Calcaneal fractures

DR.ABHIJIT MORE

ASSITANT PROFESSOR

DEPT. OF ORTHOPEDICS

ACPM MEDICAL COLLEGE DHULE

Calcaneal fractures

- 2% of all fractures

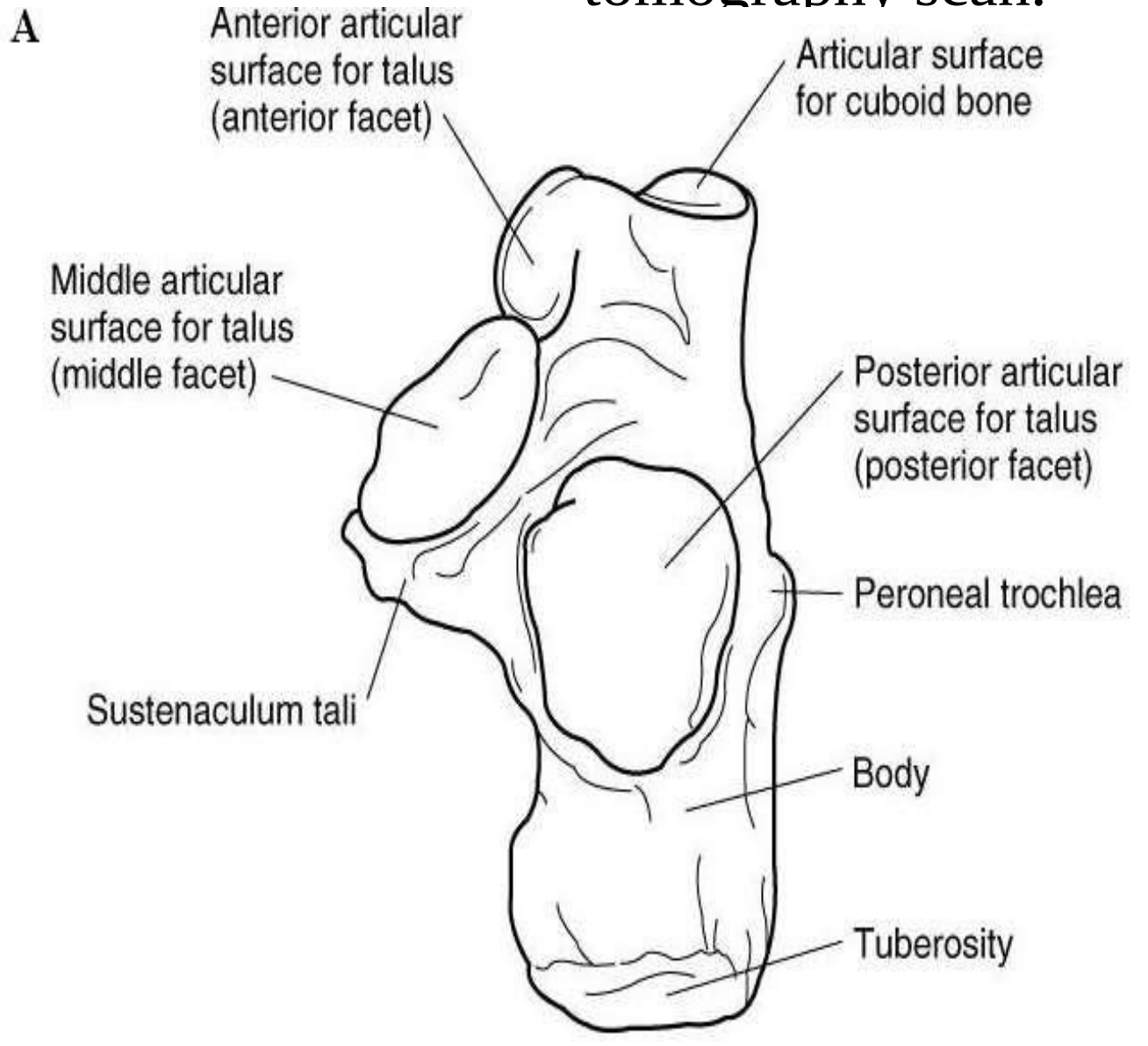
- 60-75% of them are displaced intraarticular fractures

- 10% have associated spine fractures

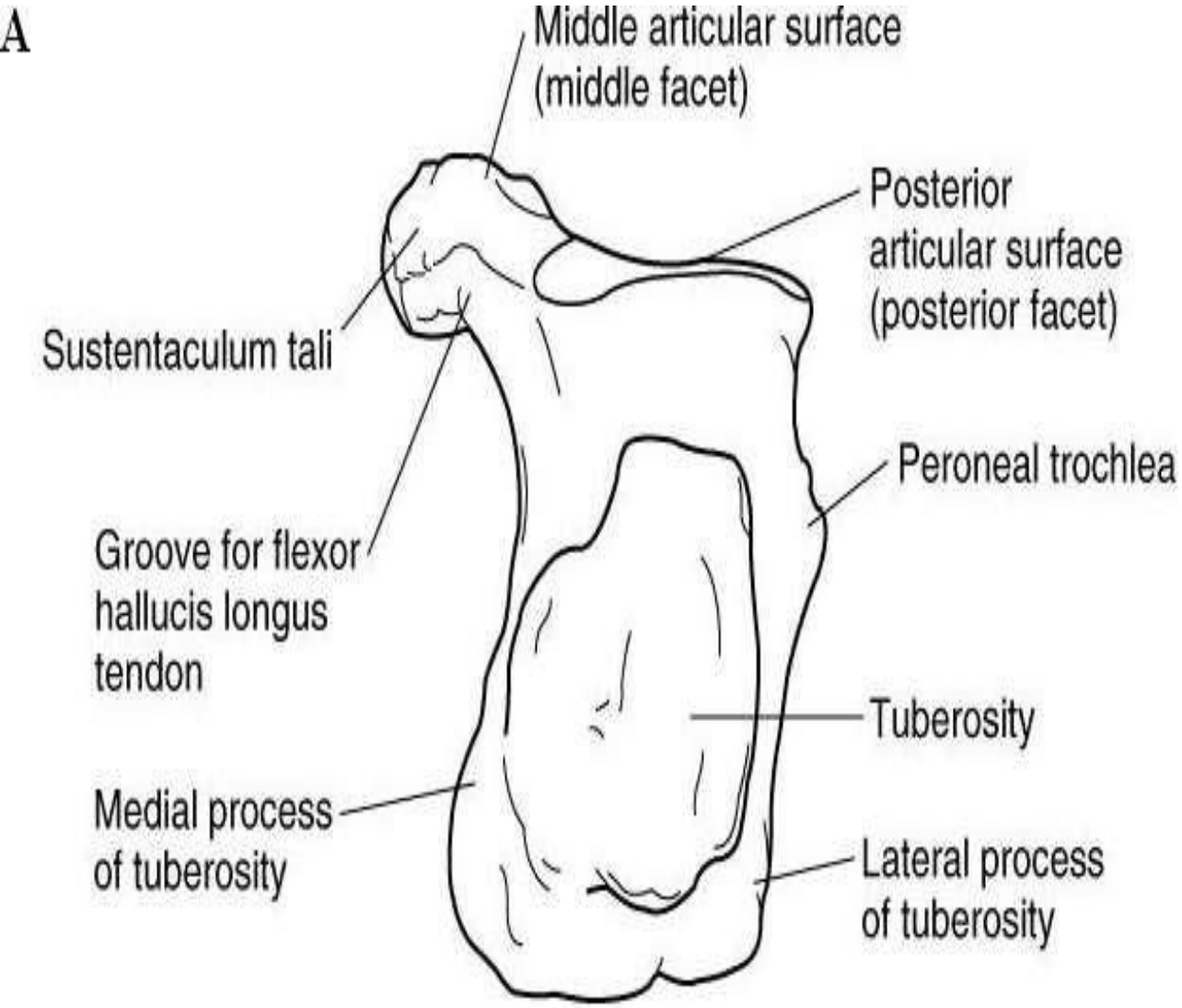
- 26% have other extremity injuries

-90% occur in young men(21 to 45 yrs)

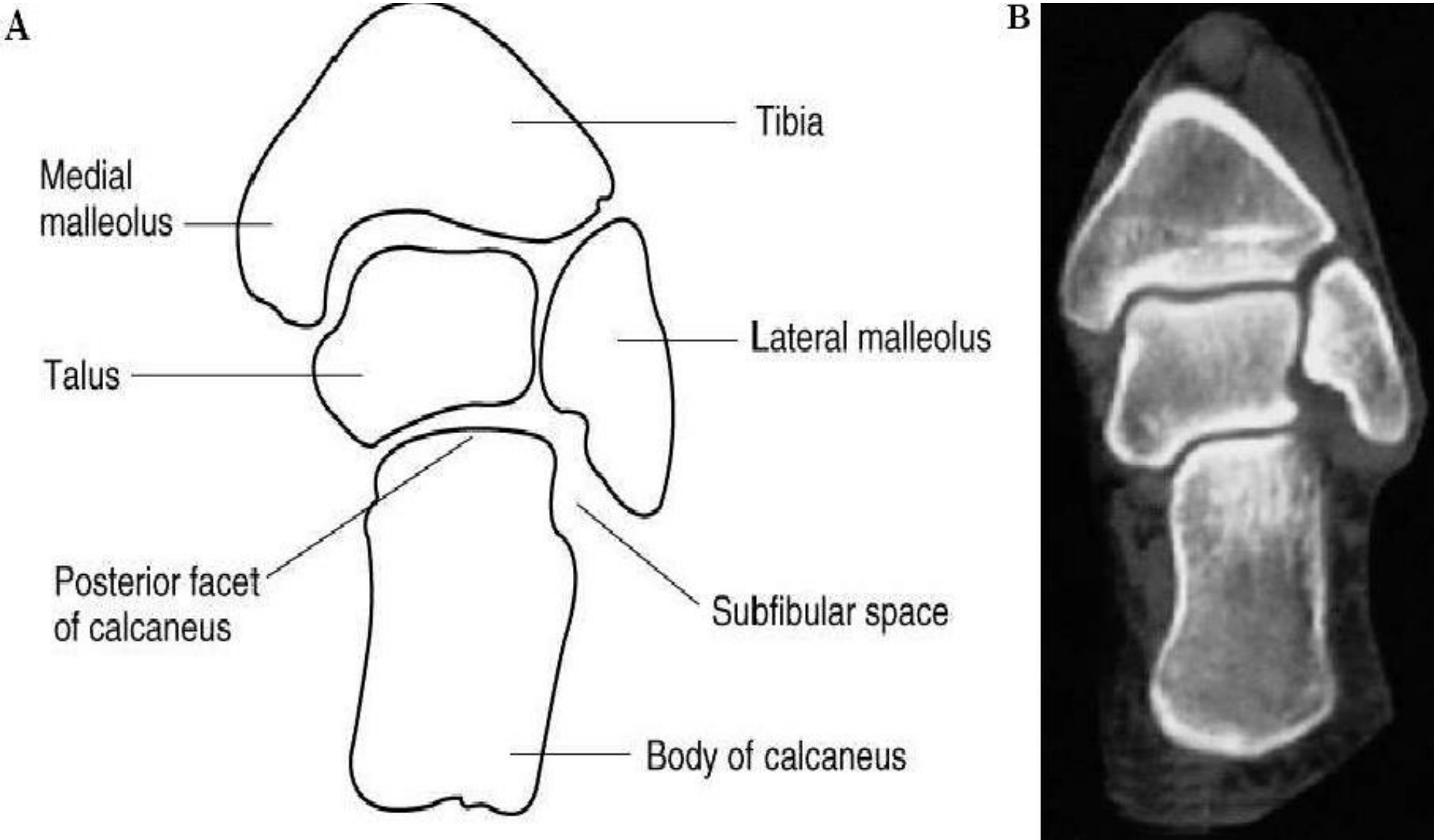
A: Schematic of the superior or axial anatomy of the calcaneus. B: Corresponding axial view on a computed tomography scan.



