

The Issue is the Tissue: CT Findings Overlooked on Soft Tissue Windows in Lower Extremity Imaging

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Objectives

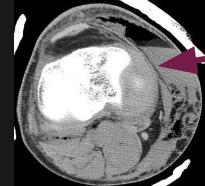
1. Review of generally overlooked soft tissue pathology that can be clearly demonstrated with soft tissue windows settings on CT, including those with traumatic musculoskeletal injuries.
2. Learn to identify non-osseous soft tissue injuries including injuries of ligaments, tendons, menisci, Morel-Lavallée lesions and nerve transection.
3. Advocate for the use of CT imaging in making early time-sensitive findings on soft tissue windows, potentially avoiding the use of costly additional imaging modalities including MRI.

OVERVIEW

BONE MARROW



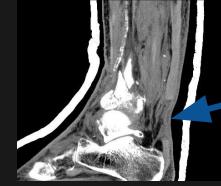
SUBCUTANEOUS/MUSCLE



LIGAMENTS/MENISCUS



TENDONS



NERVES



Fractures
Marrow Infiltrative Disease

Compartment Syndrome
Morel-Lavallee Lesion
Rhabdomyolysis
Hematoma
Muscular Atrophy
Accessory Soleus Muscle
Thoracolumbar Fascia Tear

Ligament Avulsions/Tears
Meniscal Injury
Knee Capsular Injury

PTT Entrapment
Iliopsoas Entrapment
Quadriceps Entrapment
Flexor Tendon Injury
Achilles Tendon Rupture
Plantar Fascia Injury
Patellar Tendon Injury

Baxter's Neuropathy
Nerve Transection
Fibrolipomatous Hamartoma

Fractures

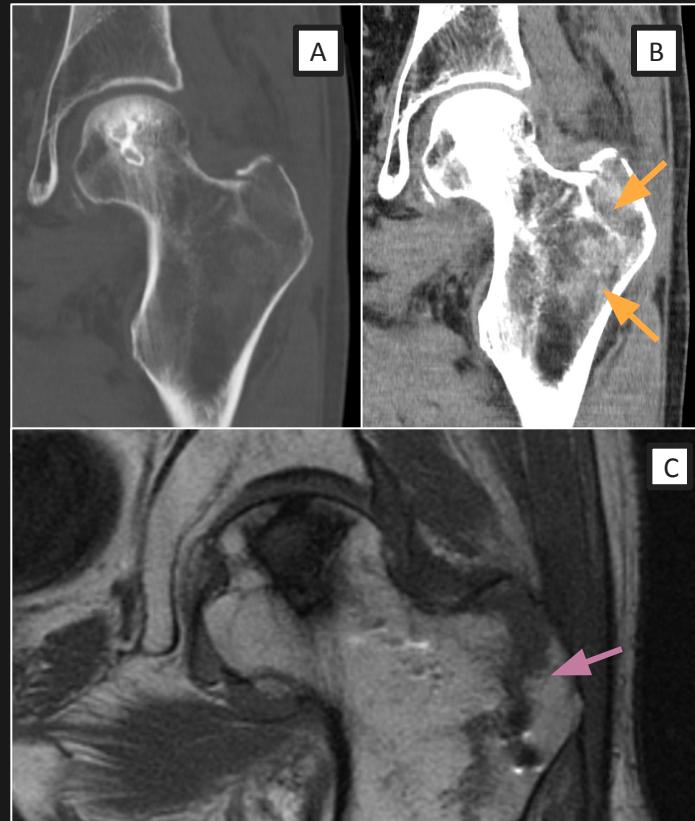
History: 58 year old male, fell on left hip at home

Findings:

CT coronal bone window image (A) of the hip initially shows a minimally displaced fracture of the greater trochanter. Additionally noted is a bone infarct within the femoral head, compatible with avascular necrosis. CT soft tissue window image (B) demonstrate notable **bone marrow edema** extending onto the intertrochanteric femur, consistent with a fracture which is difficult to appreciate on the initial bone window CT image. Coronal T1-weighted image (C) of the hip confirms an **incomplete greater trochanter fracture with extension into the intertrochanteric region**.

Discussion:

Using soft tissue windows on CT can prevent unnecessary MRI for detection of occult fractures, as this case. Although bone marrow edema is less conspicuous on CT than MRI T1-weighted or fat suppressed T2-weighted sequences, the use of soft tissue windows can help detect occult fractures and lead to earlier detection.



Bone Marrow Infiltration

History: 96 year old female after falling down multiple steps. Radiographs showed bilateral femoral neck fractures.

Findings:

CT coronal soft tissue image (A) of the pelvis and femora show **diffusely increased density with the medullary cavities, compatible with bone marrow infiltration**. Coronal T1-weighted MRI image (B) demonstrates diffuse replacement of bone marrow. This patient was subsequently diagnosed with acute myeloid leukemia.

Discussion:

Diffuse medullary-based bony changes are difficult to appreciate on CT imaging and commonly missed. Comparison with prior or normal imaging is helpful. Bone marrow infiltration is best evaluated on T1-weighted sequences to look for replacement of fatty marrow.



