Pilon Fractures

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Goals

- **Patient characteristics**
- **Radiographic interpretation**
- **Classification**
- **Emergent care**
- **Acute vs delayed definitive care**
- **Definitive stabilization**
- **Postoperative care**
- **Outcomes**

Demographics

- 3-10% of tibial fractures
- 1% of all fractures
- 30-40 yrs age
- Males predilection
- Falls, motor vehicle collision, motor cycle collision

Patient Risk Factors for Infection

- Age
- DM
- Obesity
- Urinary incontinence
- Malnutrition
- Neurologic deficit
- MRSA colonization
- Revision surgery
- NSAIDs
- Blood transfusion
- Prolonged surgical time
- > 3 comorbid conditions

Low Energy Mechanism – “The Plafond Injury”

- Twisting mechanism without articular impaction
- The transition point from ankle fracture to pilon
- Associated with injuries at top of ski boots or skateboard injury
- The fracture begins extraarticular and might spiral into the joint
- Low risk of open fracture
- Low risk of severe soft tissue injury

High Energy Mechanism -- “Mortar and Pestle”

- Fall from height
- Violent impacts
- High risk of open fracture
- Expanded zone of injury

Radiographs

- AP, Lateral and Mortise for acute ankle injuries
  - Contralateral can help delineate anatomy of individual patient
  - Fibular length, contour of distal tibia, fibular position
- CT Scan
  - Mandatory prior to definitive stabilization
  - If staged consider waiting until reduction and/or external fixation
  - Pre I&D CT scan can be beneficial if a partial reduction can be achieved through open wounds
  - 3D rendition and prints can be helpful for macroscopic reconstruction
  - Soft tissue windows helpful for incarcerated tendons and neurovascular structures

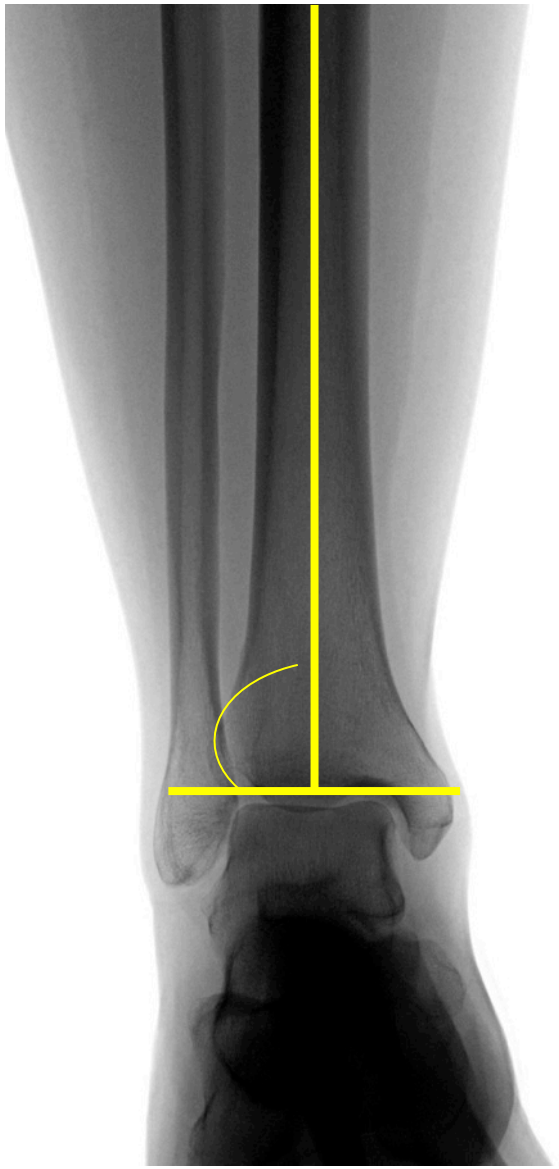
Radiographs

AP

Mortise

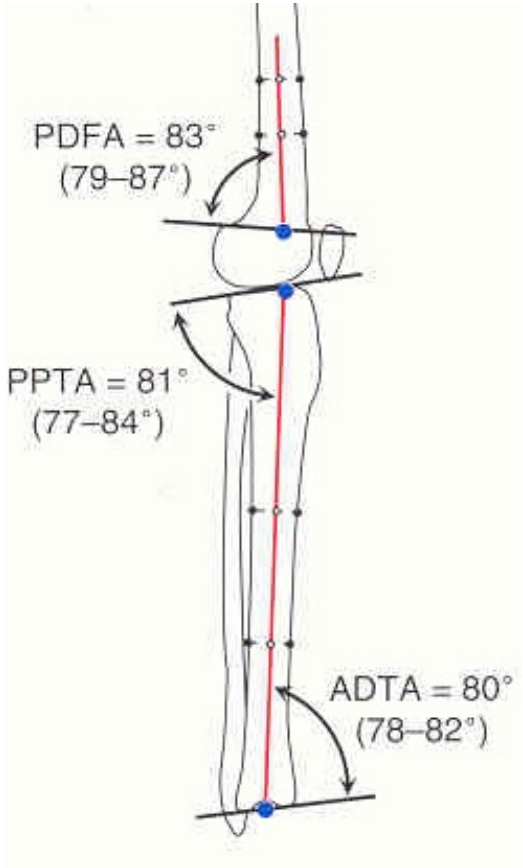
Lateral

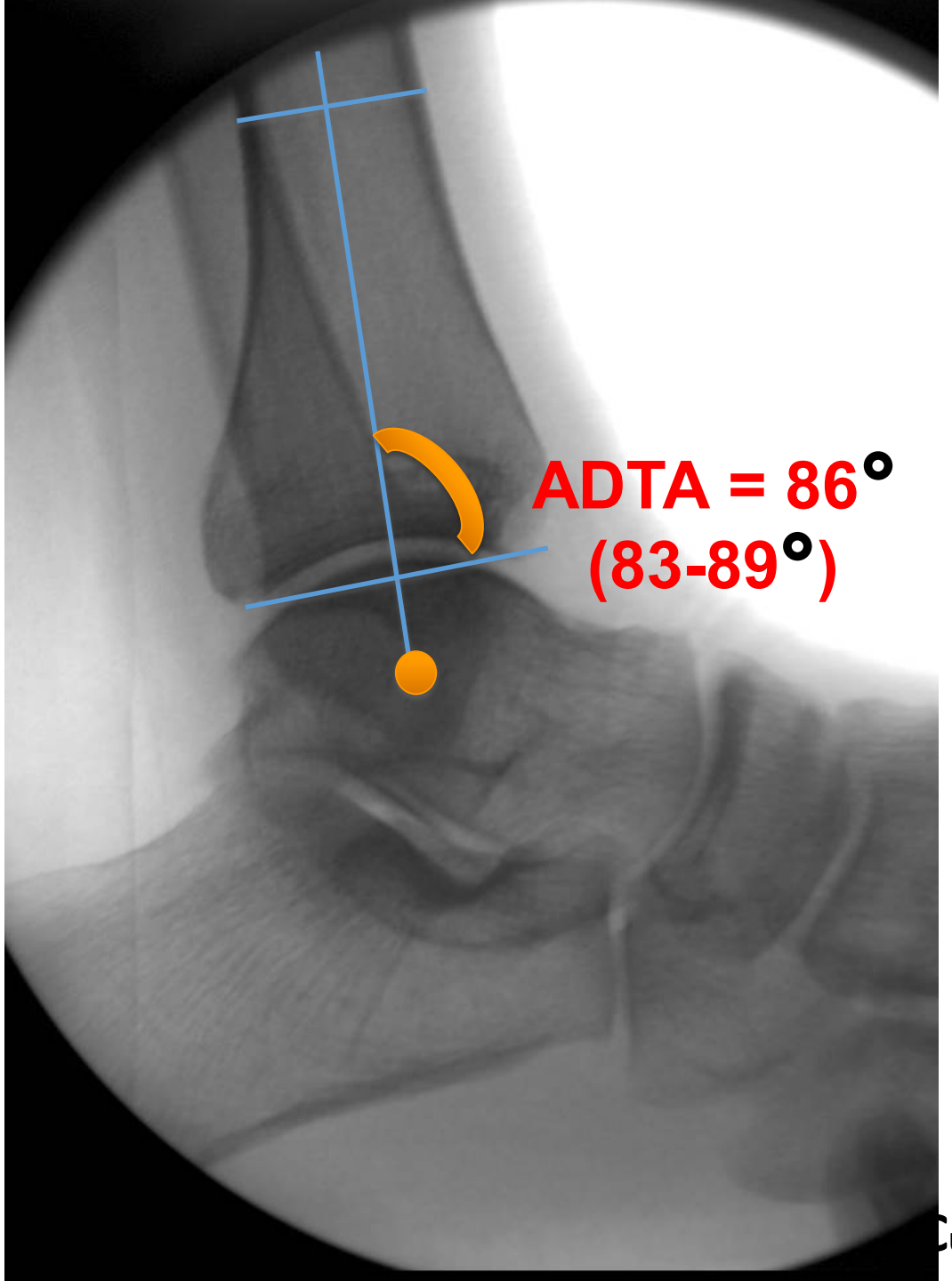
Lateral distal tibial angle (LDTA)



