injury and presence of exposed bone (Boss and Buehler *JAAOS* 1994)
- For tibia fracture with exposed bone and/or joint
  - Proximal third - gastrocnemius rotational
  - Middle third - soleus rotational
  - Distal third - free flap



Rotational flap/STSG used to cover knee and fractures of the proximal/middle tibia

Timing of coverage after open tibia < 7 days with interval vac coverage recommended

D'Alleyrand JOT 2014,  
Hou J Trauma 2011  
Pincus JOT 2019

# Management of Bone Defect Associated with Open Fracture

## Autogenous bone grafting (delayed!)

Autogenous bone grafting strategies are reliable after...

- Soft tissue envelope has recovered (re-vascularized)
- Rigid mechanical environment present



Reamer Irrigator Aspirator (RIA) method as alternative

Iliac crest bone graft—gold standard

- Osteoconductive
- Osteoinductive
- Osteogenic



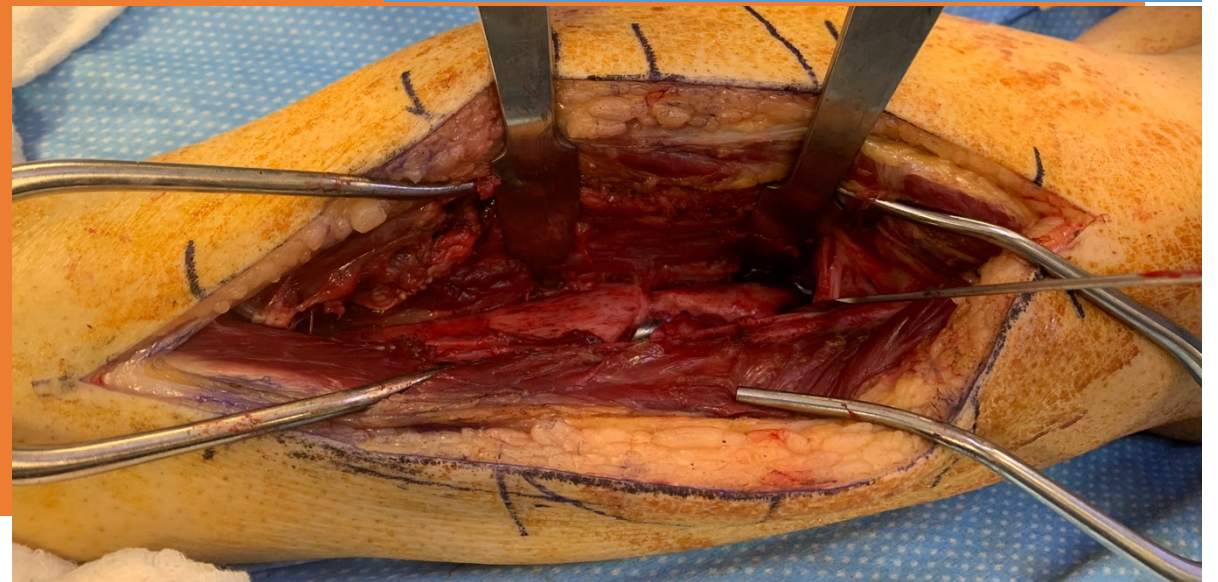
Quintero, Tarkin, Pape. Technical tricks when using the reamer irrigator aspirator technique for autologous bone graft harvesting. *JOT* 2010.



# Posterolateral Bone Grafting

- Classic strategy for bone grafting open tibia fracture with nonunion and/or critical-sized bone defect
- Nonunion debrided of fibrous scar
- Medial portion of fibula decorticated
- Graft deposited on interosseous membrane from fibula to tibia
- “Creation of synostosis”

