







## TRAUMA TO THE KNEE, ANKLE and HINDFOOT

Seppo Koskinen, M.D., Ph.D.  
Professor





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TRAUMA & EMERGENCY RADIOLOGY

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## TRAUMA TO THE KNEE

- APPROPRIATENESS CRITERIA
- LIPOHEMATRON
- SEGOND FRACTURE
- DEEP NOTCH SIGN
- OCCULT FRACTURES
- STRESS FRACTURES

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American College of Radiology  
ACR Appropriateness Criteria®  
Acute Trauma to the Knee

Revised 2019

**Variant 2:** Adult or child 5 years of age or older. Fall or acute twisting trauma to the knee. One or more of the following: focal tenderness, effusion, inability to bear weight. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography knee	Usually Appropriate	☼
Bone scan with SPECT or SPECT/CT knee	Usually Not Appropriate	☼☼☼
CT knee with IV contrast	Usually Not Appropriate	☼
CT knee without and with IV contrast	Usually Not Appropriate	☼
CT knee without IV contrast	Usually Not Appropriate	☼
MR arthrography knee	Usually Not Appropriate	○
MRA knee without and with IV contrast	Usually Not Appropriate	○
MRA knee without IV contrast	Usually Not Appropriate	○
MRI knee without and with IV contrast	Usually Not Appropriate	○
MRI knee without IV contrast	Usually Not Appropriate	○
US knee	Usually Not Appropriate	○

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Acute Trauma to the Knee

Revised 2019

**Variant 3:** Adult or skeletally mature child. Fall or acute twisting trauma to the knee. No fracture seen on radiographs. Suspect occult fracture or internal derangement. Next study.

Procedure	Appropriateness Category	Relative Radiation Level
MRI knee without IV contrast	Usually Appropriate	○
CT knee without IV contrast	May Be Appropriate	☼
Bone scan with SPECT or SPECT/CT knee	Usually Not Appropriate	☼☼☼
CT knee with IV contrast	Usually Not Appropriate	☼
CT knee without and with IV contrast	Usually Not Appropriate	☼
MR arthrography knee	Usually Not Appropriate	○
MRA knee without and with IV contrast	Usually Not Appropriate	○
MRA knee without IV contrast	Usually Not Appropriate	○
MRI knee without and with IV contrast	Usually Not Appropriate	○
US knee	Usually Not Appropriate	○

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Acute Trauma to the Knee

Revised 2019

**Variant 7:** Adult or child 5 years of age or older. Significant trauma to the knee (eg, motor vehicle accident, knee dislocation). Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography knee	Usually Appropriate	☼
CTA lower extremity with IV contrast	Usually Appropriate	☼☼☼
Arteriography lower extremity	May Be Appropriate	☼☼
CT knee with IV contrast	May Be Appropriate (Disagreement)	☼
CT knee without IV contrast	May Be Appropriate	☼
MRA knee without and with IV contrast	May Be Appropriate	○
MRI knee without IV contrast	May Be Appropriate	○
MRA knee without IV contrast	Usually Not Appropriate	○
Bone scan with SPECT or SPECT/CT knee	Usually Not Appropriate	☼☼☼
CT knee without and with IV contrast	Usually Not Appropriate	☼
MR arthrography knee	Usually Not Appropriate	○
MRI knee without and with IV contrast	Usually Not Appropriate	○
US knee	Usually Not Appropriate	○

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## LIPOHEMATRON

- The presence of liquid fat and blood (lipohemartrosis) within the joint produces a fat-fluid interface, aka FBI-sign (Fat-blood interface)
- Seen only on horizontal beam cross-table lateral view patient in supine position
- Valuable in detecting and identification of minimally displaced intra-articular fractures of distal femur and proximal tibia
- Fractures that permit flow of blood and fat from the medullary cavity into the joint space

