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Imaging of the Ankle

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Abstract

Although ankle sprains are common, fortunately, the symptoms frequently go away on their own. The Ottawa guidelines are frequently used by clinicians to decide who has to have a radiographic examination to look for fractures.

Radiographs alone, however, could miss occult and occasionally very important fractures. Additional imaging is recommended in problematic cases, particularly when there is persistent discomfort or disability. If there is evidence of an ankle joint effusion, a CT or MR scan may be ordered, as well as an ultrasound or MR scan if a ligament or tendon damage is suspected. Although an MR scan will cover bones and the deeper portions of the bone, an ultrasound examination is more accurate in identifying the type of soft tissue injury. The more comprehensive imaging may be useful for planning an athlete's rehabilitation.

Keywords: CT scan, MR Scan, Radiograph

Introduction

One of the most often fractured joints and one that orthopaedic surgeons repair most frequently is the ankle joint. An estimated 187 ankle fractures per 100,000 persons occur each year, according to estimates. The prevalence of these fractures appears to be rising in industrialized nations, most likely as a result of the growing number of people participating in sports activity, including physically active older patients. Typically, malleolar fractures occur in the ankle. 60% to 70% of fractures are unimalleolar (mostly lateral malleolus), 15% to 20% are bimalleolar, and just 7% to 12% are trimalleolar. Though higher in young males and older females, overall incidence is roughly equal between sexes.

An understanding of the proper imaging evaluation of this complicated anatomy is crucial given how frequently ankle fractures appear.

Although radiography is used for the initial evaluation, understanding subsequent evaluation with more sophisticated cross-sectional imaging is equally crucial.

When reducing and fixing fractures with or without an unstable syndesmotic damage, intraoperative imaging is crucial.

Anatomical reduction and implant placement are made easier by understanding anatomical relationships and recognizing landmarks.

The following are particularly useful:

- Mortise view

- Lateral view
- Intraoperative 3D Images
- Axial plane (10 mm proximal to the talar joint line)
- Axial plane (5 mm distal to the talar joint line)
- Sagittal plane
- Coronal plane

The following represent ideal imaging with the patient placed in the supine position.

The relation between the foot and the C-arm and the foot is the same for patients in the lateral decubitus and prone positions. The orientation of the C-arm has to be adjusted accordingly.

Taking intraoperative images of the contralateral ankle for comparison purposes can be useful to ensure that an anatomical reduction of the injured ankle is achieved.

Mortise view

Positioning for optimal view

- The beam is placed perpendicular to the tibia
- The foot is rotated internally by 15-20°
- The beam is centered at the ti bio-talar joint-line
- The ankle joint is in neutral position

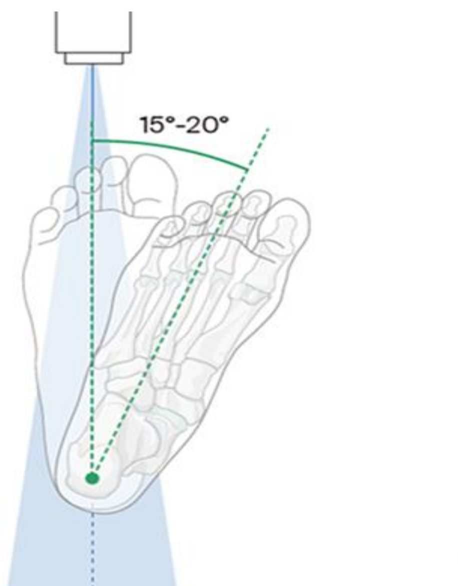

Fig 1: The foot is rotated internally by 15-20°

Verification of optimal view

The optimal view is obtained when the:

- Joint space is clearly visible
- No over projection of fibula-talus or tibia-talus overlap
- Joint space is symmetrical

If the optimal view cannot be obtained, this is most likely due to a non-reduced fracture.