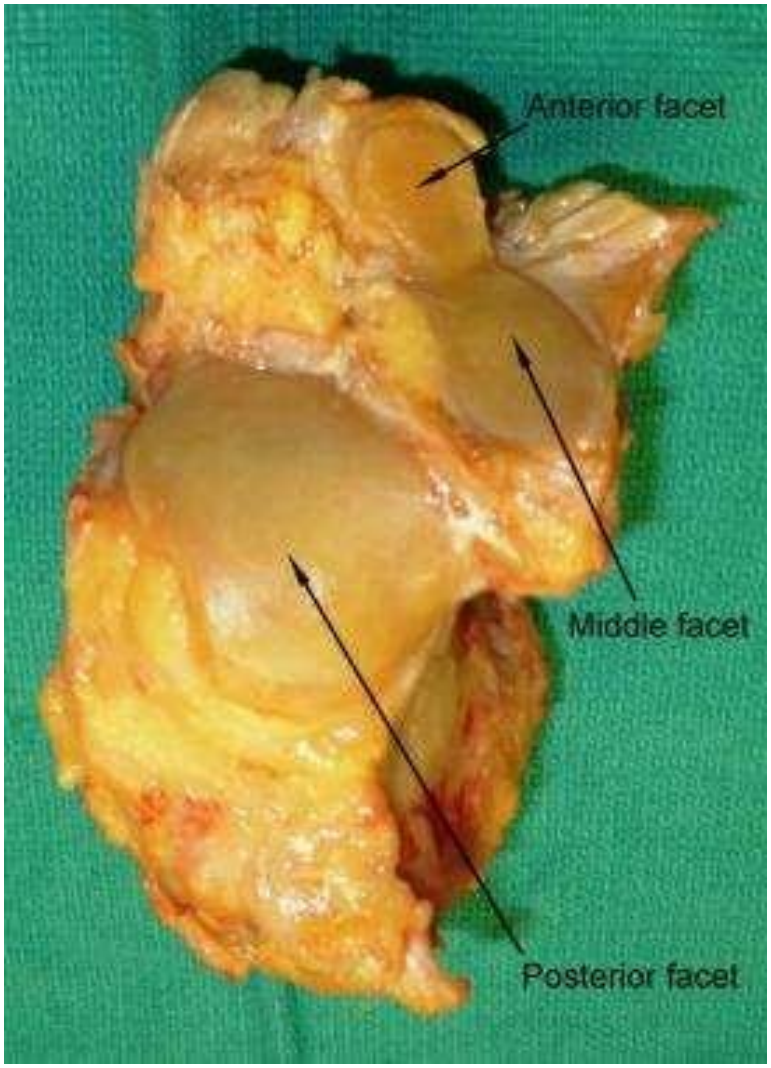
distal level of the sustentaculum tali.
B: Corresponding computed tomography scan at a similar distal coronal level.

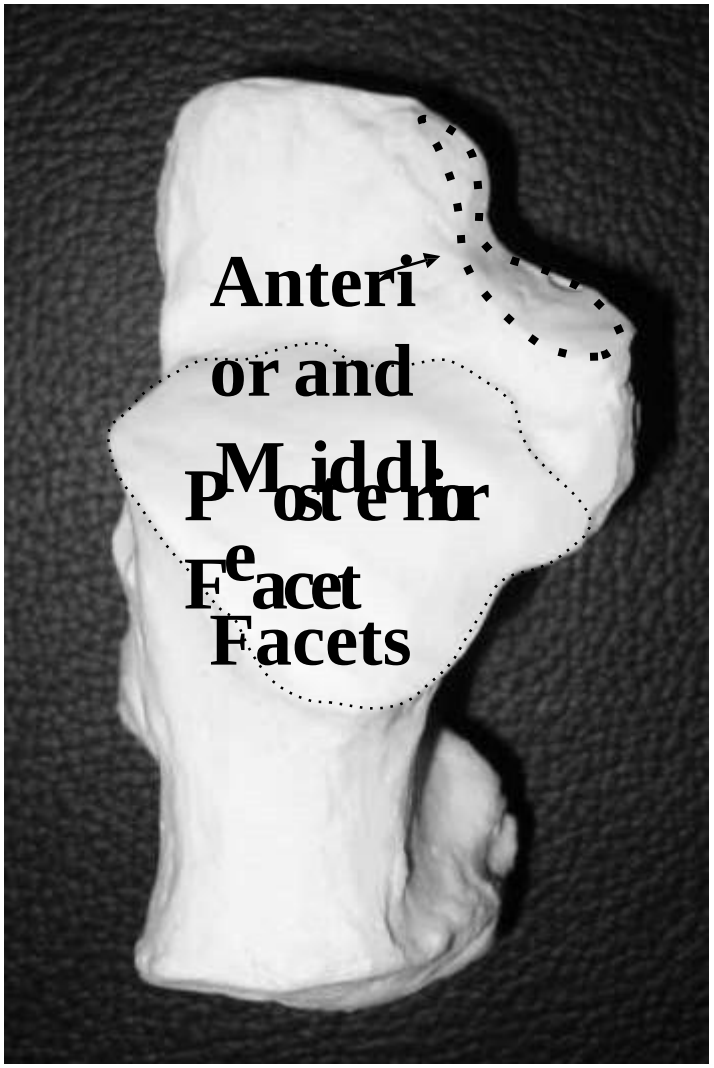


the more proximal posterior facet level with surrounding bones. B: Corresponding computed tomography scan at the same level.

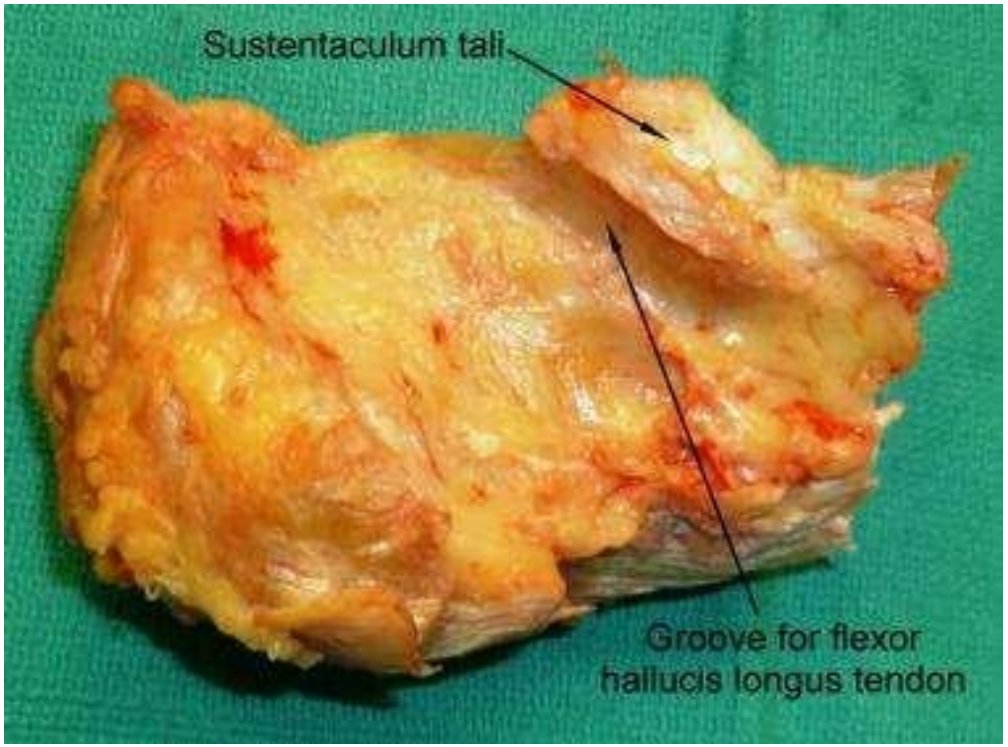


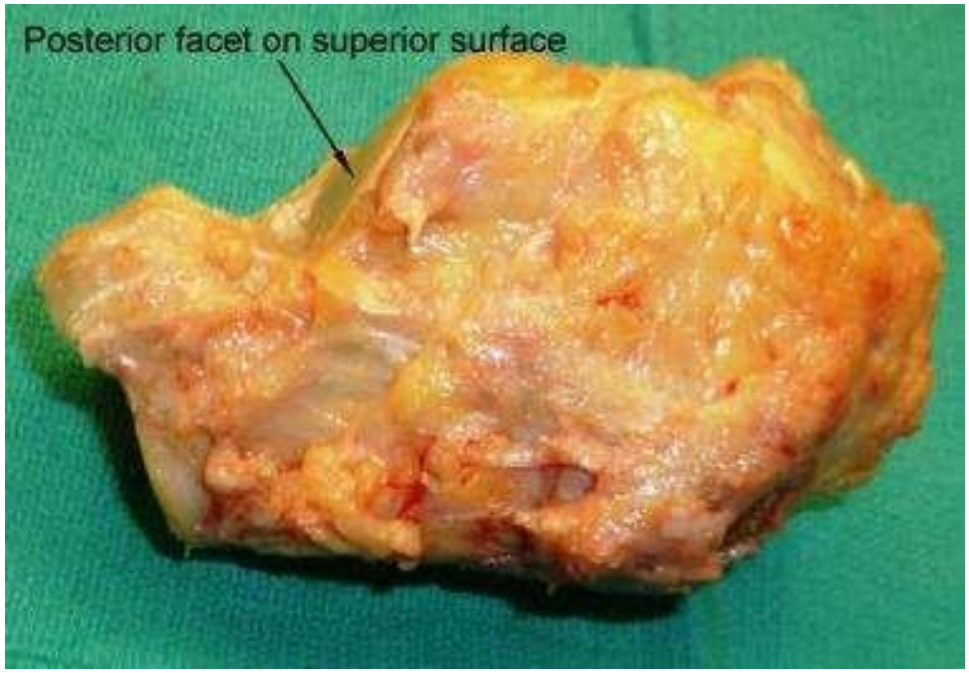
ANATOMY

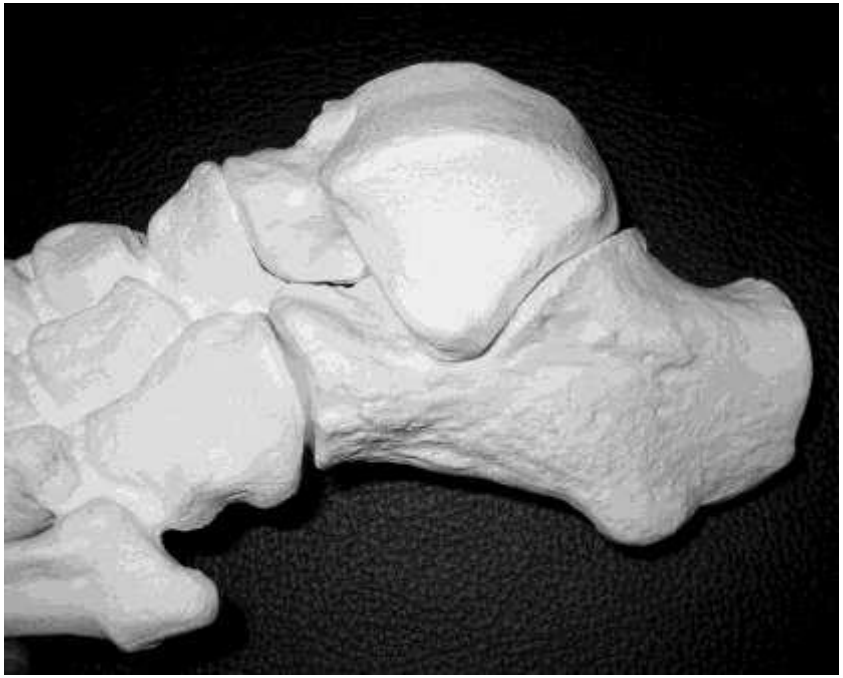

Anterior facet
Middle facet
Posterior facet


Anterior and Middle Facet
Posterior Facets

Medial surface




Posterior facet on superior surface



- **anterolateral fragment** encompasses the lateral wall of the anterior process and may include a portion of the calcaneocuboid articular surface
- **anterior main fragment** includes the anterior portion of the sustentaculum and anterior process
- **superomedial fragment**, also known as the sustentacular or constant fragment, found posterior to the primary fracture line; this fragment almost always remains attached to the talus through the deltoid ligament complex and is therefore stable