Morel-Lavallée Lesions

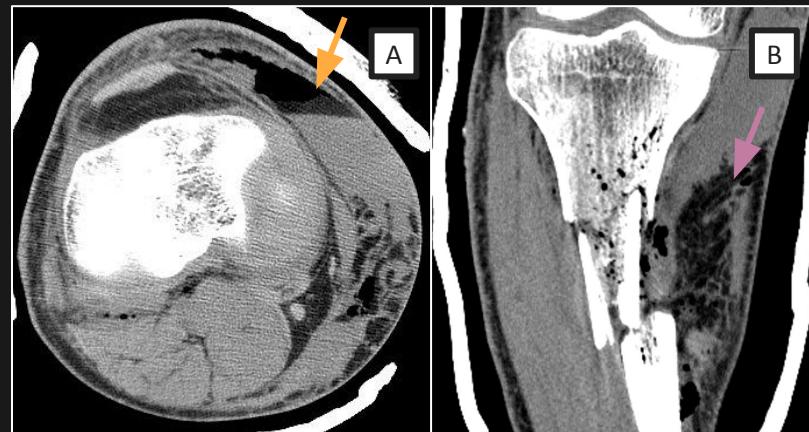
History: 26 year old male with crush injury to leg, fractures of the tibial plateau and fibular head seen on x-ray (not shown).

Findings:

CT axial soft tissue window image (A) reveals a **fat/fluid level** **within the knee joint** and CT coronal image soft tissue window image (B) demonstrates increased soft tissue density in fat across medial aspect of the distal thigh and lower leg.

Discussion:

Morel-Lavallée lesions are post-traumatic, closed degloving injury, resulting in traumatic severance of the skin and subcutaneous tissue from underlying fascia. Disruption of segmental perforating vessels with resultant hematoma (hemolymphatic fluid with a mixture of viable and necrotic fat). Fluid may accumulate slowly from shearing of the lymphatics or develop rapidly from trauma to arterial beds. Small lesions may resolve completely with a small incision, drainage, and application of a compression bandage. Persistent lesions may contain a pseudocapsule that makes them refractory to conservative treatment



Compartment Syndrome

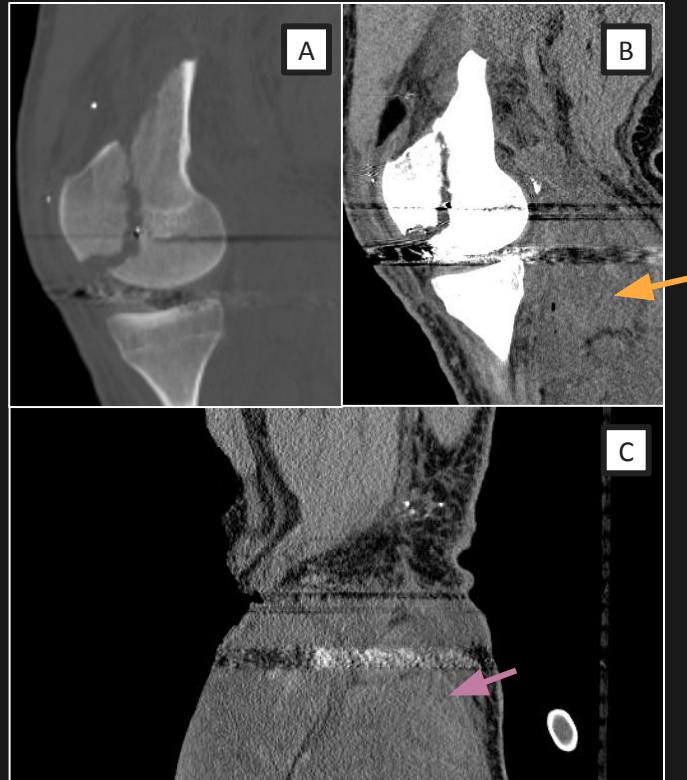
History: 34 year old male with multiple gunshot wounds to the lower extremity with subsequent surgical exploration and popliteal artery injury repair.

Findings:

CT sagittal bone window image (A) demonstrates a comminuted fracture of the distal femur. CT sagittal soft tissue window image (B) of the knee shows diffuse edema within the fat planes between musculature. CT coronal soft tissue window image (C) demonstrates **muscles of the lower leg demonstrate decreased attenuation**, concerning for ischemia. Coronal soft tissue window image of the knee shows **decreased attenuation of the musculature of the lower leg in the posterior compartment**, as well as fluid layering between the muscle bundles.

Discussion:

Etiologies of compartment syndrome include limb trauma, burn injuries, neoplasms, or contrast media extravasation. Although a clinical diagnosis based on compartmental pressures, imaging is non specific and may show diffuse edema. The presence of air locules may be related to operative intervention or infection. CT angiography imaging can be used to assess vessel patency if there is concern for limb ischemia.



Exercise Induced Rhabdomyolysis

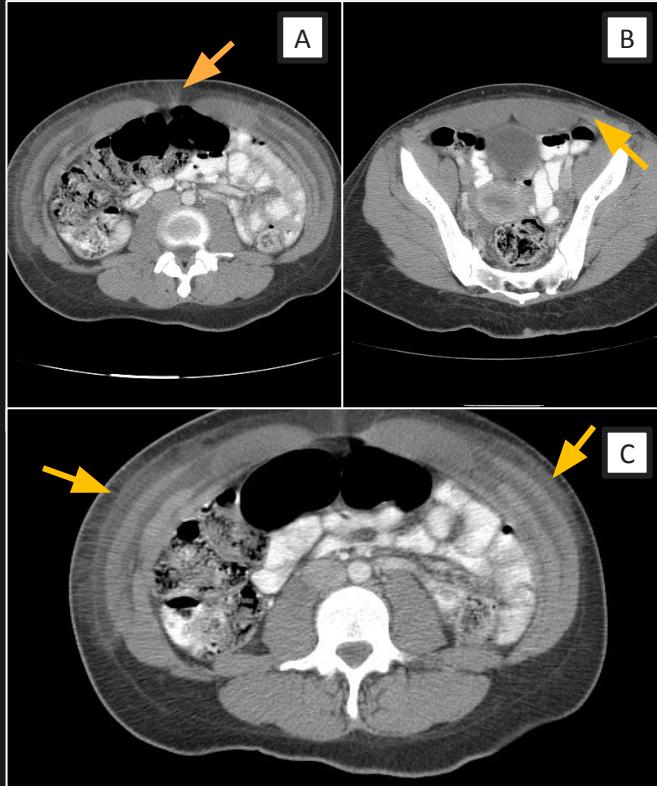
History: 24 year old woman with abdominal pain after strenuously exercising.

