Postoperative Imaging of the Ankle: A Review

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Objectives

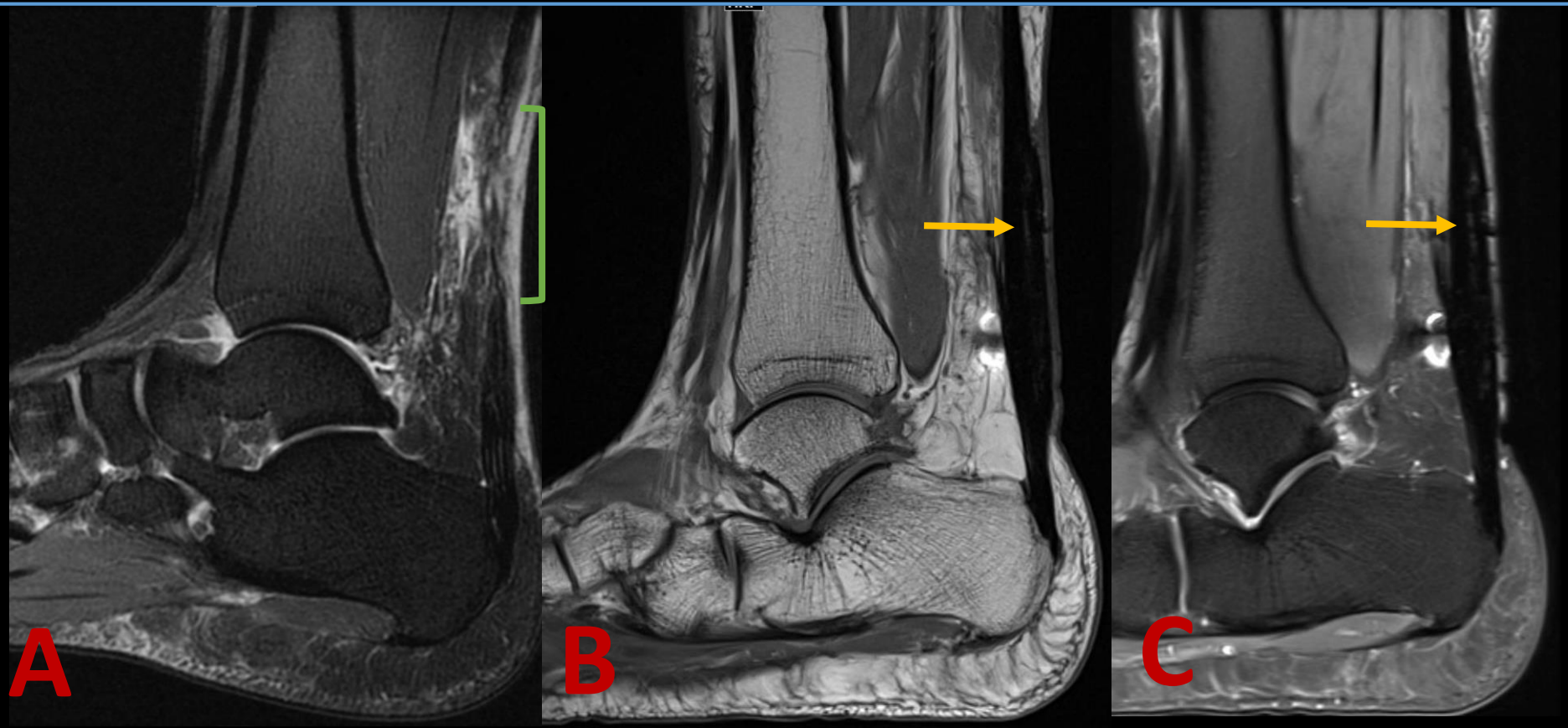
- To review common procedures performed in the ankle
- Be come familiar with the expected postoperative appearance of the various procedures
- Recognize complications associated with these procedures

Posterior Ankle

PROCEDURES

- Primary end-to-end Achilles tendon repair
- Achilles tendon lengthening
- Flexor hallucis longus (FHL) transfer
- Haglund excision and Achilles tendon reattachment

Achilles Tendon Repair



53 year old female with right posterior ankle pain after hearing a pop.

(A): Sagittal PD FS of the ankle demonstrating full thickness midsubstance tear of the Achilles tendon with tendon gap of approximately 4.0 cm (bracket).
(B and C): Sagittal T1 and PD FS postoperative images 3 years after primary end-to-end repair. There is expected thickening of the repaired tendon, which is intact. Linear intermediate intrasubstance signal (arrows) within the mid substance may represent minimal degeneration or postoperative changes. Additionally, there is loss of the calcaneus declination angle, indicative of possible lengthening of the Achilles.

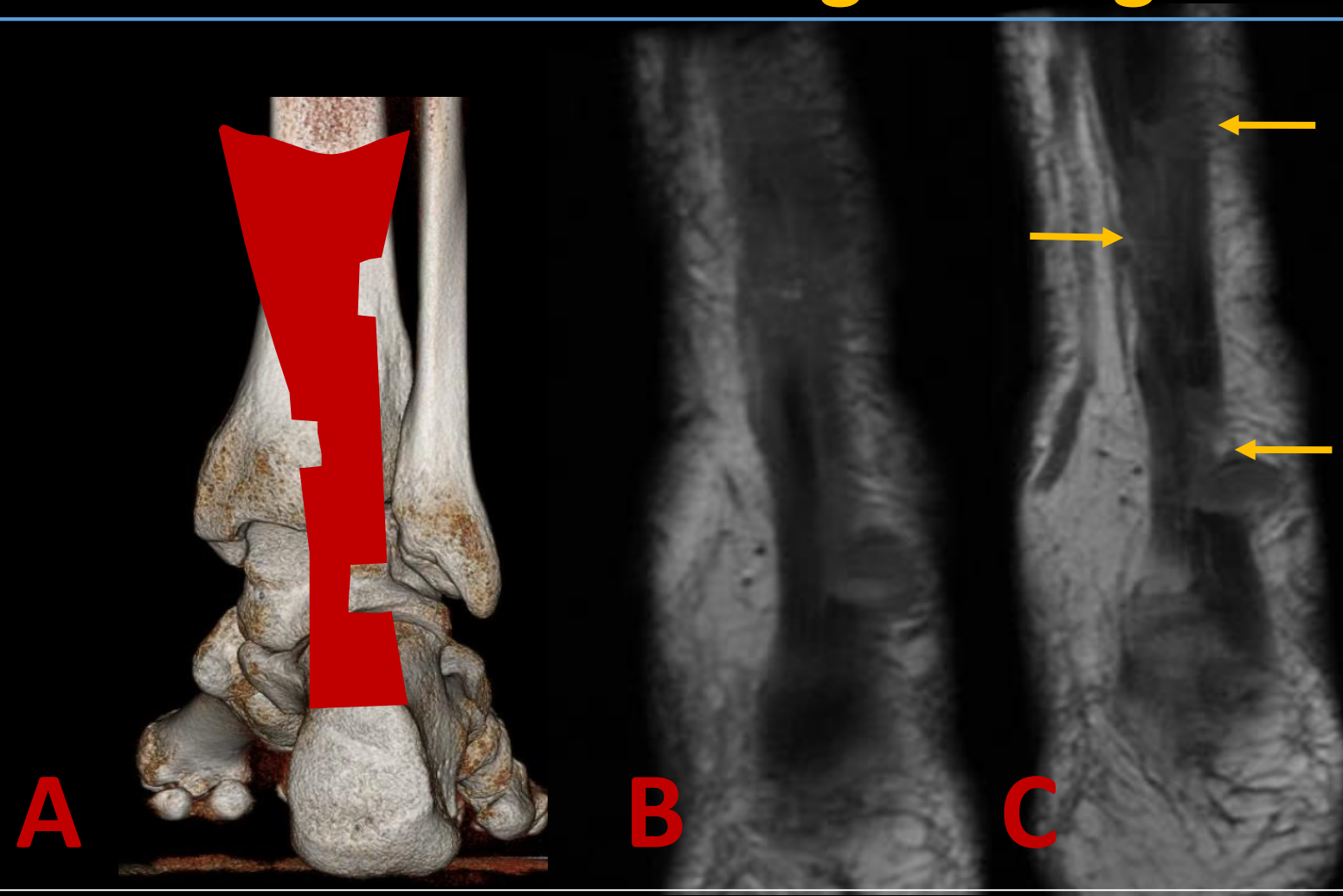
Achilles Lengthening

Achilles tendon lengthening procedures are typically done for patients with congenital or acquired equinus contracture.

Z-lengthening Technique:
(A): Illustration demonstrating the Z-lengthening technique. This is an open procedure with longitudinal incision made 2-6 cm proximal to the insertion. Two incomplete transverse incision are then made on the medial and lateral aspects of the tendon. The fibers are then distracted for appropriate lengthening with the midline fibers re-anastamosed.

(B and C): Coronal STIR images in a patient who underwent Achilles Z lengthening demonstrating fusiform thickening of the Achilles tendon with linear areas of hyperintense signal (dashed lines) representing the Z shaped incision of the Achilles tendon. Lateral MRI may also demonstrate the change of the calcaneus declination angle (see prior slide).