Fig 2: Mortise view

Anatomical landmarks and lines

The following lines and landmarks can be observed:

1. Fibula
2. Tibia
3. Talus

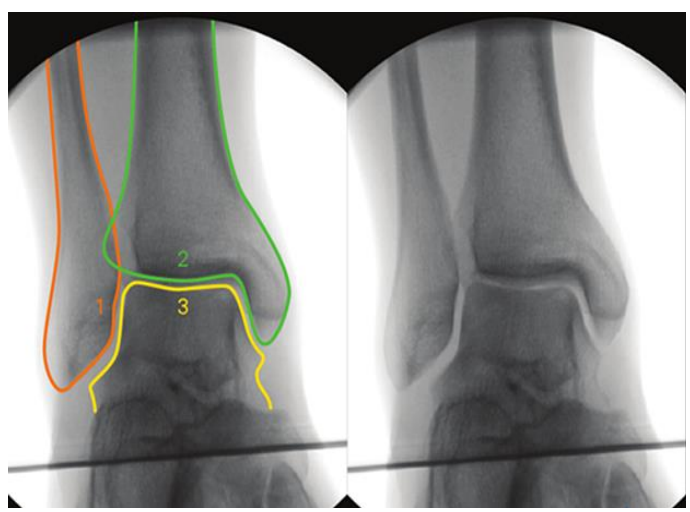

Fig 3: Intraoperative Imaging

1. Medial spike of the fibula ("Weber nose")
2. Syndesmotic region
3. Insertion of deltoid ligament

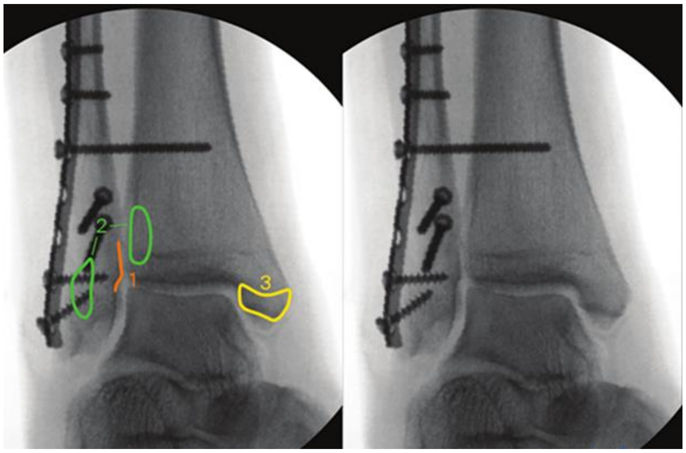

Fig 4: Observed anatomical landmarks and lines

1. Tibio-fibular overlap > 10 mm
2. Tibio-fibular clear space (TFC) < 6 mm
3. Medial clear space < 4 mm (less than or equal to superior clear space)
4. Weber ball (Dime sign)

Definition Weber ball: Circle between distal fibula and the lateral aspect of the talus.

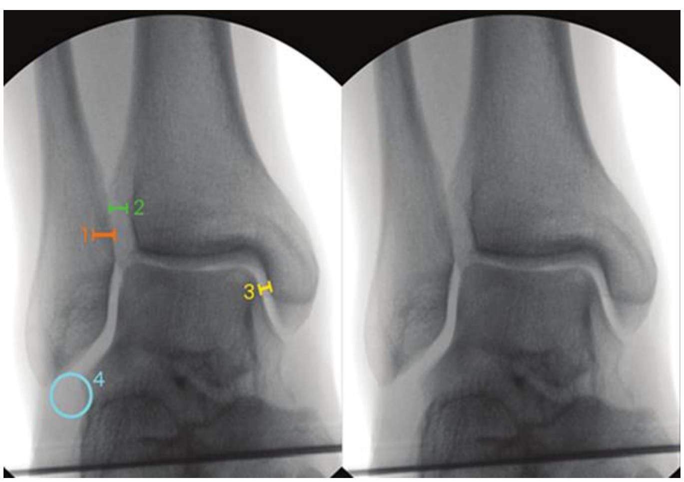

Fig 5: Further observed anatomical landmarks and lines

1. Shenton's line of the ankle

Definition of Shenton's line: Medial aspect of the fibular joint surface and distal tibal joint surface.