Findings:

Axial CT images of the lower pelvis (A and B) show edema tracking along the internal oblique, external oblique, and transverse abdominis muscles bilaterally with associated inflammatory stranding. Findings are suggestive of a diagnosis of rhabdomyolysis.

Discussion:

Etiologies of rhabdomyolysis include overexertion, crush trauma, and ischemia. The process can be symmetric/bilateral and involve multiple muscle compartments. CT findings include heterogeneous muscular enlargement with decreased enhancement. Additionally, the kidneys may show changes including enlargement and perinephric stranding/fluid.



Fatty Muscular Atrophy

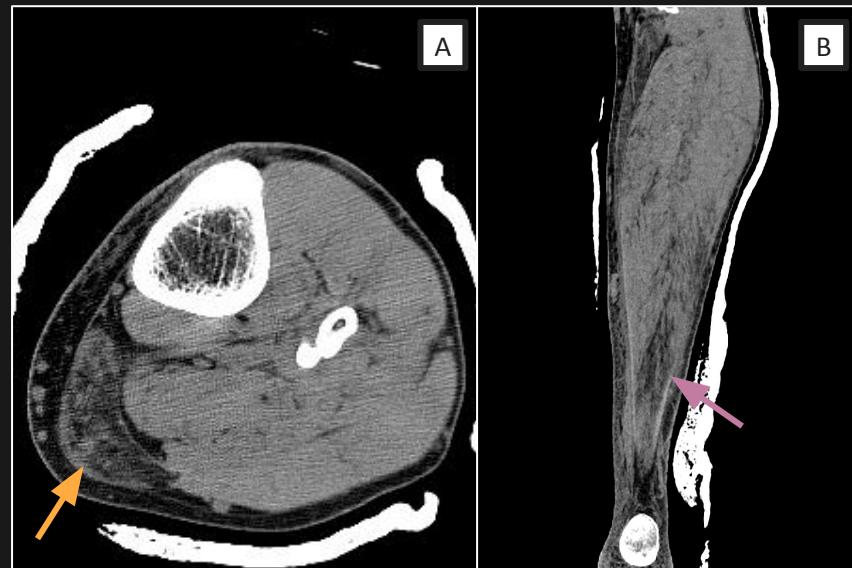
History: 40 year old male with lower extremity gunshot wound. Tibial and fibular fractures were diagnosed on previous ED visit and patient had missed outpatient orthopedic follow-up.

Findings:

Axial CT soft tissue window image (A) of the lower leg shows increased fatty attenuation of the medial gastrocnemius muscle. CT coronal soft tissue window image (B) shows fatty atrophy of the lateral gastrocnemius muscle.

Discussion:

Muscular atrophy is commonly seen with limb disuse in the setting of recent debilitating injury or disease leading to immobilization. In more diffuse muscular atrophy, metabolic and genetic conditions should be considered.



Accessory Soleus

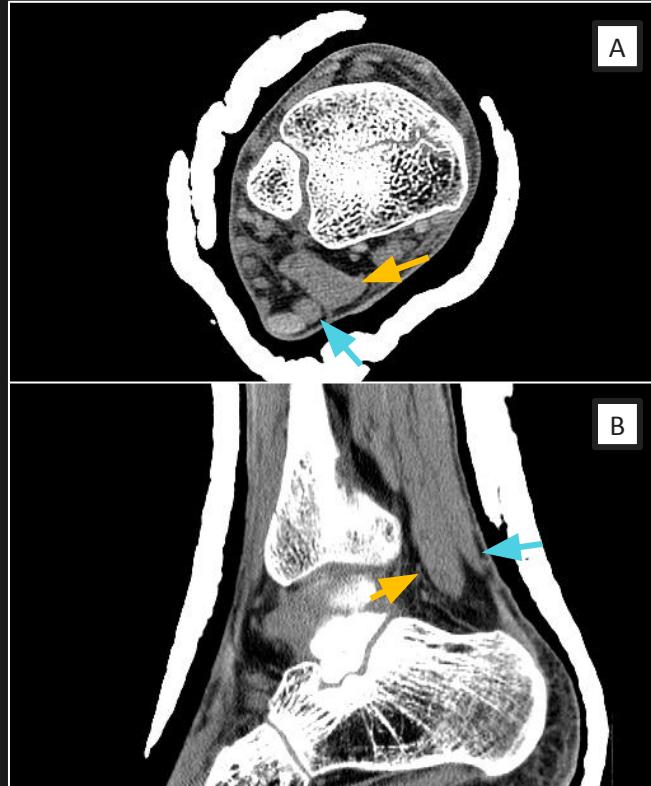
History: 27 year old male with a nondisplaced pilon fracture.

Findings:

CT soft tissue window axial and sagittal images (A and B) of the ankle demonstrate an additional soft tissue density running anterior to the **normal soleus muscle**, compatible with an **accessory soleus muscle**.

Discussion:

Seen in approximately ~3% of the population. If symptomatic may present as a mass in the posterior-distal leg that increase in size with plantar flexion. Can cause pain with running and jumping. Posterior tibial neuropathy due to compression may also occur.



