Stuck in the Middle: Imaging Overview of the Midtarsal Chopart Joint

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Disclosures

The authors have no conflicts of interests to disclose related to this presentation.

Objectives

1. Review the anatomy of Chopart joint
2. Discuss mechanisms of Chopart injuries
3. Review multimodality imaging findings of Chopart injury
4. Discuss treatment options

Overview

1. The Chopart joint complex connects the hindfoot and the midfoot
2. 20-40% of Chopart injuries are initially missed, due to:
   - Variable clinical presentation
   - Clinical confusion with other types of ankle injury, which commonly accompany Chopart injuries
   - Radiologists' unfamiliarity with Chopart joint injuries
   - Underestimation of the ligamentous component of injury
3. Missed Chopart complex injuries can lead to prolonged swelling, pain, and disability, and can occasionally lead to acquired flatfoot

Chopart Anatomy Overview

Highly mobile joint complex which joins the hindfoot and the midfoot

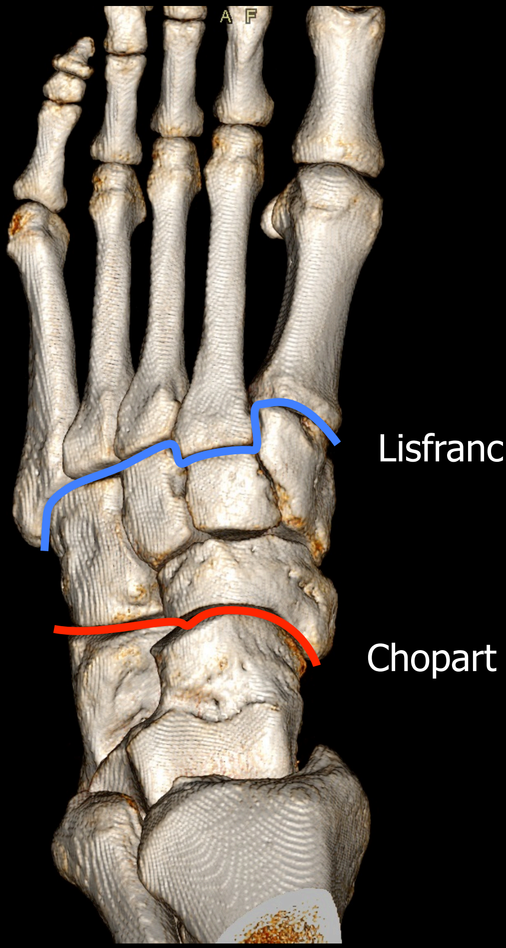
Consists of two joints

Calcaneocuboid (lateral column)

Talonavicular (medial column)

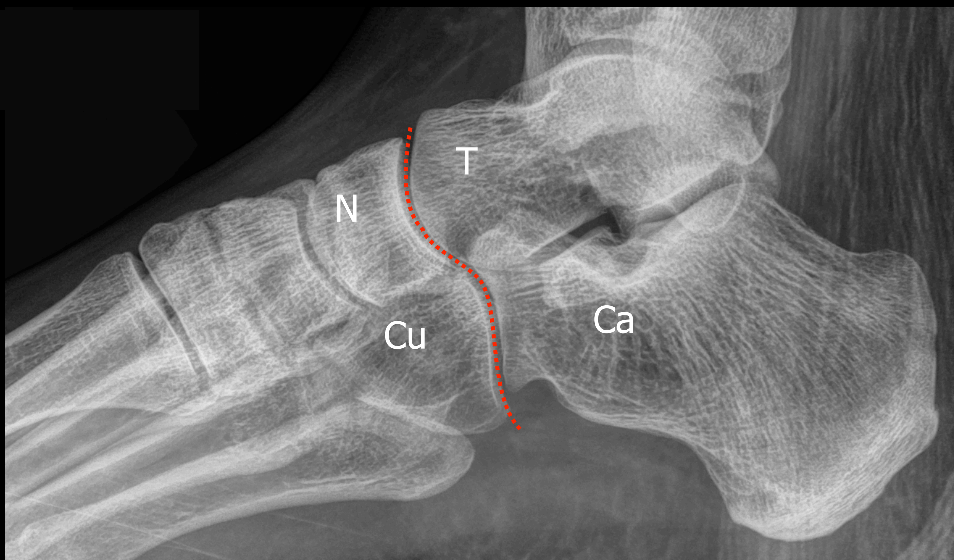
Function

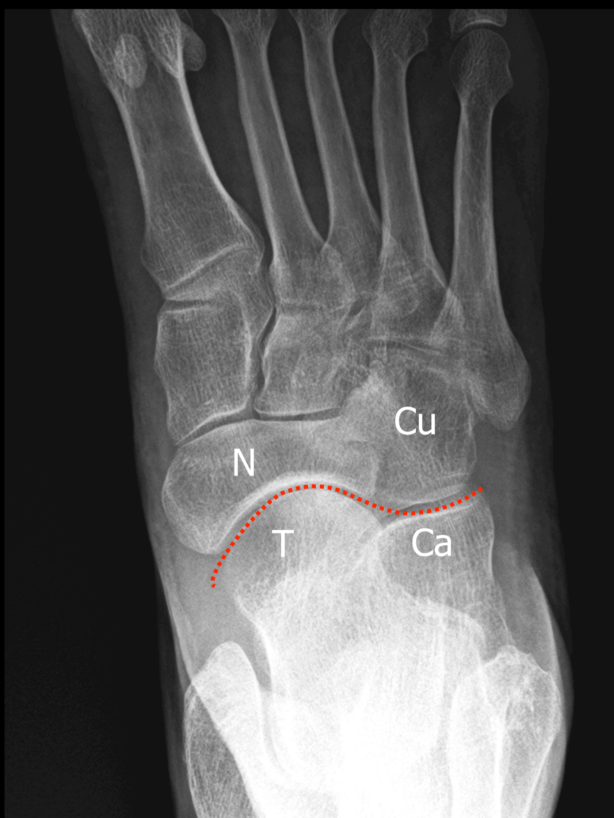
- Works in conjunction with subtalar joints to invert and evert the foot
- Provides pivotal motion of the hindfoot while the forefoot remains stationary
- Stabilizes the midfoot during the push-off phase of the gait cycle



Osseous Structures

Gently curved Cyma lines (shown in red) demonstrate the normal relationship of the Chopart joint osseous structures on lateral and AP foot radiographs





T – talus
N – navicular
Ca – calcaneus
Cu – cuboid

Ligamentous Structures

Talonavicular (TN)

- Stabilizes the talonavicular joint
- Dorsal aspect of the talar neck to the dorsal navicular

Bifurcate

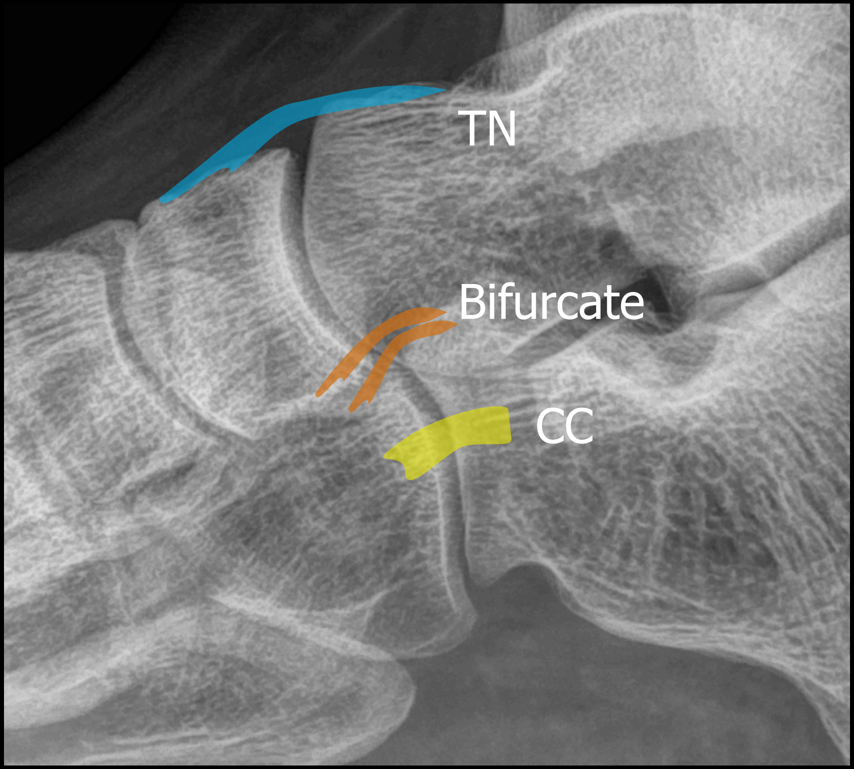
- Stabilizes the talonavicular and calcaneocuboid joints
- Y-shaped structure with 2 components:

<u>Medial calcaneonavicular ligament</u>
From the anterior calcaneal process to the lateral navicular

<u>Lateral calcaneocuboid ligament</u>
From the anterior calcaneal process to the dorsal cuboid