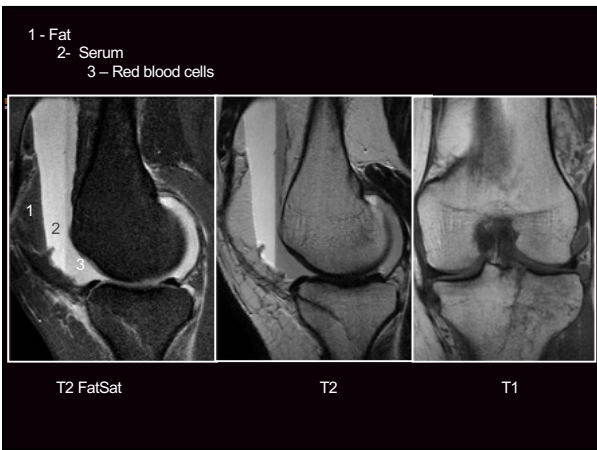
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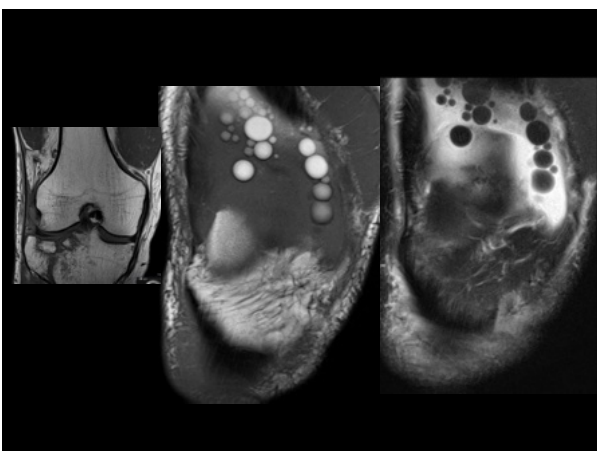
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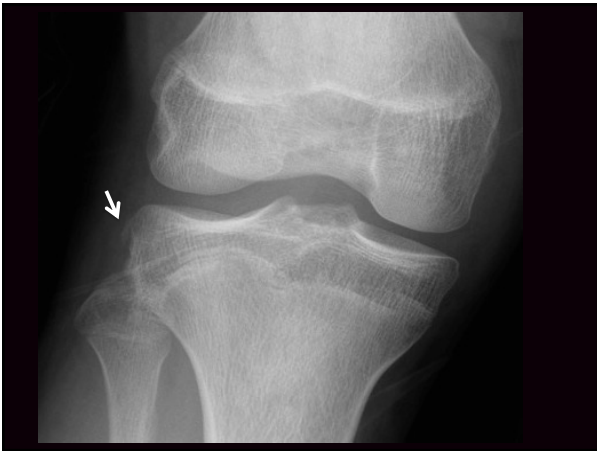


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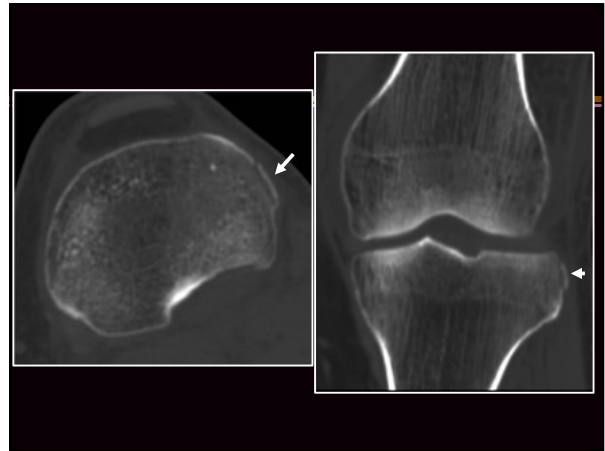
### SECOND FRACTURE

- A Second fracture is a small, vertical fracture of the lateral aspect of the proximal tibia just distal to the tibial plateau
- represents rupture of the lateral capsular fibers of the iliotibial tract or anterior oblique band of lateral collateral ligament
- trauma mechanism is usually excessive internal rotation and varus stress.
- (almost) 100% association with ACL injuries
- very high (66-75%) association with meniscal injuries
- Also, associated injuries include damage to the structures of the posterolateral corner of the knee, and other avulsion injuries
- the presence of a Second fracture may indicate substantial meniscoligamentous injury, and anterolateral rotational instability must be considered to be present until proven otherwise

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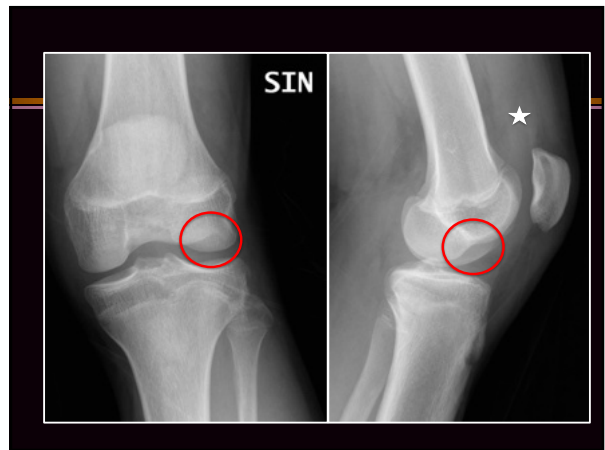
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14-year-old male, skiing injury. Present with knee pain and joint effusion. He is able to bear weight.