Intramuscular Hematoma

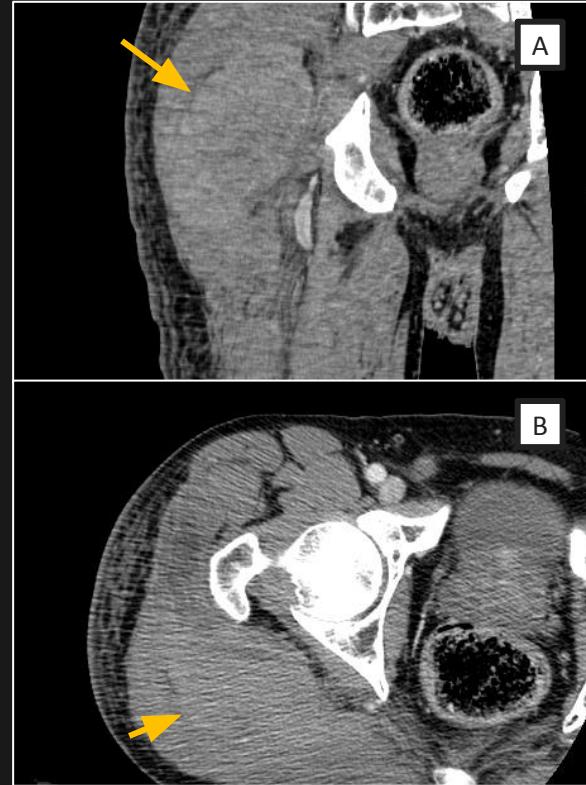
History: 52 year old male with hip pain and swelling.

Findings:

Coronal and axial CT soft tissue window images (A and B) of the hip show a **circular high density ovoid** structure in the expected location of the gluteus medius and minimus muscles. Additionally noted is loss of fat planes between the musculature. Findings are compatible with an **intramuscular hematoma**.

Discussion:

Usually isodense to muscle on non-contrast CT, but can be higher attenuation in more acute cases (such as this case). Contrast extravasation and/or hematocrit levels should always be investigated for to rule out active bleeding. Solid neoplasms should be considered in the differential, especially in non-traumatic presentations.



Thoracolumbar Fascia Tear

History: 44 year old male ran over by a garbage truck.

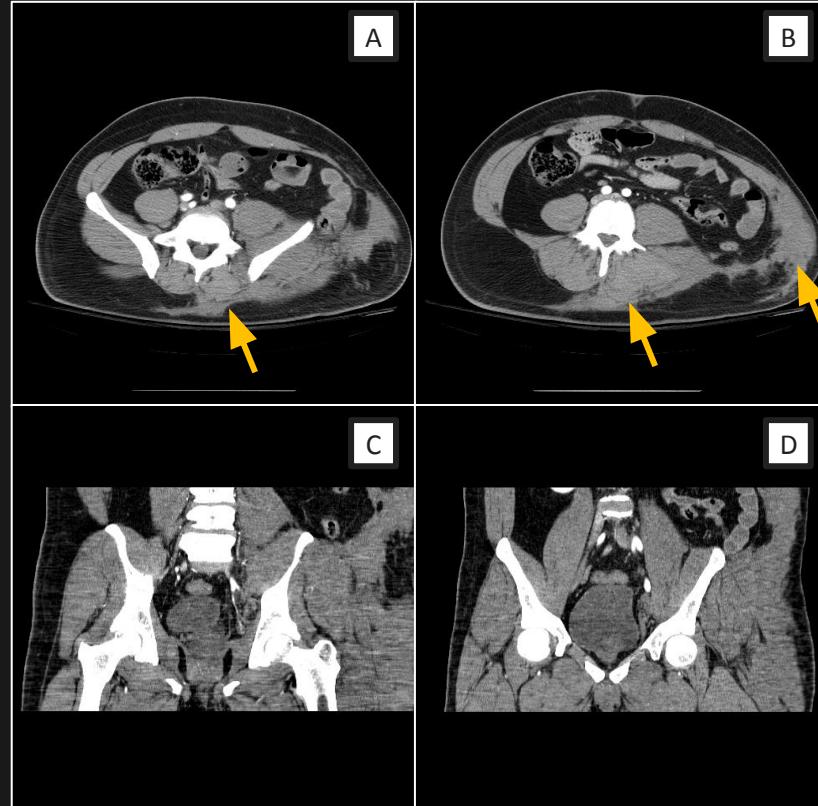
Findings:

Axial and coronal soft tissue window CT images (A, B, C, and D) demonstrate focal disruption of the posterolateral abdominal wall musculature at the level of the umbilicus. Hematoma is seen within the subcutaneous tissues of the left flank and gluteal region, as well as the posterior paraspinal region. Findings are suggestive of a thoracolumbar fascia tear.

Additionally noted, not pictured, was diastases of the left sacroiliac joint and an avulsion fracture of the left transverse process of L5.

Discussion:

Thoracolumbar fascia injury should be suspected with vertebral body and spinal fractures, especially where there is posterior disruption.