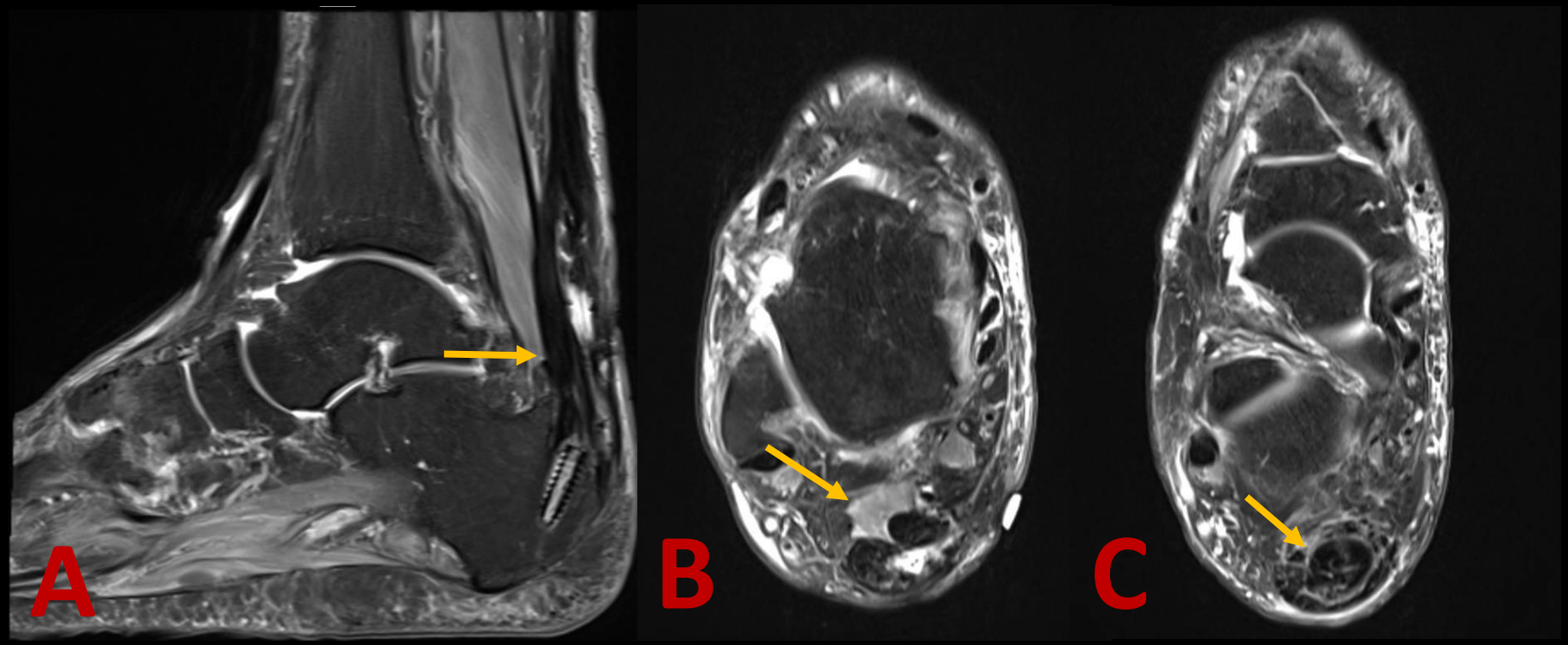
Achilles Lengthening



Hoke Lengthening Technique.

(A): Illustration demonstrating the Hoke lengthening technique. 3 percutaneous incisions are created along the medial and lateral aspects of the Achilles tendon in alternating fashion. The initial incision is made approximately 2 cm proximal to the Achilles tendon insertion.
(B and C): Coronal STIR images demonstrating the Hoke lengthening technique with the alternating defects (arrows).

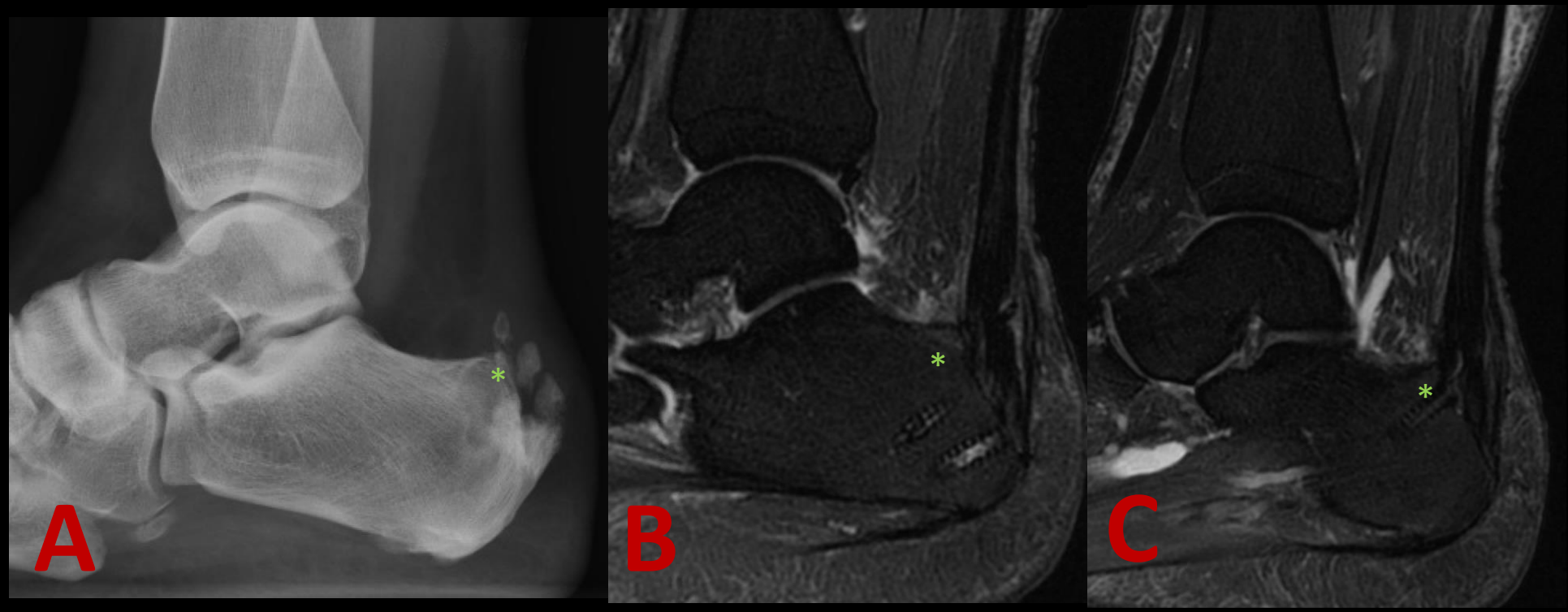
FHL Tendon Transfer



Flexor halluces longus (FHL) tendon transfer may be performed to augment Achilles tendon repairs, particularly in patients with chronic tendinosis.

Sagittal (A) and axial proton density-weighted fat-saturated (B and C) images shows FHL tendon (arrows) inserting onto the calcaneus directly anterior to the Achilles tendon. The tendon is released posterior to the talus, approximately 4-5 cm distal to the musculotendinous junction. Tendon transfer is typically done to strengthen repair in tendons with poor quality.

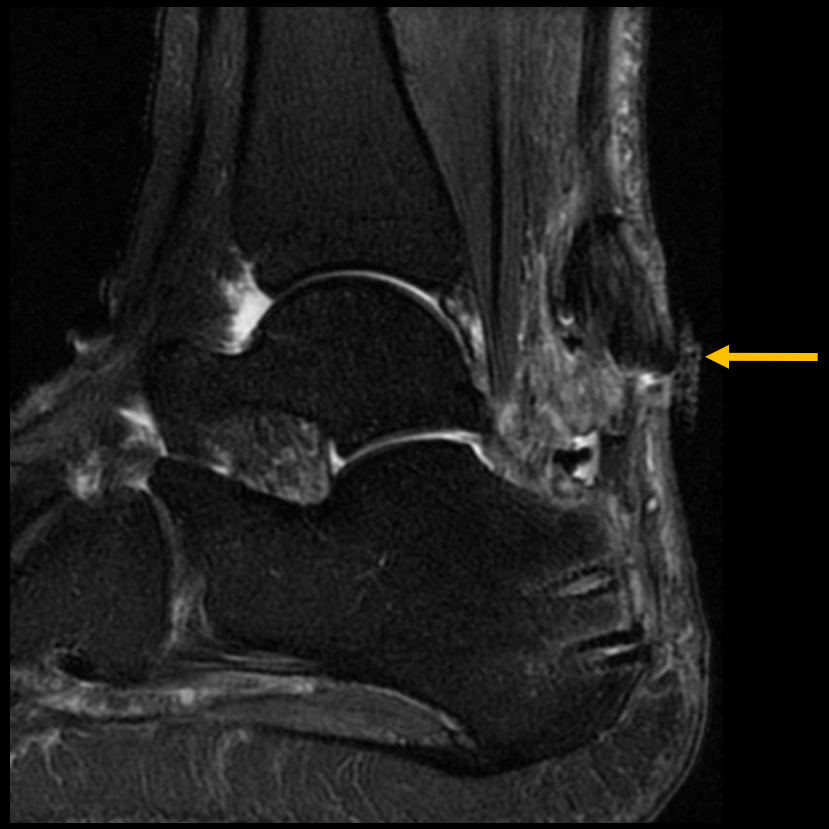
Haglund excision with Achilles tendon reattachment



49 year old female with posterior heel pain.

(A): Lateral radiograph of the left ankle demonstrating posterior calcaneal bump (*) in keeping with Haglund's deformity with calcific insertion Achilles tendinosis.
(B and C): Sagittal PD FS postoperative images 3 months after Haglund's excision with Achilles tendon debridement and re-attachment. There is expected thickening of the Achilles tendon, which is intact and secured by anchor screws within the calcaneus (double row anchor fixation). Postoperative changes of the calcaneus demonstrates removal of the Haglund deformity with mild residual marrow edema (*). Marrow edema is expected at 3 months post-op.