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**DEEP NOTCH SIGN**

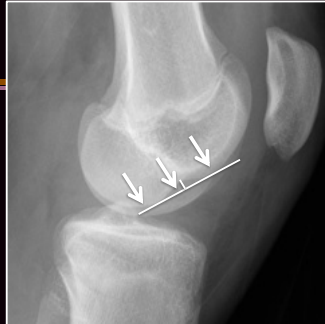
**NORMAL**



- Normally lateral femoral condylopatellar sulcus is a shallow and smooth and symmetrical
- In case of ACL injury, deepening, increased density and irregularities may occur
- Depth of 1.5 mm is abnormal, 2 mm definitive

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**DEEP NOTCH SIGN**

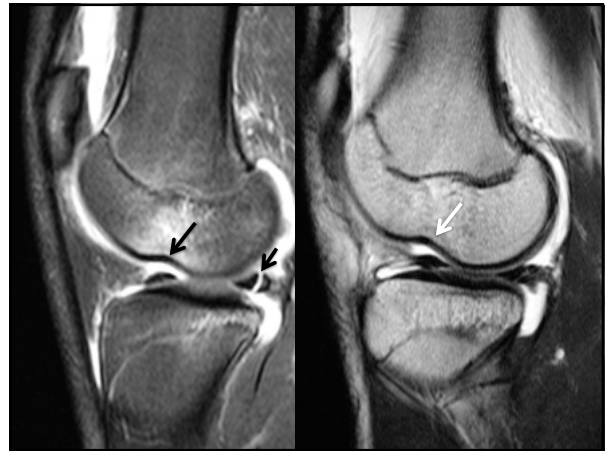


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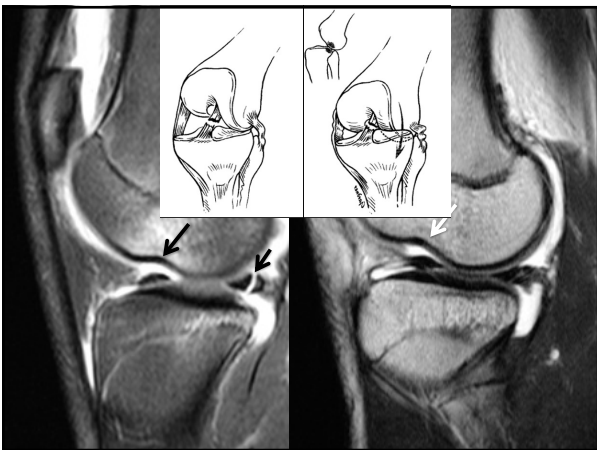
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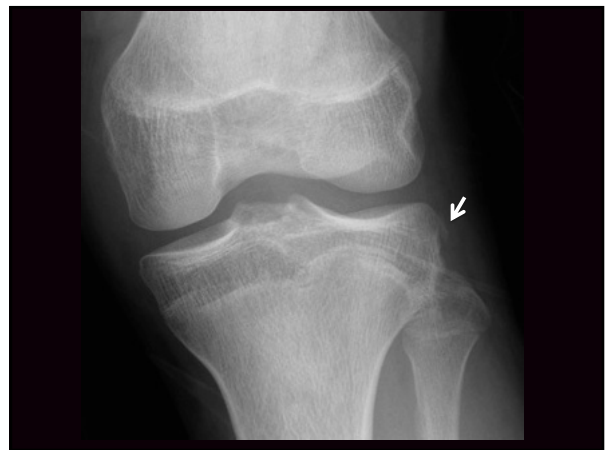
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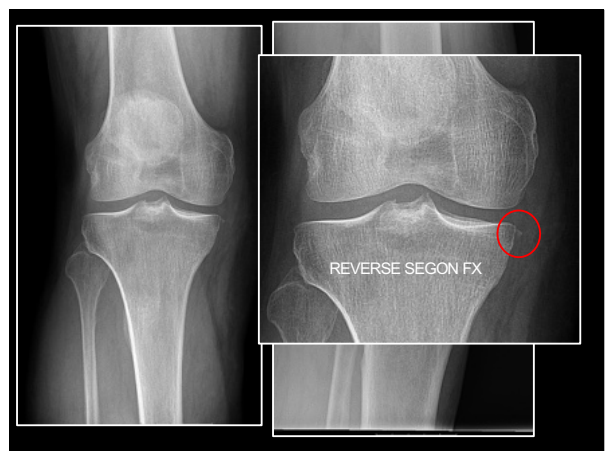
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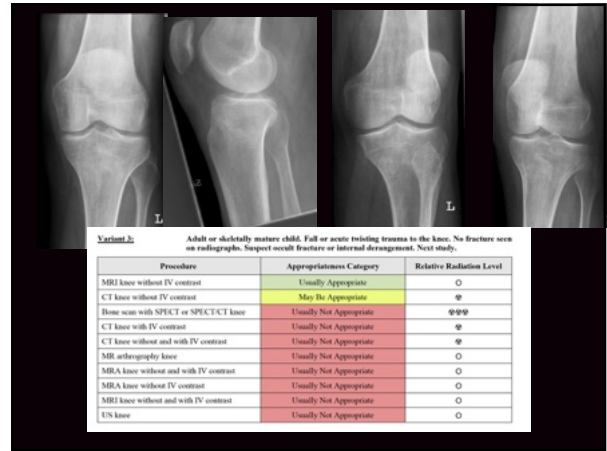