Dorsal calcaneocuboid (CC)

- Stabilizes the calcaneocuboid joint
- Dorsolateral aspect of the calcaneus to the dorsal cuboid



Ligamentous Structures

Plantar ligaments

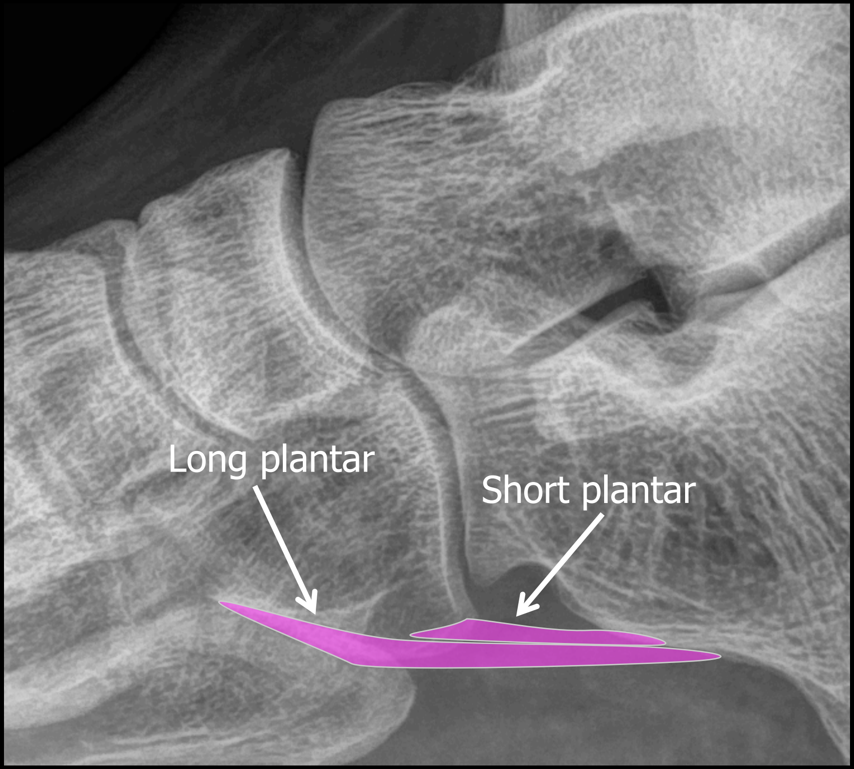
- Stabilize the calcaneocuboid joint
- Extend from the plantar aspect of calcaneus to plantar cuboid
- Long and short components

Short plantar ligament

From anterior calcaneal tubercle to the posterior plantar surface of the cuboid and cuboid beak

Long plantar ligament

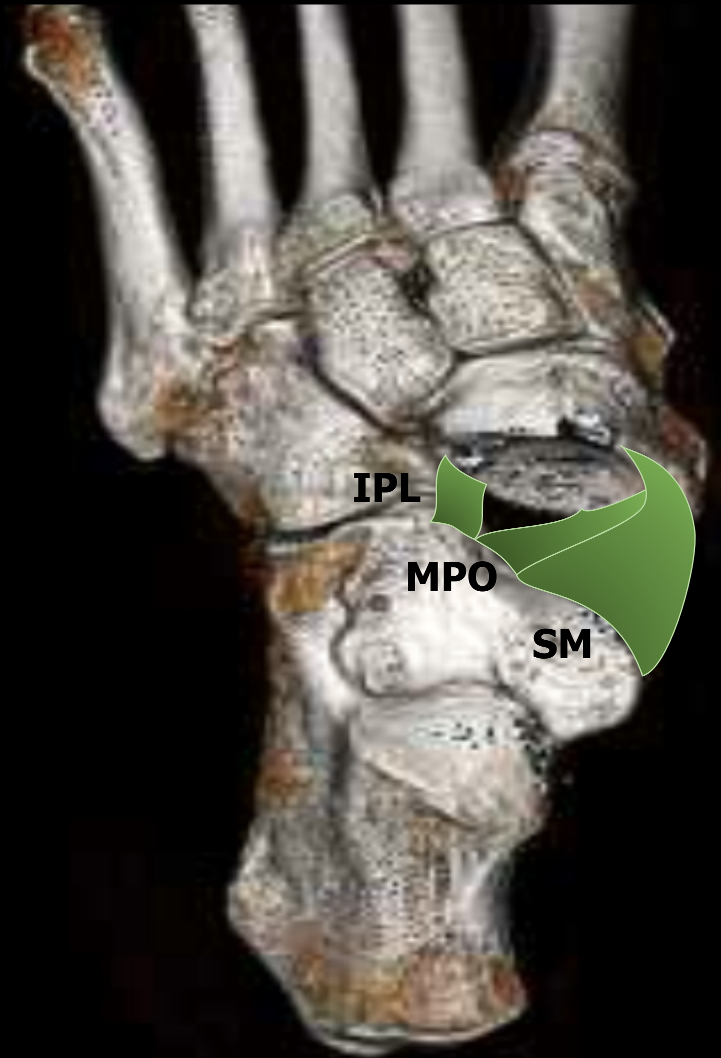
From anterior calcaneal tubercle and the intertubercular segment of the posterior calcaneal tuberosity, with deep fibers (most of the ligament) going to the cuboid crest and some superficial fibers inserting on the second to fifth metatarsal bases



Ligamentous Structures

Spring ligament complex:

- Static stabilizer of the medial longitudinal arch of the foot and talonavicular joint
- Comprised of three bundles:



Superomedial (SM)

Sustentaculum tali to dorsomedial navicular tuberosity

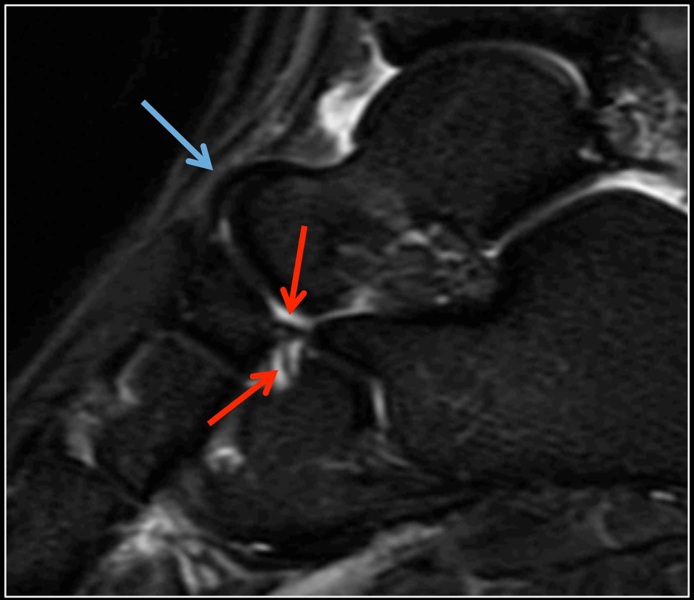
Medioplantar oblique (MPO)

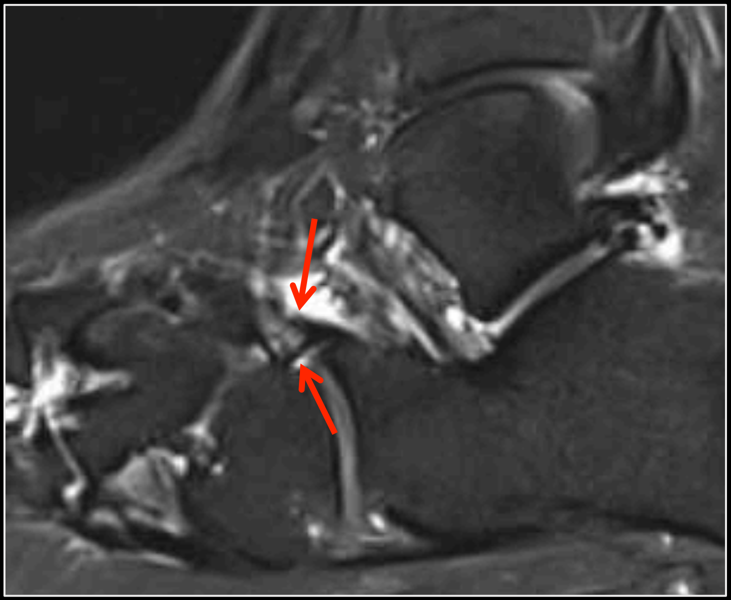
Coronoid cavity of anterior calcaneus to beak of navicular

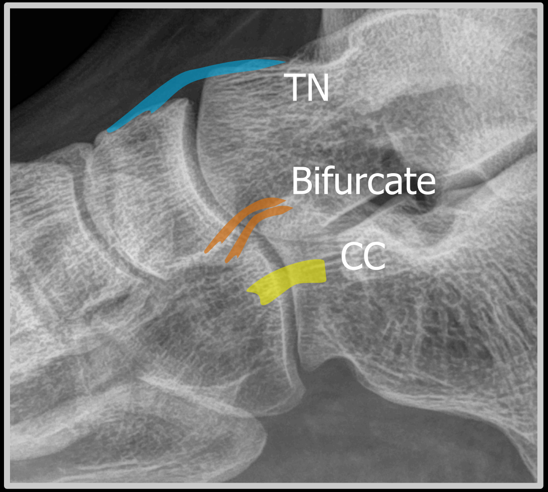
Inferoplantar longitudinal (IPL)