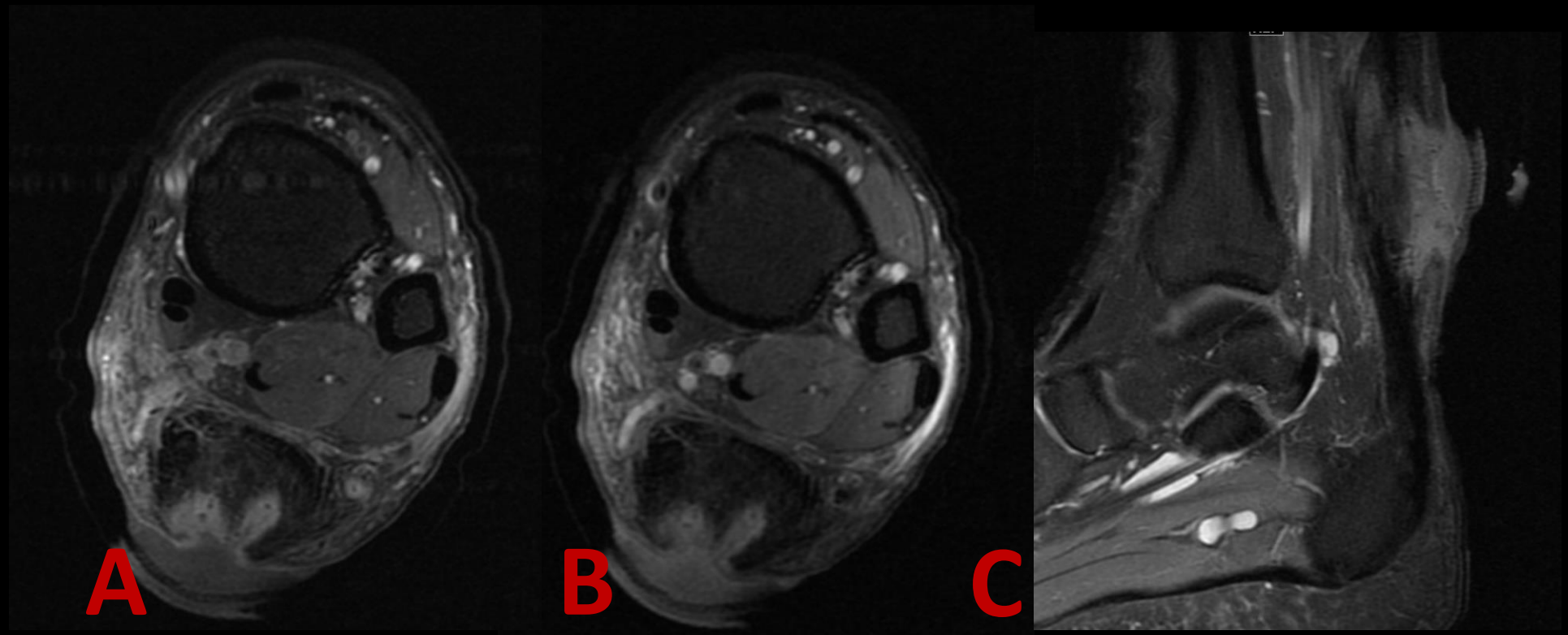
Achilles Rupture s/p Debridement and Haglund Excision



52 year old female with left ankle pain and swelling after falling. Patient was 1 month post-op from Haglund's excision with Achilles tendon debridement and re-attachment.

Sagittal PD FS image demonstrates full thickness tear of the Achilles tendon with retraction (arrow).

Wound Dehiscence s/p Achilles Tendon Repair



41 year old male with PMH of diabetes and prior Achilles tendon repair who presents with wound dehiscence.

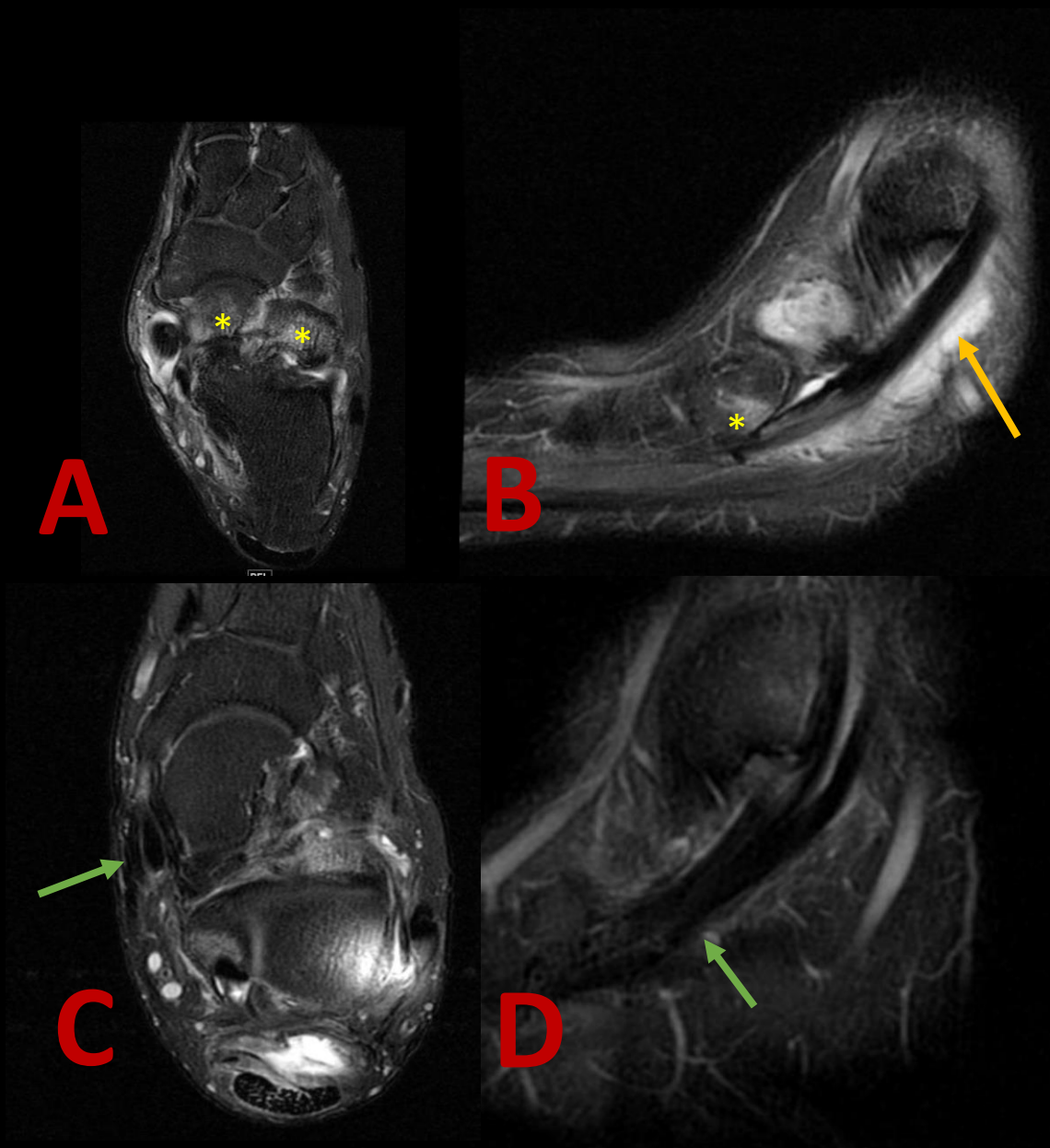
(A, B and C): Axial T1 FS post contrast, Axial and Sagittal PD FS images of the left ankle showing a peripherally enhancing fluid collection in keeping with abscess overlying and extending into the posterior aspect of the repaired Achilles tendon, which is diffusely thickened.

Medial Ankle (Posterior Tibialis Tendon Insufficiency)

PROCEDURES

- Procedures of the posteromedial compartment typically involve posterior tibialis tendon (PTT), which stabilizes the longitudinal arch of the foot. PTT insufficiency and spring ligament rupture can lead to progressive flatfoot deformity (pes planovalgus).
- Various surgical techniques for stage II PTT insufficiency
  - Flexor Digitorum Longus (FDL) to PTT transfer +/-
  - Calcaneal Osteotomies +/-
    - Medializing calcaneal osteotomy
    - Lateral column lengthening
  - Achilles lengthening (associated equinus) +/-
  - Midfoot osteotomy (Cotton)

FDL Transfer to PTT



24 year old male with posterior tibialis dysfunction and acquired pes planus.
(A and B): Axial and Sagittal PD FS images demonstrating thickening of the posterior tibialis tendon with tenosynovitis (arrow) and reactive marrow signal within the talus and calcaneus (*).
(C and D): Axial and Sagittal PD FS images demonstrating expected postoperative changes after transfer of flexor digitorum longus to the navicular (arrows). The native posterior tibialis tendon was debrided and is reinforced by FDL. Previously seen tenosynovitis has resolved.

Calcaneal Osteotomy

Calcaneal osteotomies are often done to correct hindfoot alignment (cavovarus or planovalgus).

(A and B): Medializing calcaneal osteotomies are commonly performed with FDL transfers to help correct hindfoot valgus deformity and unload the stress on the tendon transfer. The osteotomy also changes the insertion of the Achilles tendon, turning it into an ankle inverter. An osteotomy is performed posterior to the peroneal tendons and sural nerve and translated 8-10 mm medially (arrows). Notice an osteotomy done at the medial cuneiform, known as Cotton osteotomy (arrow), which can be done to correct forefoot supination.