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**Variant 2** Adult or skeletally mature child. Fall or acute twisting trauma to the knee. No fracture seen on radiographs. Suspect occult fracture or internal derangement. Next study.

Procedure	Appropriateness Category	Relative Radiation Level
MRU knee without IV contrast	Usually Appropriate	○
CT knee without IV contrast	May Be Appropriate	⊗
Bone scan with SPECT or SPECT/CT knee	Usually Not Appropriate	⊗⊗⊗
CT knee with IV contrast	Usually Not Appropriate	⊗
CT knee without and with IV contrast	Usually Not Appropriate	⊗
MR arthrography knee	Usually Not Appropriate	○
MRA knee without and with IV contrast	Usually Not Appropriate	○
MRA knee without IV contrast	Usually Not Appropriate	○
MRU knee without and with IV contrast	Usually Not Appropriate	○
US knee	Usually Not Appropriate	○

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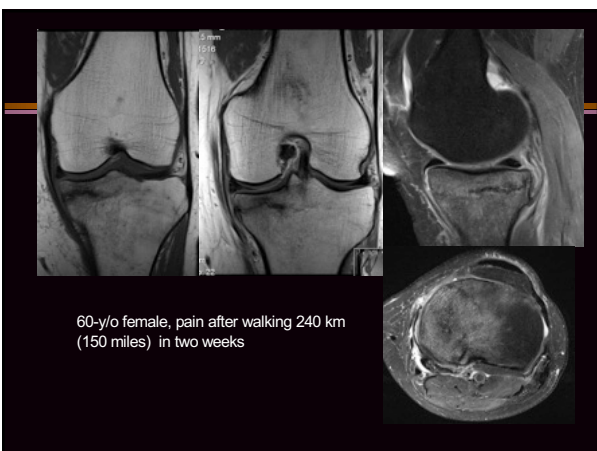
## STRESS FRACTURES

- Tibia
- Proximal fibula in runners
- Femur
- Patella

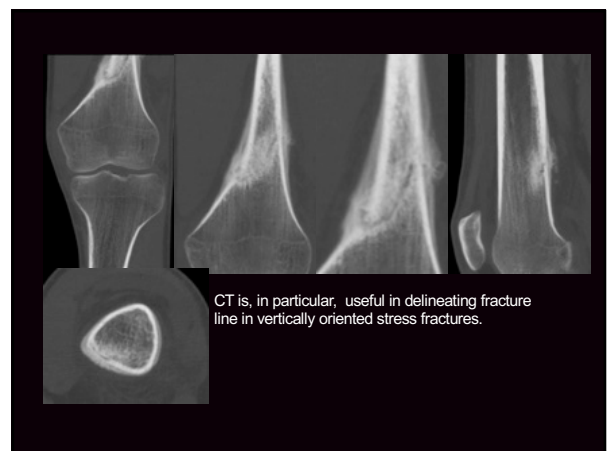
• **Stress fractures (%) in athletes** (Matheson, G.O., Clement, D.P., McKenzie, D.C., et al.: Stress Fractures in Athletes: A Study of 320 Cases. Am. J. Sports Med. 1987; 15: 46-58)