Both an uninterrupted Shenton's line and presence of the Weber ball (Dime sign) indicates correct fibular length.

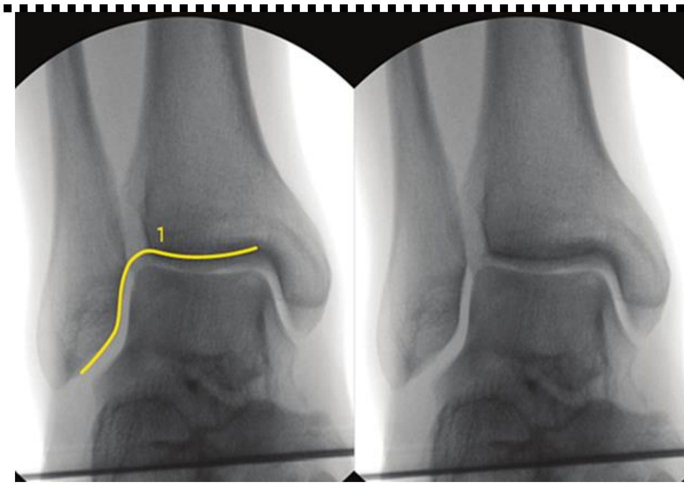

Fig 6: Shenton's line

What can be observed?

This view is particularly useful to identify:

1. Asymmetrical joint space
2. Visible gaps or steps in fracture reduction
3. Implant misplacement
4. Irregular overlaps or clear spaces
5. Incorrect length of fibula (Weber ball does not meet fibular tip, interrupted Shenton's line)

Lateral view of the ankle

Positioning for optimal view

1. The beam is placed perpendicular to plane created by the tibia and the foot.
2. The beam is centered at the tibia-talar joint space
3. The ankle joint is in neutral position

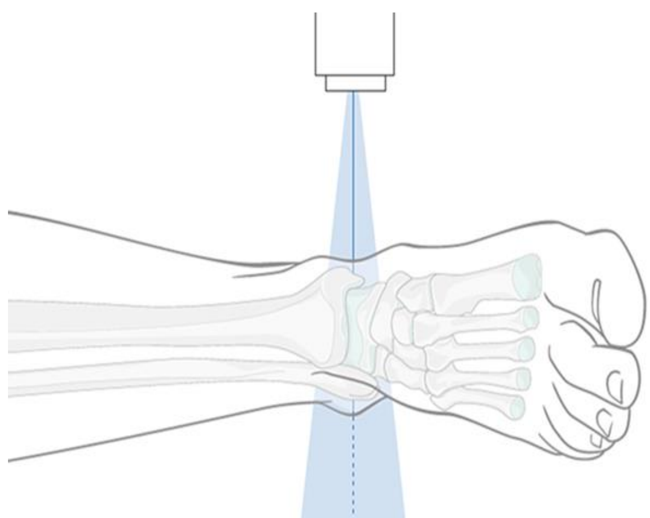

Fig 7: Lateral view

Verification of optimal view

The optimal view is obtained when:

1. Both talar shoulders are in one plane
2. Joint space is clearly visible
3. Joint space is symmetrical
4. Talar, tibial and fibular assessment is possible

Fig 8: Optimal lateral view

Anatomical landmarks and lines

The following lines and landmarks are seen:

1. Fibula
2. Tibia
3. Talus

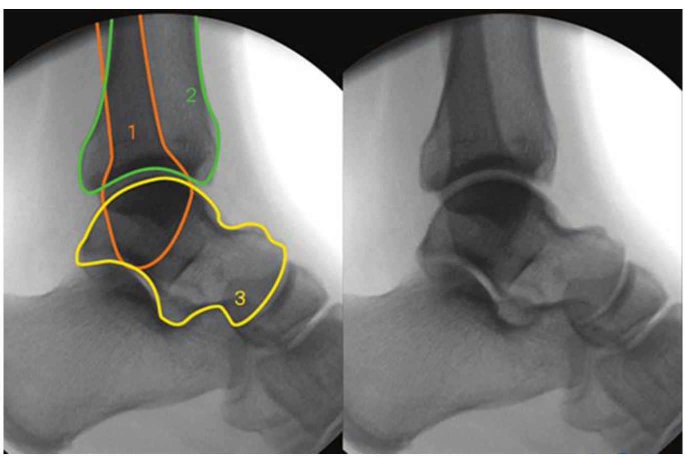

Fig 9: Anatomical landmarks and lines in lateral view of the malleoli

1. Talar shoulders projected as one line
2. Lateral malleolus

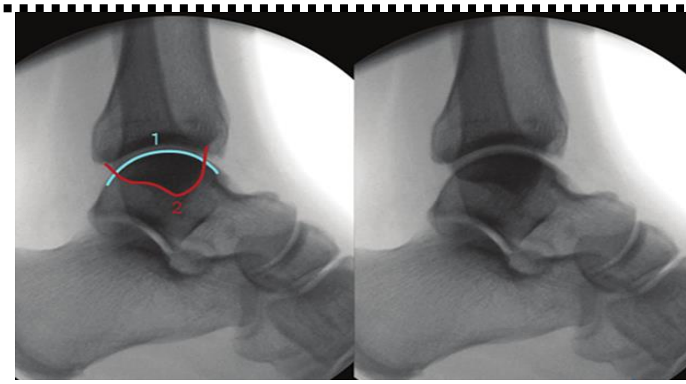

Fig 10: Anatomical landmarks and lines in lateral view of the malleoli

What can be observed?

This view is particularly useful to identify:

1. Asymmetrical joint space
2. Visible gaps or steps in fracture reduction
3. Anterior or posterior position of the fibula compared to contralateral side
4. Implant misplacement
5. Anteroposterio tibiofibular (APTF) ratio AB/BC = 0.94, indicating correctly reduced syndesmosis
6. Anterior cortex of the tibia at the level of the physeal scar
7. Intersection of the anterior cortex of the fibula and the tibial physeal scar
8. Intersection of the line crossing A and B and the posterior cortex of the tiba

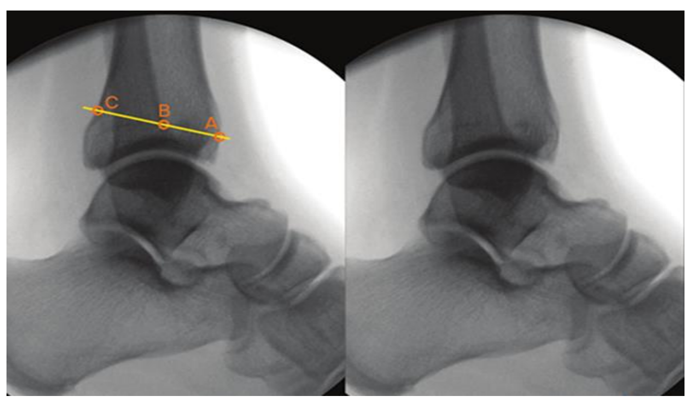

Fig 11: Intraoperative 3-D images (3-D C-arm)