ACL Avulsion and MCL Tear

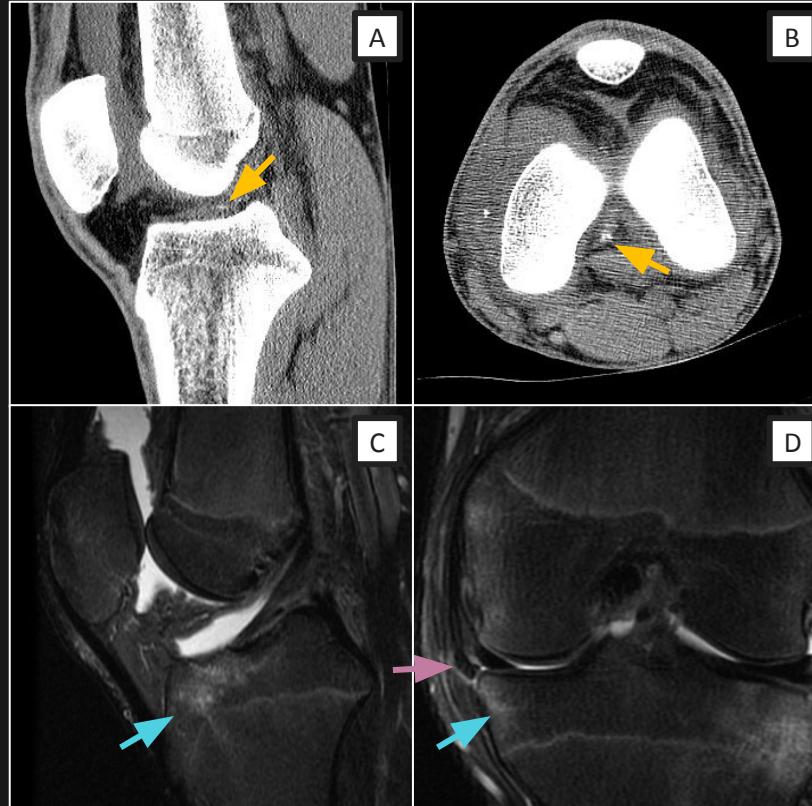
History: 15 year old male after being struck by motor vehicle. Radiographs revealed a fracture at the margin of the lateral tibial plateau (not shown).

Findings:

CT sagittal and axial soft tissue window images (A and B) reveal **tiny ossicles adjacent to the tibial spines** indicative of ACL avulsion footprint injury (McKeever fracture). On follow-up proton density weighted MRI images (C and D) of the knee, there is **bone marrow edema along the medial femoral condyle and medial tibial plateau** with mild anterior tibial translation, suggestive of ACL injury. MRI also revealed **tearing of the MCL** at the level of the medial joint line.

Discussion:

ACL avulsion injury is more common in children than adults. Injury is usually caused by forceful hyperextension of the knee. Anterior tibial translation on the lateral radiograph can clue you in on ACL injury.



Entrapped Medial Meniscus

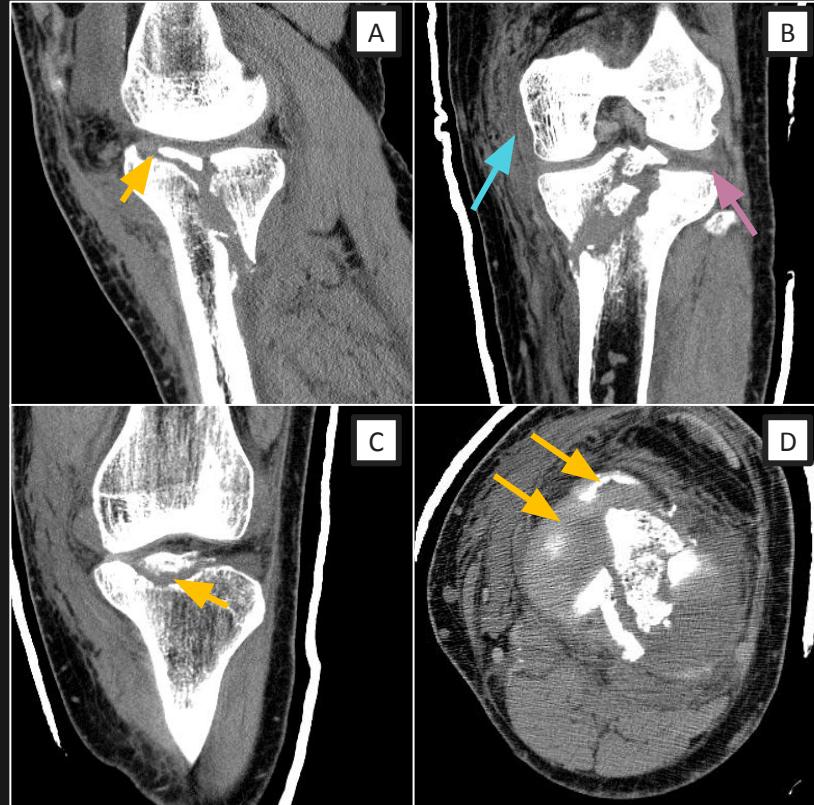
History: 28 year old male with left knee pain after falling from several feet.

Findings:

Axial, sagittal, and coronal CT images of the knee (A, B, C, and D) demonstrate an acute comminuted tibial plateau fracture. Closer evaluation on soft tissue windows show **entrapment of the medial meniscus within the tibial plateau fracture**. Additional injuries include **MCL thickening** and a **floating lateral meniscus**.

Discussion:

Medial meniscus entrapment is an uncommon entity related with tibial plateau fractures, which may have important surgical implications.



Knee Capsular Tear

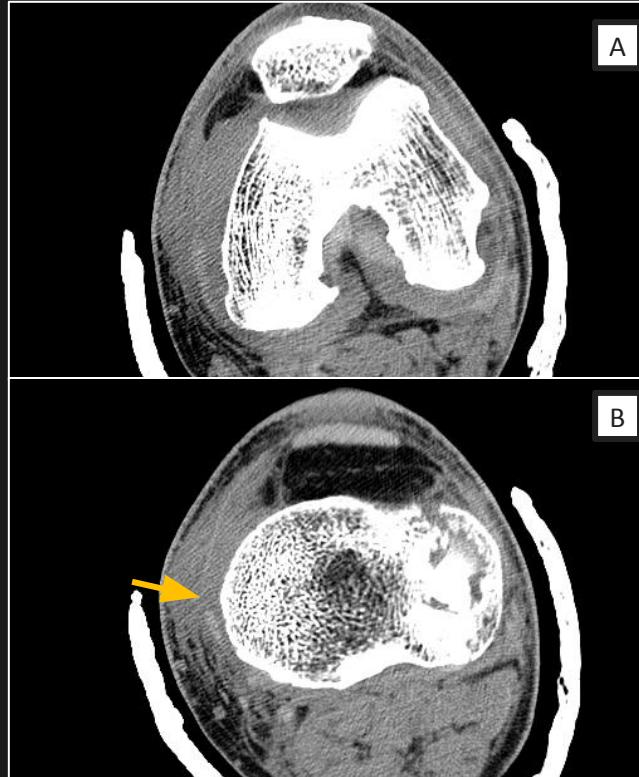
History: 55 year old male with tibial plateau fracture.