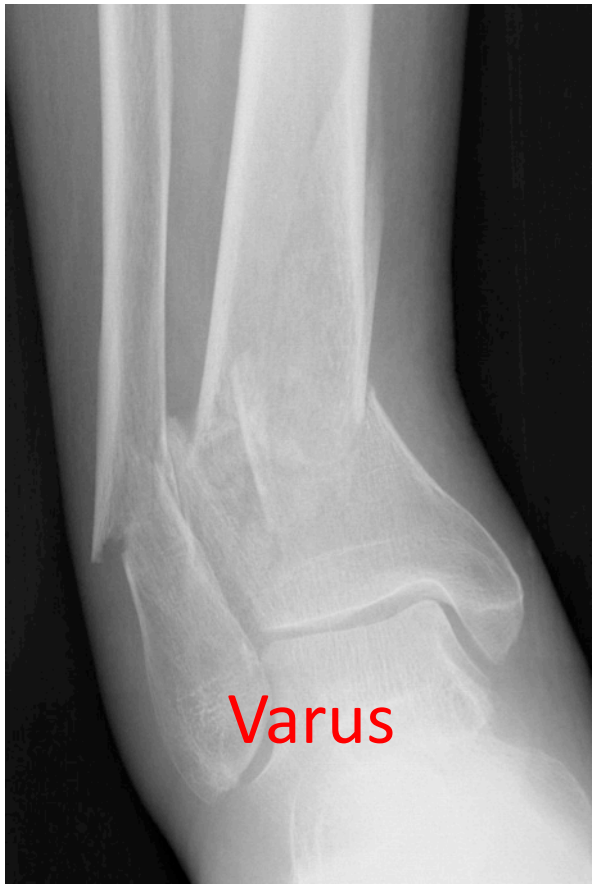
Normal is 88 degrees

ADTA
Anatomic Distal Tibial Angle

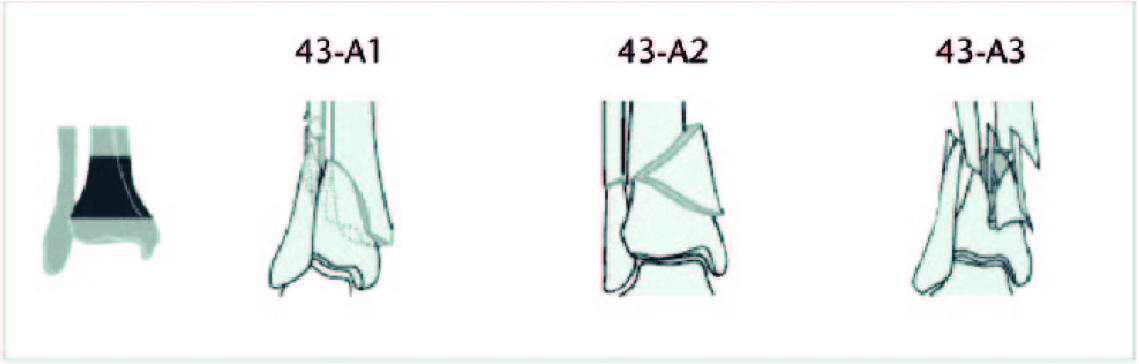




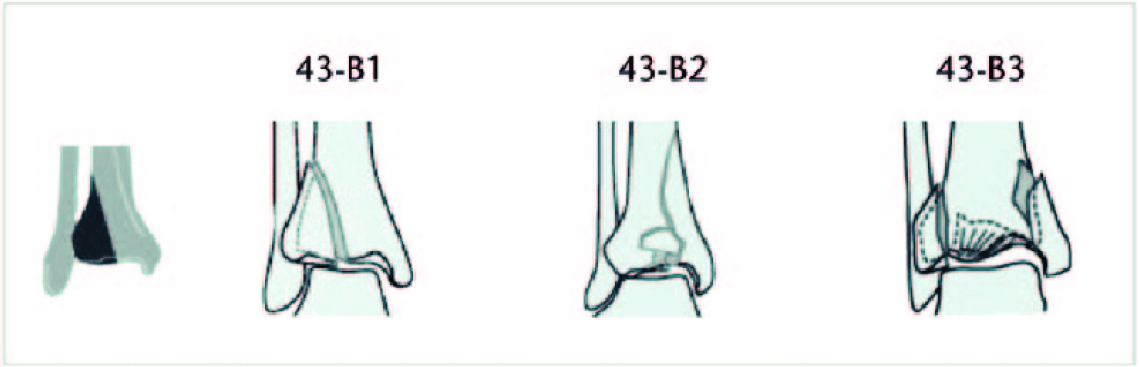
Injury Radiograph Critical



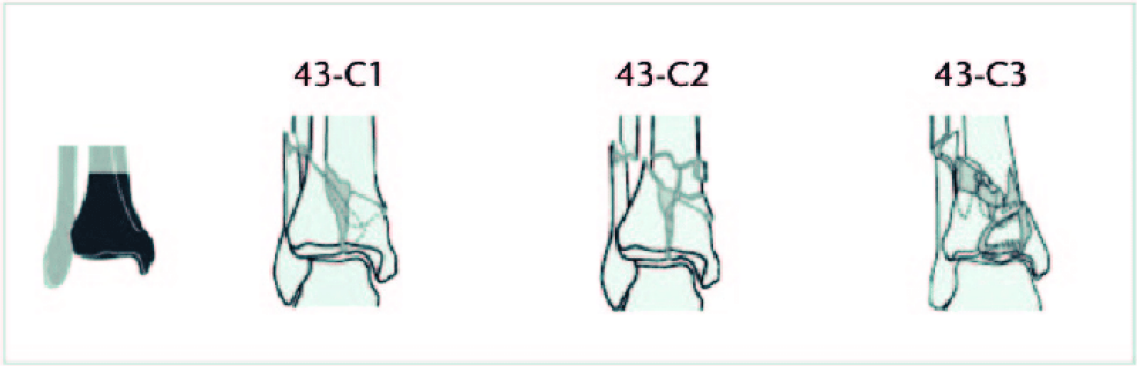
AO-OTA Classification



Extraarticular — The Good



Partial Articular — The Bad



Complete Articular — The Ugly

AO-OTA 43A1-3

AO-OTA 43B1-3

AO-OTA 43C1-3

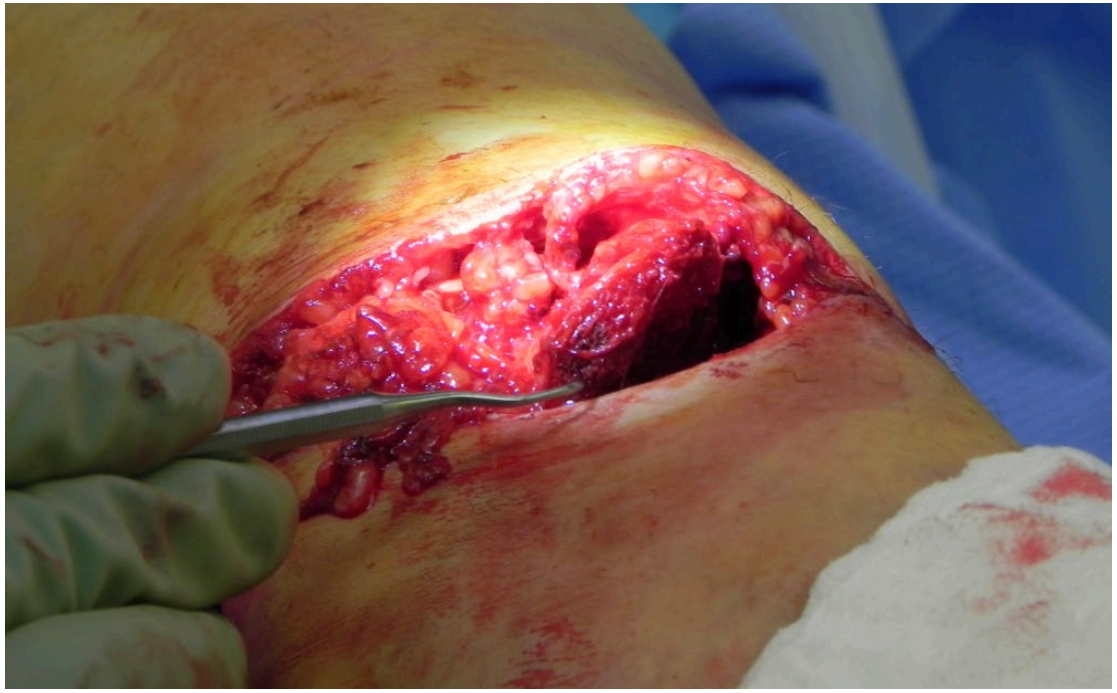



Emergent Care

- Evaluation of soft tissues
- Neurovascular evaluation
- Reduction
  - Improves vascularity
  - Pain control
  - Takes pressure off soft tissues

Open Fractures

- Soft tissue reduction
  - Skin can be invaginated in fracture site
- Valgus fracture pattern most commonly open (medially)
- Clothing and debris can be forced into wound



Open Fracture Treatment

- IV antibiotics and Td booster per institutional guidelines
- Reduce fracture
- Cover with sterile moist dressing
- Preparation for OR for debridement and probable external fixation
  - Primary closure if possible
  - Drain placement
  - Might not be able to open wound again so take advantage of open wounds

Open Fracture

- Basic open fracture guidelines
- Distal extremity nature nearly always requires free flap when not primarily closed
- Negative pressure wound care commonly used
  - Take care not to desiccate bone
  - Not recommended to change dressing on hospital floor
- Bead pouch approach with high dose antibiotics with little disadvantage
- Goal is plastic surgery coverage within 10 days

Blisters

- No uniform treatment algorithm
- Unroofing with Silvadene
  - Re epithelialization
- Don’t operate acutely, even when serous can compromise surgical field