Anterior to middle calcaneal facet to beak of navicular

Bifurcate and Talonavicular Ligaments: Normal MR Imaging



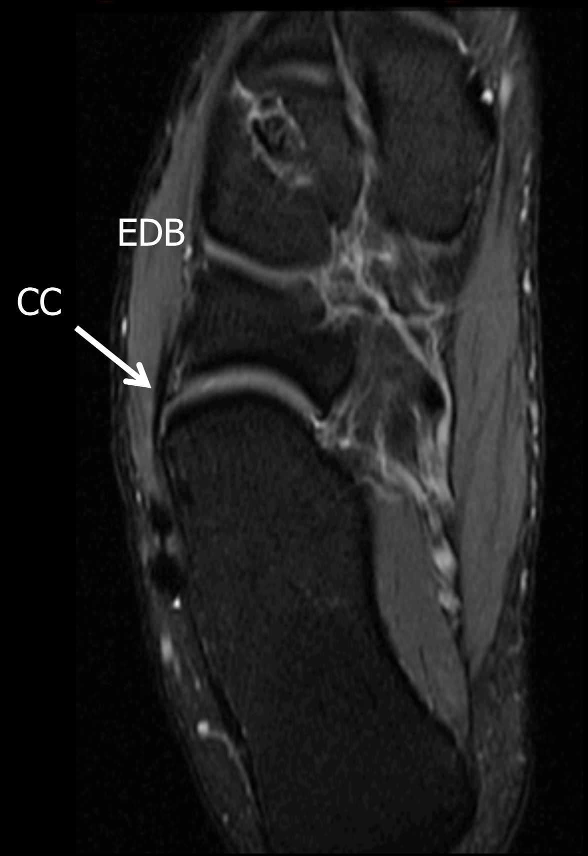


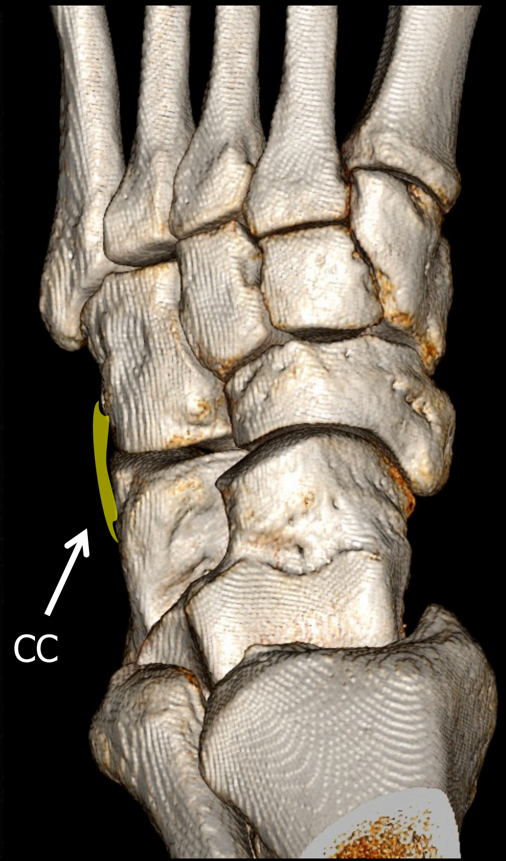


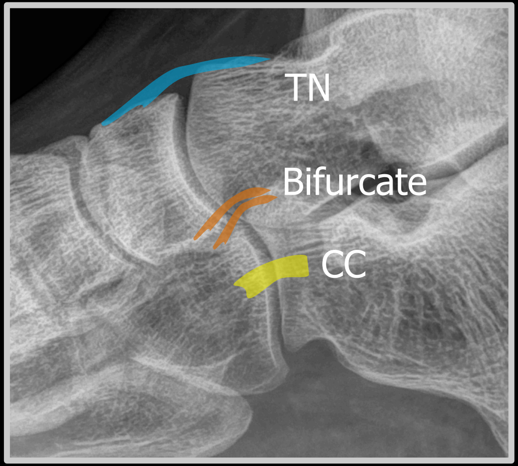
The bifurcate and talonavicular (TN) ligaments are low to intermediate signal structures best seen on sagittal plane. Normal patients can have a thickened TN ligament; therefore, a thickened TN ligament in isolation may not necessarily be a result of injury.

Sagittal T2 FS images from two different patients show the cuboidal and navicular components of the bifurcate ligament (red arrows). The talonavicular ligament is indicated by the blue arrow.

Dorsal Calcaneocuboid Ligament: Normal MR Imaging

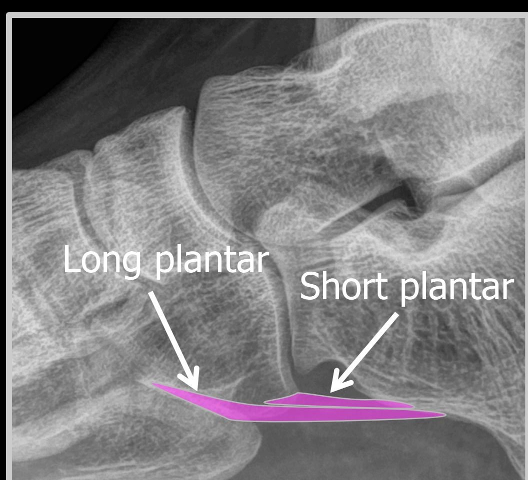






The dorsal calcaneocuboid (CC) ligament is best seen on axial plane (axial T2 FS MRI on the left). Anatomic variants are common, including multiple bands, fusion with the bifurcate ligament, and meniscoid variant. EDB=extensor digitorum brevis muscle

Plantar Ligaments: Normal MR Imaging

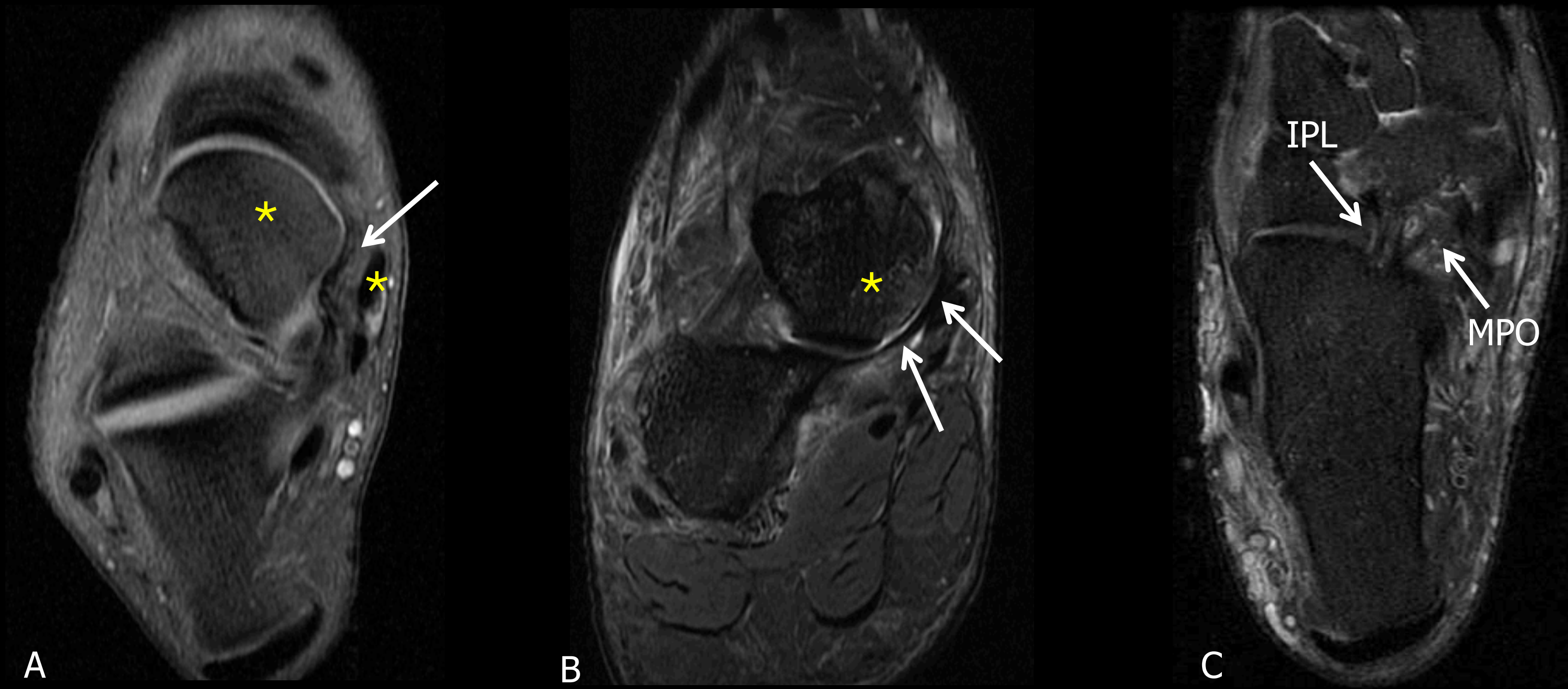


The plantar ligaments are best seen on sagittal plane.