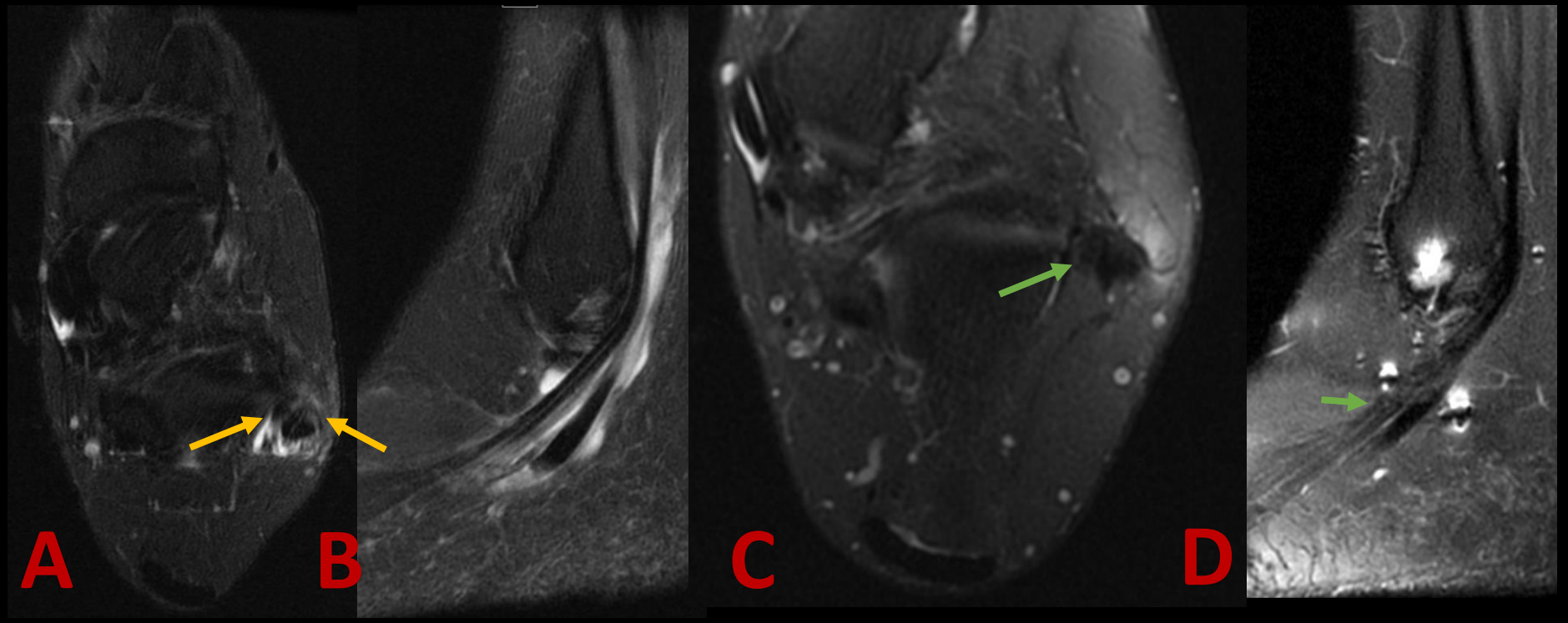
(C, D, and E): Axial T1 (C), Sagittal T1 (D) and Sagittal CT (E) postoperative images in a patient with FDL to PTT transfer and lateral column lengthening. Lateral column lengthening restores the arch of the foot and rotates the forefoot and hindfoot medially. This is usually done in addition to FDL transfers in patients who also have forefoot abduction. An osteotomy is performed 15 mm proximal to the calcaneocuboid joint. The fragments are distracted and bone graft is applied which is secured by a lateral plate and screw construct (arrow). The sagittal MR and CT images better demonstrate the lengthened calcaneus.

Lateral Ankle

PROCEDURES

- Peroneal tendinopathy
  - Peroneal brevis repair and tubularization
  - Peroneal longus transfer
- Lateral ankle ligament reconstruction
  - Anatomic reconstruction of the ATFL and CFL (Broström procedure)
  - Non-Anatomic Repairs (Tendon re-routing)
  - Allograft tendon reconstruction of ATFL and CFL

Peroneal Brevis Repair

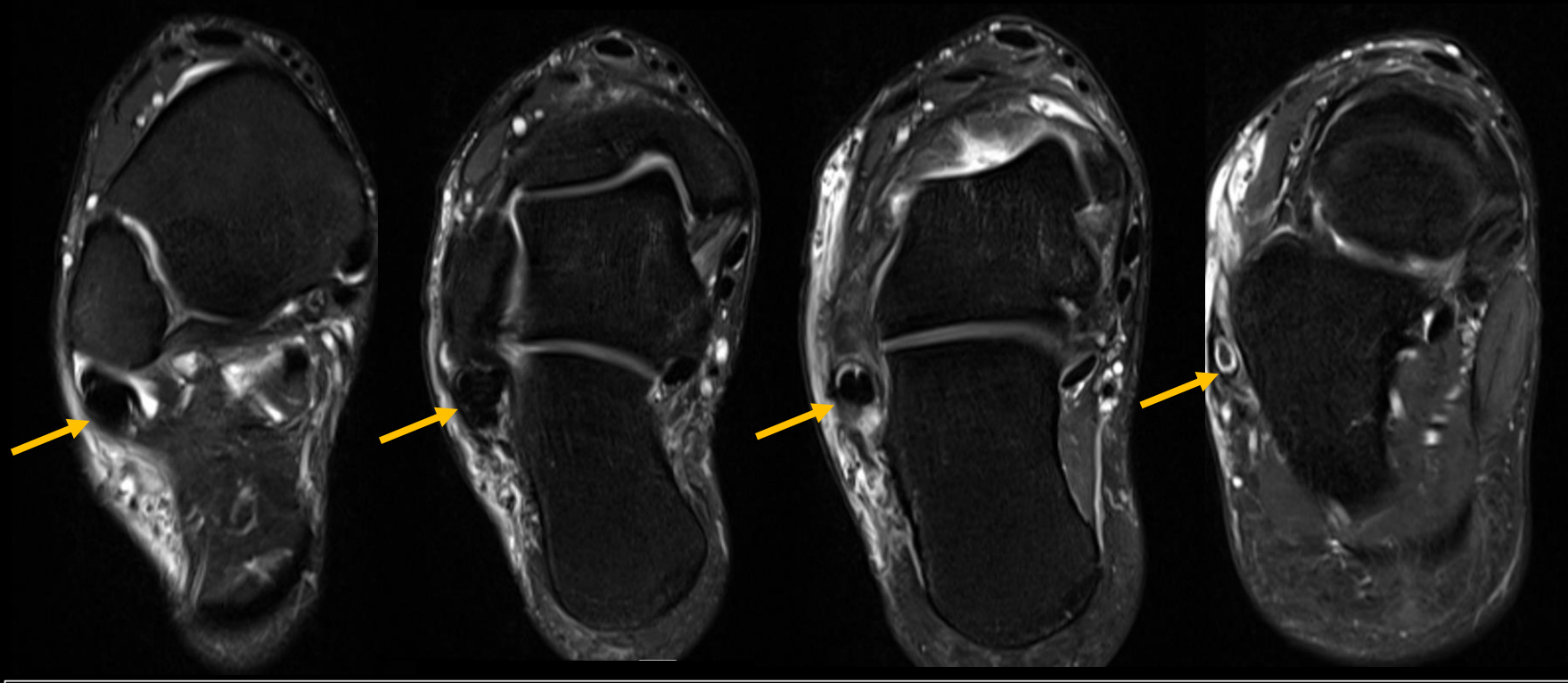


(A and B): 52 year old female with chronic left ankle pain. Axial and Sagittal PD FS images demonstrating longitudinal split tear of the peroneus brevis tendon (arrows) with tenosynovitis of the common peroneal tendon sheath.

(C and D): Axial and Sagittal PD FS images shows postoperative changes of peroneal brevis tendon repair and tubularization. The repaired peroneal brevis (arrow) is now intact with mild intermediate signal, likely due to prior surgery.

Primary repair and tubularization involves debridement of the tendon and suturing the debrided torn edges with thin suture. Tears involving less than 50% of the tendon area are typically managed with tubularization. Tears involving greater than 50% of the tendon area may require tenodesis, tendon transfer, or grafting.