Positioning for optimal view

1. Ankle in neutral position (not in plantarflexion as this would shift the talus anteriorly)

2. The heel is placed freely to prevent anterior shift of the talus. The lower limb is supported under the calf.

3. The beam is centered in AP and lateral combined at the tibiotalar joint line

4. It must be possible to rotate the C-arm freely 190° around the ankle joint

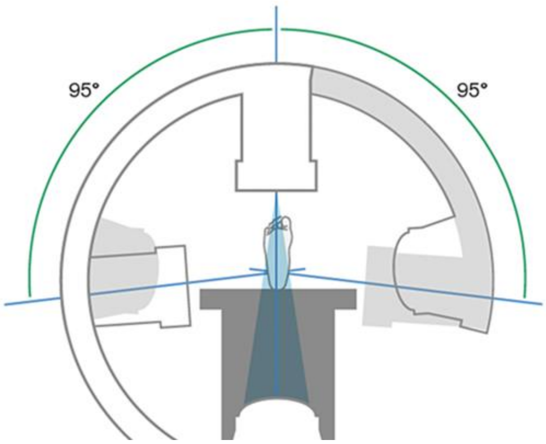

Fig 12: Positioning for optimal oblique view C arm

Axial plane (10 mm proximal to the talar joint line)

Verification of optimal view

The optimal view is obtained when the:

1. Talofibular joint space is symmetrical
2. Fibula is anatomically reduced in the tibial incisura
3. Fibula position is identical to the contralateral
4. Harmonic line of anterior cortices of tibia and fibula
5. Harmonic line of posterior cortices of tibia and fibula

The correct placement of the axial plane is perpendicular to the sagittal and coronal plane.

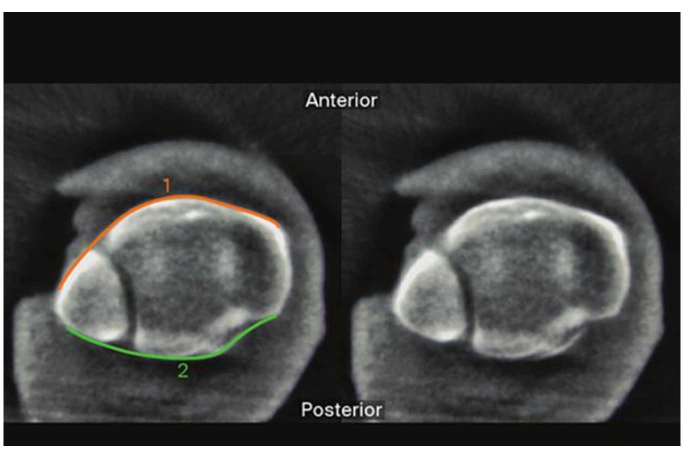

Fig 13: Axial plane (10 mm proximal to the talar joint line)

Anatomical landmarks and lines

The following lines, landmarks and parameters can be observed:

1. Anterior aspect of the fibula
2. Anterior aspect of the tibia
3. Medial malleolus
4. Tibio-fibular joint line

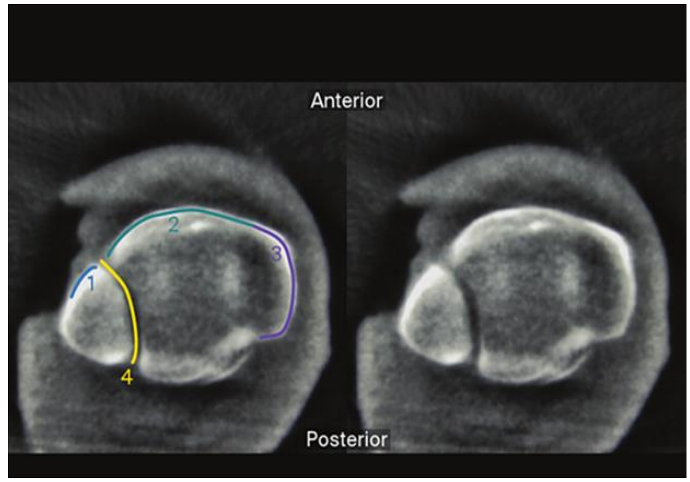

Fig 14: Axial plane (10 mm proximal to the talar joint line)

What can be observed?