Sagittal T1 MR images show the (A) long plantar ligament (red arrow) and (B) short plantar ligament (arrowheads).

Spring Ligament Complex: Normal MR Imaging

The superomedial bundle is a hammock-like structure that supports the talar head. It is best seen on axial and coronal planes. While the superomedial bundle should always be seen, the other two components of the spring complex (medioplantar oblique and inferoplantar longitudinal) are not as reliably visualized.



Normal spring ligament. (A) Axial T2 FS shows the superomedial bundle (arrow) between the talar head and the posterior tibial tendon (asterisks). (B) Coronal T2 FS showing the superomedial bundle (arrows) supporting the talar head (asterisk). (C) The medioplantar oblique (MPO) and inferoplantar longitudinal (IPL) bundles have a striated appearance and are best seen on axial T2 FS.

Chopart Joint Injuries: Overview

Most common mechanism of injury is ankle inversion, with or without plantar flexion

- Varus force can result in calcaneocuboid ligament injury
- Superimposed plantar flexion can cause tear of the talonavicular ligament and there may be impaction at the plantar calcaneocuboid joint

Types of Injuries

- Chopart fracture-dislocations
- Chopart ligamentous sprains +/- fracture

Imaging Modalities

XR: Evaluation of bony alignment; look for normal Cyma line
Small avulsion fracture fragments may be seen

CT: Primarily for evaluation of fractures
May identify additional fractures not visible on XR

MR: Evaluation of marrow edema and ligamentous injury

Chopart Joint Injuries: Fracture-Dislocations

Fracture-dislocations typically result from high force mechanisms such as motor vehicle collisions or fall from height.

Main and Jowett Classification: Based on injury mechanics

Type	Mechanism	Resulting injury
Medial*	Medial force to the forefoot	Dorsal edge fractures of the navicular and talar head, "swivel" dislocation disrupting the talonavicular joint, medial dislocation with fracture of the body of the navicular
Axial*	Longitudinal force along the axis of the first ray	Navicular central fracture along the borders of the cuneiforms, often with disruption of the talonavicular ligament with dorsal displacement of the navicular
Lateral	Lateral force to the forefoot	Cuboid fracture, anterior calcaneal fracture
Plantar	Flexion force on the forefoot	Dorsal navicular and talar fractures, anterior process calcaneal fracture, talonavicular and calcaneocuboid dislocations, talonavicular and talocalcaneal dislocation
Crush	Random high velocity and high energy forces	No consistent pattern

** Medial and axial injuries are more common*

Chopart Joint Injuries: Fracture-Dislocations

Zwipp Classification: Based on affected anatomic structures

Six types:

Transligamentous
Transnavicular
Transcuboidal
Transcalcaneal
Transtalar
Combined (any combination of the above, except for transligamentous)

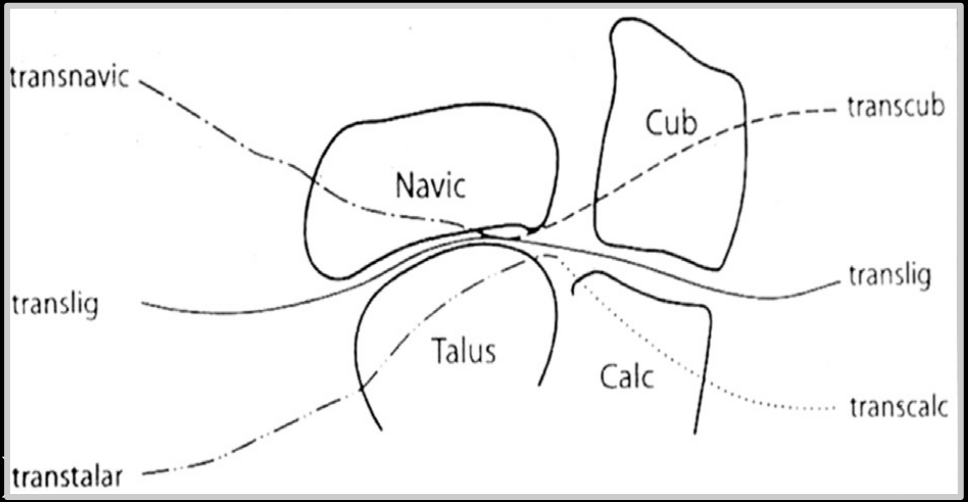
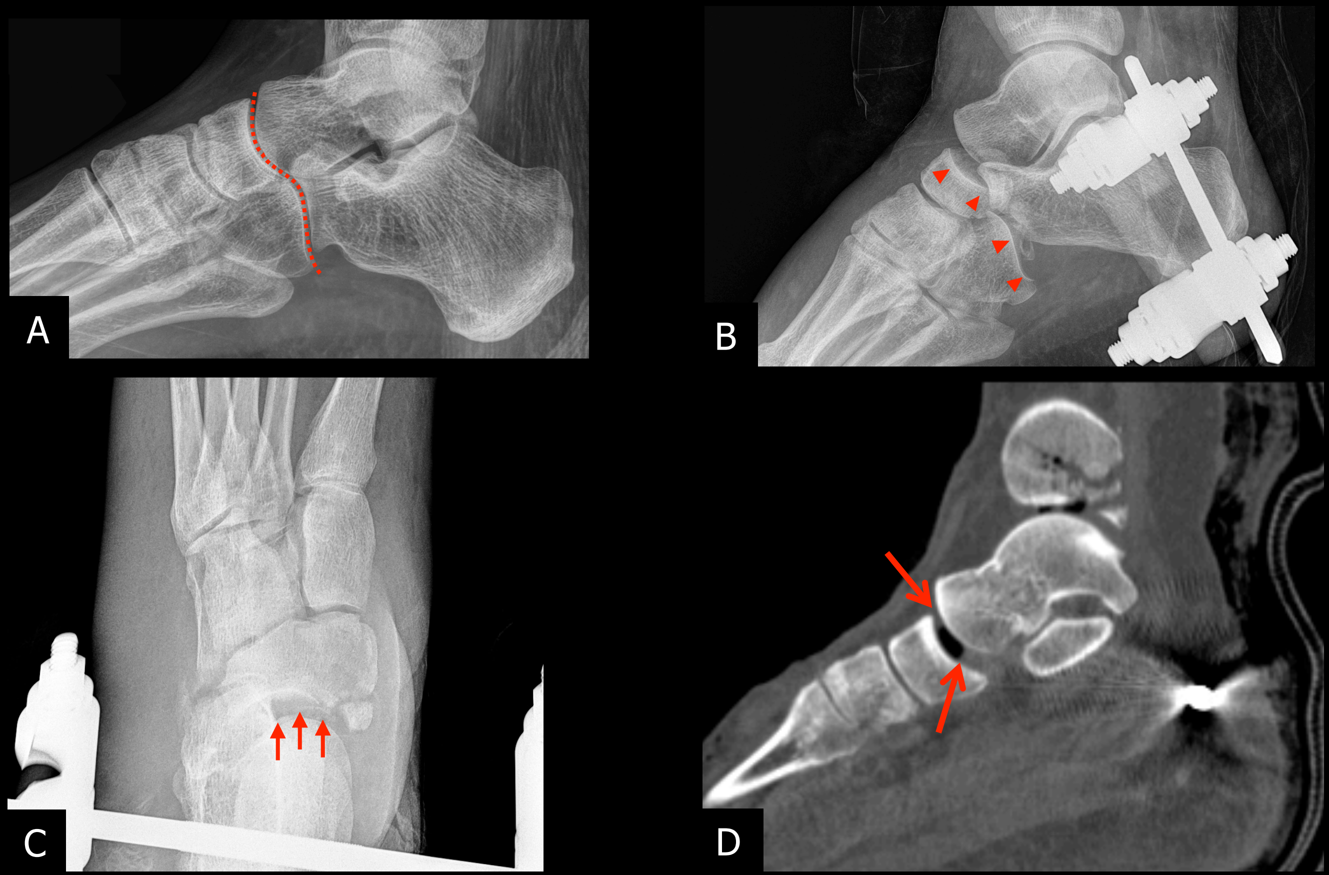


Image originally published in Rammelt S and Schepers T. Chopart Injuries: When to Fix and When to Fuse? Foot Ankle Clin N Am, 2017.