- **superolateral fragment**, also referred to as the semilunar or comet fragment, is the lateral portion of the posterior facet which is sheared from the remaining posterior facet in joint-depression fractures.
- **tongue fragment** refers to the superolateral fragment that remains attached to a portion of the posterior tuberosity including the Achilles tendon insertion, and is found in tongue-type fractures
- **posterior main fragment** represents the posterior tuberosity.

axial view

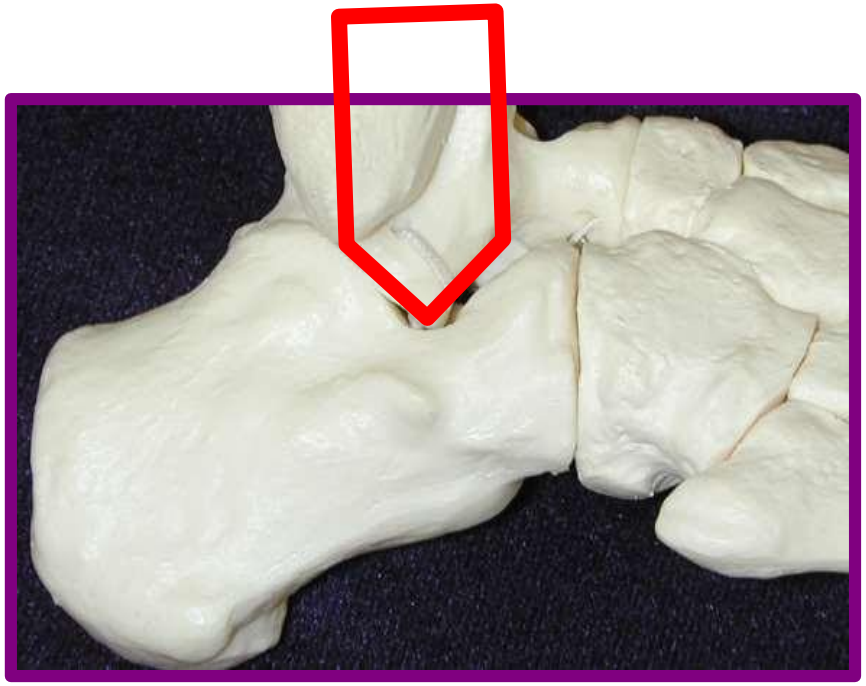
sagital view

coronal view

FIGURE 61-19 Pathoanatomy of a joint-depression calcaneal fracture. **A:** Axial/transverse view. Note lateral wall expansion (*white arrow*). **B:** Sagittal view. **C:** Coronal view. Note dislocated peroneal tendons (*white arrow*). AL: anterolateral fragment; AM: anterior main fragment; PM: posterior main (tuberosity) fragment; SL: superolateral fragment; SM: superomedial (sustentacular) fragment.

Mechanism of Injury

- **High energy**
  - **MVA**
  - **fall from a height**
- **Lateral process of talus acts as wedge**
- **Impaction fracture**



CLINICAL FEATURES

C/O ***pain swelling not able to bear weight***

On Examination–

>marked swelling
>ecchymosis
blisters
>tenderness & movements restricted
>other foot and spine also should examined

- ***compartment syndrome of foot should be ruled out***
- ***Between 7.7% and 17% of fractures to the calcaneus are open.***

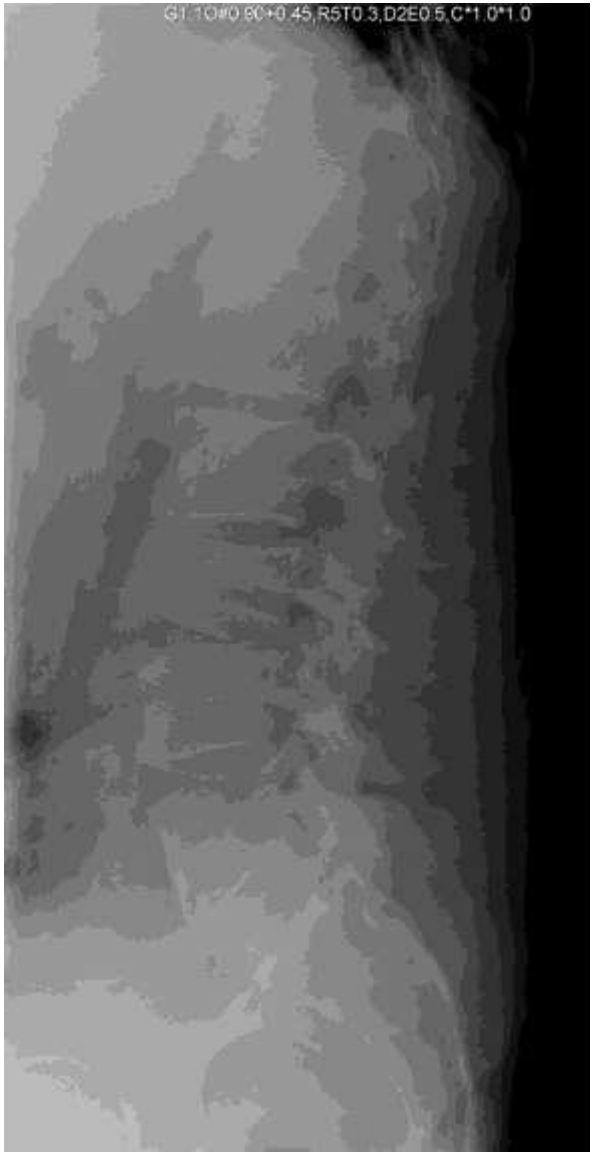
Initial Evaluation

- **Thorough primary, secondary, tertiary survey**
- **Bilateral injuries**

  spine injuries

  other extremity fractures

  can occur in 10 – 15%
- **Routine Lumbar spine films**



Exam

- **Note condition of skin**
  - **Open fractures**
  - **Fracture Blisters**
  - **Threatened skin (pressure from displaced fracture fragments)**

- **Neurovascular exam**

emergency room management

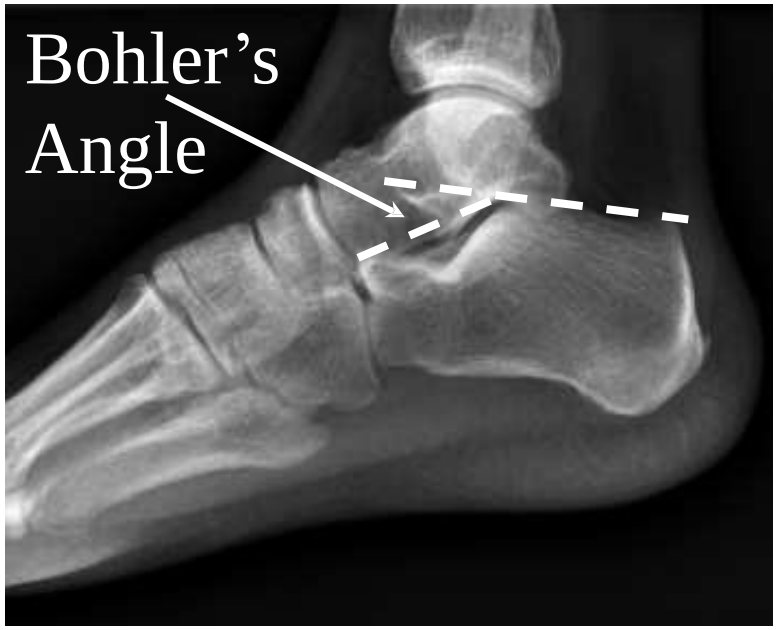
- irrigation with 9 L of normal
- saline and debridement of the wound with stabilization of the
- fracture to protect the soft tissues
- antibiotic prophylaxis

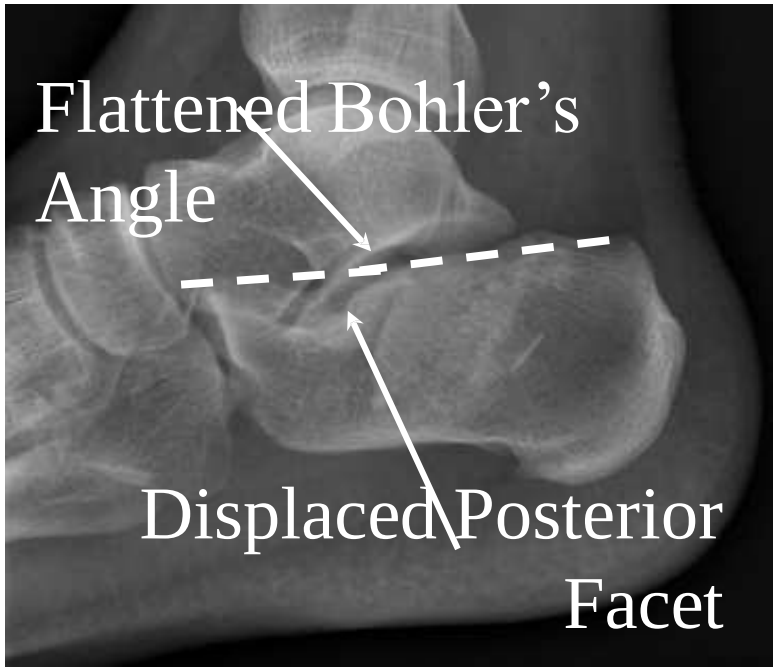
RADIOGRAPHIC EXAMINATION

1) lateral radiograph of the hindfoot
2)anterior posterior radiograph of the foot,
3)Harris heel view,
4)ankle series