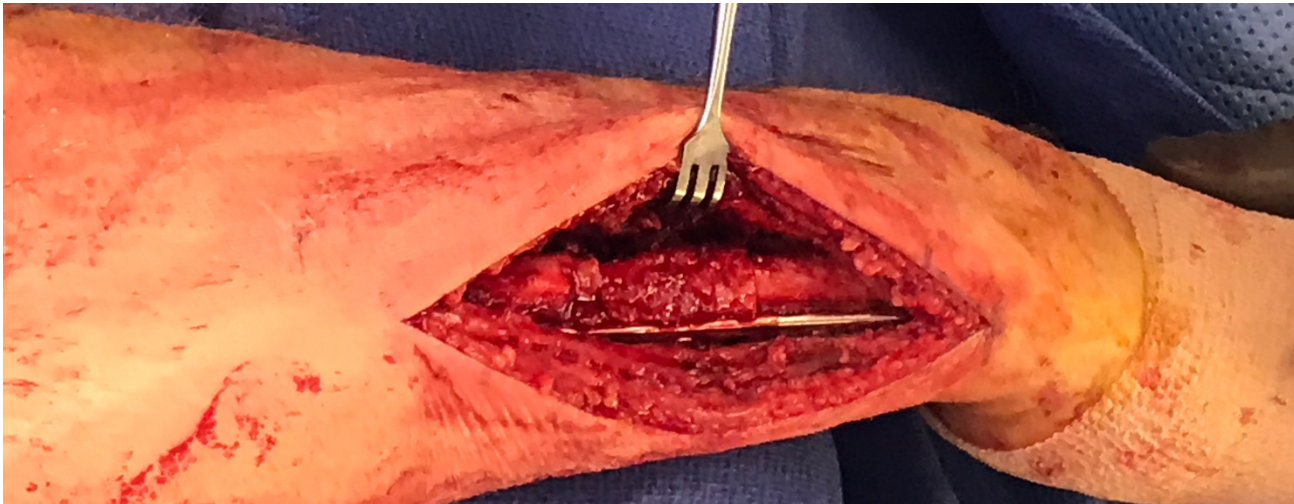
Nonunion after open fracture initially managed with nail



# Management of Bone Defect after Open Fracture

## Masquelet technique

- Critical-sized bone defect often realized after open fracture care
- Masquelet technique uses antibiotic spacer (Masquelet et al. *Orthop Clin North Am* 2010)
  - Sterilization of previously contaminated environment
  - Creates of vascularized space/envelope ideal for delayed bone grafting



- Open ulna fracture with critical-sized bone defect after open fracture care managed initially with plate osteosynthesis/antibiotic spacer
- Tricortical grafting then performed in delayed fashion

# Open Distal 1/3 Tibia with Bone Defect

## Induced membrane technique



26yo s/p multiple GSW



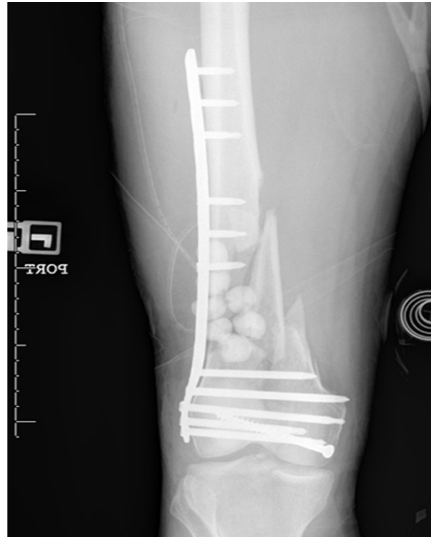
- Critical-sized defect after debridement
- IM nail as bridging device
- Antibiotic beads applied to defect



- Removal of beads
- Autograft applied in vascularized pocket
- Plate over retained nail

# Open Supracondylar Femur Fracture

## Masquelet technique



Figures from – Dugan, Tarkin et al. Open supracondylar femur fractures with bone loss in the polytraumatized patient–Timing is everything! *Injury* 2013 (with permission from Elsevier)

# Management of Bone Defect after Open Fracture

## Acute shortening (+/- lengthening)

- Technique used to simplify management of open fracture with both bone and soft tissue defects
- Typically reserved for severe cases in lower-demand hosts
- Option for delayed lengthening procedure

- Open pilon fracture with metaphyseal bone loss and transverse medial wound
- Traumatic wound could be closed without tension after shortening



- Bone transport options include those such as the Ilizarov technique (Cattaneo et al. *CORR* 1992) or newer techniques using magnetic intramedullary limb lengthening system (Barinaga et al. *JAAOS* 2018)

# Salvage for Severe Open Fracture

(limb threatening)

- Requires individualized treatment plan based on injury, host factors, patient goals and expectations
- Standard, unconventional, and innovative treatment options
- Think “Out of the Box” when standard treatments not reliable (Cole 2006)

**Clinical judgment!!!**

- Intramedullary nailing
- Open reduction internal fixation
- External fixation
- Selected fusion
- Arthroplasty
- Combinations of above or OTHER