This view is particularly useful to identify:

1. Asymmetrical Tibio-fibular joint space
2. Anterior or posterior position of the fibula compared to contralateral side (irregular incisura)
3. Implant misplacement
4. Visible gaps or steps
5. Failure to address syndesmotic avulsions

Typical fracture patterns that are easily recognized are:

- Wagstaffe – Le Fort fragment
- Tubercule de Chaput fragment
- Posterior malleolus or Volkmann fragment

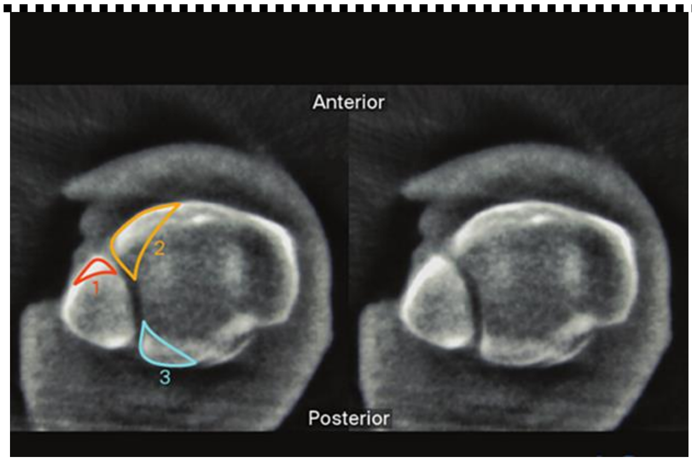

Fig 15: What can be observed in axial plane (10 mm proximal to the talar joint line)

Axial plane (5 mm distal to the talar joint line)

Verification of optimal view

The optimal view is obtained when the:

- Tibia, fibula, and talus are visible

The correct placement of the axial plane is perpendicular to the sagittal and coronal plane.

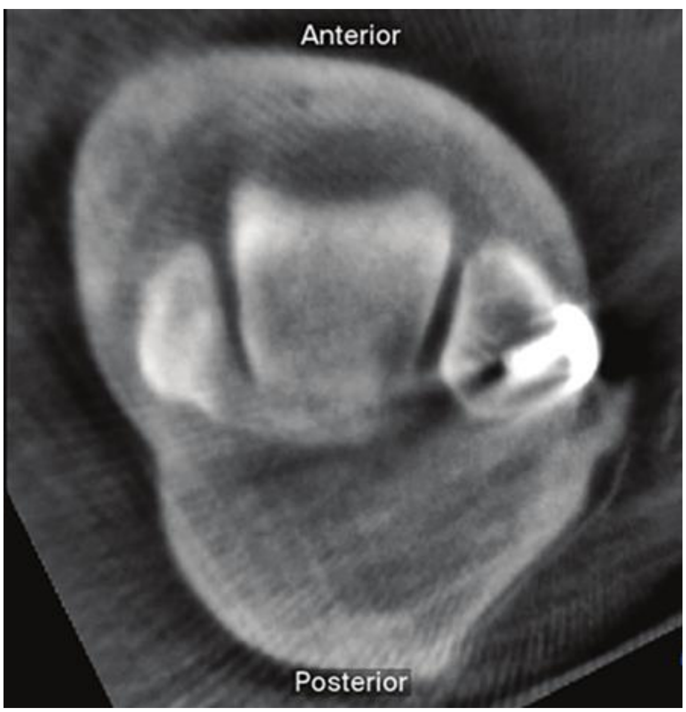

Fig 16: Axial plane (5 mm distal to the talar joint line)

Anatomical landmarks and lines

The following lines and landmarks and parameters can be observed:

1. Medial joint surface of the fibula
2. Lateral joint surface of tibia

Both medial and lateral talar surfaces

Fibular rotation may also be observed.