OTHER X-RAYS--- >ANKLE JOINT
>OPPOSITE FOOT
>DORSOLUMBAR SPINE

C.T SCAN ----for pathoanatomy of intra-articular fracture





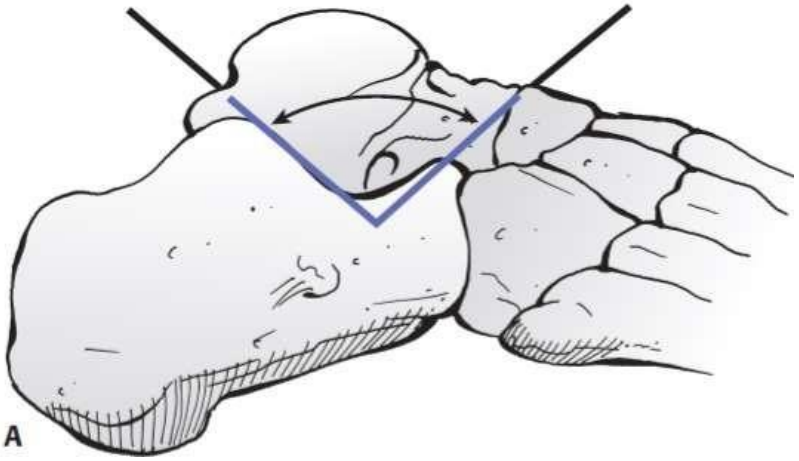
Xray measurements

tuber angle of Böhler is composed of a line drawn from the highest point of the anterior process of the calcaneus to the highest point of the posterior facet and a line drawn tangential to the superior edge of the tuberosityle

- *Normal 25-40 degrees*
- *Severity (lower Bohler's angle) correlates with outcome*

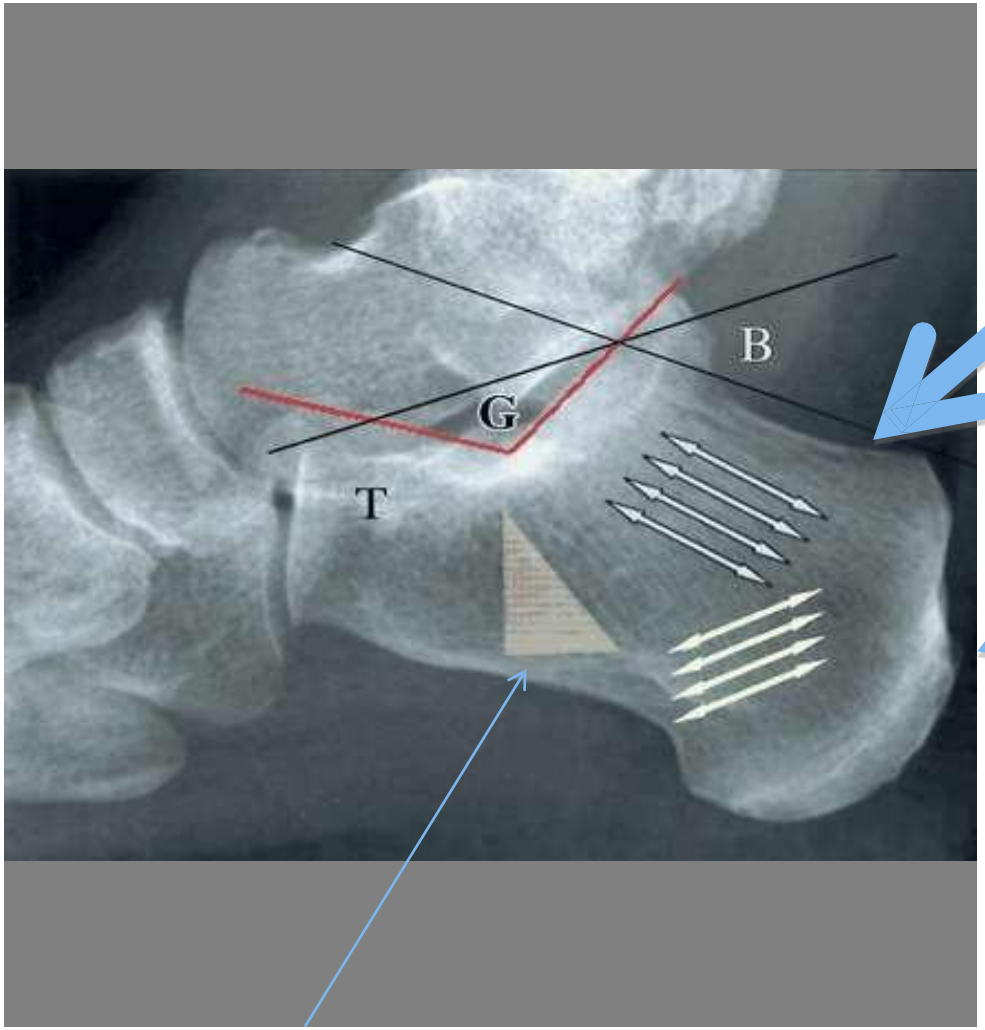
Xray Measurements

- **crucial angle of Gissane** is formed by two strong cortical struts extending laterally:
- One along the lateral margin of the posterior facet and the other extending anterior to the beak of the calcaneus.
  - Normal 120-145 degrees
  - Change in angle indicates change in relationship between posterior, medial, and anterior facets



Critical Angle of Gissane

Radiographic Anatomy



Compression Trabeculae

Traction Trabeculae

neutral triangle

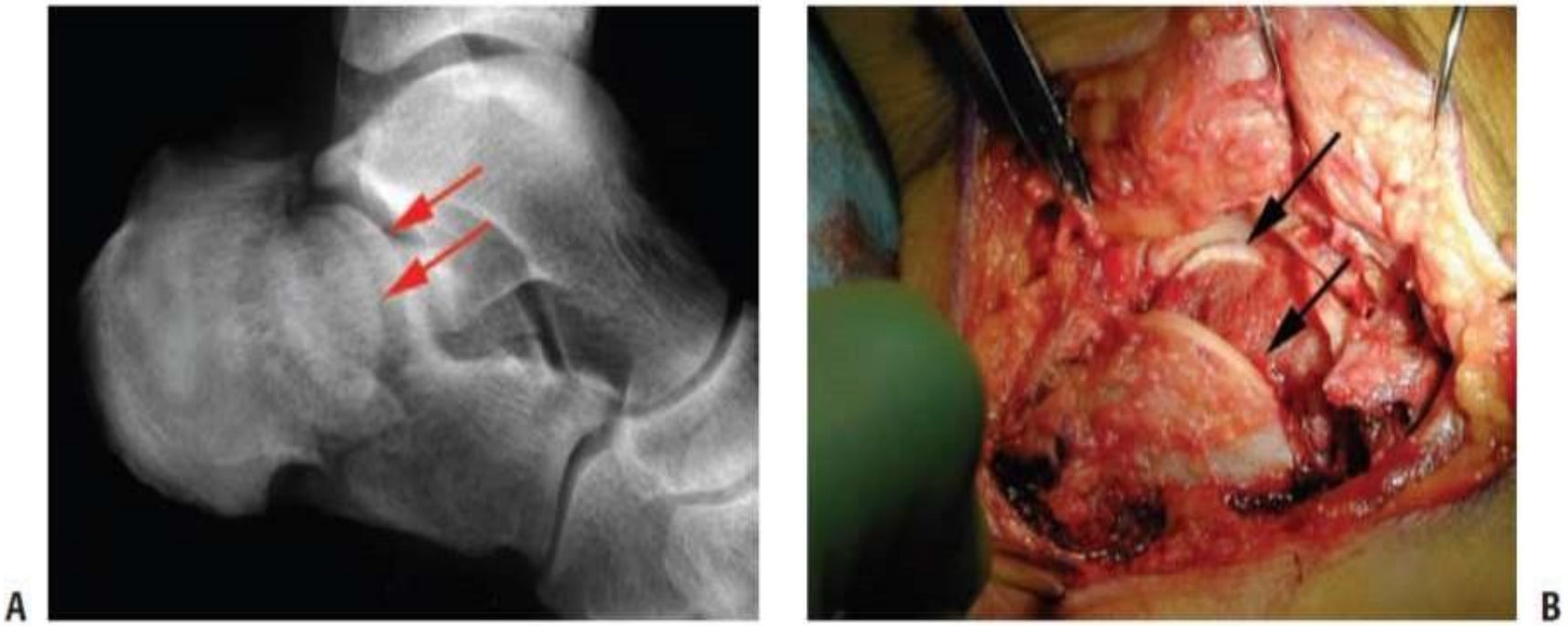


FIGURE 61-7 The "double density"; a joint-depression–type fracture where the lateral portion of the joint is impacted but both Böhler and Gissane angles are normal. **A:** Lateral radiograph (*red arrows*). **B:** Intraoperative correlation (*black arrows*).

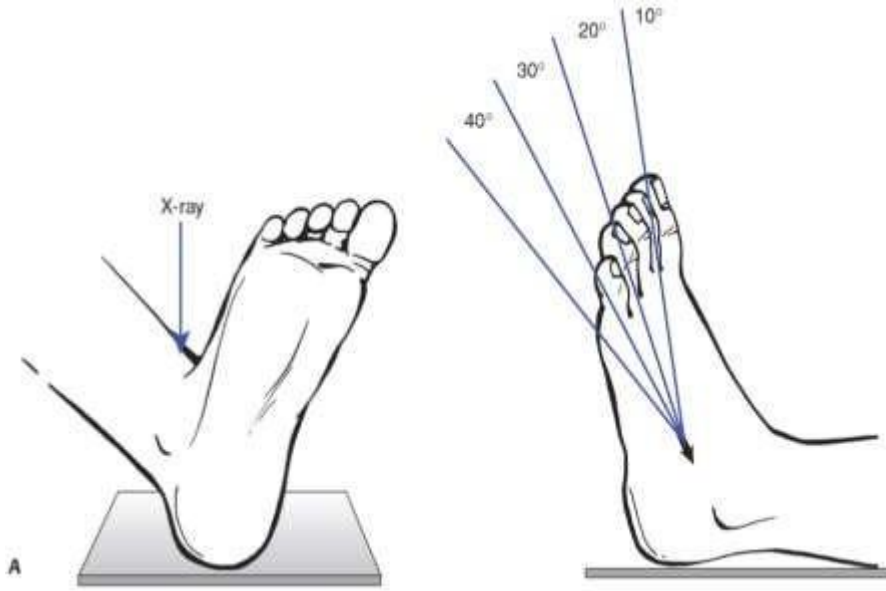
If only the lateral half of the posterior facet is fractured and displaced a split in the articular surface will be seen as a double density density" and Bohler's and Gissane's angles mayappear to be normal

Broden's View
(for posterior facet)

Patient supine and the x-ray cassette under the leg and the ankle.

The foot is in neutral flexion, and the leg is internally rotated 30 to 40 degrees.