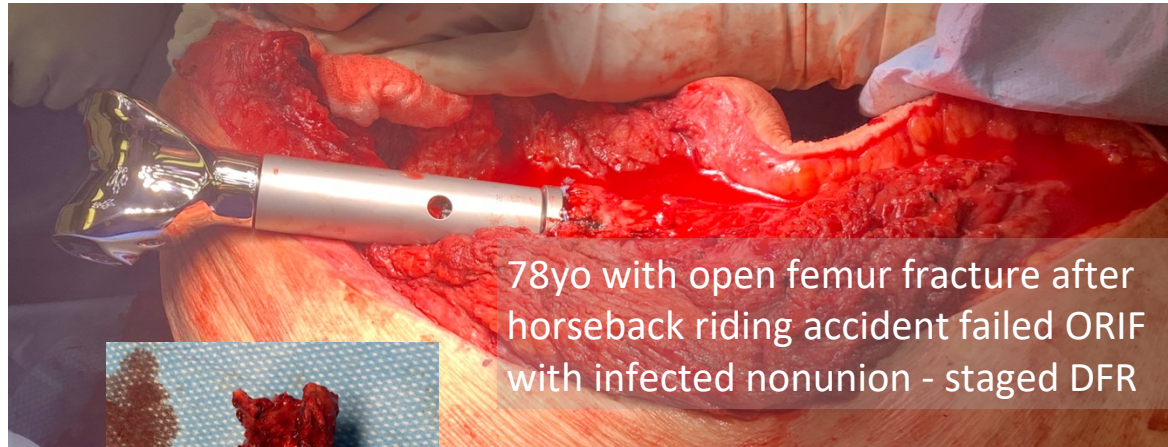
Amputation (i.e., BKA, AKA) should also be considered as part of the treatment armamentarium (as opposed to “treatment failure”)



# Arthroplasty for Open Fracture

Lower extremity

Used for primary reconstruction or for nonunion, malunion, arthrosis after open peri-articular fracture - esp peri-prosthetic in geriatric host

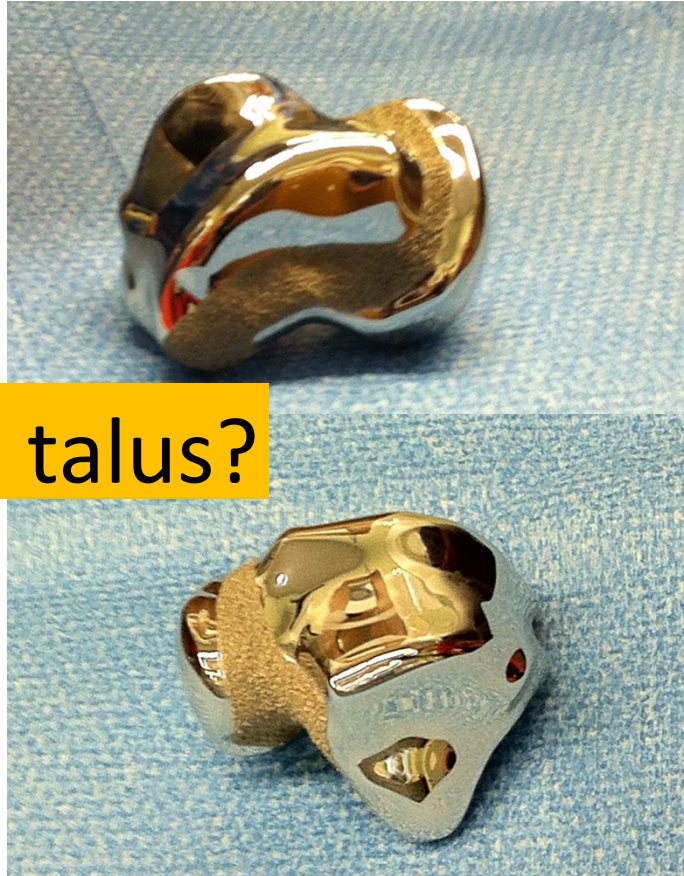


TEAMWORK!!!



Hoellwarth, Tarkin et al. Equivalent mortality and complication rates following periprosthetic distal femur fractures managed with either lateral locked plating or a distal femoral replacement. *Injury* 2018.  
Chen, Tarkin, et al. Primary versus secondary distal femoral arthroplasty for treatment of total knee arthroplasty periprosthetic femur fractures. *J Arthroplasty* 2013.  
Pushilin & Tarkin. Management of distal femoral nonunions. *Operative Techniques in Orthopaedics* 2018.  
Moloney, Tarkin et al. Geriatric distal femur fracture: are we underestimating the rate of local and systemic complications? *Injury* 2016.