- More commonly used than Main and Jowett
- Purely transligamentous dislocation is rare due to strong support at the TN and CC joints
- The navicular and cuboid are more frequently fractured than the more proximal bones

Chopart Joint Injuries: Example of Fracture-Dislocation

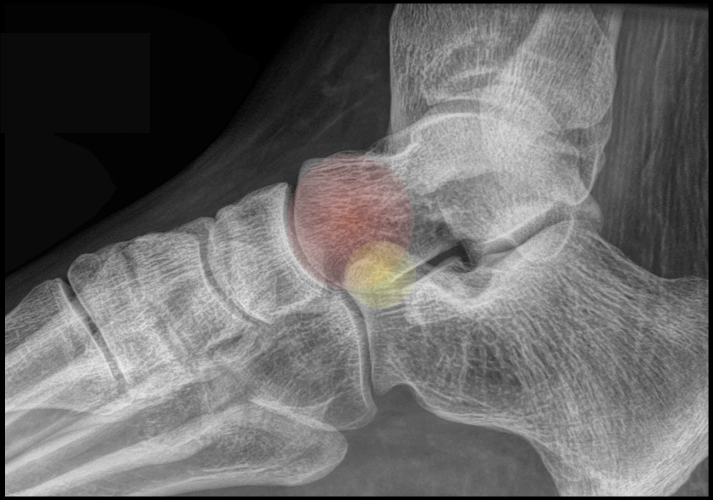


Chopart fracture-dislocation. Normal Cyma line for comparison (A). Disrupted Cyma line with dislocated talonavicular and calcaneocuboid joints on lateral ankle radiograph (B). AP foot radiograph (C) in the same patient again shows abnormal alignment of the Cyma line. (D) Sagittal CT image in the same patient shows subluxation and widening of the talonavicular joint.

Chopart Joint Injuries: MRI Findings

Common bone marrow edema patterns

Location of edema	→	***Frequently associated injury***
Plantar talar head	→	Tears of the spring ligament and attachment sites of the bifurcate and calcaneocuboid ligaments
Dorsal talar head	→	Talonavicular ligament avulsion
Lateral anterior calcaneal process	→	Calcaneocuboid and/or bifurcate ligament avulsion
Medial calcaneocuboid joint	→	Short plantar ligament avulsion



Chopart Joint Injuries: MRI Findings

Retrospective review of 47 patients who obtained ankle MRI within 8 weeks of an acute ankle injury

Acute or subacute Chopart joint ligament injury seen in 17% of patients

AJR JOURNAL CLUB

MRI Evaluation of Midtarsal (Chopart) Sprain in the Setting of Acute Ankle Injury

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OBJECTIVE. This study determined the frequency and MRI appearance of osseous and ligamentous injuries in midtarsal (Chopart) sprains and their association with ankle sprains after acute ankle injuries. Prospective diagnosis of and interobserver agreement regarding midtarsal injury among musculoskeletal radiologists were also assessed.

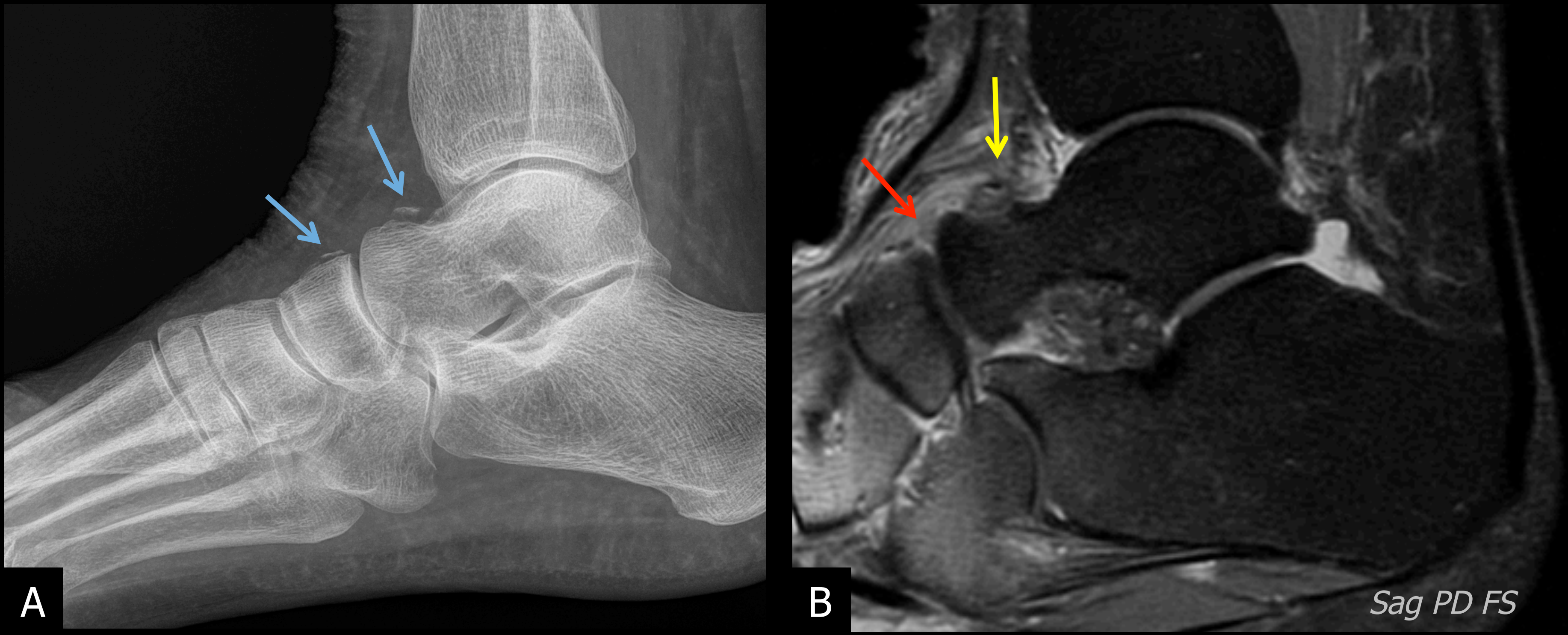
Most common mechanism of injury: Ankle inversion
Most common ligament injured: Dorsal calcaneocuboid ligament
Bone marrow edema: seen in 100%
Most common site of marrow edema: Plantar talar head
Fracture: seen in 50%
Most common fracture sites: Dorsal talar head = Anterior calcaneal process > Lateral cuboid

75% had concurrent lateral ankle ligament sprains (at least grade 2)
45% had concurrent deltoid ligament sprains
64% of all Chopart injuries (include acute, subacute, and chronic) had edema of the extensor digitorum brevis muscle

In the initial radiology reports, acute or subacute Chopart ligament injuries were missed in 83% of cases

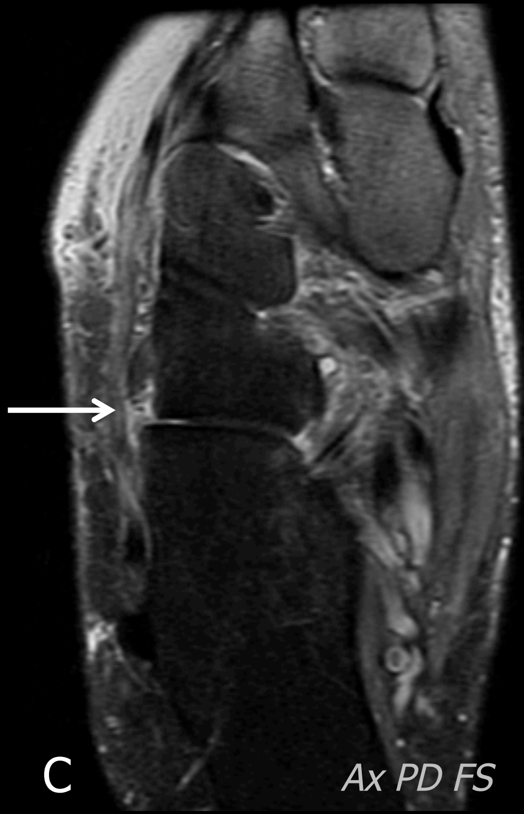
Let’s review what we’ve learned.