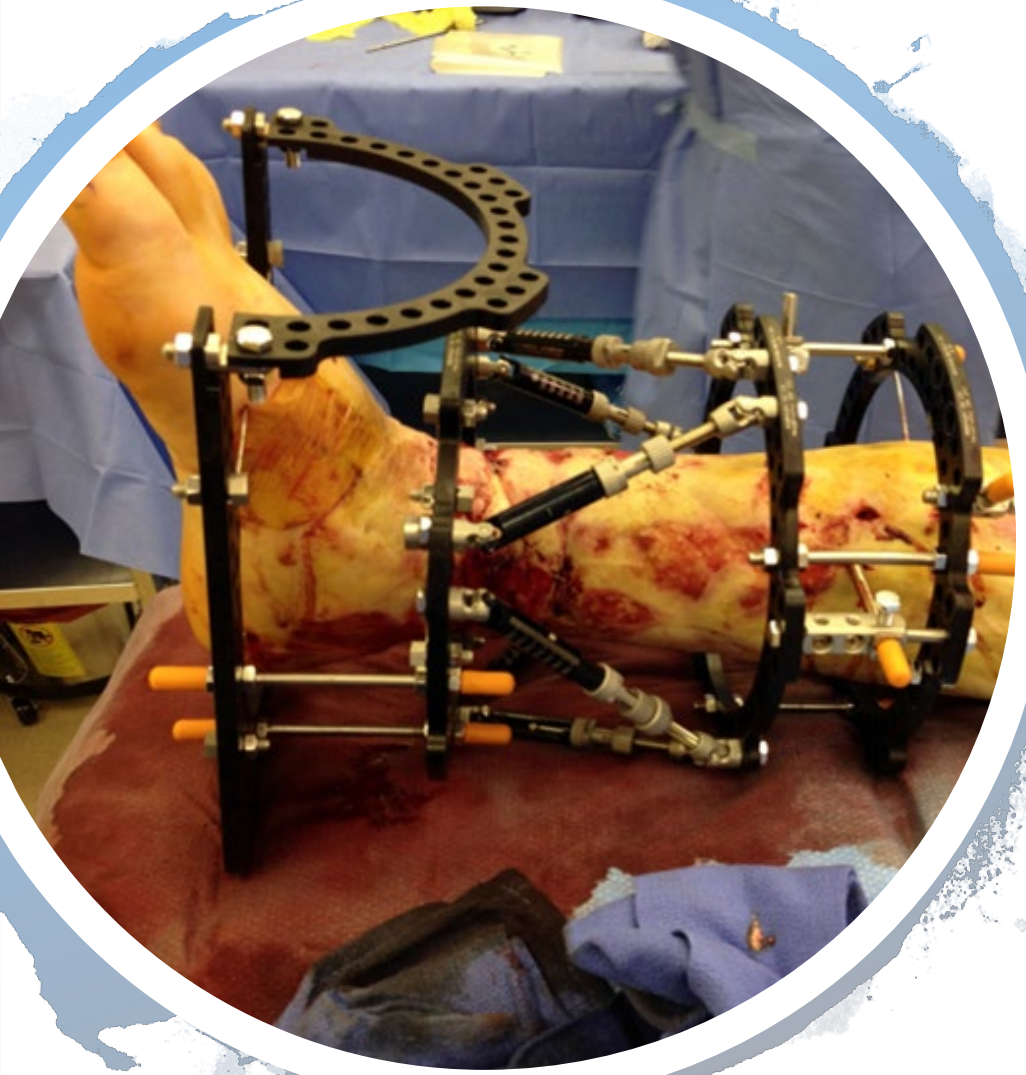
Treatment Algorithms

Acute vs. Staged

Complications can be catastrophic

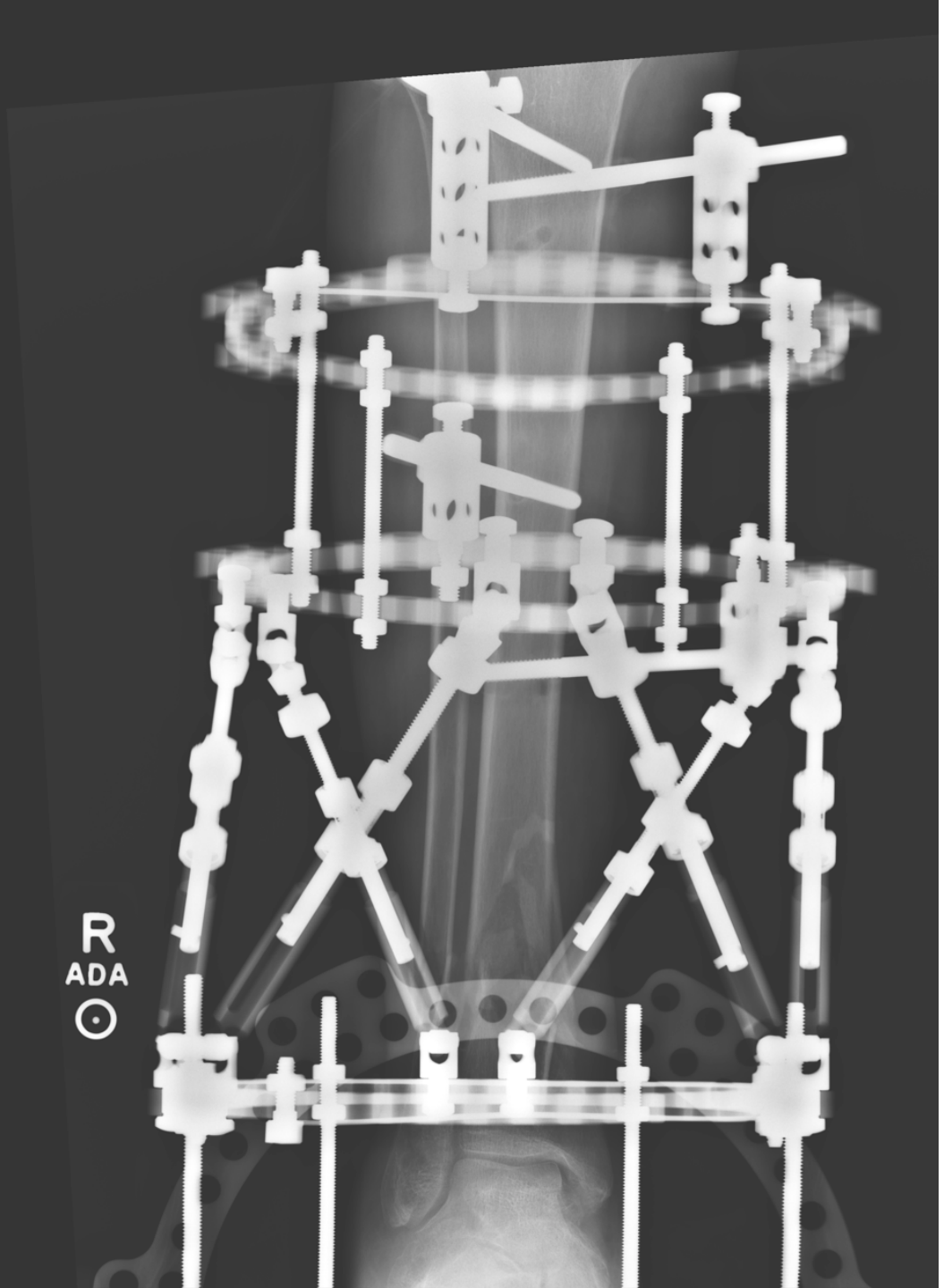
Rüedi and Allgower, 1969

- 4 tenets in open treatment of pilon fractures.
    1)Anatomic reduction and fixation of associated fibular fracture
    2)Anatomic restoration of the articular surface
    3)Autologous bone grafting of metaphyseal defects
    4)Medial buttress plating to allow early motion.



North American Experience

- 55% risk of soft tissue complication vs. European experience
- Higher energy injuries in NA
- Developing options:
  - Limited ORIF with ex fix
  - Staged management with ex fix
  - Multiplanar external fixation



Multiplanar Ex Fix

Malunion

Nonunion

Pin site infection

Staged Ex Fix +/- ORIF of Fibula

- Sirkin et al. and Patterson & Cole
  - Fibular fixation and ex fix of plafond injury
  - Delayed definitive internal fixation until soft tissue recovery
- Acceptably low rate (0-5.1%)of soft tissue complications/infection

External Fixation

Improve alignment

Centrally located talus

Slight joint distraction

https://otaonline.org/video-library/45036/procedures-and-techniques/multimedia/16731321/ankle-spanning-external-fixation-indications-and

Fibular ORIF

- Advantages
  - Improves stability of spanning frame
  - Allows soft tissue recovery
  - Indirect reduction of tibial components via ligamentotaxis
- Disadvantages
  - Malreduction can adversely affect pilon ORIF
  - Planned tibial incisions can be compromised

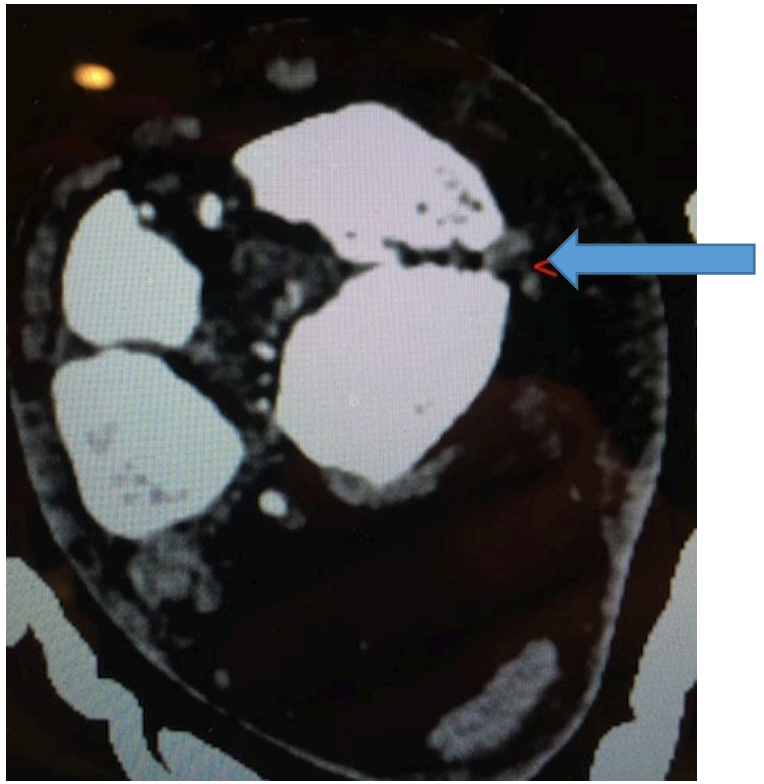
Fibular Follies

- Failure to attain length
- Ex fix pins within zone of injury
- Talus subluxation
- Incision too anterior to allow for tibial incisions

Fibular Malreduction

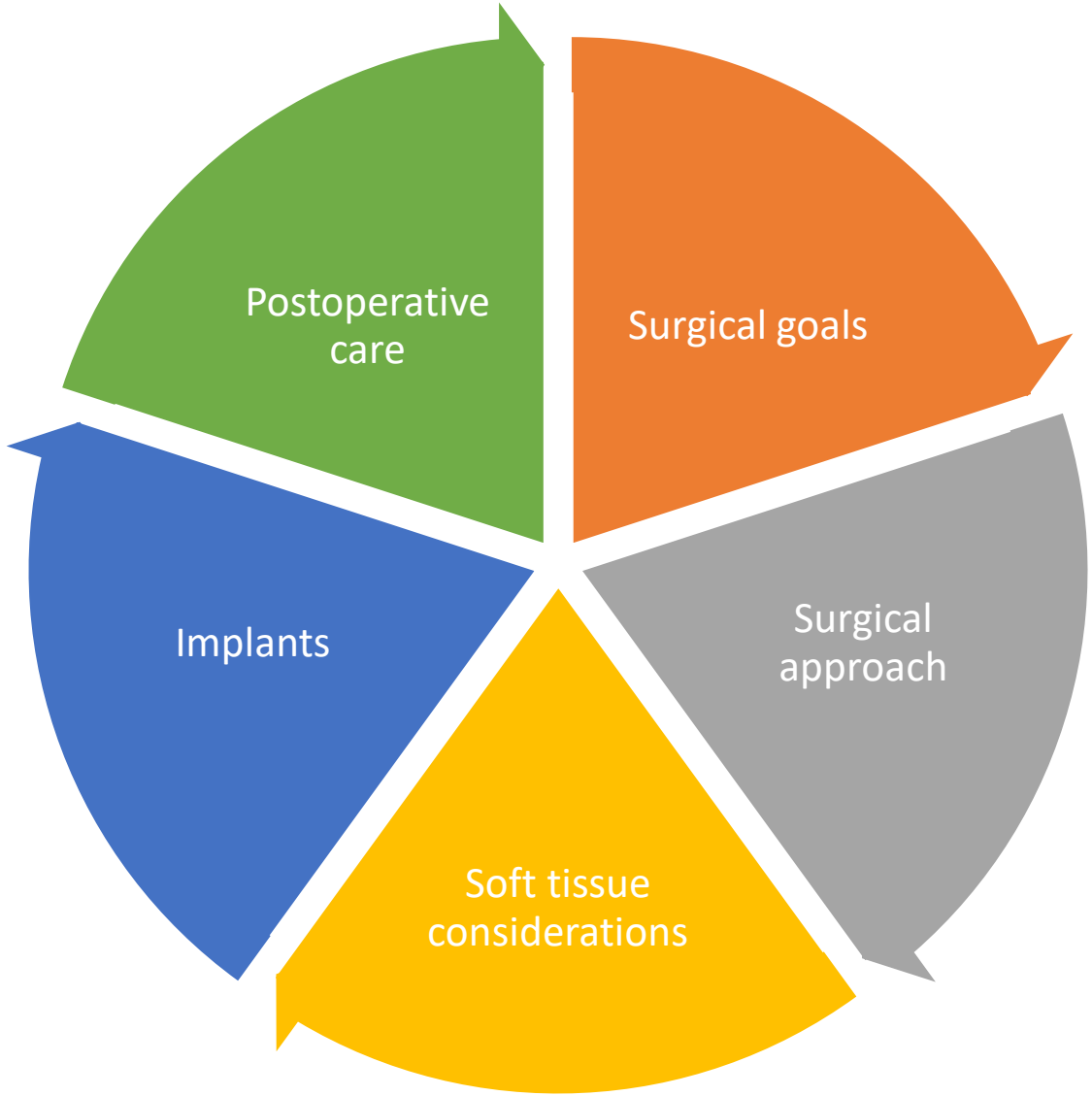
- Length or procurvatum/recurvatum
  - Often appears well aligned on AP radiograph
- Use of intramedullary fixation can obviate varus valgus and sagittal plane malreduction
  - Can leave rotational malreduction