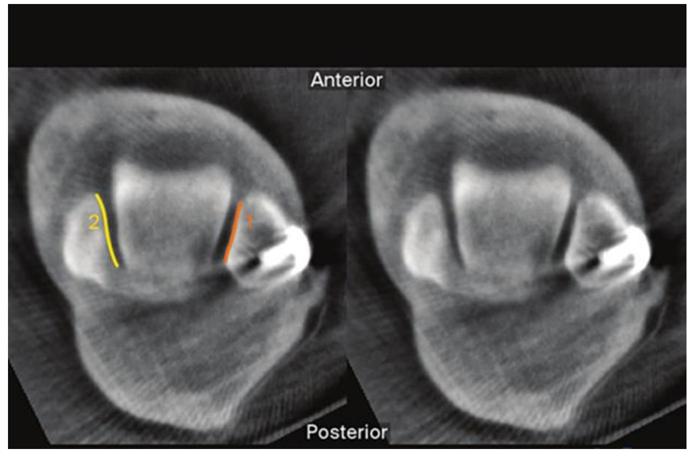

Fig 17: Axial plane (5 mm distal to the talar joint line)-Anatomical landmarks and lines

What can be observed?

This view is particularly useful to identify:

- Asymmetrical joint space
- Rotational malalignment of the fibula

Sagittal plane

Anatomical landmarks and lines

The following lines and landmarks can be observed:

- Talar shoulders
- Distal tibial joint surface

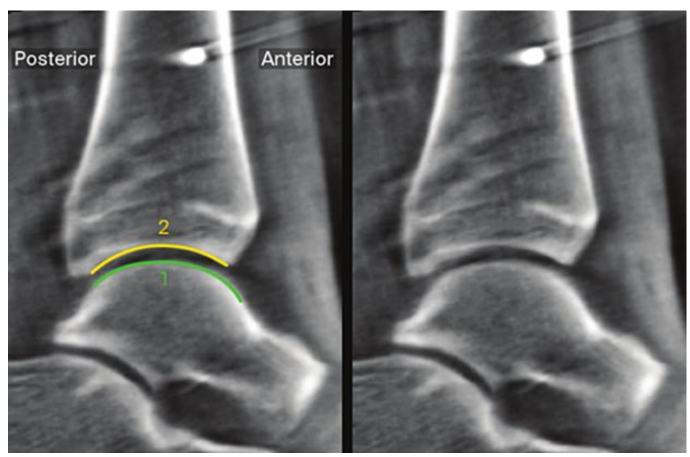

Fig 18: Anatomical landmarks in Sagittal plane

What can be observed?

This view is particularly useful to identify:

1. Implant misplacement

2. Visible gaps or steps
3. Anterior shift of the talus

Typical fracture patterns that are easily recognized are

- Tubercule de Chaput fragment
- Posterior malleolus or Volkmann fragment

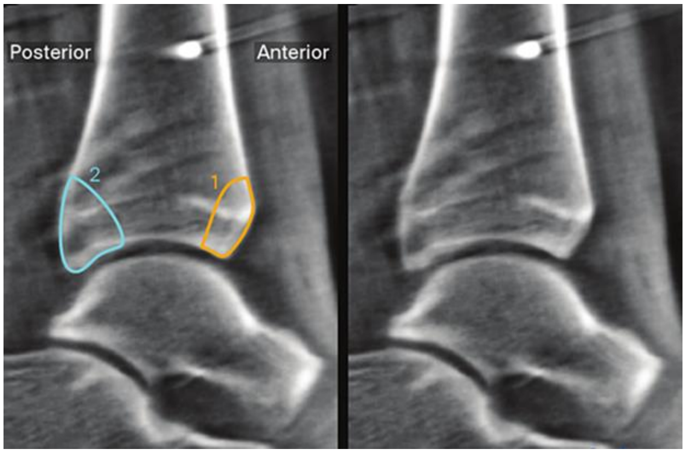

Fig 19: What can be observed in Sagittal Plane?

Coronal plane

Verification of optimal view

The optimal view is obtained when the:

- The correct placement of the coronal plane is perpendicular to the sagittal and axial plane.
- Symmetrical joint line

Fig 20: What can be overserved in Coronal Plane?