- Tibia 49,1
- Ankle & navicular 25,3
- MTs 8,8
- Femur 7,2
- Fibula 6,6
- Pelvis 1,6
- Sesamoid bones 0,9

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## SUMMARY

- Good-quality radiographs in minor & major trauma
- MRI in suspect occult fracture or internal derangement: MRI
- CTA in major trauma
- Do not forget cross-table lateral projection (FBI)

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## ANKLE

Revised 2020

American College of Radiology  
ACR Appropriateness Criteria®  
Acute Trauma to the Ankle

**Variant 1:** Adult or child 5 years of age or older. Acute trauma to the ankle or acute trauma to the ankle with persistent pain for more than 1 week but less than 2 weeks. No exclusionary criteria present. Initial imaging. Patient meets the requirements for evaluation by the Ottawa Ankle Rules which are positive:

- Inability to bear weight immediately after the injury, OR
- Point tenderness over the medial malleolus, the posterior edge or inferior tip of the lateral malleolus, talus, or calcaneus, OR
- Inability to ambulate for 4 steps in the emergency department.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography ankle	Usually Appropriate	☼
US ankle	Usually Not Appropriate	○
MRI ankle without and with IV contrast	Usually Not Appropriate	○
MRI ankle without IV contrast	Usually Not Appropriate	○
CT ankle with IV contrast	Usually Not Appropriate	☼
CT ankle without and with IV contrast	Usually Not Appropriate	☼
CT ankle without IV contrast	Usually Not Appropriate	☼
Bone scan ankle	Usually Not Appropriate	☼☼☼

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## ANKLE

**Variant 6:** Adult or child 5 years of age or older. Acute trauma to the ankle. Radiographs negative for osseous injury and physical examination or radiographs demonstrate alignment abnormality suggesting syndesmotic/ligamentous injury or dislocation. Next study.

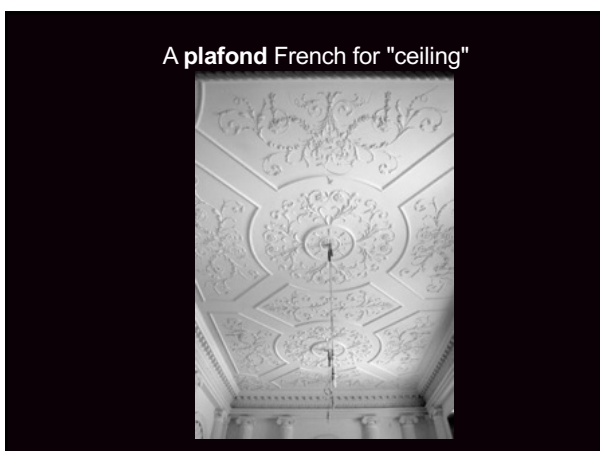
Procedure	Appropriateness Category	Relative Radiation Level
Radiography ankle stress views	Usually Appropriate	☼
Radiography leg	Usually Appropriate	☼
MRI ankle without IV contrast	Usually Appropriate	○
CT ankle without IV contrast	Usually Appropriate	☼
US ankle	Usually Not Appropriate	○
MRI ankle without and with IV contrast	Usually Not Appropriate	○
CT ankle with IV contrast	Usually Not Appropriate	☼
CT ankle without and with IV contrast	Usually Not Appropriate	☼
Bone scan ankle	Usually Not Appropriate	☼☼☼

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## ANKLE

- STANDARAD VIEWS**
  - AP, lateral and mortise (10° -15° internal rotation), include base of MT V
  - Some institutions replace mortise view with 45° oblique views
- ANKLE MORTISE**
  - Medial and lateral malleolus and tibial plafond (distal articular surface of tibia)
- ANKLE JOINT**
  - Joint between ankle mortise and superior articular surface of the talus

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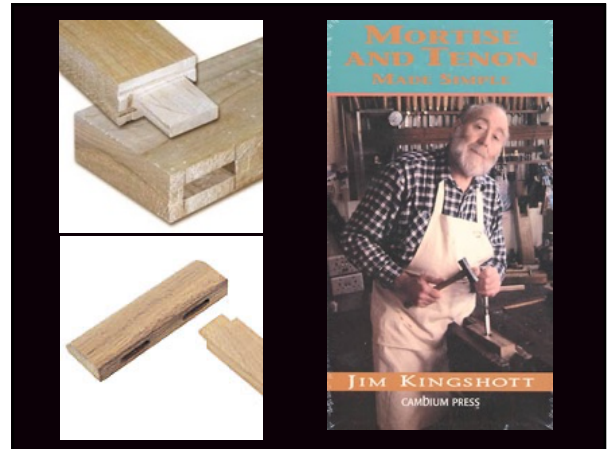
## ANKLE