Second Stage



- Post span CT scan helpful
- Surgical planning
  - Incarcerated tendons
- When to do?
  - 13-24 days most common
  - Planned tibial incisions should be wrinkled
- Reopening of traumatic wounds take extreme caution
- Fracture blisters should be re epithelialized
- Delayed need for flap coverage not uncommon

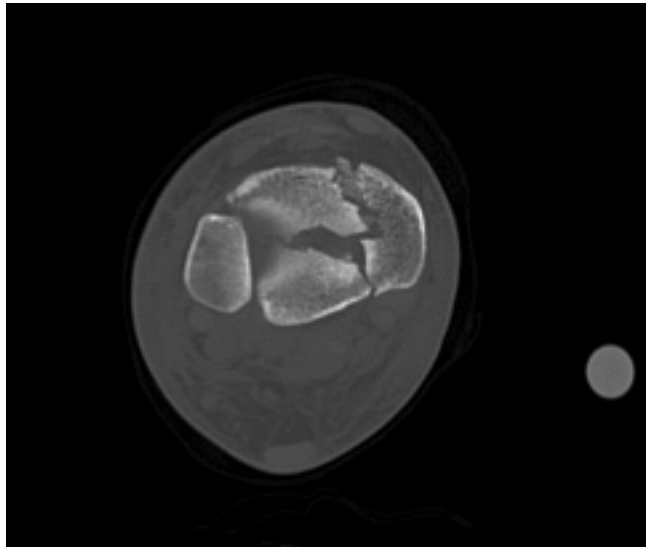
Pre-operative Planning

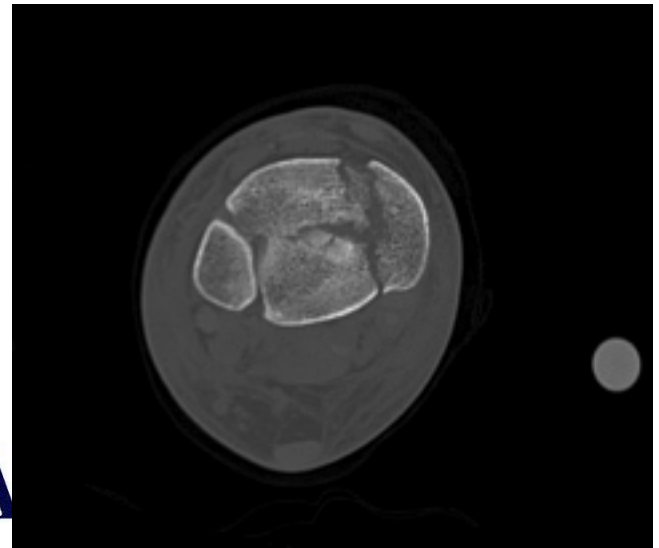


Goals

- Articular reconstruction is a given goal unless not reconstructable or the patient is unable to tolerate incisions
- Metaphysis
  - Reconstruction
    - Direct or Indirect
    - Bone grafting needed

Define Articular injury after Distraction



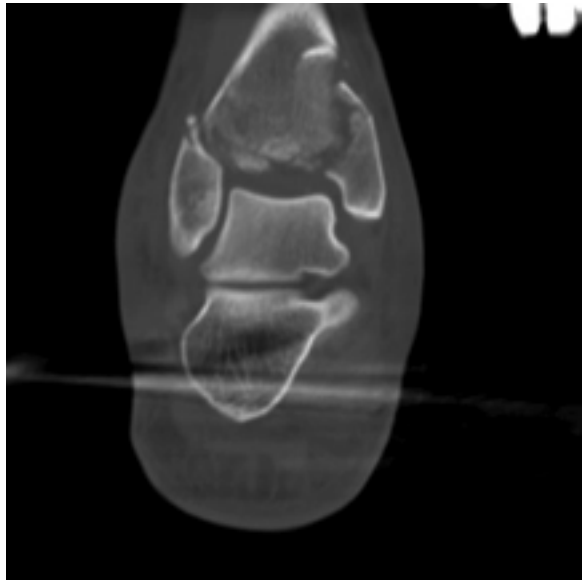


Goal:

1. **Define Reduction & Fixation Strategy**

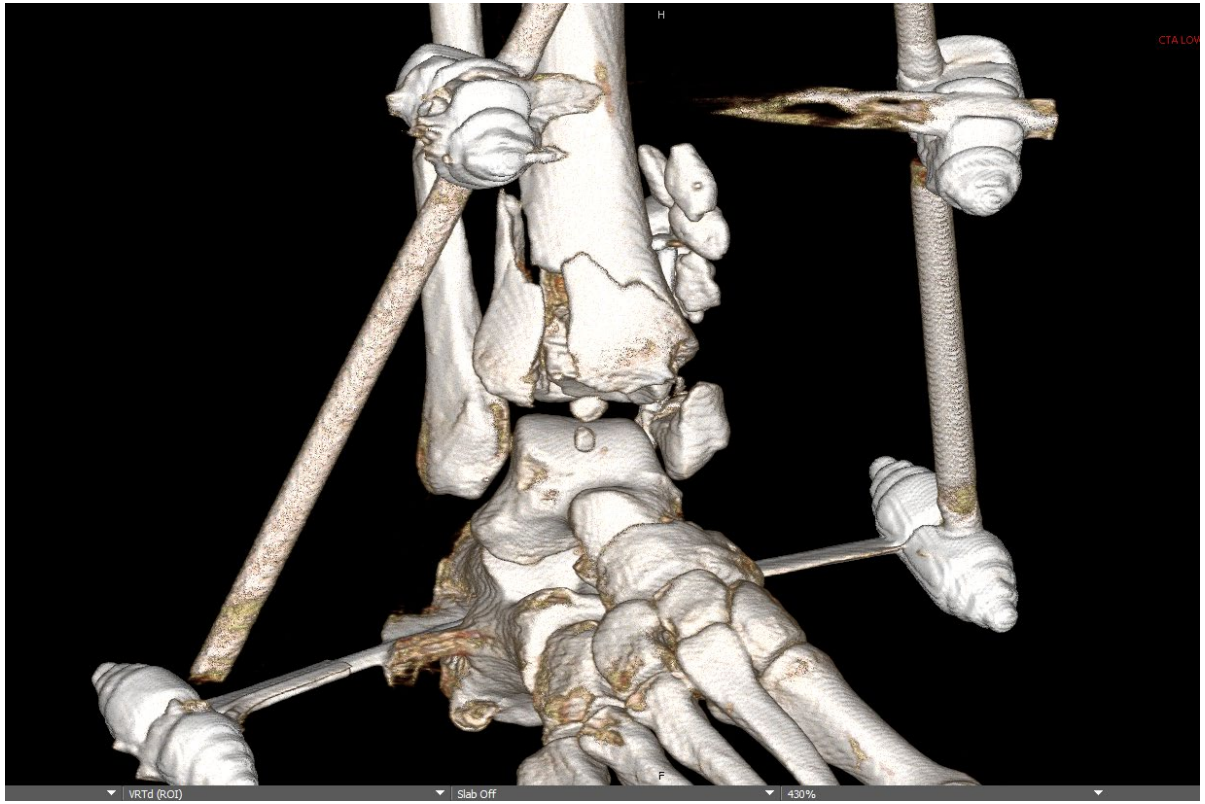
Mandate:

1. **Anatomic Reduction**
2. **Absolute Stability**

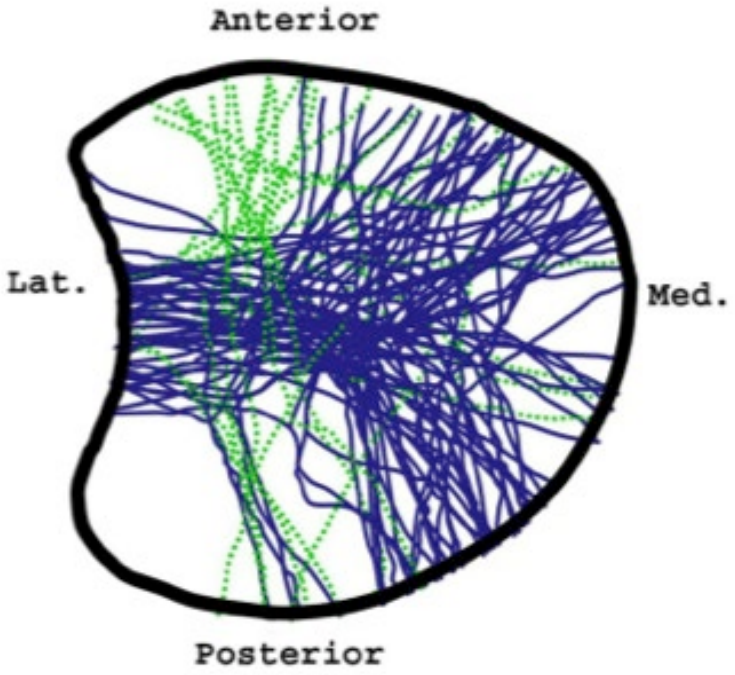


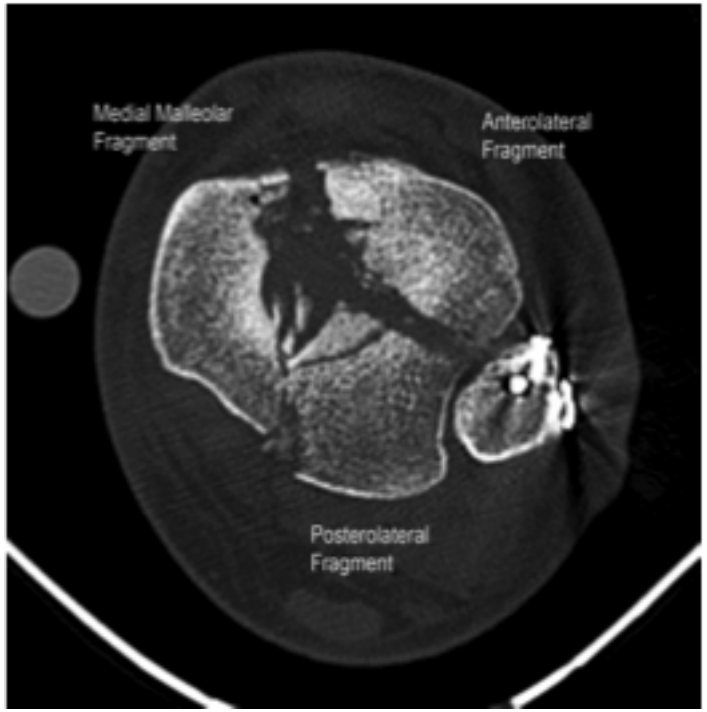
Define Extrarticular Fracture Pattern

- Use of 3D surface rendering can be helpful along with 3D model prints



Pilon Access Fracture Map





Primary Fracture Lines → Main Fragments

Cole, Mehrle et al. The Pilon Map Fracture Lines and Comminution Zones in OTA/AO Type 43C3 Pilon Fractures. Journal of Orthopaedic Trauma: July 2013 - Volume 27 - Issue 7 - p e152-e156