The x-ray beam then is centered over the lateral malleolus, and four radiographs aremade with the tube angled 40, 30, 20, and 10 degrees toward the head of the patient



Broden's View

- Posterior facet

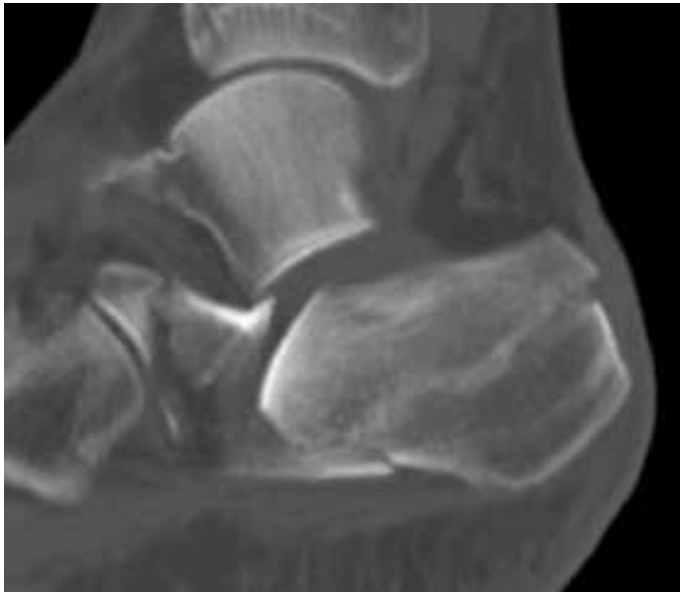
CT Scan and 3D

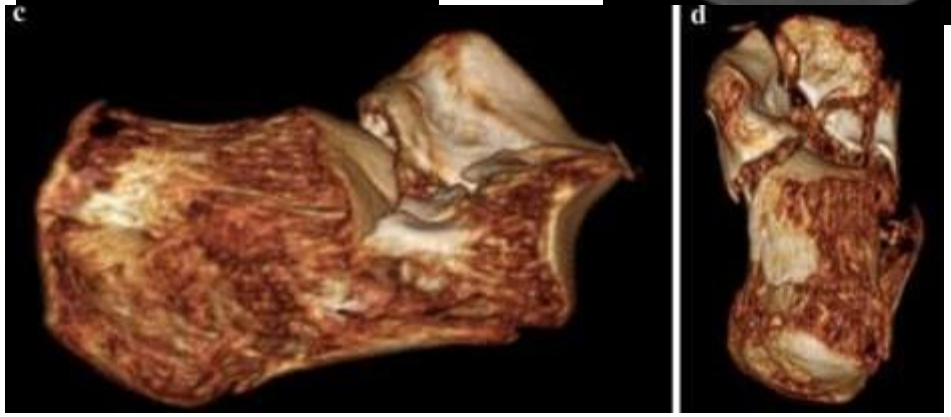
the diagnostic value of three dimensional CT was equivalent to that of conventional two-dimensional CT.

Axial

Coronal

Sagital



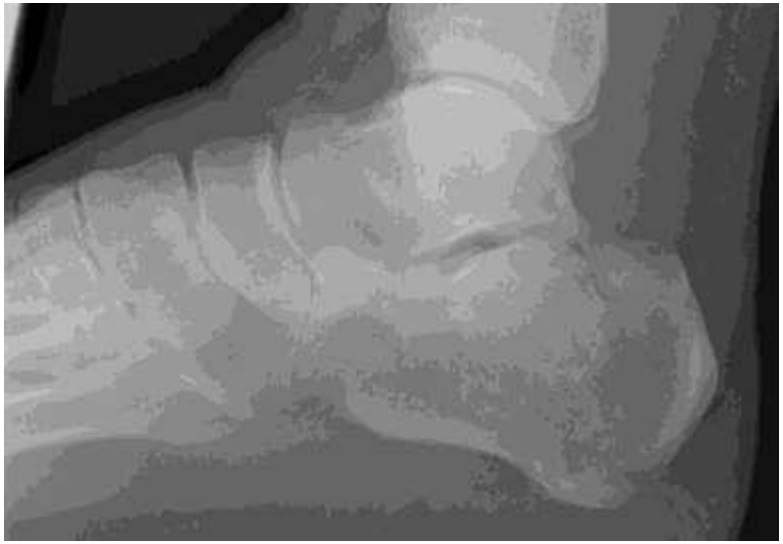


Essex-Lopresti
Described two distinct fracture patterns

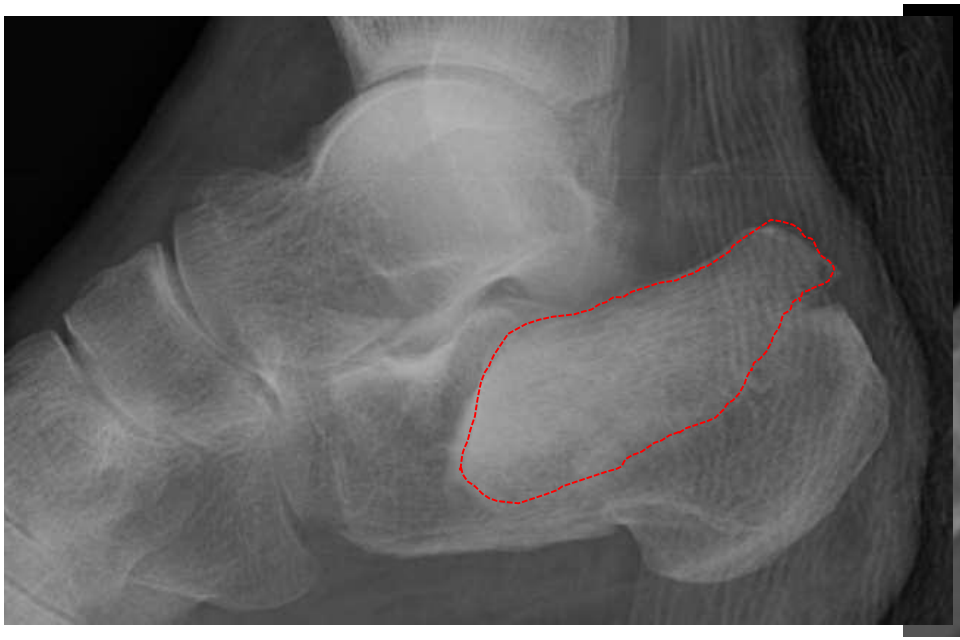
- **Joint-Depression**
- Posterior Tuberosity NOT attached to Posterior Facet
- Not amenable to Essex-Lopresti percutaneous reduction technique
-

Tongue-Type

- Posterior Tuberosity attached to Posterior Facet
- May be amenable to Essex-Lopresti percutaneous reduction technique



Essex-Lopresti Classification: Tongue Type

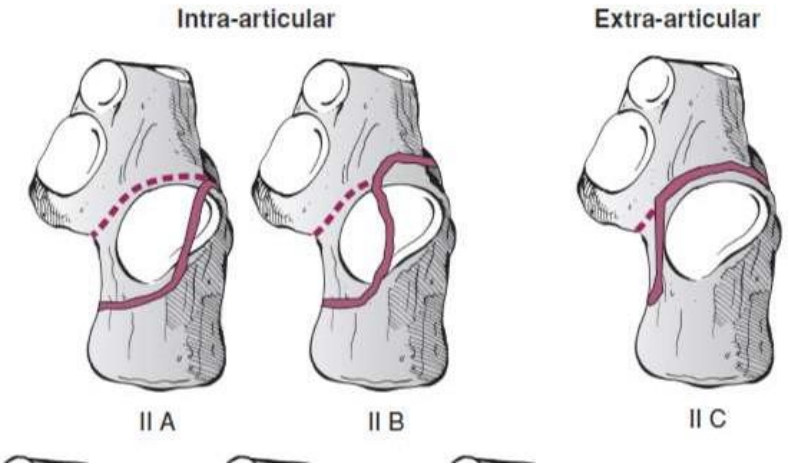


May be amenable to Essex-Lopresti percutaneous reduction technique

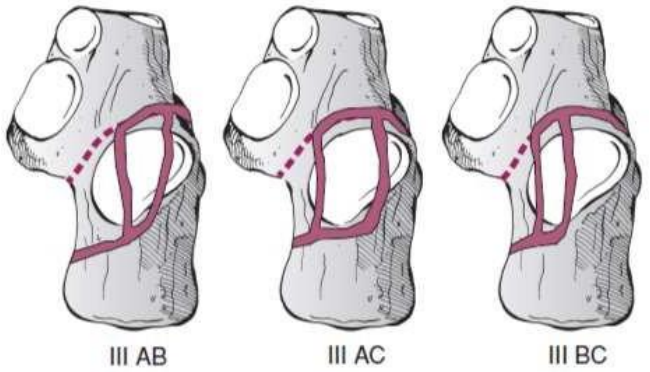
classification system of Sanders

- based on the number and location of articular fracture fragments.
- useful in determining both treatment methods and prognosis after surgical fixation.

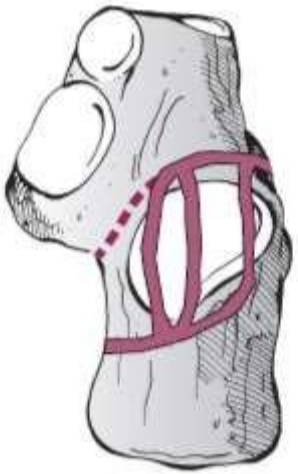
type I: All nondisplaced articular fractures (less than 2 mm), regardless of the number of fracture lines



type II :two-part fractures of the posterior facet

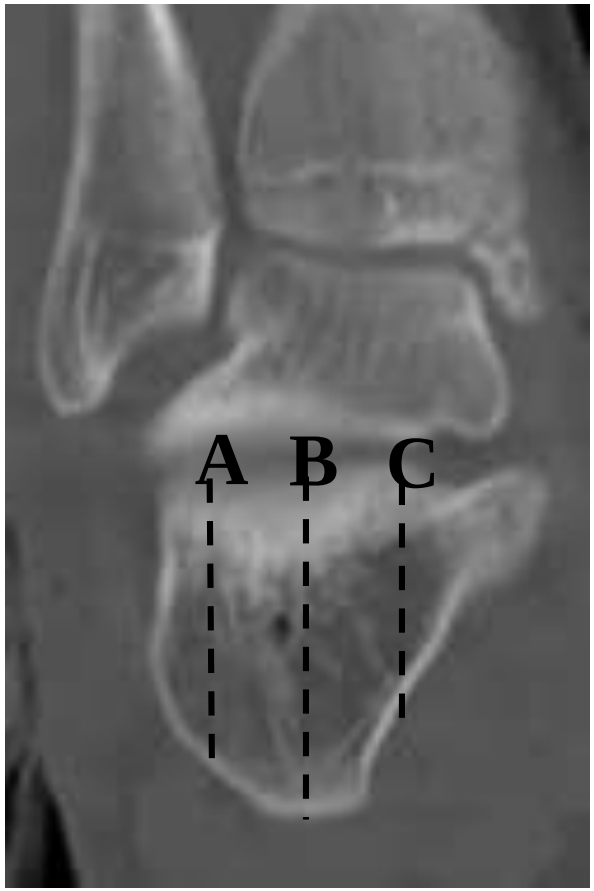


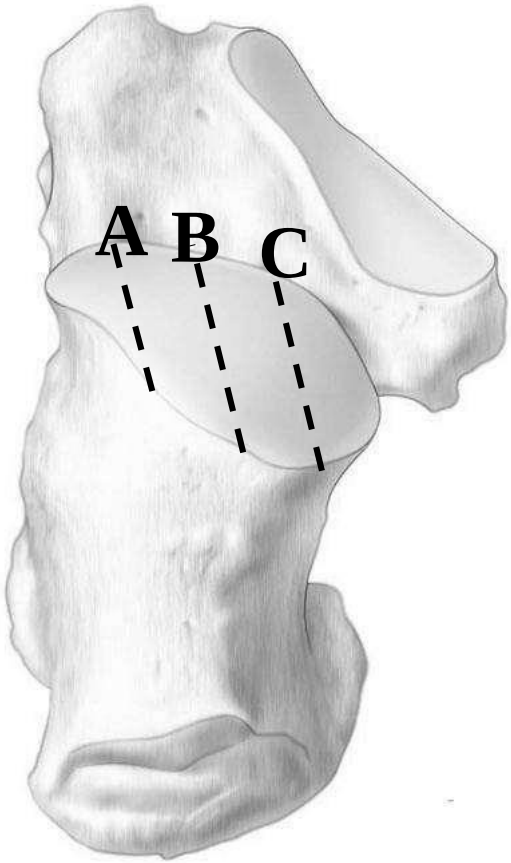
type III : three-part fractures that usually featured a centrally depressed fragment