# Innovative Treatment Solutions for Open Fracture



Metal talus?

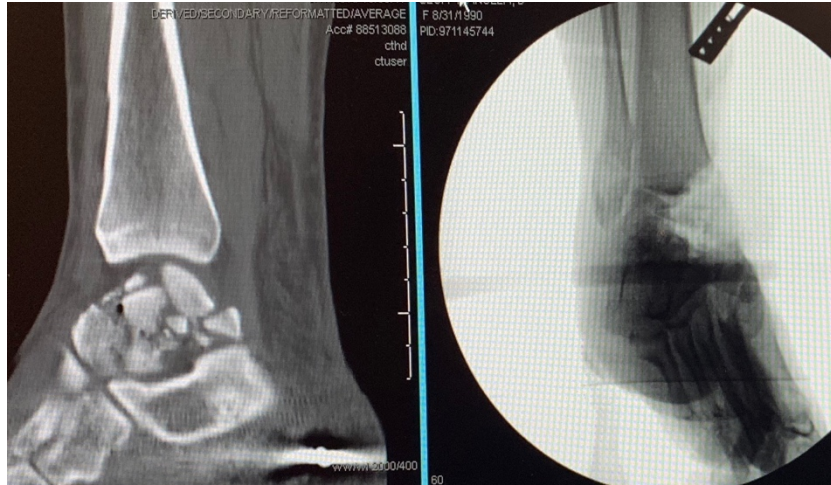


25yo s/p close-range GSW to talus, which was not amenable to ORIF. Patient did not want to pursue TTC fusion.

# Formal Arthrodesis

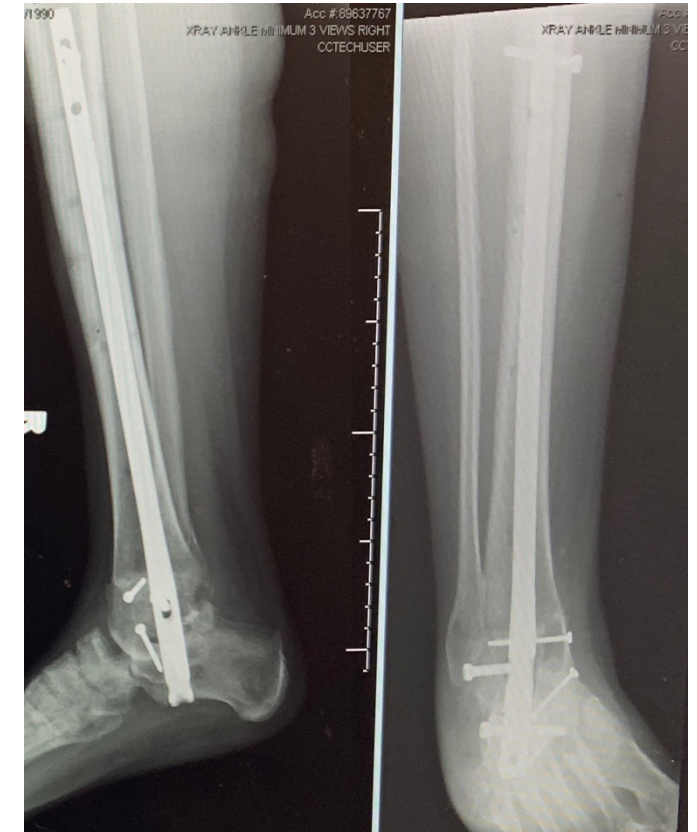
for open peri-articular fracture

Select open peri-articular fractures with profound cartilage injury or loss



Severe open talus fracture with bone/joint loss after MCC managed with TTC fusion and delayed bone grafting