Findings:

CT axial soft tissue window images of the knee (A and B) demonstrate a centrally depressed fracture of lateral tibial plateau with lipohemarthrosis. Additionally, there is **capsular knee tear** in the area of the medial patellar retinaculum/medial collateral ligament with associated edema and hemorrhage.

Discussion:

The medial patellar retinaculum is comprised of a superficial layer (fibers of vastus muscles, sartorius, and MCL) and a deep layer (medial patellofemoral ligament and fascia thickenings). The retinaculum blends more posteriorly with the medial knee capsule and inferior surface of the medial tibial condyle.



Displaced Quadriceps Tendon

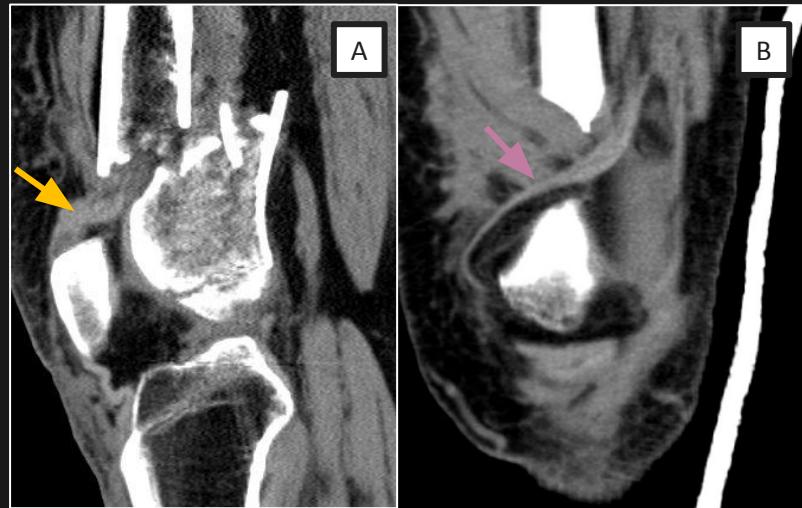
History: 59 year old female as unrestrained backseat passenger in a car that flipped with prolonged extraction. Open right lower leg fracture deformities were noted.

Findings:

CT sagittal soft tissue window image (A) reveals a **displaced and entrapped quadriceps tendon within a comminuted distal femoral fracture**. CT coronal soft tissue window image (B) shows the quadriceps tendon running from the patella through the fracture defect.

Discussion:

Quadriceps tendon rupture is usually a result of high loading on the knee extensor mechanism. Radiographs may show displacement of the patella. Tendon entrapment is important to report for orthopedic reduction/surgical planning, as the tendon must be freed from the entrapment site, and this may need an altered approach.



Iliopsoas Entrapment

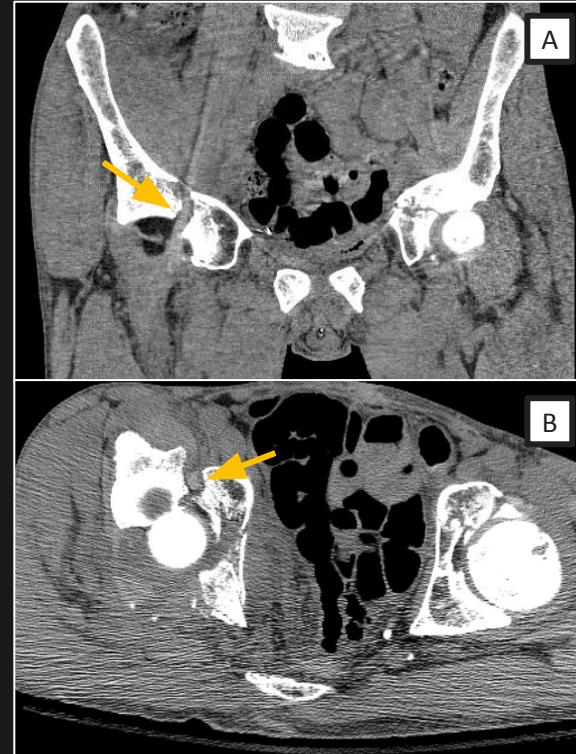
History: 45 year old with history of motor vehicle trauma with multiple pelvic and spinal fractures.

Findings:

Coronal and axial CT soft tissue window images (A and B) of the pelvis demonstrates comminuted bilateral acetabular fractures. Upon further inspection, the iliopsoas tendon travels through the bony fragment of the right acetabular, compatible with an **entrapped iliopsoas tendon**.

Discussion:

Tendon entrapment represents an important complication of fracture injury that may prevent healing, compromise muscle function and result in morbidity. Timely identification is crucial in guiding management.