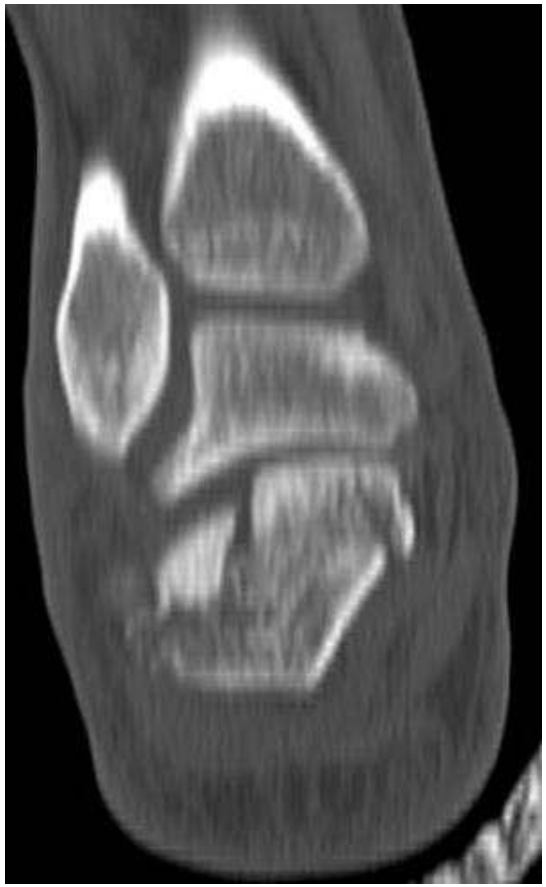


four-part articular fractures,
(comminuted)

Sanders Classification







Sanders R, Fortin P, DiPasquale A, et al. Operative treatment in 120 displaced intra-articular calcaneal

Anterior process of the calcaneus fractures

- Anterior process of the calcaneus fractures often are misdiagnosed as ankle sprains, hence the designation “sprain fractures”
- result from a forced inversion and plantarflexion injury
- fracture line exits into the calcaneocuboid articulation
- pain, swelling, and ecchymosis overlying the anterolateral hindfoot region
- palpation directly over the anterior process fragment

Tuberosity Fracture**:**

FIGURE 61-22 Calcaneal beak fracture. **A:** Lateral radiograph showing displacement from pull of Achilles. The patient was discharged from the emergency room in a splint. **B:** Skin necrosis 1 week later.

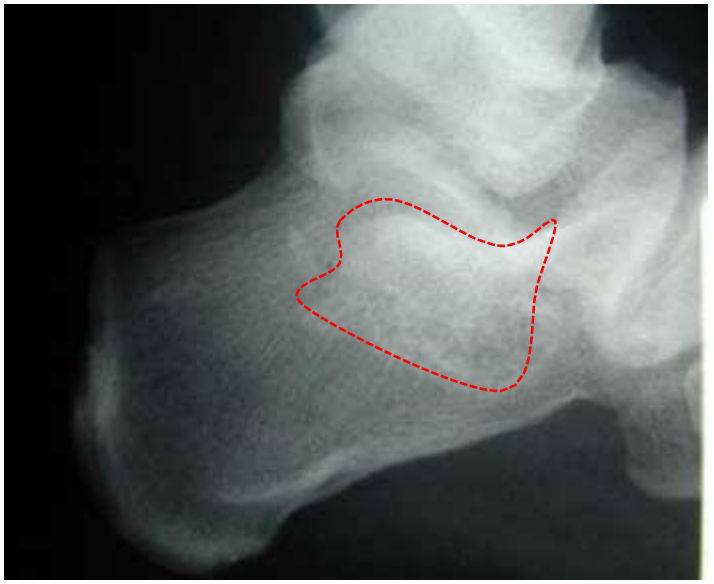
Usually open beak-type fracture or an avulsion fracture

- avulsion fracture pulls the entire Achilles tendon from its insertion
- pain and swelling in the posterior hindfoot
- weakness with resisted plantarflexion
- non-operative (displacement)
  - Swelling control
  - Early ROM

indication for surgery in tuberosity fracture

(a) the posterior skin is at risk because of pressure from the displaced tuberosity,
(b)the posterior portion of the bone is extremely prominent and will affect shoe wear,
(c) the gastrocnemius-soleus complex is incompetent, or, rarely,
(d) the avulsion involves the articular surface of the joint.

Sustentaculum Fracture:



- **Most small/ nondisplaced:**
  - **Non-operative**
- **Large/ displaced**
  - **ORIF (med. approach)**
  - **Buttress plate**

Goals of Treatment

- **Restore Anatomy**

- **Restore Function**

TABLE 61-1 Calcaneus Fractures

Nonoperative Treatment

Indications	Relative Contraindications
Nondisplaced to minimally displaced extra-articular fractures; Nondisplaced intra-articular fractures	Displaced intra-articular fractures involving the posterior facet
Anterior process fractures with <25% involvement of calcaneocuboid articulation	Anterior process fractures with >25% involvement of calcaneocuboid articulation
Fractures in patients with severe peripheral vascular disease, insulin-dependent diabetes mellitus, medical comorbidities prohibiting surgery, minimally ambulatory elderly patients	Displaced fractures of calcaneal tuberosity; Fracture–dislocations of calcaneus Open fractures of calcaneus

Techniques for Nonoperative Treatment

- supportive splint to allow dissipation of the initial fracture hematoma, followed by conversion to fracture boot with the ankle locked in neutral flexion to prevent an equinus contracture,
- elastic compression stocking to minimize dependent edema.
- Early subtalar and ankle joint range-of-motion exercises
- non–weightbearing restrictions for approximately **10 to12 weeks**, until radiographic union is confirmed.

anterior process of the calcaneus fractures

- fracture boot

and stocking immobilization with **immediate weight bearing** in the boot

- early ankle and subtalar range-of motion exercises.
- The fracture should be radiographically healed in **6 weeks**

Operative Treatment of Calcaneus Fractures

- indications
- Surgery within the initial 3 week of injury
- Surgery should not be attempted until swelling in the foot and ank has adequately dissipated, as indicated by a positive **wrinkle test**
- dorsiflexion and eversion of the involved foot and palpation and visual assessment of the lateral calcaneal skin test is positive if skin wrinkling is seen and no pitting edema

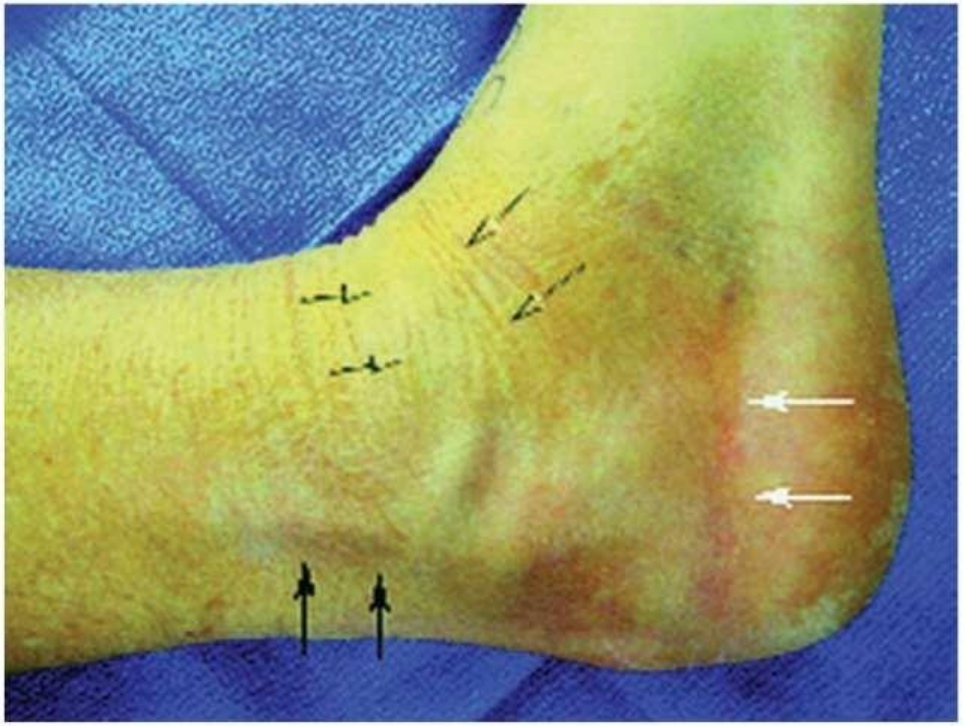


FIGURE 61-23 Wrinkle sign. Note the wrinkling of the skin throughout (*open arrows*), as well as the visualization of the subluxated peroneal tendons (*black arrows*) and lateral edge of calcaneal heel pad (*white arrows*).

degree of soft tissue injury was the most important variable in predicting outcome
open calcaneal fracture; ;; management

- all type I
- type II with medial wound

↓

delayed orif

- type II with non medial wound
- all open type IIIA

↓

ex..fixation/ percuteneous fix

all open type IIIB

↓

delayed reconstruction

Percutaneous and Minimally Invasive Fixation

- indications:
- a) Sanders 2C tongue-type fractures in which the entire posterior facet is attached to the tongue fragment;
- (b)displaced calcaneal tuberosity or beak fractures;
- (c) emergent reduction and temporary stabilization of fractures with severe or impending soft tissue compromise from displaced fracture
- (d) fractures in patients with relative contraindications to open surgery, such as heavy smokers or patients requiring chronic anticoagulation

TABLE 61-2 Percutaneous/Minimally Invasive Fixation of Calcaneus Fractures

Preoperative Planning Checklist

- OR table: Radiolucent or standard table with radiolucent diving board attachment
- Position/positioning aids: Prone or lateral decubitus on beanbag
- Fluoroscopy location: Perpendicular to table; opposite the surgeon
- Equipment: Standard C-arm; cordless drill; Kirschner wires; Schanz pins; periosteal elevators
- Tourniquet (sterile/nonsterile): Nonsterile
- Implants: Small-fragment set; large (6.5–8.0 mm) cannulated screw set

TABLE 61-3 Percutaneous/Minimally Invasive Fixation of (Extra-Articular) Tongue-Type Calcaneus Fractures

Surgical Steps

Place 2 parallel terminally threaded guidepins into tongue fragment

Perform Essex-Lopresti reduction maneuver

Advance one guidepin across anterior process toward plantar corner of calcaneocuboid joint; confirm guidepin placement on fluoroscopy; place large cannulated screw over guidepin

Exchange other (bent) guidepin for new pin; advance parallel to first guidepin; place second large cannulated screw

Use periosteal elevator through lateral stab incision for assistance with reduction if necessary

Use large pelvic clamp between sustentaculum and lateral incision for widening between sustentaculum and posterior facet if necessary

Add small guidepin from sustentaculum to body of calcaneus; place small cannulated screw

Alternatively use cortical lag screws as definitive fixation

- terminaly threaded gide pins are inserted percutaneously into the medial and lateral borders of the Achilles tendon at the superior aspect of the posterior calcaneal tuberosity
- pins are directed to exit the fracture just below the inferior margin of the anterior portion of the displaced posterior facet, but are not driven beyond the facet
- reduction maneuver is performed by using one of the wires as a reduction tool