- FREQUENT SITE OF INJURY**
  - malleoli
- MEDIAL CLEAR SPACE**
  - On mortise view, the medial ankle joint space should be equal to the superior joint space, and  $\leq 4$  mm wide. Widening indicates lateral talar shift
- TIBIOFIBULAR CLEAR SPACE**
  - Distance between medial wall of distal fibula and incisural surface of the tibia and should be  $< 6$  mm on mortise and AP-views. Widening indicates syndesmotic disruption

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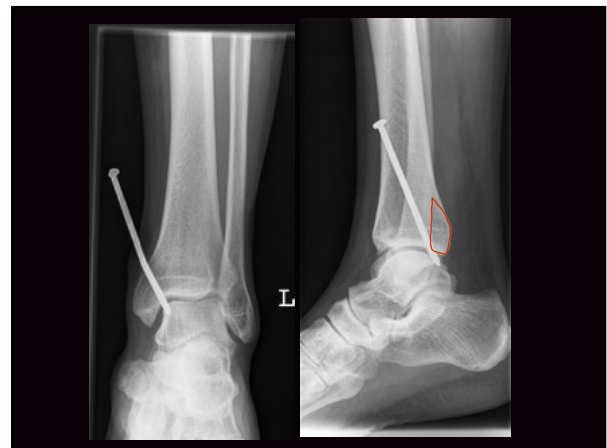
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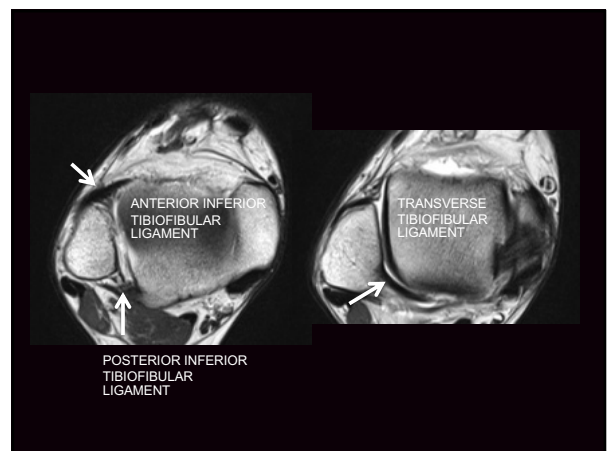
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## ANKLE

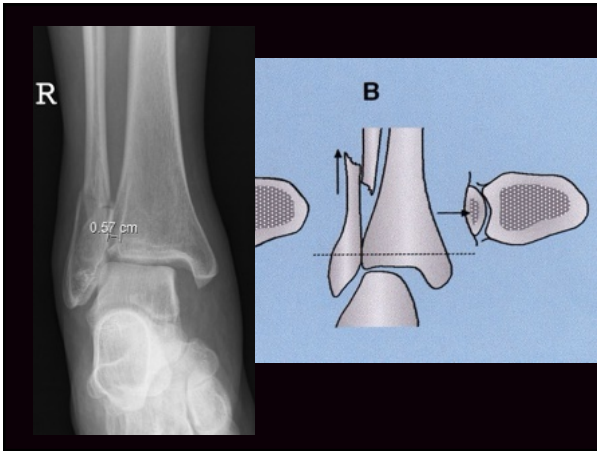
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- **LIGAMENTOUS ANATOMY**
  - » Medial and lateral ligaments
  - » **Distal tibiofibular complex (syndesmosis) - most important**
    - Anterior inferior tibiofibular ligament
    - Posterior inferior tibiofibular ligament
    - Transverse tibiofibular ligament
    - Interosseous membrane