Metaphyseal Fracture Pattern
Direct vs. Indirect Reduction

Simple→Absolute Stability

Complex→Relative Stability

Fixation Construct

- Fixation construct
- Anatomic articular reconstruction
- Plate located to resist initial fracture displacement vector
  - Varus deformity → Medial buttress
  - Valgus deformity → Lateral buttress
  - Anterior/posterior talar escape → Anterior/posterior buttress

Injury Radiograph Dictates the Plate Position

Understand the forces you need to resist

Varus = Medial

Valgus = Lateral

Anterior Buttress

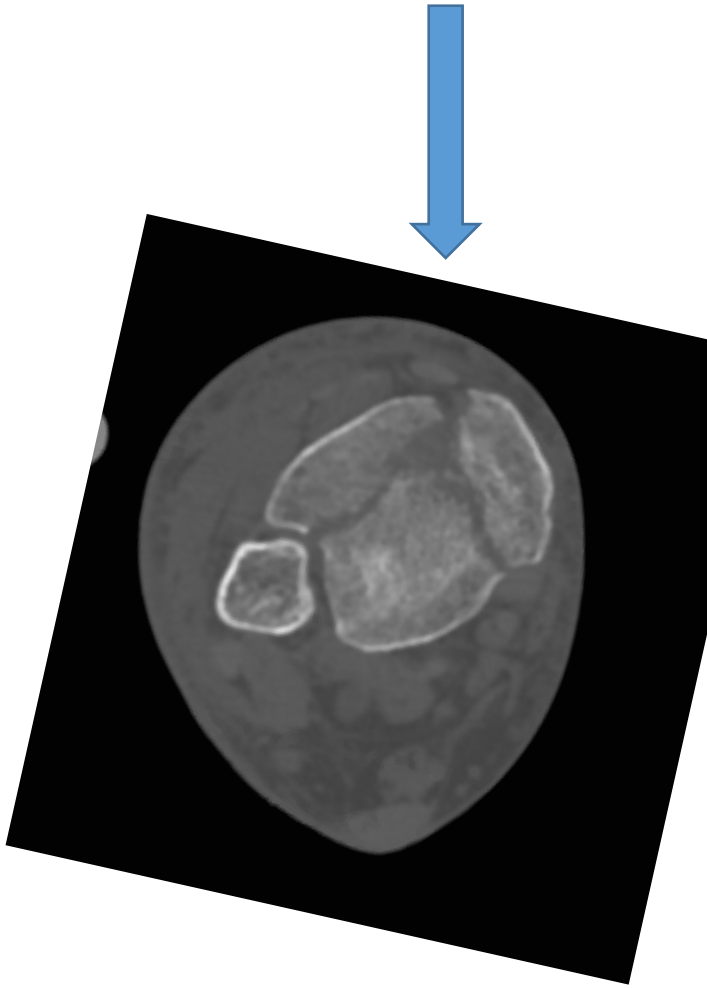
Posterior Buttress

Surgical Approaches

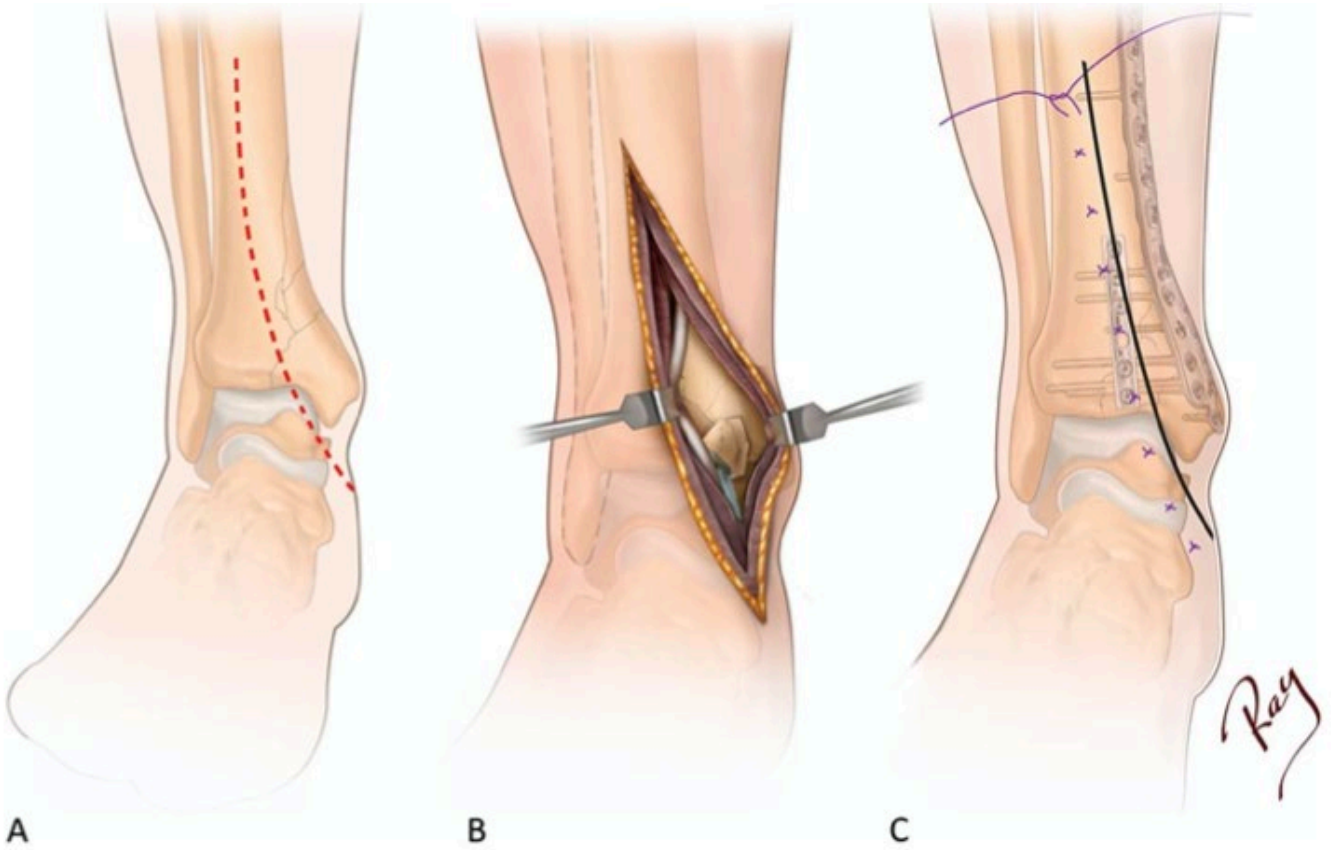
- Fracture pattern
- Soft tissue injury
- Local anatomy.

Anteromedial Approach

- ~1 cm lateral to tibial crest proximally, parallel to the tibial crest
- At ankle joint, incision curves to the distal point of the medial malleolus
- Anterior compartment fascia incised between tibial crest and tibialis anterior tendon sheath. Do not violate the tendon sheath
- Anterior compartment is retracted laterally
- This allows the placement of plate support on medial face or along lateral tibia



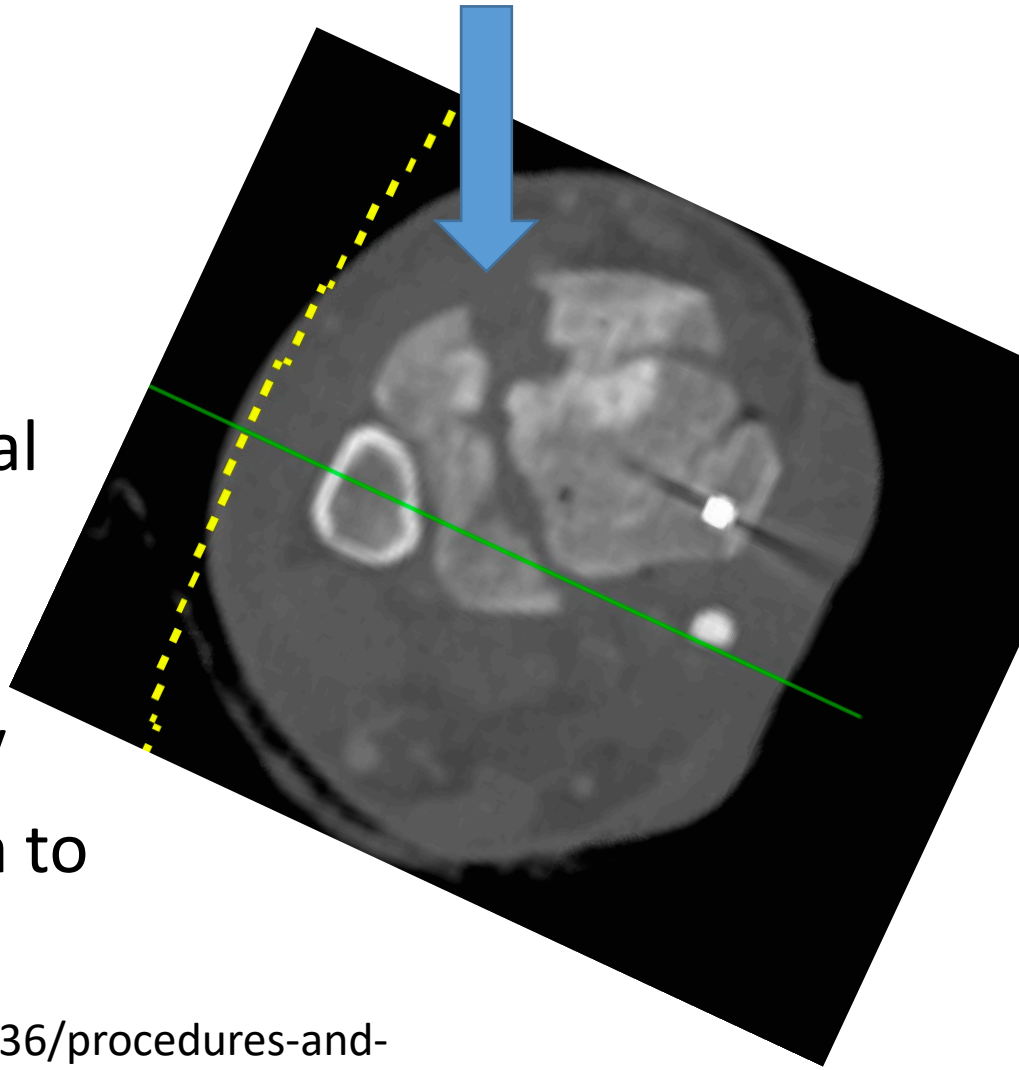
Anteromedial Approach



Mathieu et al. Strategies for Surgical Approaches in Open Reduction Internal Fixation of Pilon Fractures. 2015. J Orthop Trauma. 29: 69-79.