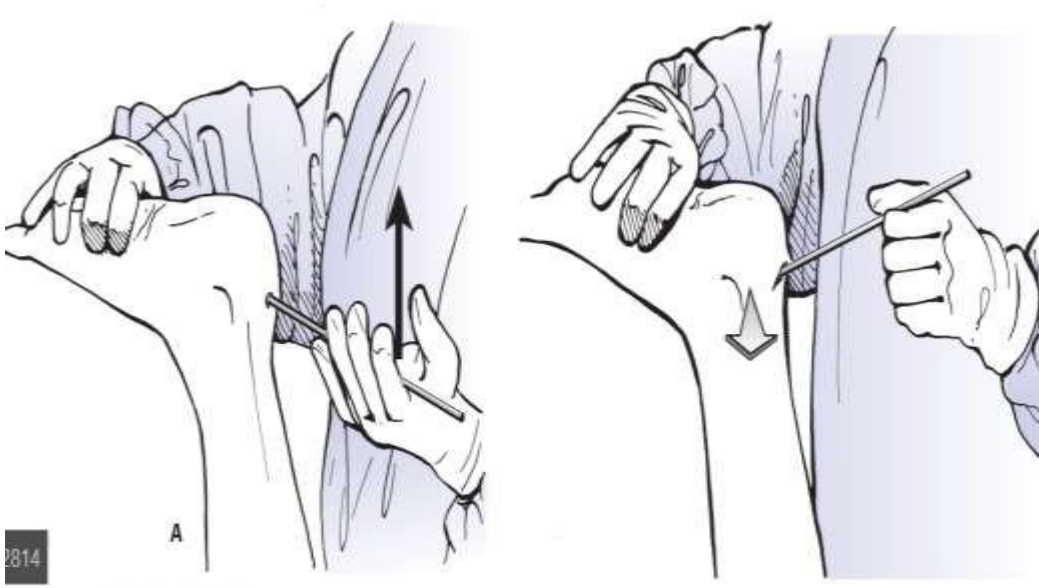


FIGURE 61-26 Percutaneous Essex-Lopresti maneuver. **A:** With patient prone, leverage of heavy K-wires toward the ceiling (*arrow*) will cause **(B)** disimpaction and elevation of fragment (*arrow*).

Tornetta et al modification

- The first step is to disimpact the fracture by lifting up on one of the pins and simultaneously plantarflexing the foot .
- Reduction of the tongue fragment is confirmed fluoroscopically while the foot is held in plantarflexion.
- If this is successful, the second pin is advanced across the anterior process, stopping just short of the plantar corner of the calcaneocuboid joint

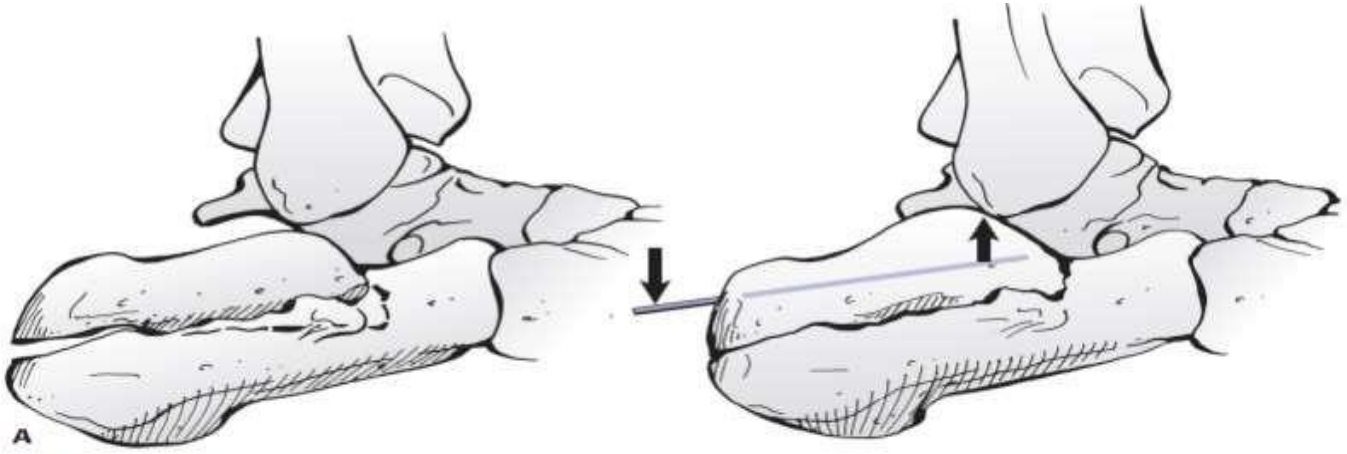
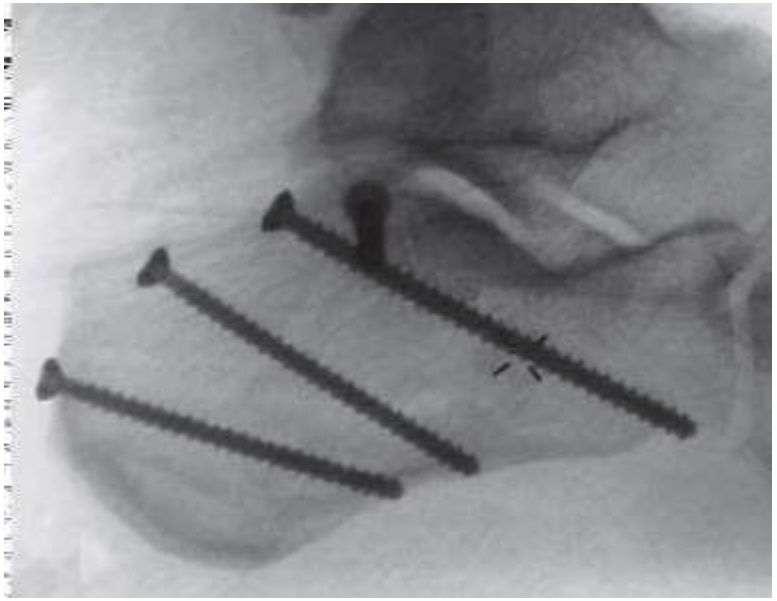


FIGURE 61-27 Essex-Lopresti technique as modified by P. Tornetta, MD. Once guidepins are correctly positioned, they are exchanged for 6.5 to 8.0-mm cannulated cancellous lag screws.

- Definitive fixation is achieved with a large (6.5 to 8.0 mm) cannulated lag screw that is inserted over the guidewire
- Alternatively, 3.5-mm cortical lag screws may be used as definitive fixation
- Two or three parallel screws are placed perpendicular to the tongue fracture line, exiting the plantar cortex



sinus tarsi aproach

- sinus tarsi incision may additionally be utilized for direct visualization of the posterior facet articular surface
- percutaneous screws are placed more plantarly from calcaneal tuberosity into the anterior process, and beneath the displaced posterior facet fragments

percuteneous aproach :outcome

- Inadequate reduction and/or loss of reduction of the articular fragments may occur in a significant number of cases
- In conclusion, minimally invasive and/or percutaneous techniques should be reserved for relatively simple tongue-type fracture patterns

ORIF Through an Extensile Lateral Approach for Joint-Depression Fractures

- The incision starts approximately 2 cm above the tip of the lateral malleolus, just lateral to the Achilles tendon.
- This line is continued vertically toward the plantar surface of the heel.
- It is connected to a line drawn at the junction of the lateral foot and the heel pad—typically when compressing the heel, a crease will appear in this region the two drawn lines form a right angle, this is replaced with a gentle curve heel.
- The incision is started at the proximal part of the vertical limb, becoming full thickness once the calcaneal tuberosity is reached.
- The knife should be taken “straight to bone” at this level, with care taken not to bevel the skin.
- As the knife rounds the corner, pressure is relaxed and a layered incision is developed along the plantar aspect of the foot

A

C

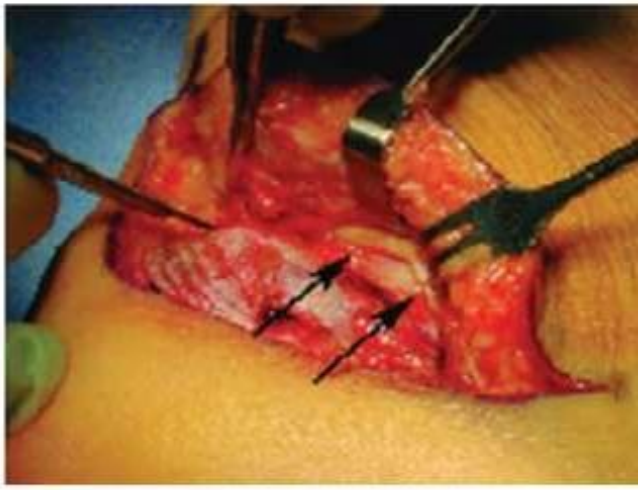


FIGURE 61-30 Extensile lateral approach and exposure (*fracture lateral, mortise, and CT scans can be seen in Figs. 61-7, 8, 9, and 11*). **A: Planned** incision. **B:** No touch full-thickness incision, using no retractors (note open Adson forceps as only means of assistance). **C:** Insertion of Senn retractor once subperiosteal flap has been developed in corner of incision. **D:** Flap development, with identification and protection of peroneal tendons (*black arrows*).