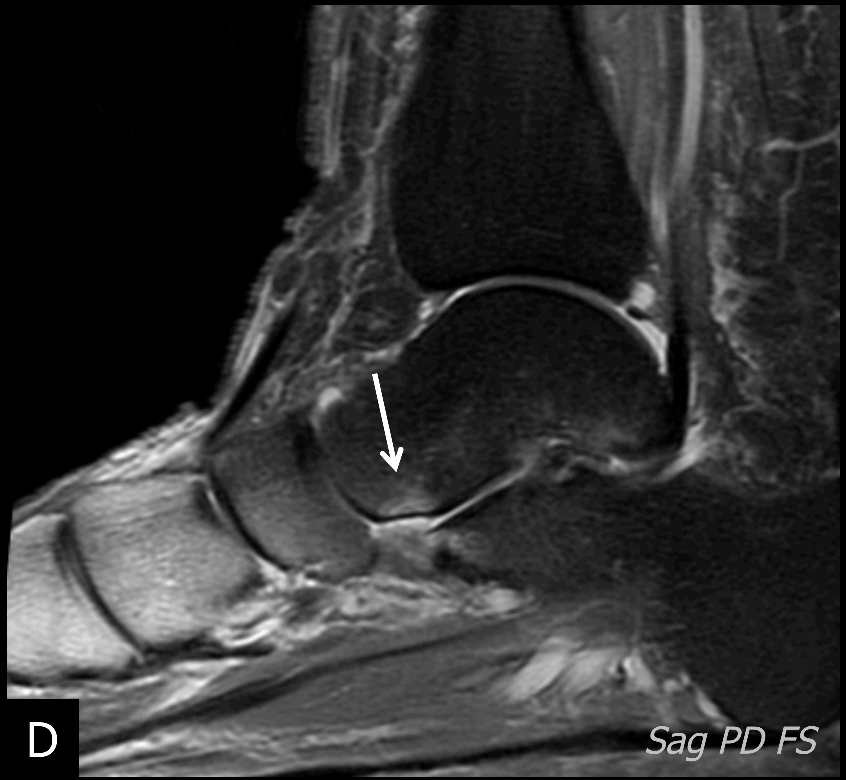
Case 1: 64 F with fall and twisting inversion injury



Talonavicular ligament injury. (A) Lateral radiograph shows avulsion fractures of the navicular and talus (blue arrows). (B) Tear of the talonavicular ligament (red arrow), with avulsion fracture and marrow edema of the dorsal talus (yellow arrow).

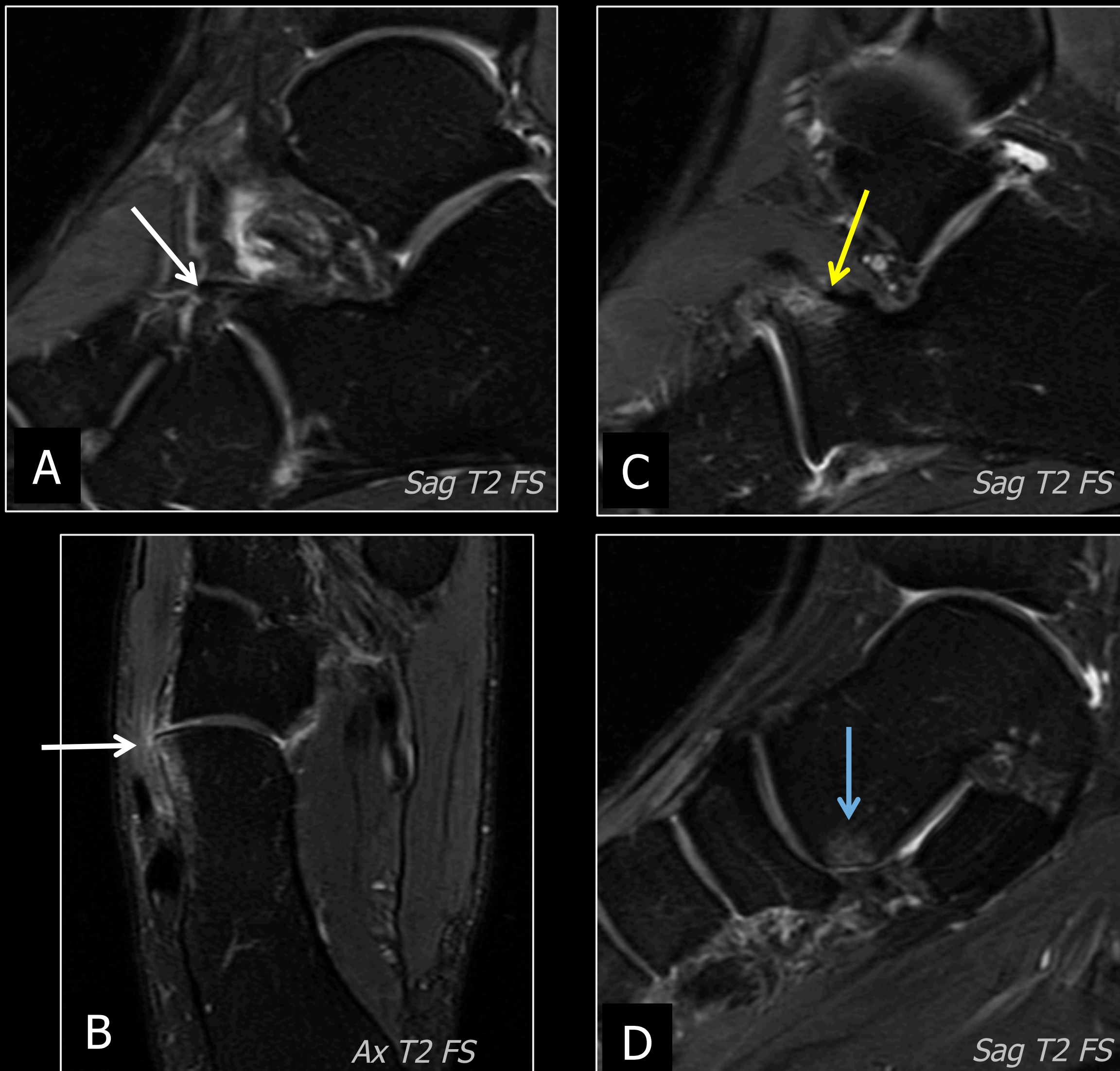
Case 1: 64 F with fall and twisting inversion injury (continued)





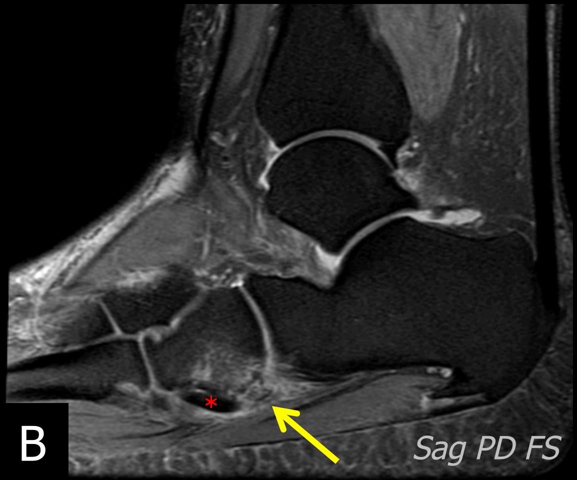
Calcaneocuboid ligament tear. (C) Complete tear of the calcaneocuboid ligament is shown. (D) Mild plantar talar head marrow edema is also present. Notice the failed fat saturation in the mid and distal foot in these images.

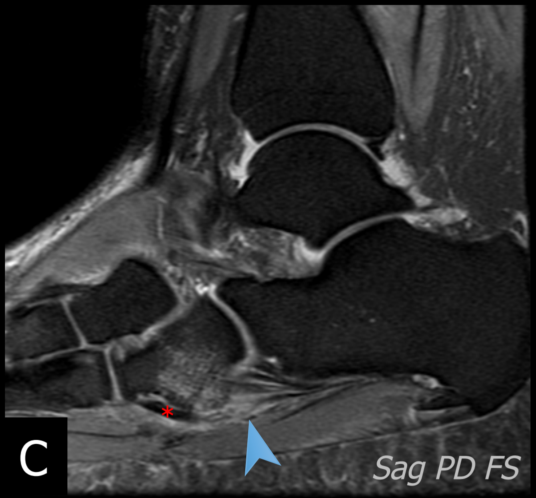
Case 2: 33 M with inversion injury



Bifurcate and calcaneocuboid ligament tears. (A) Sprain of the lateral calcaneocuboid ligament (component of the bifurcate). (B) Tear of the calcaneocuboid ligament with associated marrow edema in the lateral calcaneus. Nondisplaced fracture of the calcaneal process (yellow arrow, C) and edema of the plantar talar head (blue arrow, D).