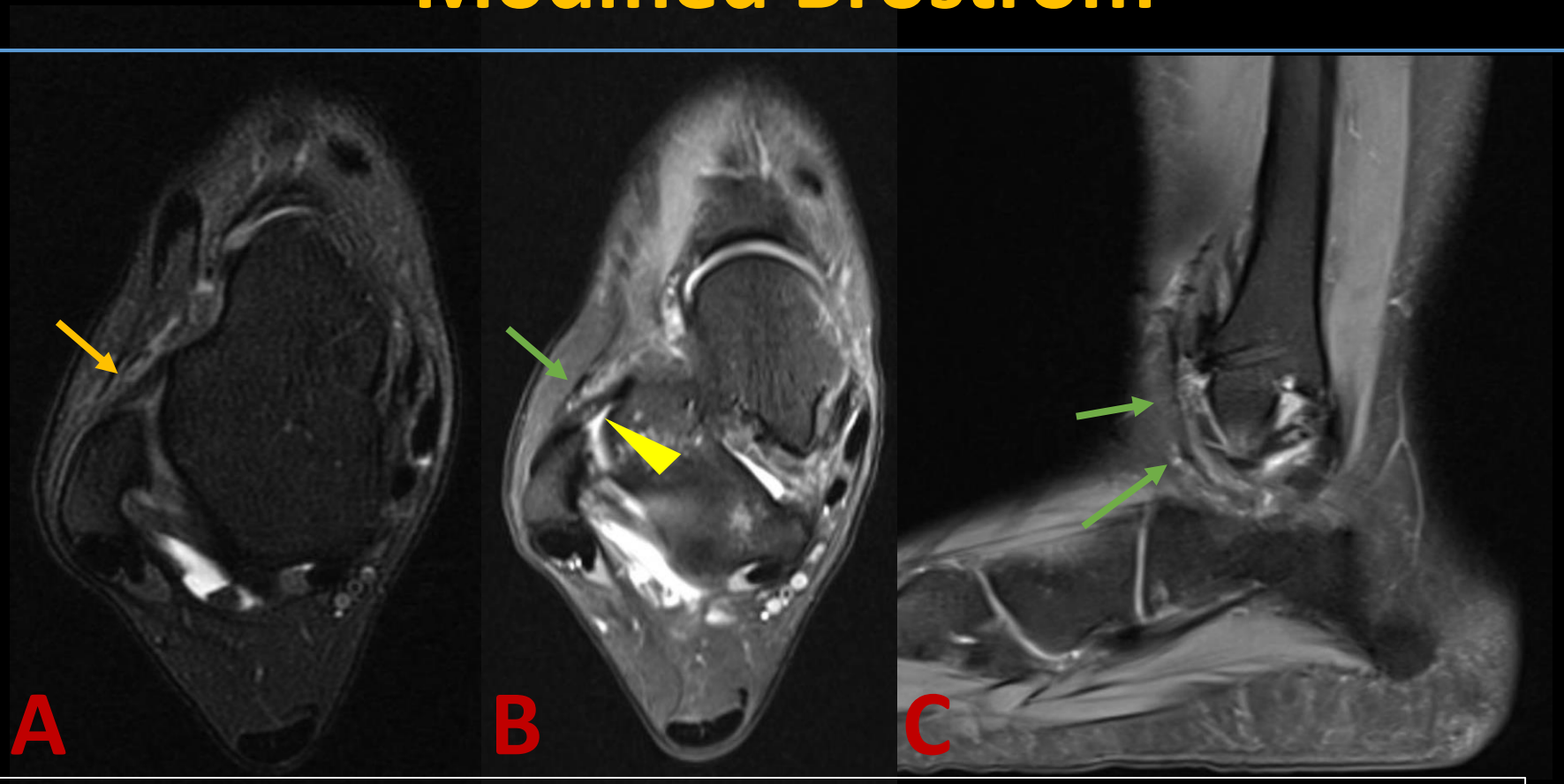
Peroneal Longus to Brevis Transfer



23 year old male with previous peroneal longus to brevis tendon transfer.

Sequential oblique axial PD FS images demonstrating peroneus longus (arrow) to brevis transfer and tubularization, with peroneus longus now coursing in the expected location of peroneal brevis which was split. The image on the far right demonstrates diminutive appearance of the unified tendon with surrounding fluid suggesting partial tear of the tendon transfer.

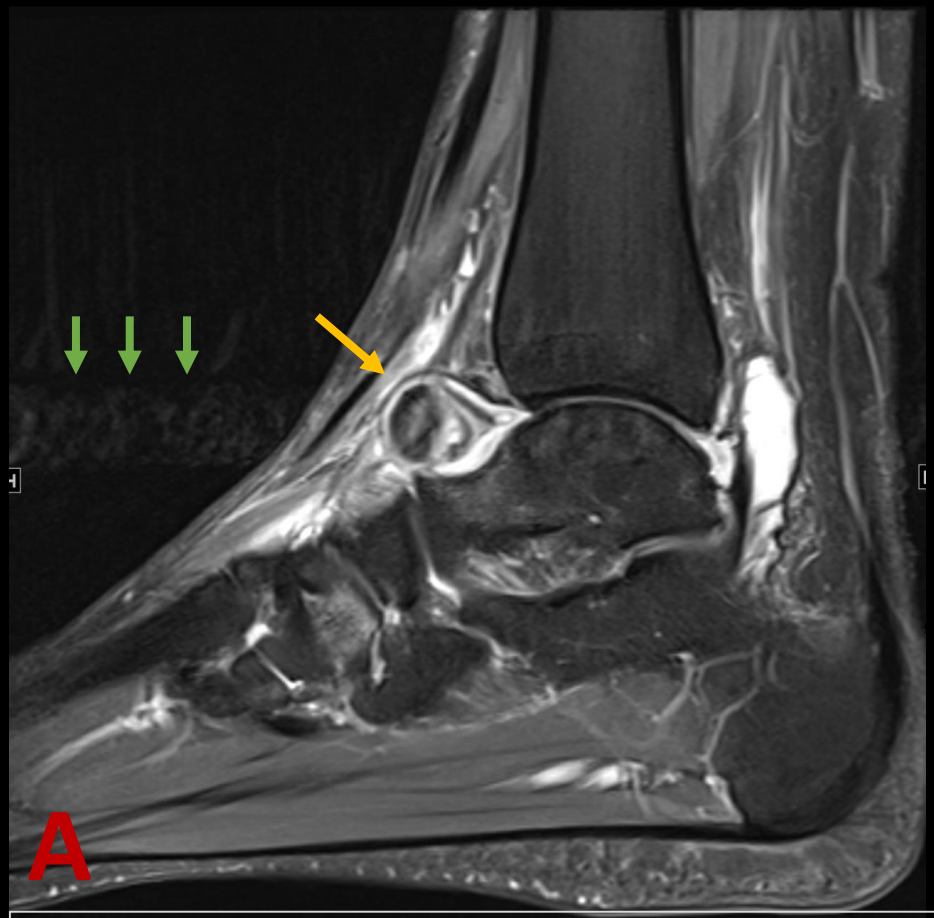
Modified Broström

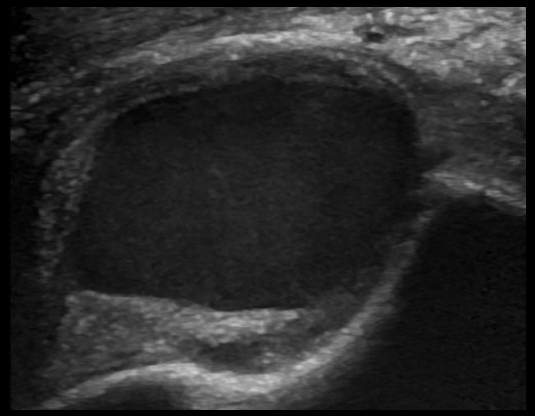


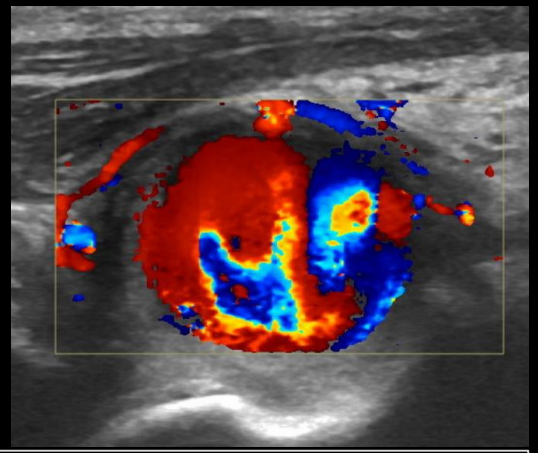
18 year old female with right anterolateral ankle pain and instability after slipping. Bromström technique involves primary repair of the lateral ankle ligaments (imbrication). The Modified Bromström technique also includes advancing the extensor retinaculum to the fibula to reinforce the ligament repair.

(A) Axial PD FS of the right ankle at the level of the anterior talofibular ligament (ATFL) demonstrating thickening and intermediate signal of the ATFL (arrow) compatible with chronic tear.
(B and C) Axial and Sagittal PD FS images after Modified Bromström demonstrating mild, expected thickening of the repaired ATFL, which is intact (arrowhead). The overlying extensor retinaculum (arrows) is then advanced to the anterior edge of the fibula to further augment the repair.

Pseudoaneurysm after Broström Repair







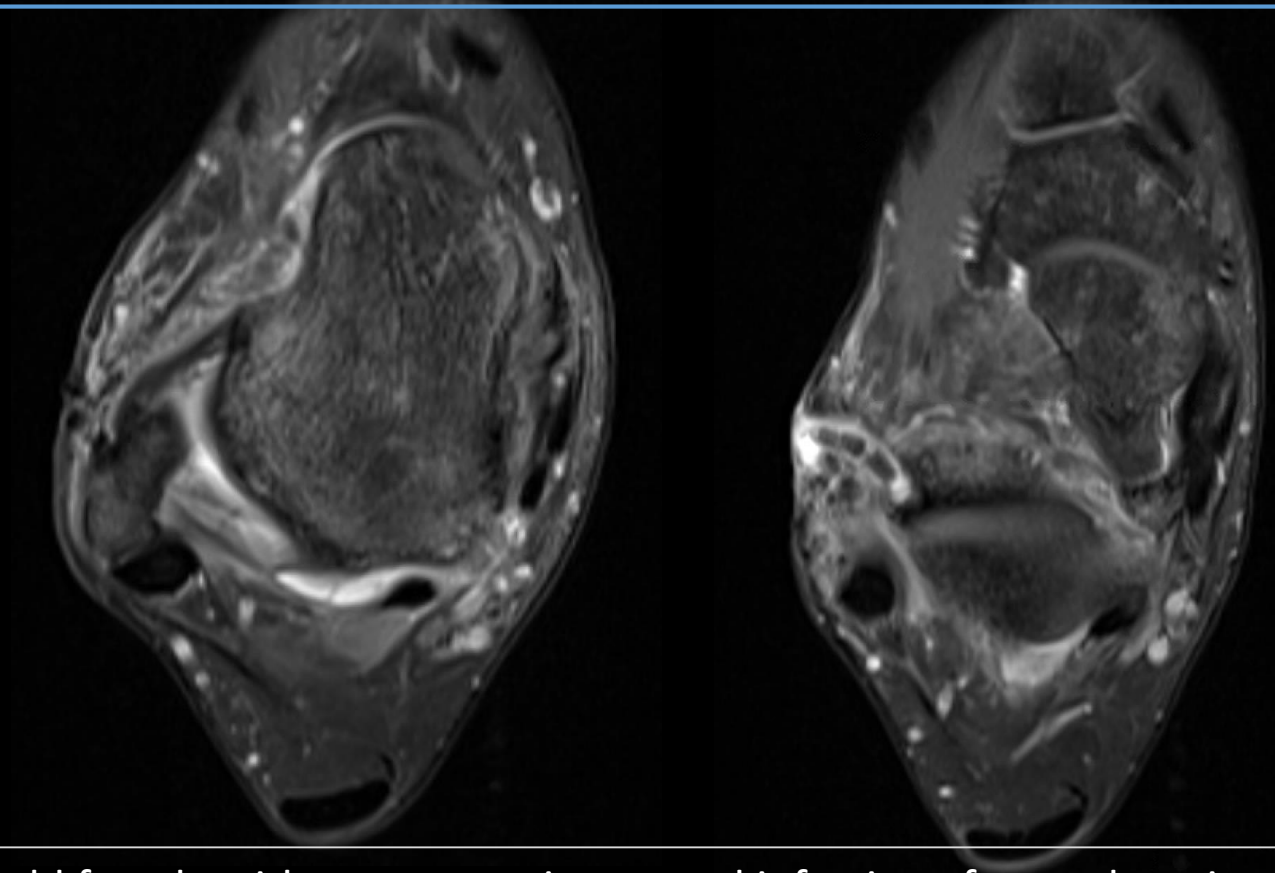
15 year old female with right ankle pain, swelling, and discoloration after Bromström repair and arthroscopic loose body removal.