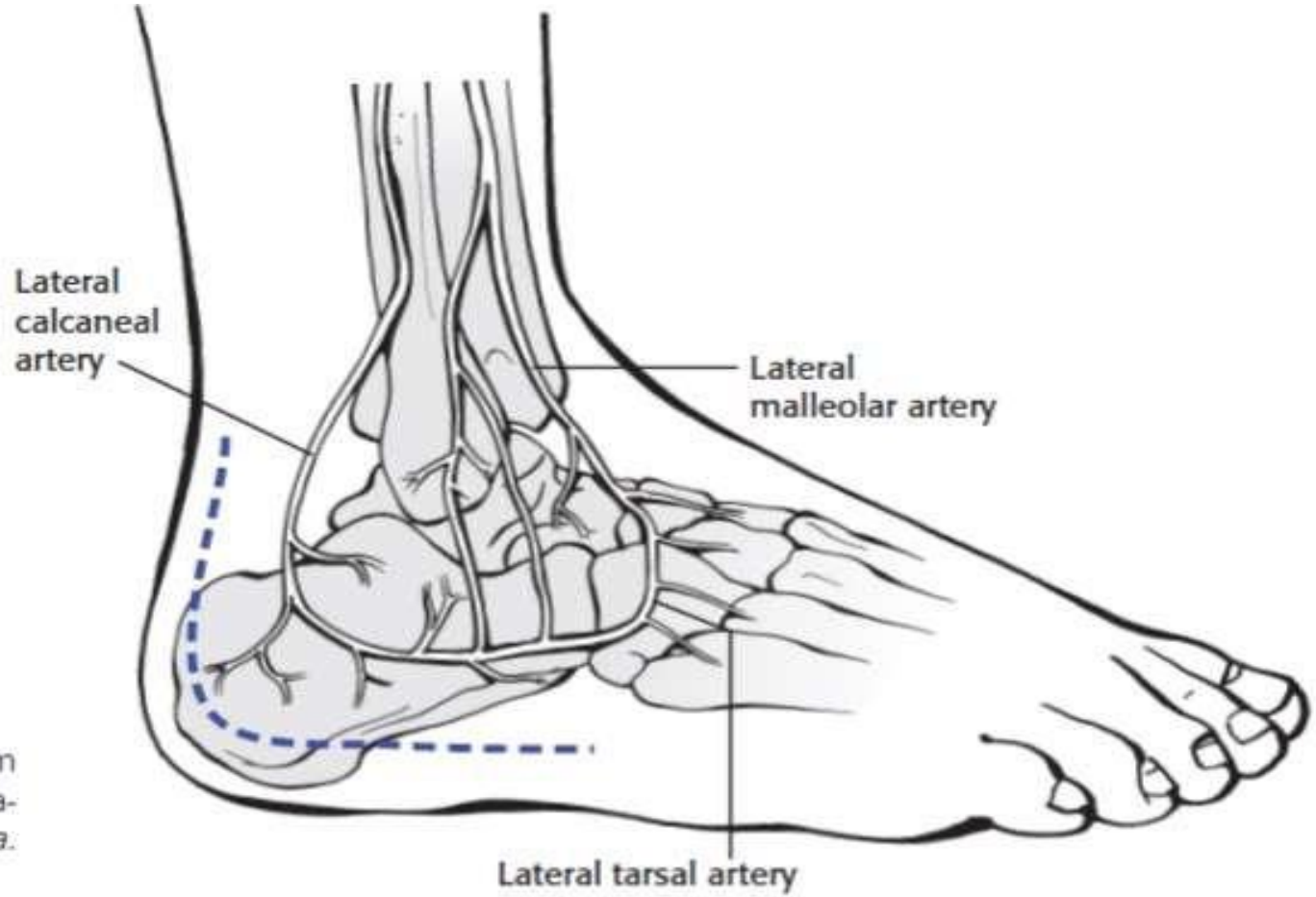


FIGURE 61-31 Lateral vascular anatomy. (Redrawn from Borrelli J Jr, Lashgari C. Vascularity of the lateral calcaneal flap: a cadaveric injection study. *J Orthop Trauma.* 1999;13: 73–77, with permission)

TABLE 61-6 ORIF of Intra-Articular Calcaneus Fractures

Surgical Steps

Perform extensile lateral approach to calcaneus
Place K-wire retractors in cuboid, talar neck, and fibula

Mobilize lateral wall and superolateral articular fragments
Mobilize tuberosity through primary medial fracture line
Place Schanz pin in tuberosity

Reduce superolateral articular fragment to sustentacular fragment
Provisionally stabilize with K-wires

Reduce anterior process and anterolateral fragment(s) to articular fragments to restore crucial angle of Gissane
Provisionally stabilize with K-wires

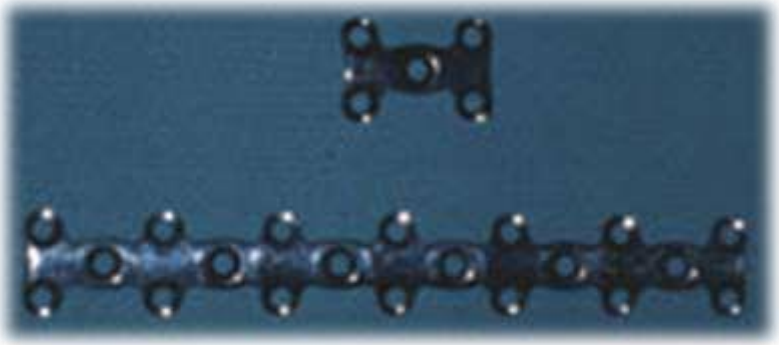
Reduce tuberosity to body of calcaneus; provisionally stabilize with K-wires
Replace lateral wall fragment; add bone void filler as needed

Apply anatomic calcaneal plate
Place cortical or cancellous screws through perimeter holes in plate in box configuration
Place cortical lag screws to stabilize articular fragment(s)
One screw through plate; one screw outside plate

Assess stability of superior peroneal retinaculum

Flap closure over deep drain; sutures tied sequentially from ends to apex; skin closure in identical sequence

Fixation Options

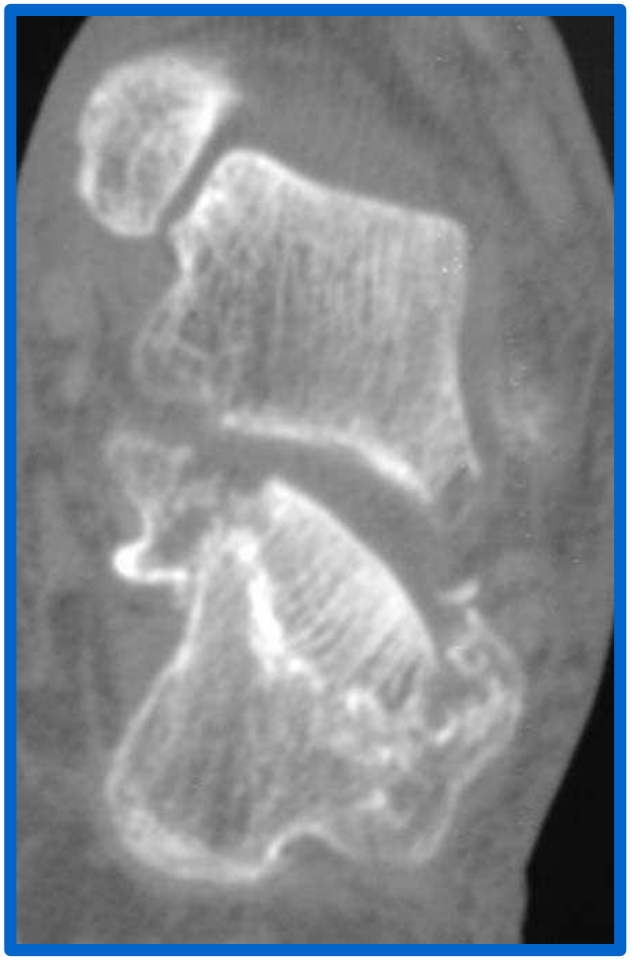


Postoperative Care

- **Elevate, splint**
- **Sutures out at 2-3 wks.**
- **Fracture boot to prevent equinus contracture**
- **Early motion ankle and foot**
- **NWB for 12 weeks**

Non-op Treatment: Complications

Malunion



Operative Treatment
Complications

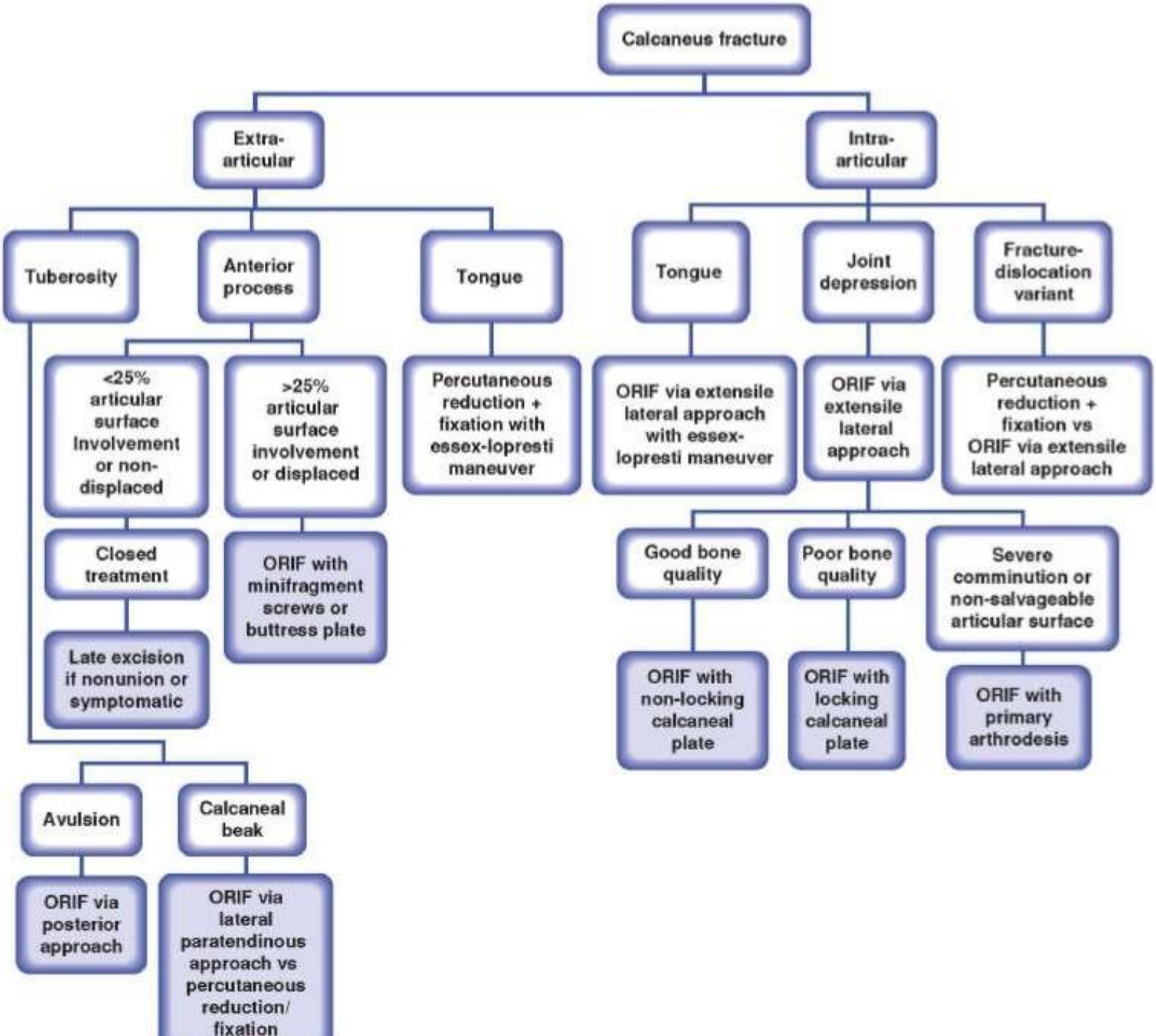
- **Wound problems**
- **Apical wound necrosis**
- **Infection**

Surgery: Primary Fusion

- **Articular comminution**
- **Severe cartilage injury**
- **ORIF calcaneus, debride cartilage, and fuse**

SUMMARY

- ***High energy injuries***
- ***Risk for long term morbidity***
- ***ORIF can give good, reproducible results <u>if</u> complications are avoided***
- ***Individualize treatment***


Calcaneus fracture
Extra-articular
Intra-articular
Tuberosity
Anterior process
Tongue
Tongue
Joint depression
Fracture-dislocation variant
<25% articular surface involvement or non-displaced
>25% articular surface involvement or displaced
Percutaneous reduction + fixation with essex-lopresti maneuver
ORIF via extensile lateral approach with essex-lopresti maneuver
ORIF via extensile lateral approach
Percutaneous reduction + fixation vs ORIF via extensile lateral approach
Closed treatment
ORIF with minifragment screws or buttress plate
Good bone quality
Poor bone quality
Severe comminution or non-salvageable articular surface
Late excision if nonunion or symptomatic
ORIF with non-locking calcaneal plate
ORIF with locking calcaneal plate
ORIF with primary arthrodesis
Avulsion
Calcaneal beak
ORIF via posterior approach
ORIF via lateral paratendinous approach vs percutaneous reduction/ fixation