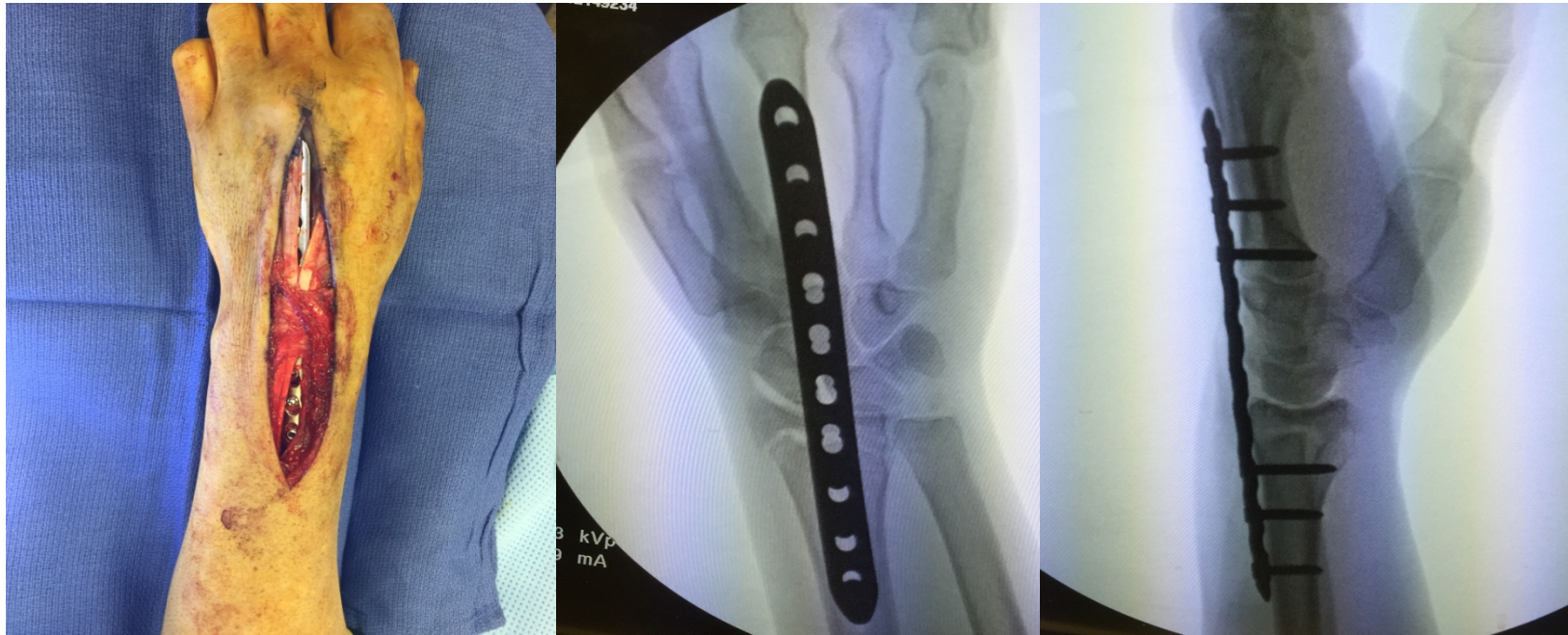
Tricortical graft from pelvis to span tibia to calcaneus



Tarkin & Fourman. Retrograde hindfoot nailing for acute trauma. *Curr Rev Musculoskelet Med* 2018.

# Unconventional Open Fracture Stabilization

Temporary trans-articular fixation



Open distal radius fracture (transverse volar wound) with diminutive articular block treated with open fracture care and dorsal spanning plate to internally splint the fracture and soft tissue wound)

# Decision for Limb Salvage



The decision for amputation vs salvage is typically not as clear as in this extreme case



# Amputation

Definitive reconstructive option after severe open fracture (ieBKA)

## LEAP Study

- 601 patients
- Multicenter
- No significant difference in functional outcomes for limb salvage vs amputation

MacKenzie EJ, Bosse MJ. Factors influencing outcome following limb-threatening lower limb trauma: lessons learned from the Lower Extremity Assessment Project (LEAP). *JAAOS* 2006



S/p open distal femur fracture and mangled leg managed with open fracture care after boating propeller - distal femur ORIF and BKA. Patient returned to water skiing with prosthesis



BKA with posterior myofascial cutaneous flap

# Complications after Open Fracture

- Unfortunately common
  - Infection
  - Nonunion
  - Malunion
  - Arthrosis
  - Chronic pain
  - Physical dysfunction
  - Psychosocial distress



# Open Fracture Complications

## Infection

Etiology of infection after open fracture secondary to...  
environmental contamination,  
compromised soft tissue envelope  
(i.e., vascularity), delayed or frank  
failure of wound healing, and/or host  
factors (polytrauma, co-morbid  
conditions, nutritional deficiency)

Are you on call? One of my partners at [redacted] has an open pilon. Pt fell from a roof into mulch. He washed it out, ex fixed, but still needs definitive fixation and plastics

This is all mulch...