(A): Sagittal PD FS image of the right ankle demonstrated an intra-articular hypointense mass (arrow) within the anterior tibiotalar joint. Notice the pulsation artifact associated with the lesion (arrows).

(B and C): Gray scale and color Doppler imaging of the mass demonstrates internal color Doppler flow with to and fro waveforms and "yin-yang" appearance, compatible with pseudoaneurysm. CTA confirmed pseudoaneurysm of dorsalis pedis artery which was subsequently surgically repaired.

Reference: Skeletal Radiol. 2019 Mar;48(3):451-455.

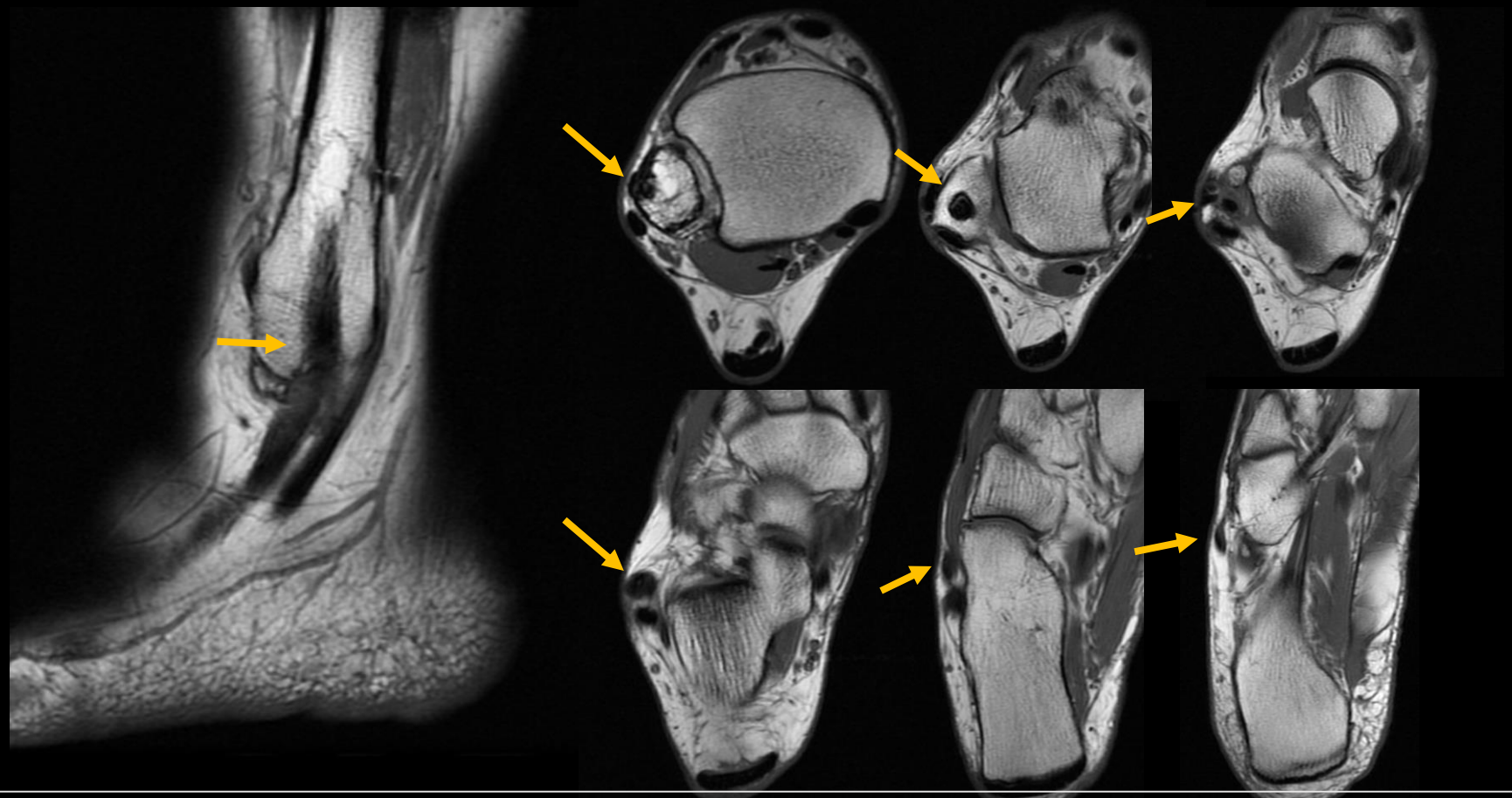
Wound Infection s/p Modified Broström



21 year old female with post operative wound infection after undergoing a Modified Bromström lateral ligamentous reconstruction of her right ankle.

Axial PD FS images of the right ankle demonstrates thickening of the ATFL in keeping with prior repair. Distally, there is a linear hypointense object within the lateral ankle soft tissues extending to the skin surface with associated susceptibility artifact. Patient was taken to the OR which revealed an extruded, fractured suture anchor.

Non-Anatomic Repairs



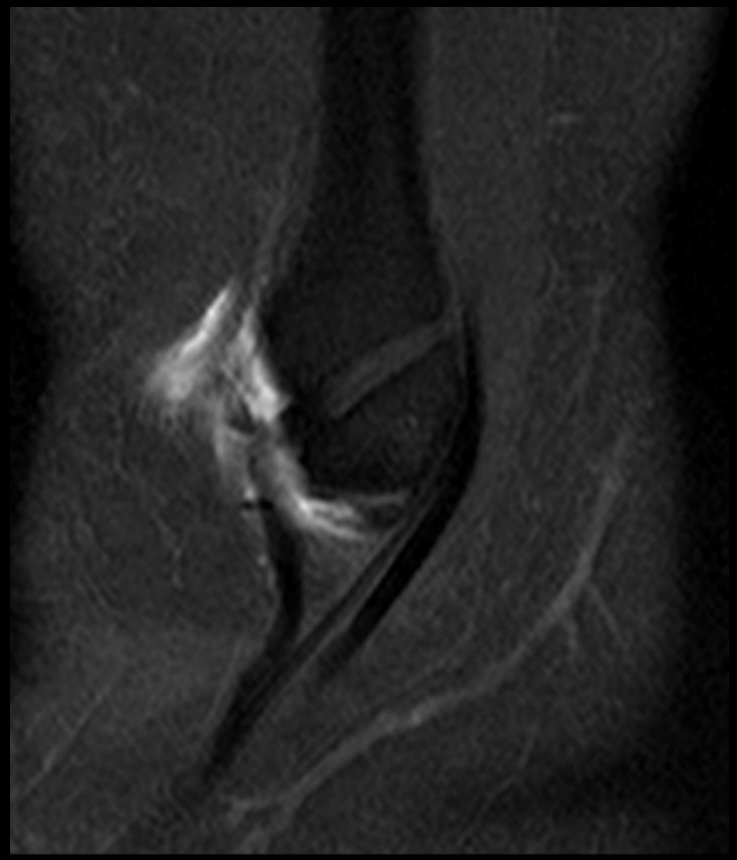
Non-anatomic repairs involve rerouting tendons, typically the peroneal brevis tendon, to augment torn or lax ligaments. Non-anatomic repairs were introduced as early as the 1930s and popularized in the 1950s with many variations until Bromström introduced his primary repair technique in 1966.

Evans technique: In this technique shown above, the peroneal brevis tendon is transected distal to the musculocutaneous junction and re-routed through a distal fibular tunnel. The tendon is then reattached to either its native muscle belly or the fibular periosteum. In this case, the peroneus brevis was re-attached to the fibula (arrows).