Anterolateral Approach

- Incision is in line with Chaput's tubercle to the midportion of 4th metatarsal
- Identify and protect the superficial peroneal nerve
- Incise fascia over anterior compartment
- Retract the anterior compartment medially
- Can access the anterior aspect of the fibula to avoid a lateral approach (and plate the anterior fibula)



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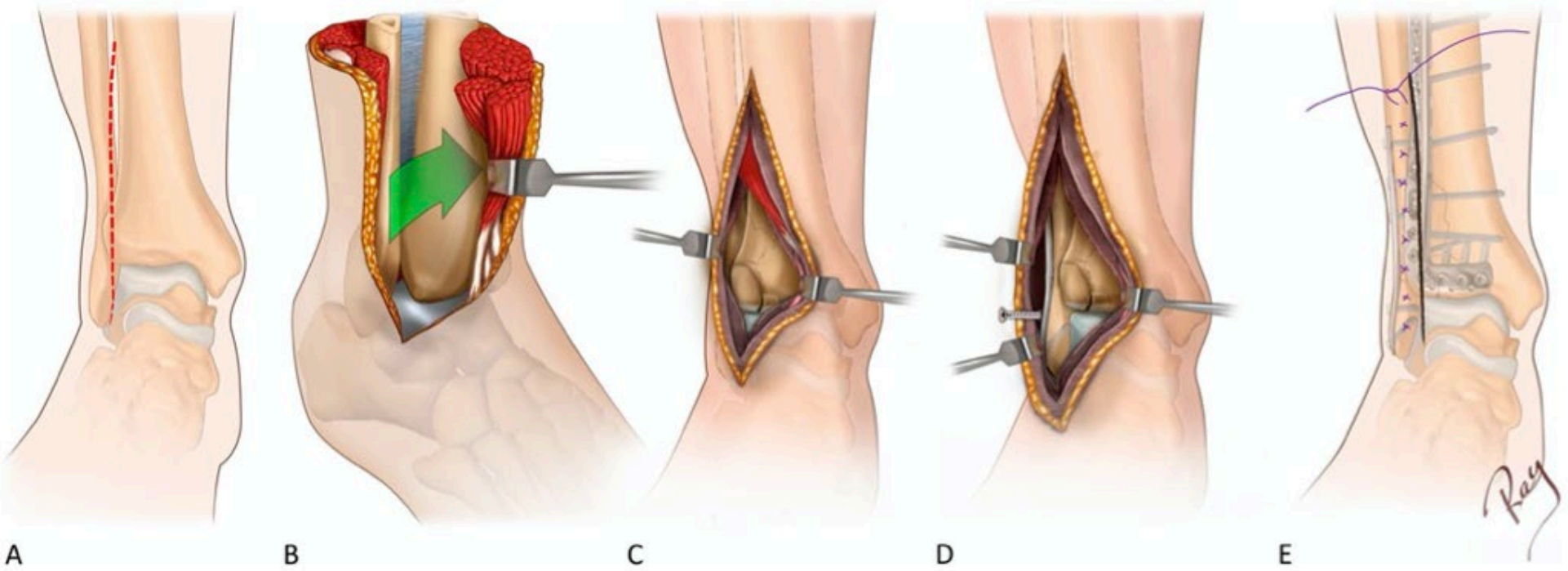
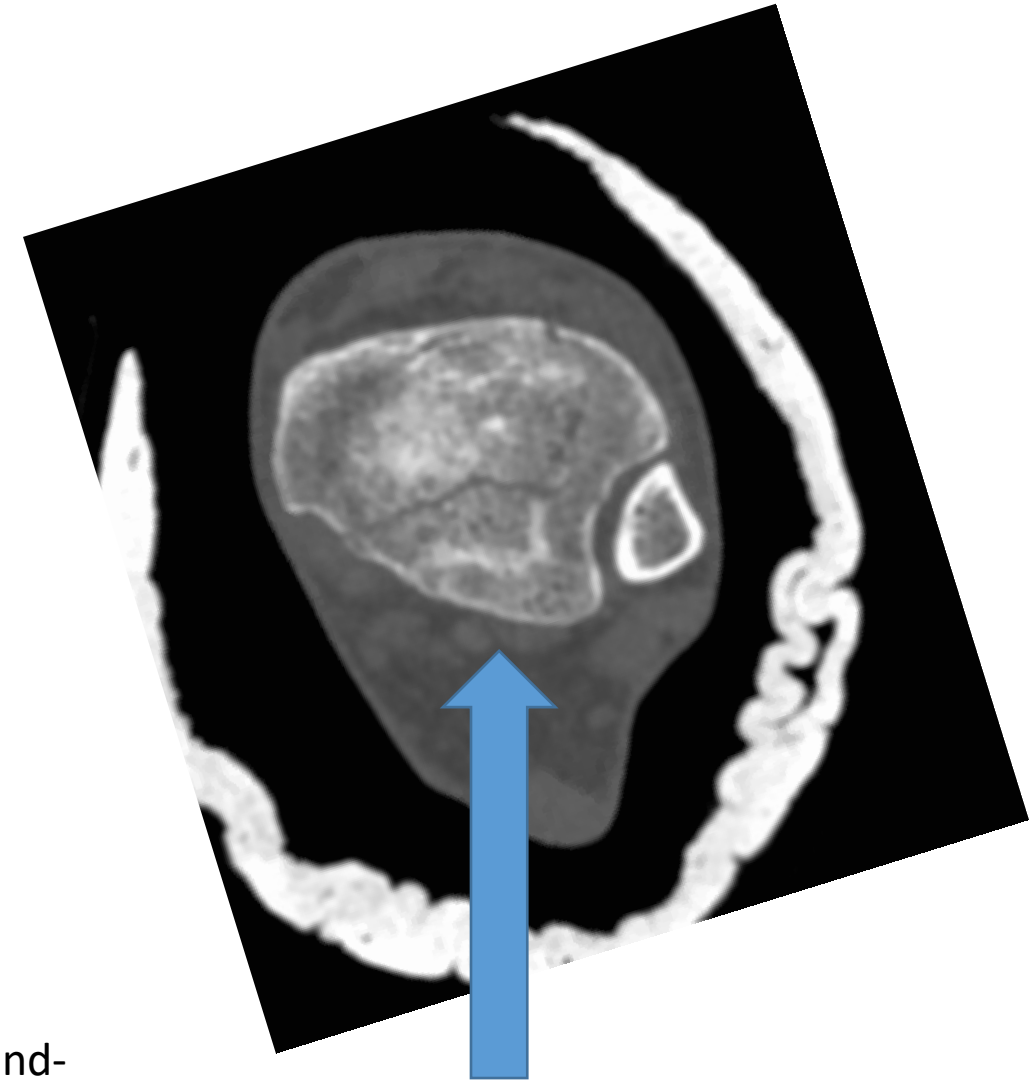
Anterolateral Approach



Mathieu et al. Strategies for Surgical Approaches in Open Reduction Internal Fixation of Pilon Fractures. 2015. J Orthop Trauma. 29: 69-79.

Posterolateral

- Prone position
- Incise midway between Achilles and posterior border of fibula
- Identify sural
- Superficial interval
- Achiilles and peroneals
- Deep interval
- FHL and peroneals
- Elevate the FHL off posterior tibia



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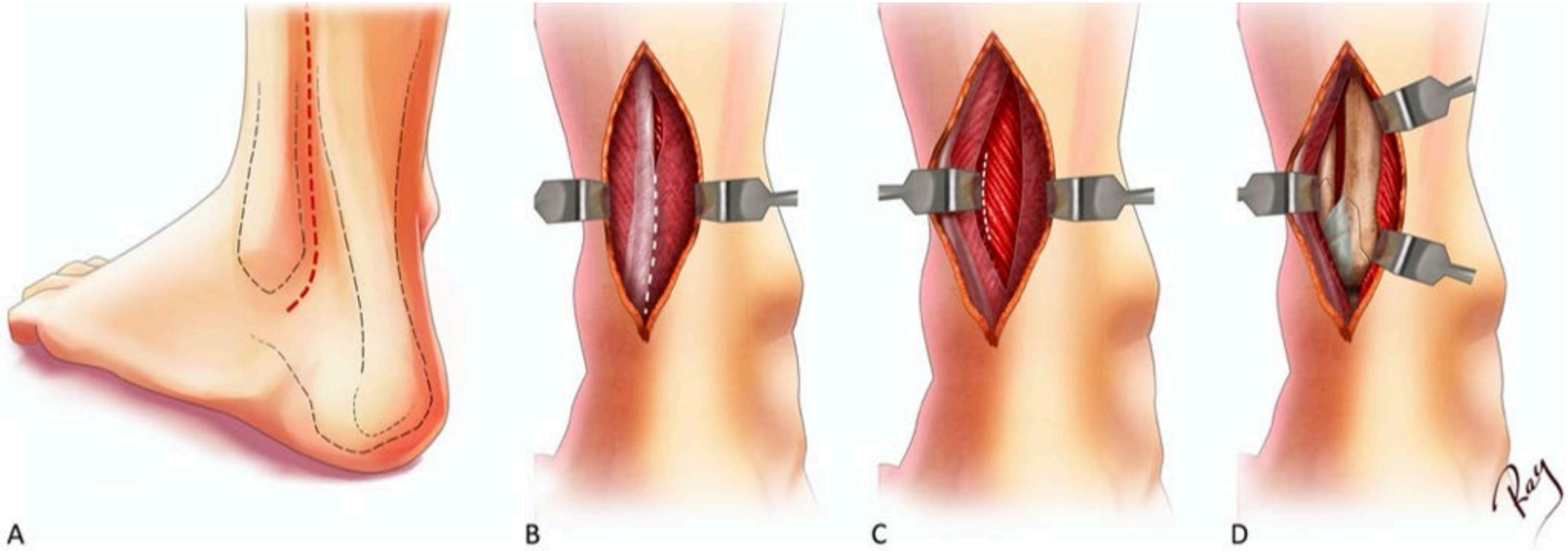
Posterolateral



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Posteromedial

- Incise between Achilles and posteromedial border tibia
- Flexor retinaculum incised
- Interval between posterior tibial tendon/flexor digitorum communis and flexor hallucis longus
- Neurovascular bundle between FDC and FHL