Flexor Hallucis Longus Entrapment

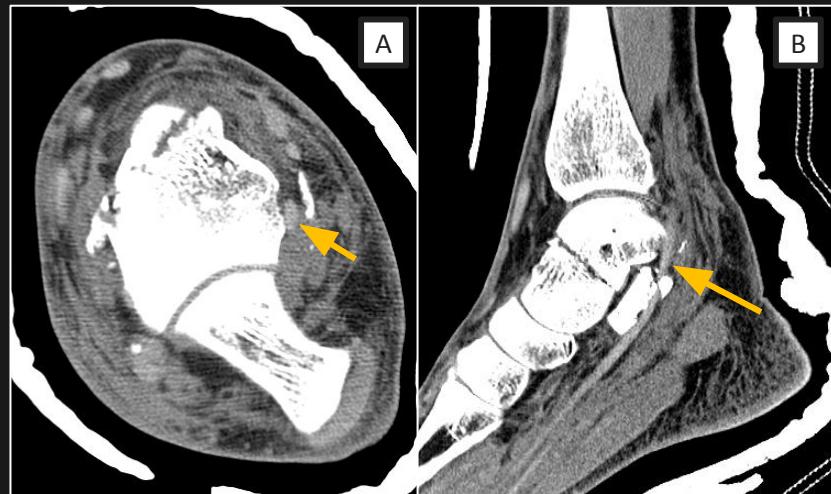
History: 25 year old male in motor vehicle accident with right lower extremity deformities.

Findings:

Axial and sagittal CT soft tissue window images of the ankle (B) demonstrate fractures of talar neck, sustentaculum tali, and calcaneus. There are multiple displaced fracture fragments within sinus tarsi. Upon further inspection, there is **entrapment of the flexor hallucis longus tendon within the sustentaculum tali fracture fragments**.

Discussion:

In addition to traumatic injury, entrapment of the flexor hallucis longus tendon may also refer to when an enlarged os trigonum places repetitive pressure on the tendon by the ossicle.



Achilles Tendon Rupture

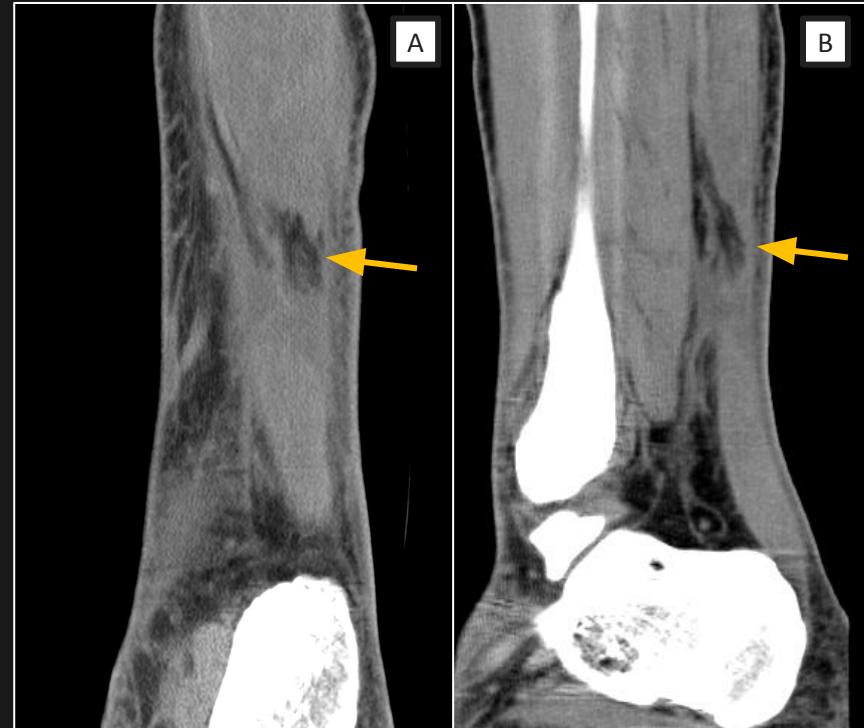
History: 24 year old male with posterior ankle pain after playing basketball.

Findings:

Coronal and sagittal CT soft tissue window images (A and B) of the lower leg demonstrate **discontinuity of the Achilles tendon** with surrounding edema, compatible with an high-grade/full thickness Achilles tear.

Discussion:

Achilles tendon rupture is associated with physical activity with sudden starting and stopping motion (e.g. football, basketball, tennis). Most ruptures occur at the “critical zone” which is a region of hypovascularity. approximately 2-6 cm above its insertion on the calcaneus.



Plantar Fascia Injury

History: 27 year old male presenting with bilateral lower extremity fractures after falling from forty feet.

Findings:

CT sagittal soft tissue window image of the foot demonstrates **discontinuity of the plantar fascia near its origin with retraction**, suggestive of a plantar fascia tear.

Discussion:

Plantar fascia tears typically occur in patients with chronic plantar fasciitis or steroid use, but can be seen with trauma as in our case. Patients may describe hearing a “pop” with sudden severe arch pain along with swelling and bruising.



Posterior Tibial Tendon Rupture

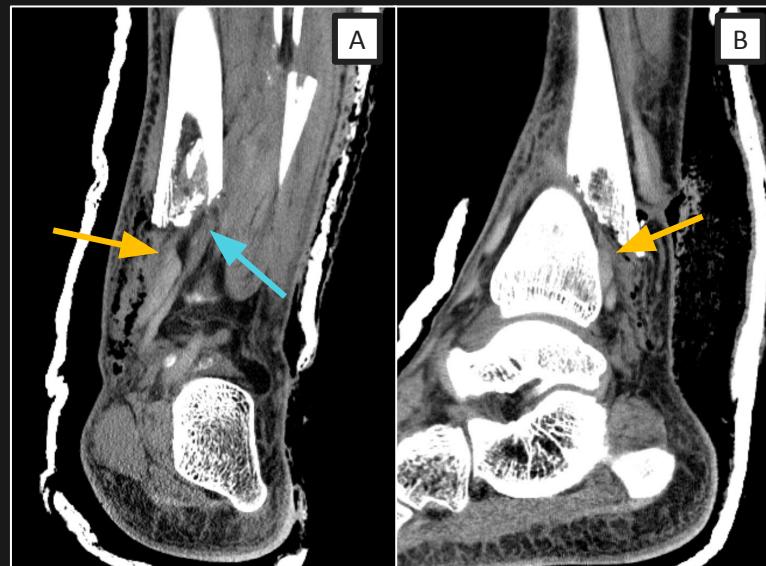
History: 26 year old male with a distal tibial fracture after struck by motor vehicle.