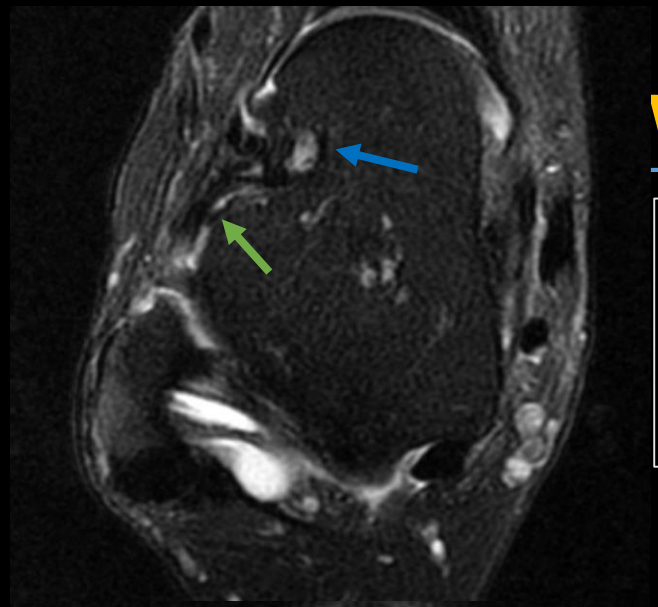
Lee Procedure

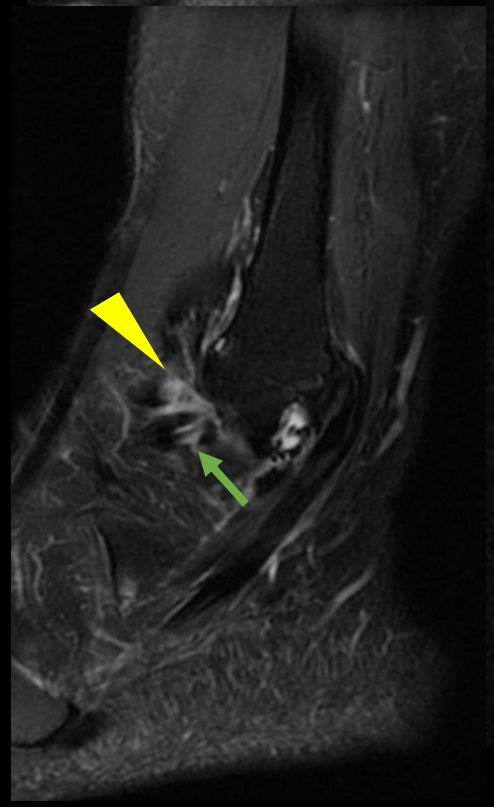
Sagittal T1 FS image demonstrating the Lee technique. In this example, the peroneus brevis is transected distal to the myotendinous junction. The peroneus brevis tendon is then re-routed through the fibular and looped and sutured distally back upon itself (arrows).

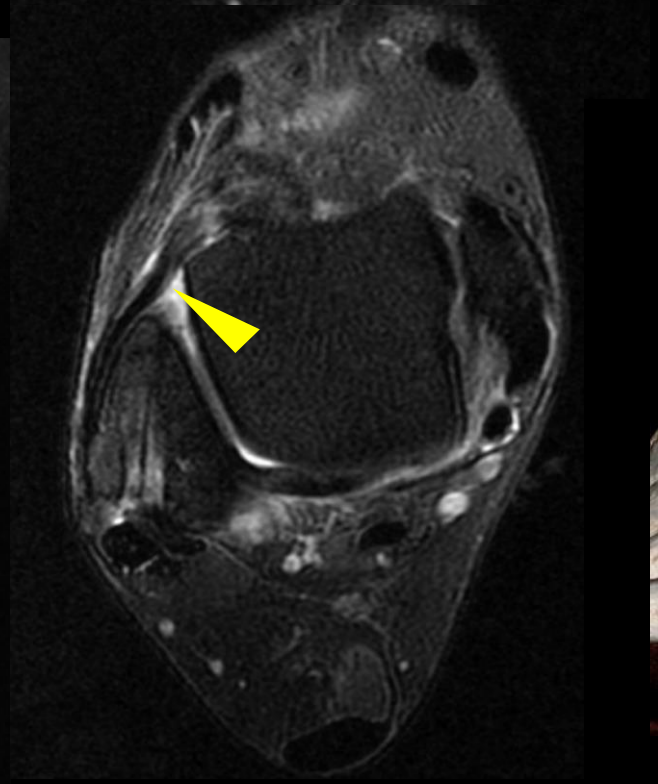
Lee procedure 15 years later



Same patient 15 years lateral with lateral ankle pain demonstrating tear of the re-routed peroneus brevis tendon as it exits the fibular tunnel anteriorly (arrow).

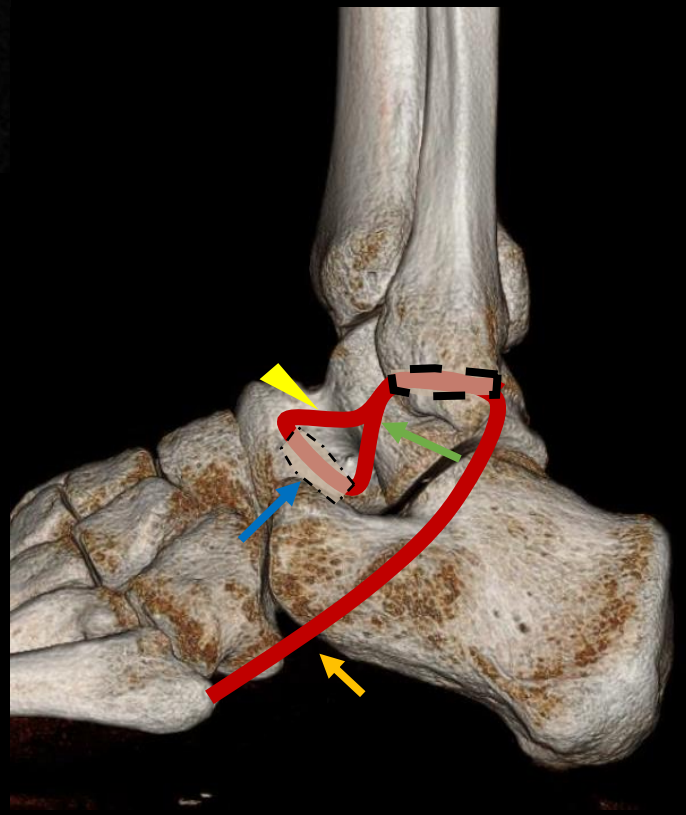






Watson-Jones Procedure

In this example, the peroneus brevis is resected proximally, maintaining its distal insertion (arrow). The tendon is the tunneled through the lateral malleolus from posterior to anterior to the lateral talus, simulating the ATFL (arrows). The tendon is then passed through a tunnel within the talus superiorly (arrow) and pulled backwards, back to the fibula (arrowheads).

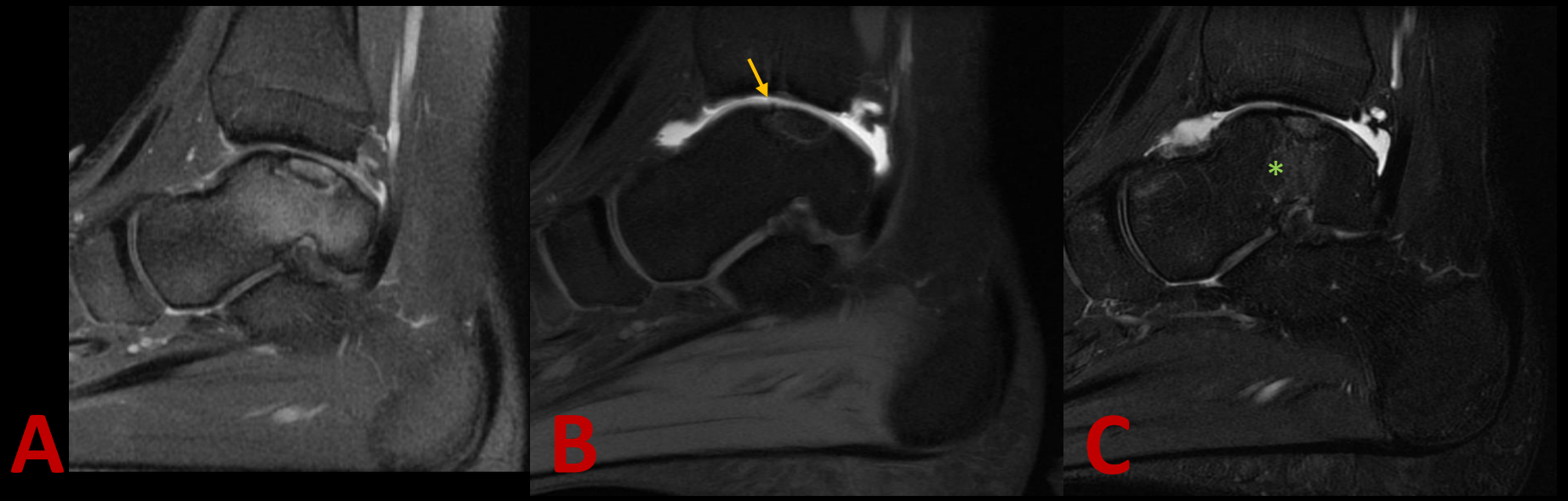


Talus Osteochondral Lesion

PROCEDURES

- Microfracture/Drilling
- Osteochondral Allograft/Autograft Transplantation

Microfracture/drilling

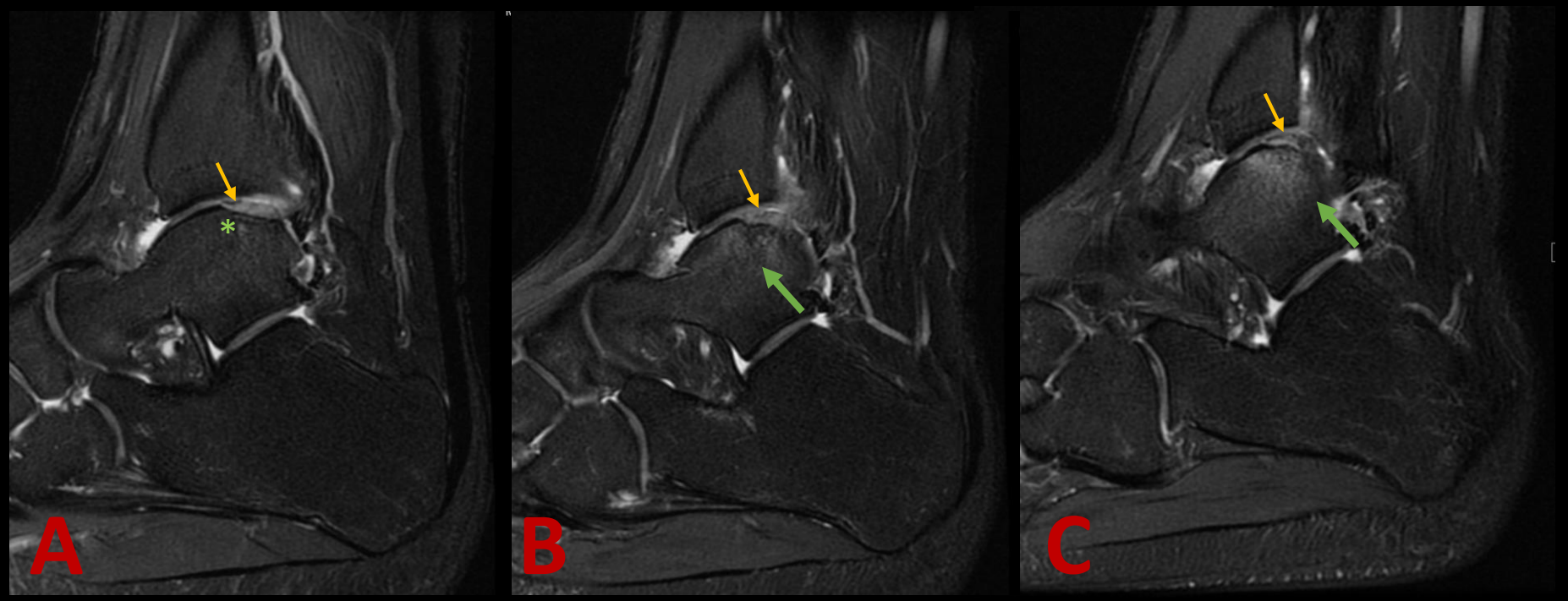


16 year old with right talar dome osteochondral lesion (OCL) treated with drilling.