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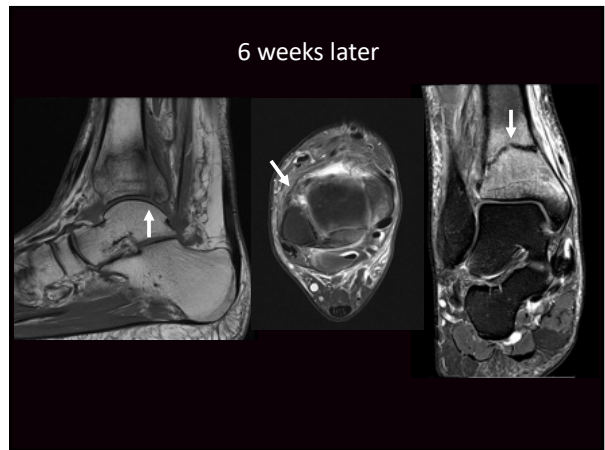
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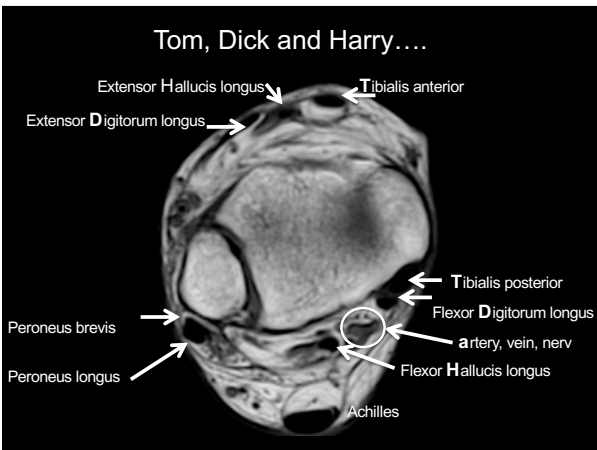




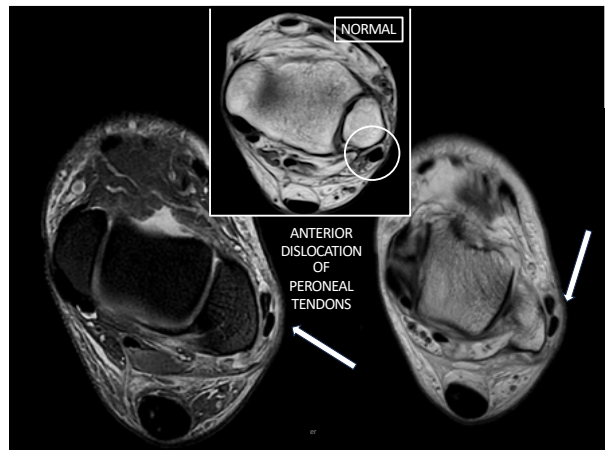
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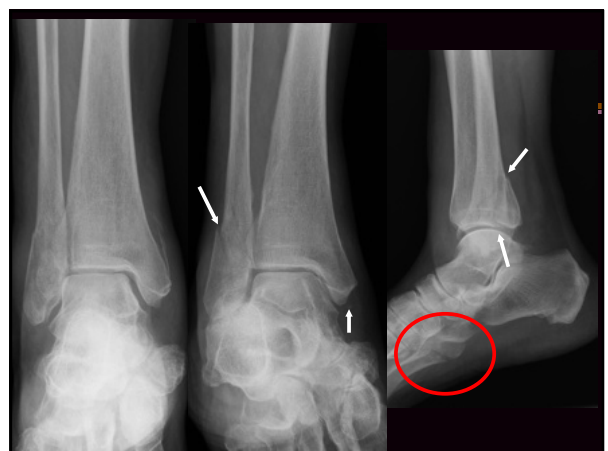
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**SO...**

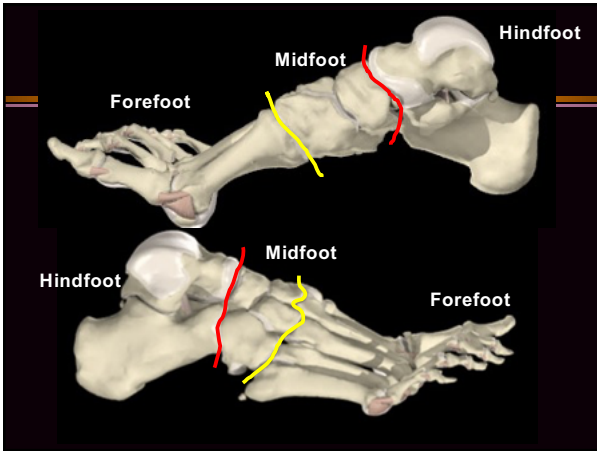
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- Evaluate all three malleoli
- TC-joint width: 3-4 mm
- If isolated fx in medial or posterior malleolus, consider imaging proximal fibula as well
- Talar dome and neck
- Proximal MT V