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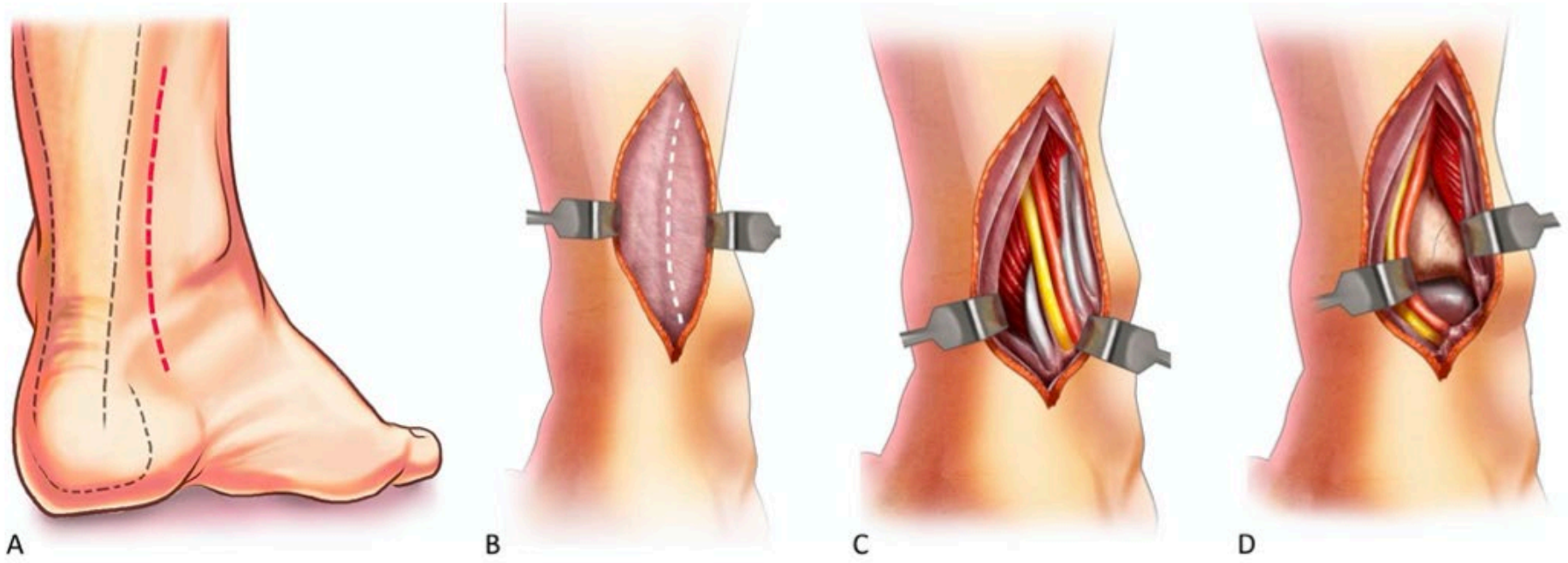
Posteromedial Approach



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Combined Surgical Approaches

- Many patients will need a minimum of 2 incisions
- More than 2 with care as swelling in flap and incision breakdown possible
- Classically 7 cm skin bridge to prevent skin bridge necrosis
  - Not an absolute
  - Meticulous soft tissue handling and appropriate surgical timing

Angiosomes

- A 3D anatomic unit describing the skin and muscle supplied by a source artery
- Must be considered while selecting combined surgical approaches
- “Choke vessels” between angiosomes provide blood flow to adjacent angiosomes if source arteries are damaged.
  - Choke vessels require 4-10 days become widely patent

Taylor et al *Br. J. Plast. Surg.* 1990,
Attinger et al Plas, Recon Surg. 2006

Angiosomes

- Posterior tibial artery
  - Anterior border of tibia to midline of gastroc posteriorly
  - Posterior medial malleolar artery
  - Plantar foot

Attinger et al Plas, Recon Surg. 2006

Ang

- Anterior tibial artery
  - Anterior tibia to anterior border of fibula
  - Lateral malleolar artery
  - Anterior branch of medial malleolar artery
  - Dorsal foot

Attinger et al Plas, Recon Surg. 2006

Angiosomes

- Peroneal artery
  - Anterior border of lateral compartment to midline posteriorly
  - Anterior perforating branch
  - Lateral calcaneal artery
  - Plantar and lateral heel

Attinger et al Plas, Recon Surg. 2006

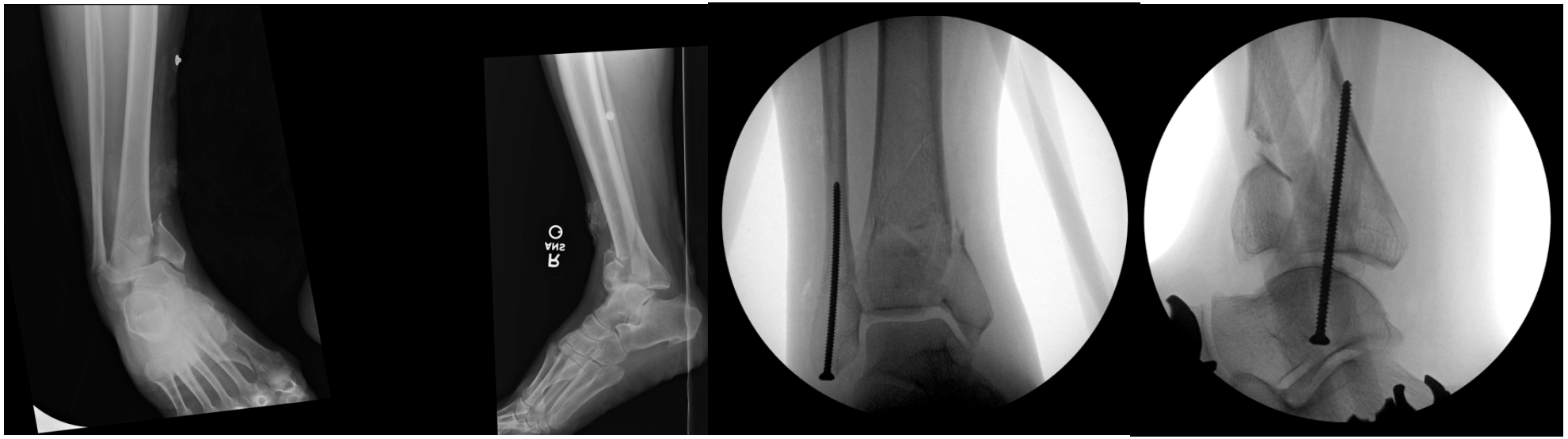
Fixation Considerations

- Minimum fixation for maximal stability
- Buttress can be more powerful than poorly located locked fixation construct
- Use percutaneous screw insertion
- Pre-contoured not always better as plates cannot be effectively contoured

- Locked fixation indications:
  - Small articular blocks that are already reconstructed
  - Large metaphyseal comminution
  - Osteoporotic patients

Intramedullary Fibula Fixation

- Percutaneous intramedullary fixation of fibula fractures can maximize surgical approach options.



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Tibial Intramedullary Nail

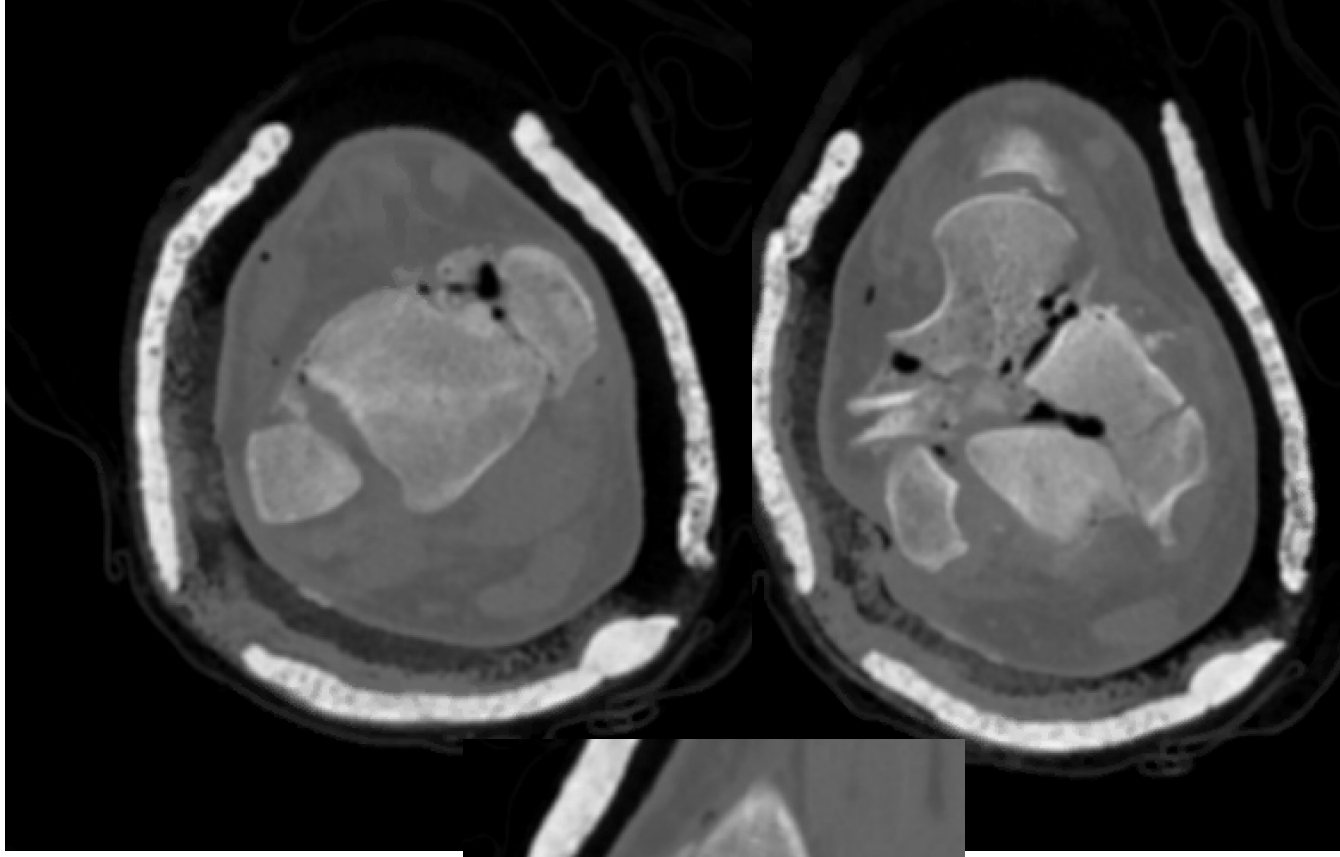
- Can Improve early stability for healing of long regions of comminution in conjunction with lag screw and plate neutralization of articular blocks