(A): Sagittal PD FS image demonstrates a crescentic osteochondral fragment with underlying marrow edema. Patient was subsequently treated with drilling of the OCL down to the base of the talus to stimulate marrow and chondrocyte repair.

(B and C): Sagittal T1 FS and PD FS images after arthrogram demonstrating interval decrease in talar dome marrow edema with linear areas of residual marrow edema extending into the talus, likely related to the drilling technique (*). Notice the T1 hypointense signal at the cartilage interface demonstrating fibrocartilage development (arrow).

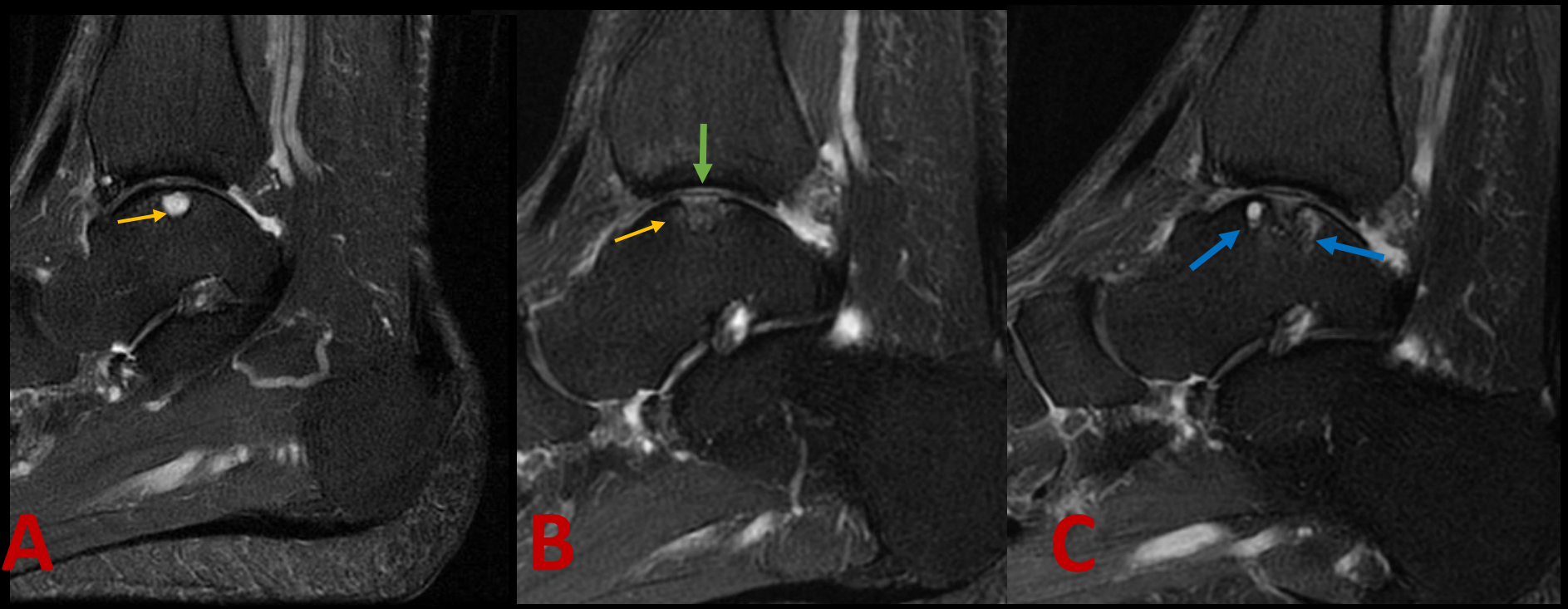
OCD Allograft- Biocartilage Augmentation



17 year old with right talar dome OCL treated with removal of the OCL, curettage and microfracture of the base followed by allograft repair

(A, B, and C): Sagittal PD FS images demonstrating the area of prior OCD with flattening of the subchondral bone plate (*). Overlying intermediate signal similar to the adjacent native cartilage, likely representing the allograft is seen filling the defect (arrow). There is mild underlying edema-like signal (arrow), which can be seen in the post operative setting. Reactive marrow signal can last for up to 12 months after the procedure.

Curettage with microfracture and subsequent recurrence



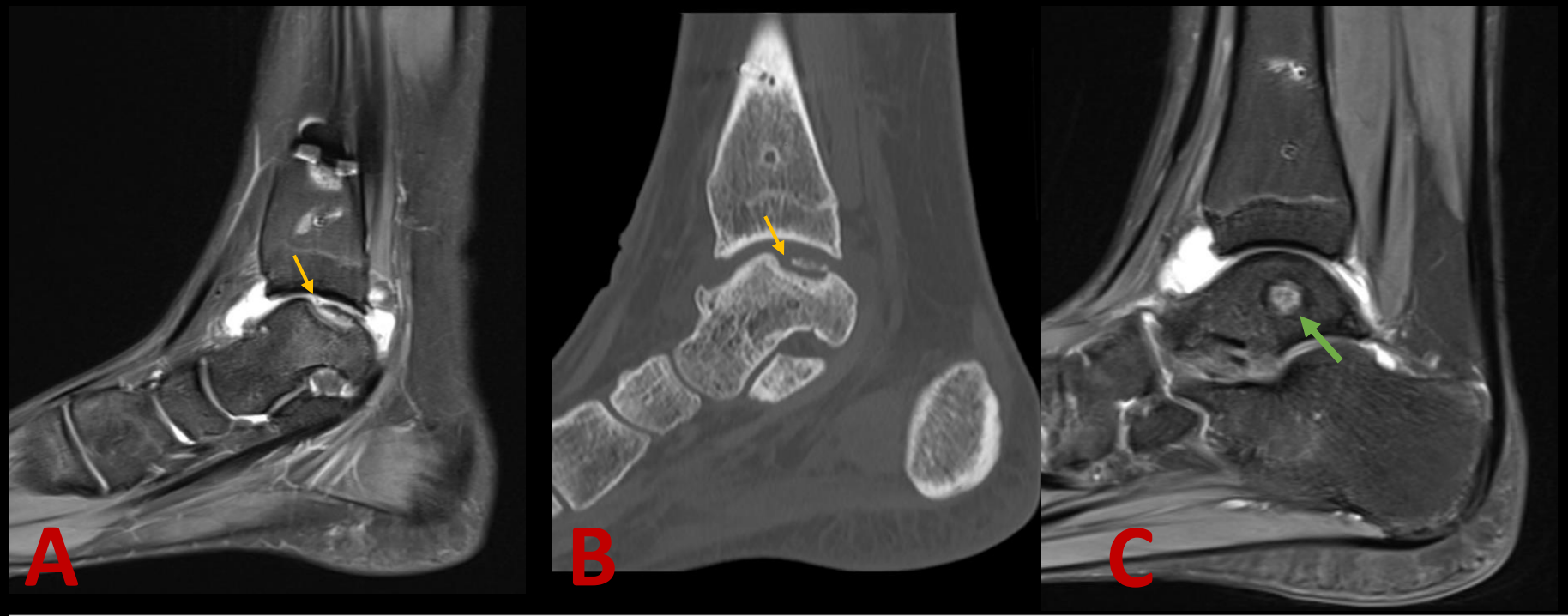
09/2013 05/2014 08/2016

(A): 57 year old who underwent curettage with microfracture of a medial talar dome osteochondral lesion (arrow).

(B): MRI approximately 6 months after curettage and microfracture showing interval filling of the defect (arrow) with intermediate marrow signal as well as overlying cartilage development (arrow).

(C): MRI almost 3 years after the initial surgery demonstrating development of adjacent subchondral cystic formation concerning for recurrence (arrows).

OCD Autograft Failure



13 year old with history of prior tibiofibular syndesmosis ORIF, osteochondritis dessicans (OCD) repair with autograft repair and retrograde drilling who presented with continued ankle pain.

(A and B): Sagittal PD FS and Sagittal CT images of the right ankle demonstrating an unstable medial talar dome OCD (arrows) with fluid undercutting the osteochondral fragment in keeping with failure.

(C): Rounded area of PD FS hyperintense signal in the central aspect of the talus favored to represent presumed drill track (arrow).

Conclusion

- The wide variety of procedures performed in the ankle can be challenging for the interpreting radiologist
- Familiarity with the common procedures performed in the ankle is helpful for recognizing true pathology as opposed to expected postoperative changes
- Radiologists should be aware of complications such as re-tear, infection, graft or tendon transfer failure, and vascular injury.

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Thank you!