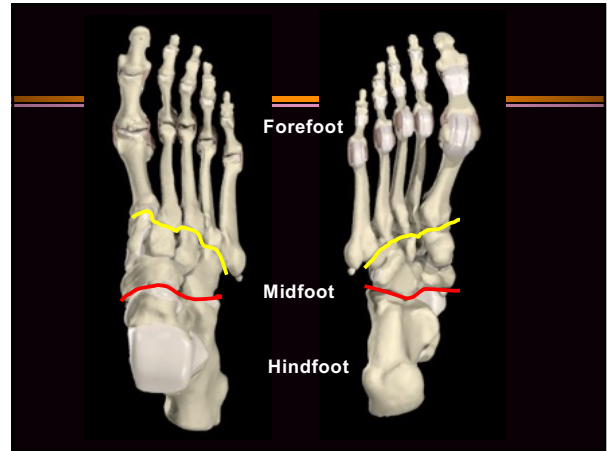
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## TALAR FRACTURES

- Fall from height, MVC

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## TALAR FRACTURES

- Talar neck
  - » I: nondisplaced
  - » II: displaced with subtalar dislocation or subluxation
  - » III: displaced with dislocation of the body of the talus from both the subtalar and ankle joints
  - » IV: any neck fracture with dislocation of the talar head

Case courtesy of Matt Skalski, Radiopaedia.org. rID: 35399

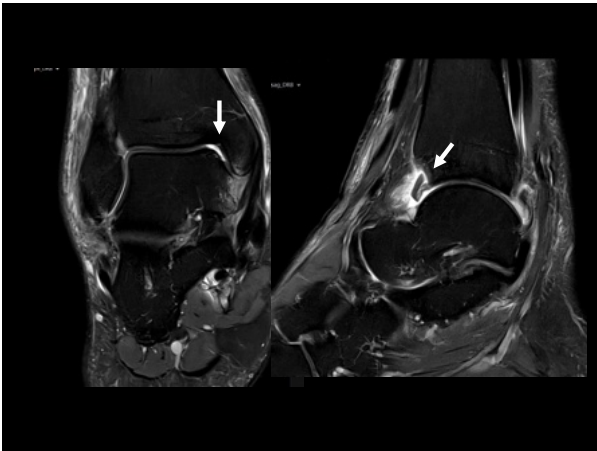
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## CALCANEUS

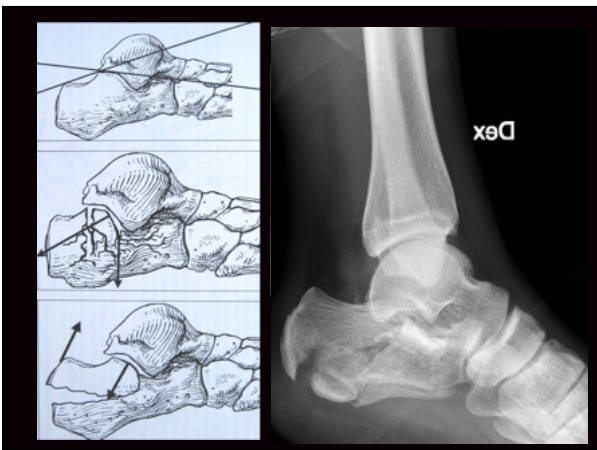
- FALL FROM HEIGHT
- OFTEN BILATERAL + TH-LS-fxs
- SUBTALAR FACETS
- BÖHLER'S ANGLE 20°-40°
- CT

**Lateral surface**

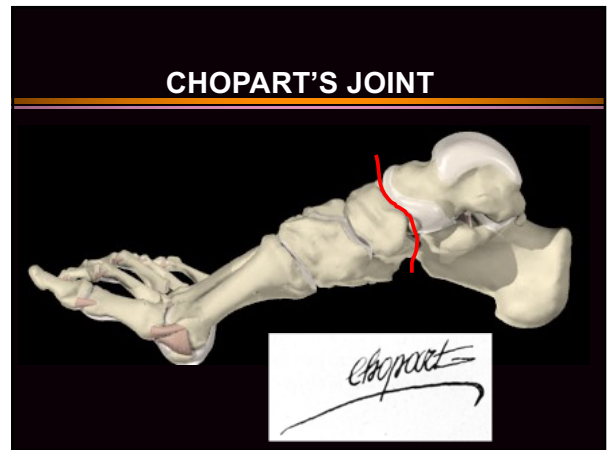
**Superior surface**

ANATOMY STANDARD  
Case courtesy of Matt Skalski, Radiopaedia.org, ID: 23709

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