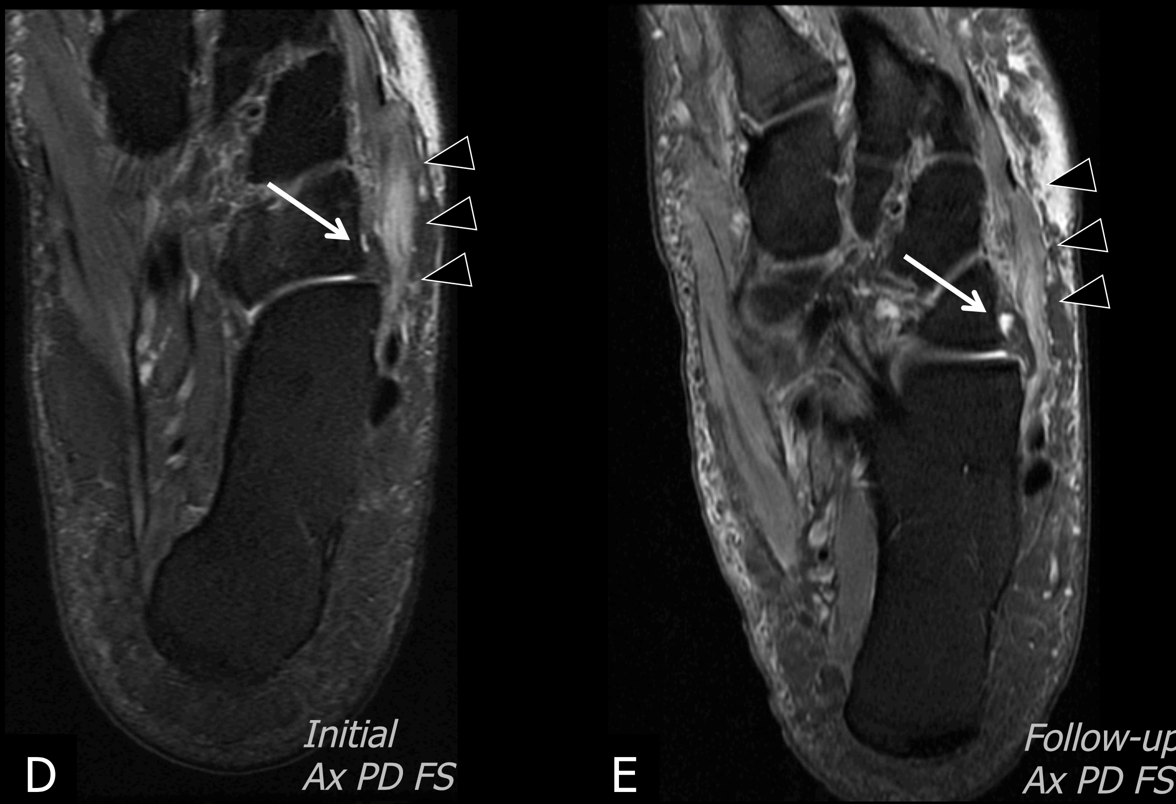
Case 3: 34 year old female with fall





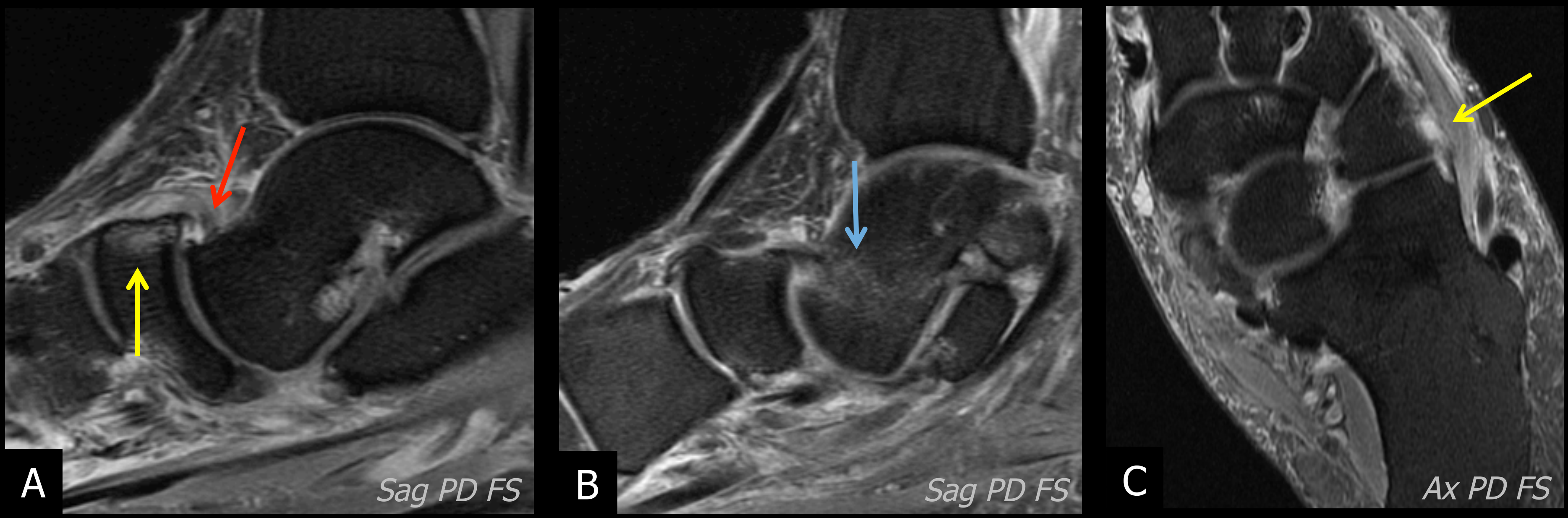
Plantar ligament injury with cuboid avulsion fracture. (A) Lateral radiograph demonstrates a fracture at the plantar aspect of the cuboid. (B) and (C) show the avulsion fracture at the cuboid crest (yellow arrow) and tear of the long plantar ligament at the cuboid attachment (blue arrowhead). The peroneus longus tendon is indicated by the asterisk.

Case 3: 34 year old female with fall (continued)



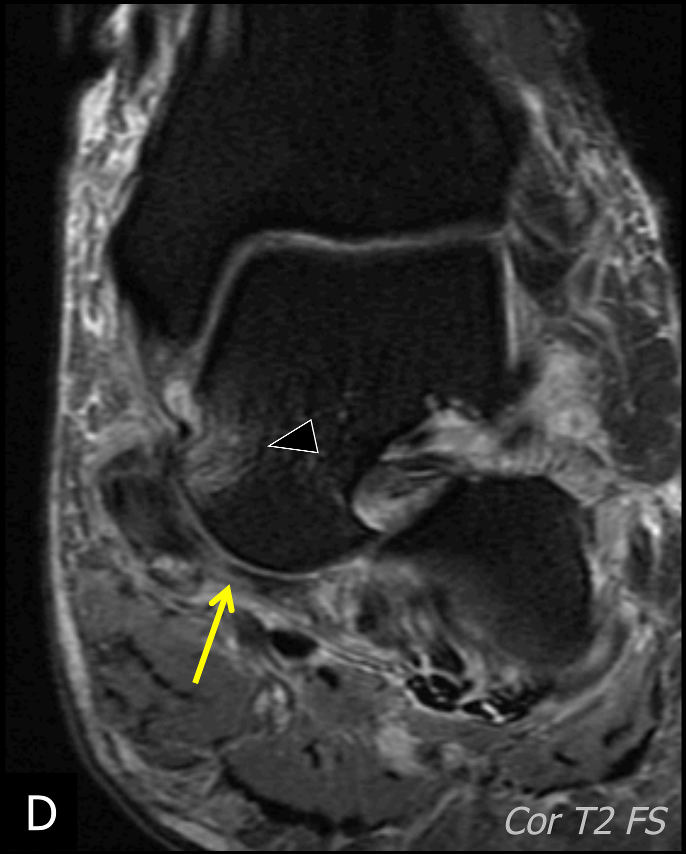
Extensor digitorum brevis edema. (D) There is partial calcaneocuboid ligament tear (arrow) with adjacent extensor digitorum brevis edema (arrowheads). (E) MRI performed 2 months later for persistent pain better demonstrates the ligamentous tear (arrow). Extensor digitorum brevis edema is decreased but persists (arrowheads).

Case 4: 77 F with insidious onset pain and swelling for 1 week



Talonavicular and calcaneocuboid ligament injury. Plantar subluxation of the talus with tearing of the talonavicular ligament (A, red arrow). Note the marrow edema in the dorsal navicular (A, yellow arrow) and medial talus at the head/neck junction (B, blue arrow). (C) Additional tearing of the calcaneocuboid ligament at the cuboid attachment was present.

Case 4: 77 F with insidious onset pain and swelling for 1 week (continued)

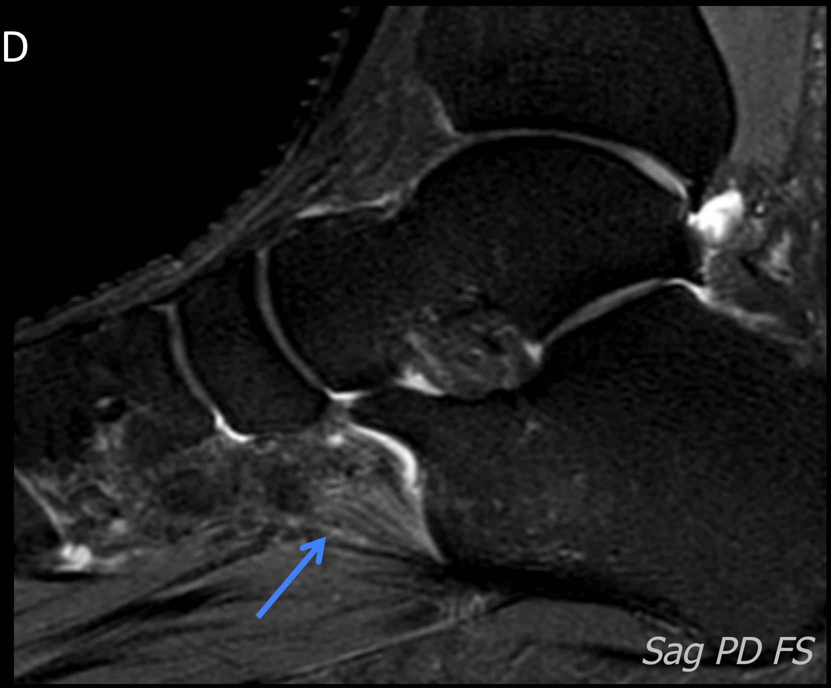


Spring ligament injury. (D) Coronal and (E) axial images showing high grade tear of the superomedial bundle of the spring ligament complex (arrows). Marrow edema is again seen in the talar head (arrowheads).