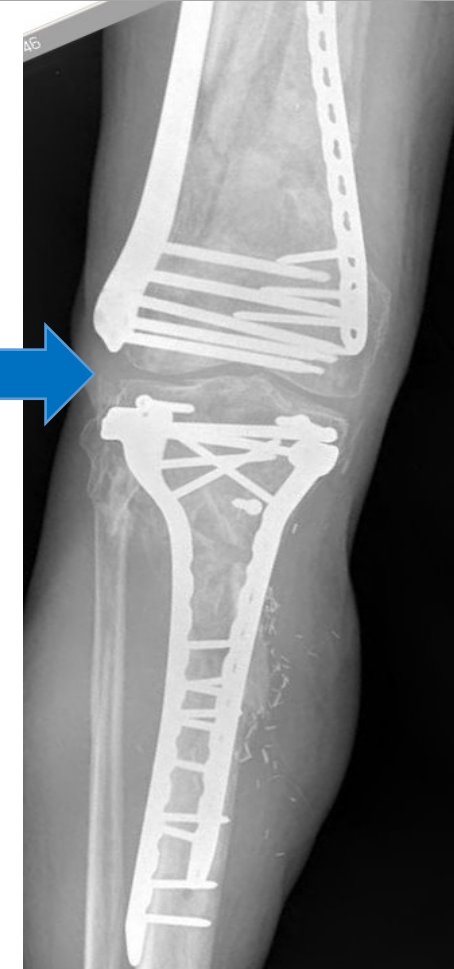
# Open Fracture Complications

## Nonunion



Ineffective healing response after bridge plating

“Anticipated” nonunion - Critical-sized bone defect initially managed with antibiotic beads

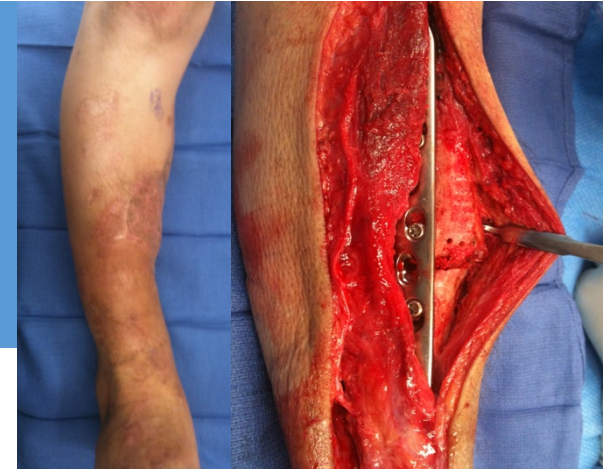


Sands, Siska, Tarkin. Reconstructive strategies for skeletal complications in the polytrauma patient. In *The Poly-Traumatized Patient with Fractures 2011* (pp. 333-344). Springer, Berlin, Heidelberg.

# Open Fracture Complications

## Deformity/Malunion

- Patient referred after treatment for open tibia fracture with ambulatory dysfunction secondary to varus malunion
- Post-traumatic reconstruction (osteotomy) required to restore mechanical axis



Infected nonunion/malunion (varus collapse) treated with serial debridements, interval external fixation, osteotomy, and tricortical wedge graft/Internal fixation

Tarkin et al. Soft tissue and biomechanical challenges encountered with the management of distal tibia nonunions. *Orthop Clin* 2010.

# Open Fracture Outcomes

Infection, nonunion, and secondary amputation predicted by host factors and severity of injury

Functional outcomes improving, but significant impacts on health-related quality of life

Giannoudis et al. *Injury* 2009- Grade 3B/C open tibia fractures associated with ongoing pain and difficulties with activities

Outcomes of severe open fractures most commonly predicated on “economic, social, and personal resources”

MacKenzie & Bosse. [LEAP] *JAAOS* 2006

*Bowen CORR 2005*

N=195 open fractures

As compared to Type A (healthy) Hosts

- Type B had 2.86X infection risk
- Type C had 5.72X infection risk

*Westgeest JOT 2016*

N=791 open fractures

- Infection and higher Gustillo Grade associated with risk of fx nonunion

# Summary

- Open fractures are a surgical urgency requiring thorough debridement/irrigation and skeletal stabilization
- External and internal fixation, amputation, as well as innovative strategies are necessary for skeletal reconstruction of open fractures
- Orthoplastic reconstruction is often necessary for open fracture with soft tissue loss
- Complications are commonplace with open fracture including infection and nonunion as well as physical and psychosocial dysfunction
- Host, injury pattern, and treatment plan will influence outcome after open fracture

# Acknowledgement



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Thank you for your attention...



s/p IIB open tibia fracture  
enjoying his grandchildren