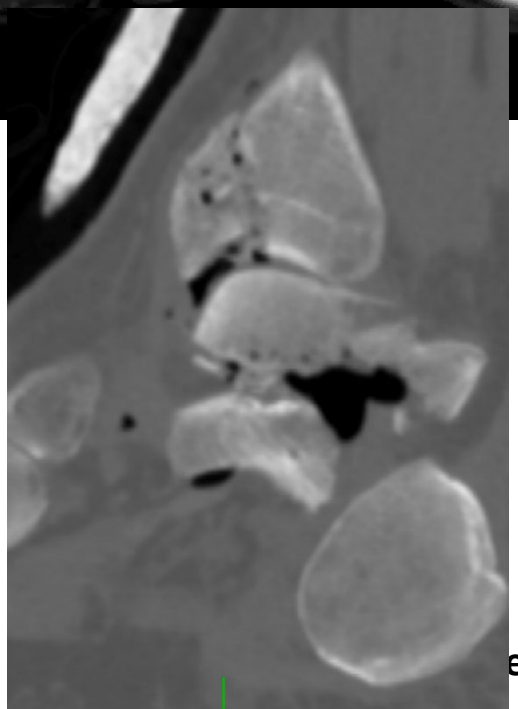
- 60 year old male fall from deck



Unreconstructable

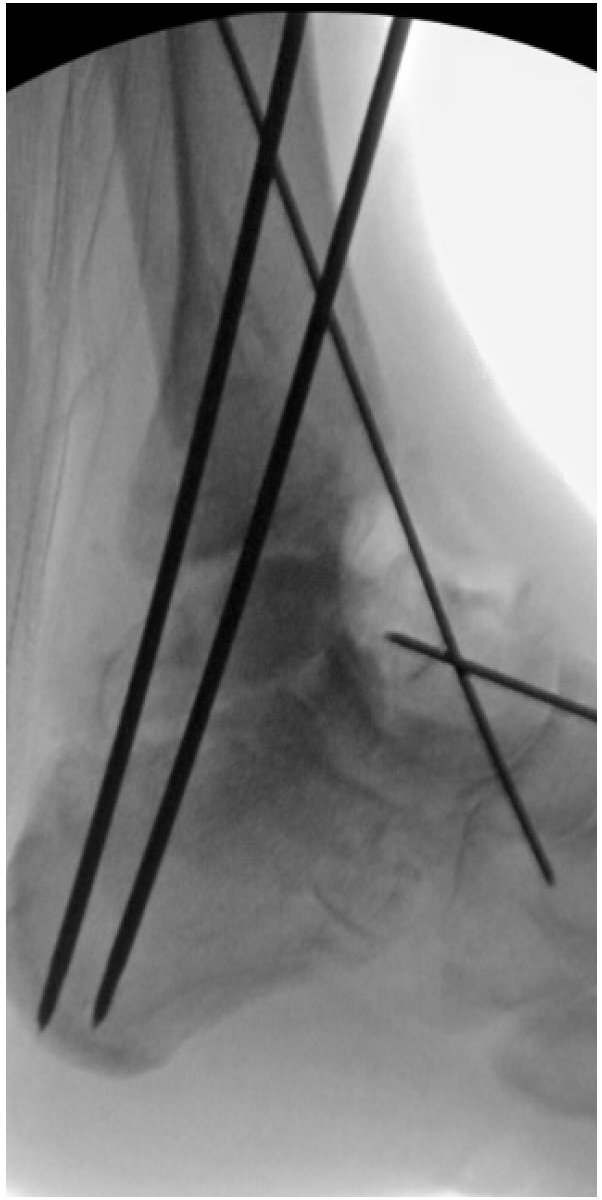
- 56 year old female polytrauma
- Open pilon, talus and calcaneus
- Bilateral clavicle fractures, multiple rib fractures
- Delayed presentation
- Wounds would require free flap if used for staged fixation



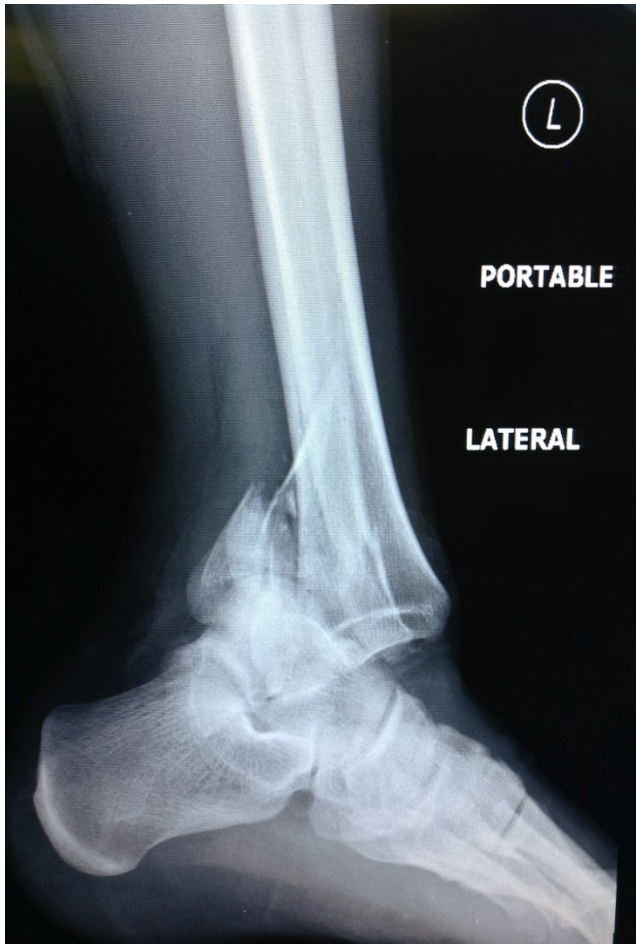


Staged management

- External fixation during irrigation debridement
  - Spanning K wire stabilization
- Primary closure
- Recovers from trauma
- Excise all cartilage and allow for consolidation of cancellous bone
- Return to OR fro retrograde TTC nailing

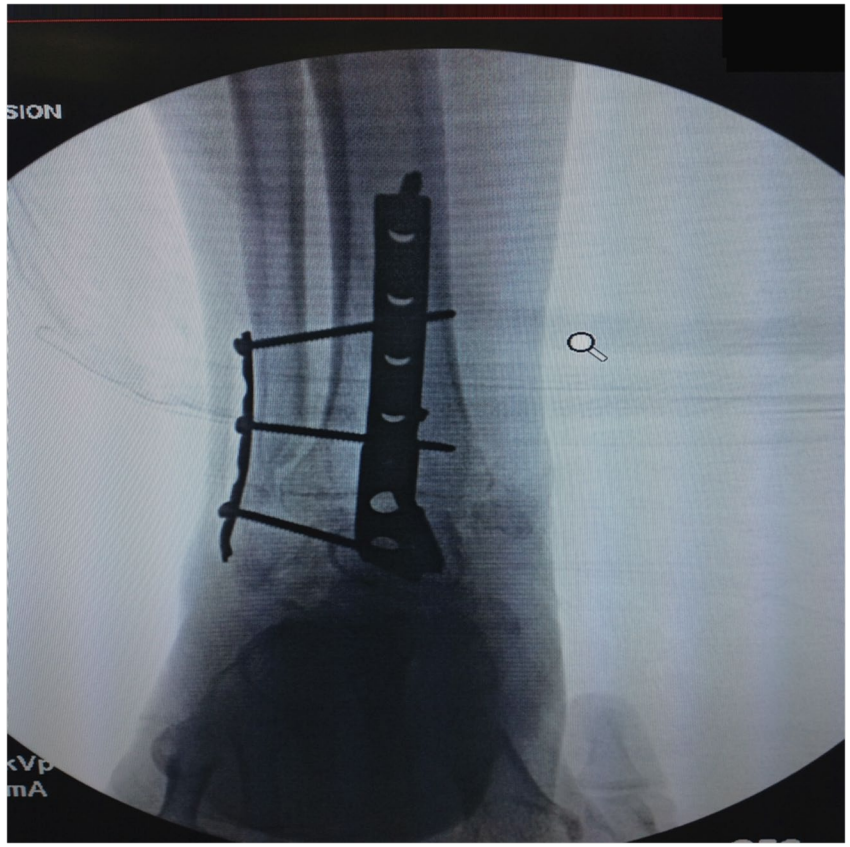


Unreconstructable



Lack of articular surface

Primary Ankle Arthrodesis



Postoperative Care

- Well padded splint
- Ice
- Elevation
- Analgesia
- Goal is early motion if possible at 2-3 weeks
- DVT prophylaxis based on medical comorbidities and other trauma considerations

Rehabilitation

- Early mobilization
- Swelling control (compression)
- Achilles stretching
- Non weight bearing 8-12 weeks
- Physical therapy

Complications

- Wound breakdown
- Infection
- Malunion
- Nonunion

Malunion/Nonunion

- Malunion most common with intact fibula leading to varus malunion
- Malunion of joint
  - Occurs at time of surgery
  - Critical evaluation
  - Intraoperative CT scanning
- Malunion/Nonunion Metaphysis
  - Common
  - Likely related to watershed region or comminution
  - Bone grafting
  - Complex hardware removal and intramedullary nailing

Nonunion

- 69 year old female who fractured pilon 3 weeks after contralateral total knee replacement

Primary ORIF – Low Energy, Mild Swelling

Plate Fatigue at 3 months

Removal of HW, IMN – Healed at 3 months

Bone grafted with reamer contents from proximal canal aspirated at time of surgery

Outcomes

- Stiffness
- Declining function over time
- Osteophyte formation and arthrofibrosis with higher energy injuries

Outcomes

- Pollak et al. reported on 80 pilon pts (ORIF and exfix) at 3.2 years
  - Lower SF-36 scores in physical health and function than population
  - Low income and lower educational level more likely to have poor clinical outcomes
  - 2 or more co-morbidities had poorer outcomes

  - Ex-fix treatment more likely to have
    - limited ROM
    - more pain
    - more ambulatory dysfunction

Pollak et al JBJS 2003

Conclusion

- Life changing injuries
- Challenging reconstructions at articular surface and metaphyseal complexity
- Staged approach common in high energy fractures
- Multiple surgical approaches needed
- Arthrodesis is viable option

Acknowledgements

- Clay Spitler, MD
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- Steve Benirschke, MD
- Cory Collinge, MD
- Selected Images from: Court-Brown, C. et al. Rockwood & Greens Fractures in Adults. Philadelphia: Lippincott Williams & Wilkins, 2014

Bibliography

- Rüedi TP, Allgöwer M. The operative treatment of intra-articular fractures of the lower end of the tibia. *Clin Orthop Relat Res.* 1979;138:105–110.
- Sirkin M, Sanders R, DiPasquale T, Herscovici D., Jr A staged protocol for soft tissue management in the treatment of complex pilon fractures. *J Orthop Trauma*. 1999;13:78–84. doi: 10.1097/00005131-199902000-00002.
- Cole P, Mehrle RK, Bhandari M. The pilon map: fracture lines and comminution zones in OTA/AO Type 43C3 Pilon Fractures. *J Ortho Tr***.** 27(7):e152-e156, July 2013.
- Bozic V, Thordarson DB, Hertz J. Ankle fusion for definitive management of non-reconstructable pilon fractures. *Foot Ankle Int*. 2008;29:914–918. doi: 10.3113/FAI.2008.0914.
- Pollak AN, McCarthy ML, Bess RS, Agel J, Swiontkowski MF. Outcomes after treatment of high-energy tibial plafond fractures. *J Bone Joint Surg Am*. 2003;85:1893–1900