Case 5: 34 F with history of a twisting injury

Dorsal calcaneocuboid injury. (A) AP radiograph shows an avulsion fracture of the distal lateral calcaneus at the attachment site of the dorsal calcaneocuboid ligament (red arrow). (B) MRI shows the dorsal calcaneocuboid ligament tear with adjacent calcaneal marrow edema at the site of bony avulsion (yellow arrow).

Case 5: 34 year F with history of a twisting injury (continued)

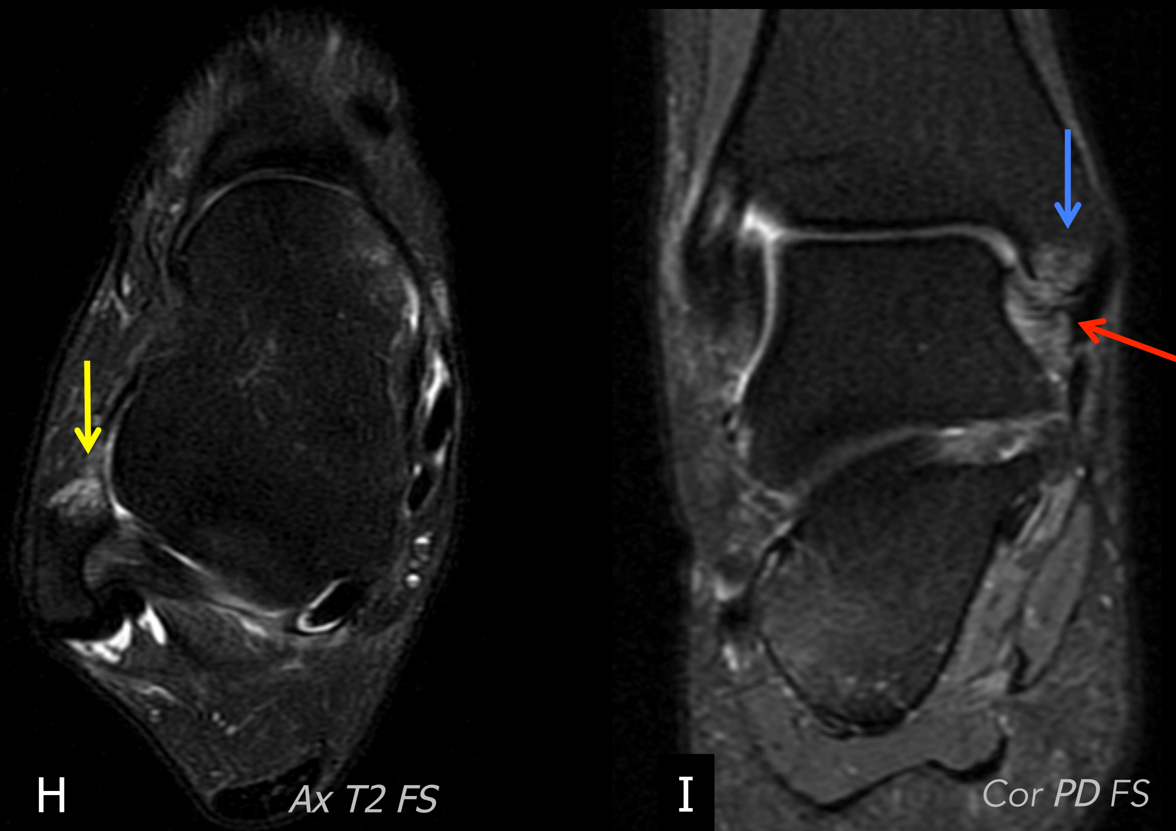


Plantar ligament injury. MRI showing sprain of the short plantar ligament (blue arrows in C and D) and adjacent bone marrow edema in the cuboid (yellow arrow in C).

Case 5: 34 year F with history of a twisting injury (continued)

Bifurcate ligament injury. (E) MRI shows intermediate signal and sprain of the medial calcaneocuboid ligament, which is a part of the bifurcate ligament (red arrow). (F) Note the adjacent mild marrow edema in the dorsal proximal cuboid (yellow arrow). (G) Marrow edema is also seen in the plantar talar head (yellow arrow).

Case 5: 34 year F with history of a twisting injury (continued)



Concurrent lateral and medial ankle sprains. (H) Bone marrow edema is seen within the lateral malleolus at the attachment of the anterior talofibular ligament (not pictured here). (I) There is also sprain of the deltoid ligament (red arrow) and associated edema within the medial malleolus (blue arrow).

Treatment

Nonoperative: Stable fractures/sprains

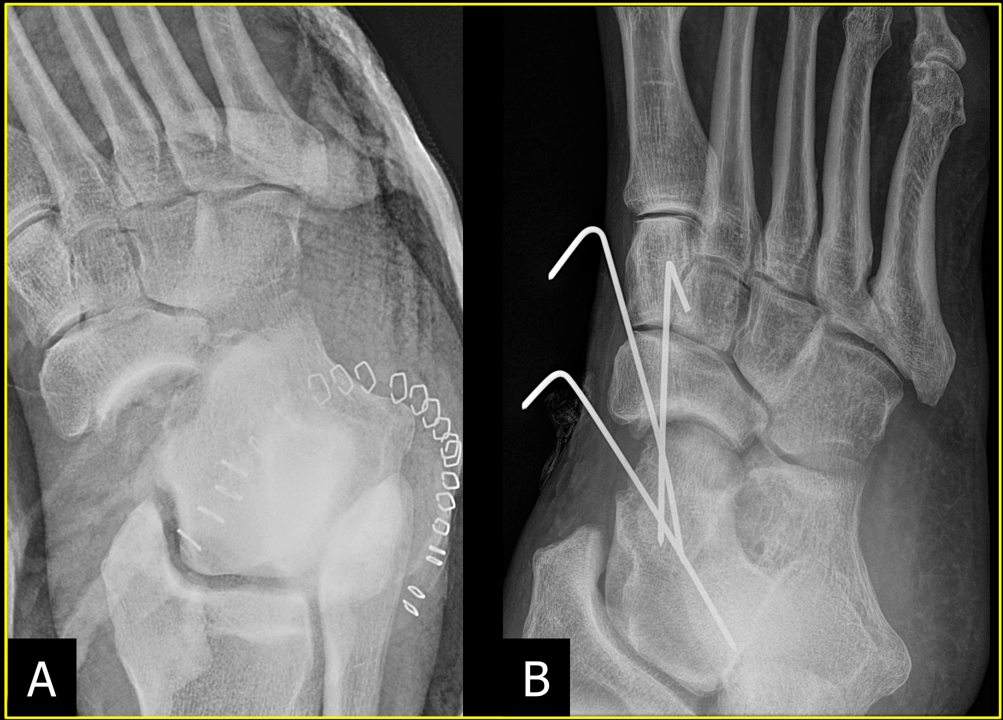
- No dislocation or displaced fracture fragments
- Treated with immobilization with progressive weightbearing. Example injuries include:
  - Extra-articular bony avulsion fractures
  - Impacted articular fragments of the lateral column (more forgiving than the medial column, which is more load bearing)
  - Inaccessible fractures such as plantar navicular and plantar medial aspect of the cuboid, for which the benefit of ORIF is not proven

Operative: Unstable fractures/dislocations

- All displaced fractures and dislocation
- Goal of surgery is to restore normal joint alignment
- Needs to be reduced as soon as possible to prevent further damage to the soft tissues
- Primary fusion of the CC or TN joints should be reserved for cases of severe destruction of the articular surface, due to the important roles of these joints in global foot function

Treatment Options: Examples

Nonoperative treatment. Small avulsion fractures at the talonavicular joint located outside the joint space, with normal alignment of the talonavicular joint. This was treated nonoperatively with weight bearing as tolerated, and the patient was given a CAM walker boot to use as needed.



Operative treatment. Pre reduction (A) and post reduction (B) images of talonavicular joint dislocation. Compare the relative alignment of the talus and navicular before and after fixation with K wires.

Take Home Points

- The Chopart joint complex is a midtarsal foot joint connecting the hindfoot and midfoot, and consists of the talonavicular and calcaneocuboid joints

- Chopart joint injuries are frequently overlooked and may clinically be masked by concurrent ankle injuries

- Knowledge of the anatomy of the Chopart joint and recognition of Chopart injuries is important to preventing prolonged pain, disability, and potentially acquired flatfoot deformity

- Clues that may indicate Chopart joint injury include concurrent injuries to the lateral ankle ligaments or deltoid ligament, and extensor digitorum brevis edema

- Operative management is needed for unstable injuries in which there is displaced fracture or dislocation

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