Anatomical landmarks and lines

The following lines and landmarks can be observed:

1. Fibular joint surface
2. Talar joint surface
3. Distal tibial joint surface

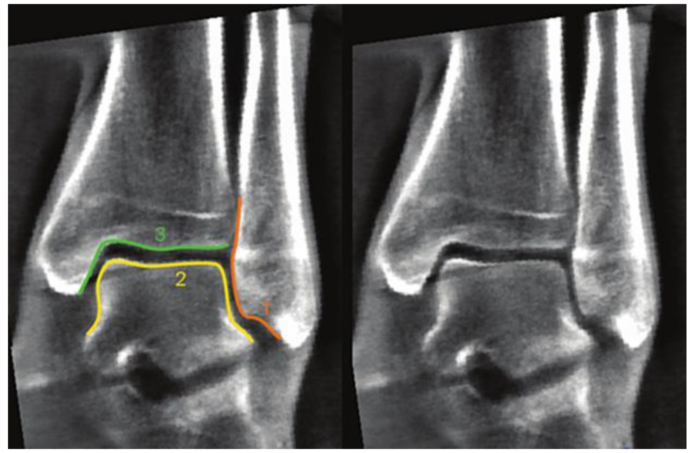

Fig 21: Anatomical landmarks and lines in Coronal plane

- Shenton's line

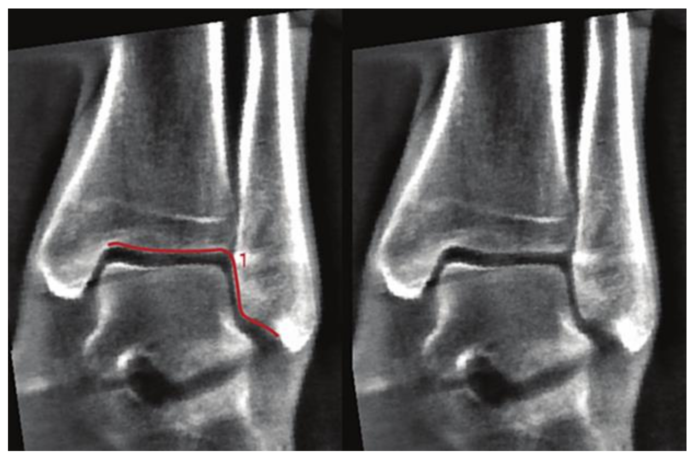

Fig 22: Shenton's line

What can be observed?

This view is particularly useful to identify:

- Asymmetrical joint space
- Shortening of the fibula compared to contralateral side
- Implant misplacement
- Visible gaps or steps in the joint surface
- Failure to address syndesmotic avulsions
- Tubercule de Chaput fragment

- Wagstaffe – Le Fort fragment

Fig 23: Chaput and Le Fort fragment

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Declarations

Informed consent

Informed consent was obtained for experimentation with human subjects. The privacy rights of human subjects must always be observed.

"Institutional Ethical Committee Approval"

Taken from Institutional Ethical Approval Committee, MGM Medical College & Hospital, Navi Mumbai, Maharashtra, India.

Availability of data and materials

1. Postoperative Imaging of the Ankle. M. K. Jesse, Kenneth J. Hunt and Colin Strickland

American Journal of Roentgenology. 2018; 211: 496-505. 10.2214/AJR.18.19600

2. MR Imaging of the Ankle and Foot

Zehava S. Rosenberg, Javier Beltran, Jenny T. Bencardino https:// Doi. org/ 10.1148 / radio graphics .20. suppl_1. g00oc26s153

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2. MR Imaging of the Ankle and Foot Zehava S. Rosenberg, Javier Beltran, Jenny T. Bencardino https:// Doi. org/ 10. 1148/ radio graphics. 20. suppl_ 1.g00o c26s153

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