Findings:

CT coronal and sagittal soft tissue window images (A and B) of the ankle demonstrate a comminuted fracture of the distal tibial metaphysis. Soft tissue windows demonstrate **disruption of the posterior tibial** and **flexor digitorum longus** tendons.

Discussion:

Common in late middle aged adults with flatfoot/pes planus deformity due to excessive tension on the posterior tibial tendon. Younger athletes can present with posterior tibial tendon injuries with direct blows to the medial aspect of the ankle.



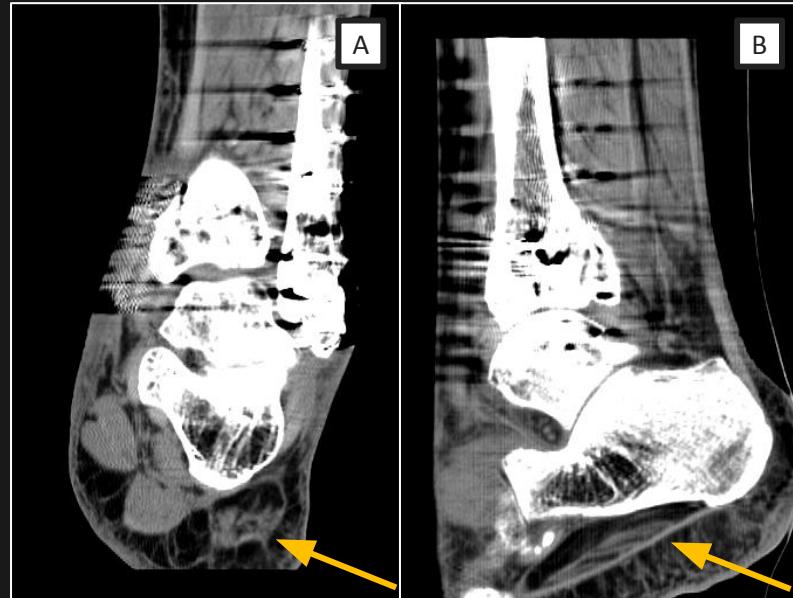
Baxter Neuropathy

History: 61 year old female status post ORIF for trimalleolar fracture 8 months prior. Presenting with persistent pain at surgical site.

Findings: CT coronal and sagittal soft tissue windows images (A and B) of left ankle demonstrated a healed trimalleolar fracture status post ORIF without evidence of hardware complication. Incidentally noted was **fatty atrophy abductor digiti minimi muscle**.

Discussion:

Baxter's neuropathy is a nerve entrapment syndrome due to compression of the inferior calcaneal nerve. Typically presents with heel pain which is maximal at the medial aspect of the foot as well as motor weakness related to atrophy of abductor digiti minimi.

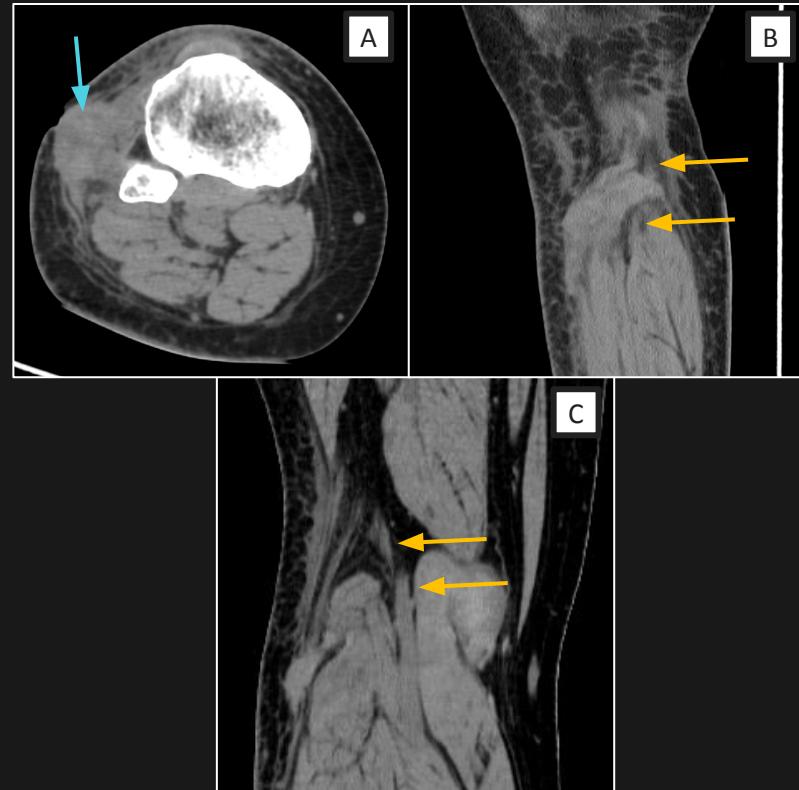


Peroneal Nerve Transection

History: 37 year old female presenting with right leg pain and foot weakness after she sustained leg wounds jumping over a fence while running from a dog several days prior. Clinical exam revealed foot drop and sensory loss over the anterolateral leg and dorsum of foot.

Findings: CT axial soft tissue window image (A) shows a **focal hematoma** at the lateral aspect of the knee with overlying soft tissue defect. There is associated loss of peroneal nerve visualization. CT coronal soft tissue window images (B and C) of the knee demonstrate the **transection of the nerve with discontinuity of the proximal and distal segments**.

Discussion: Traumatic peripheral nerve injury can be the result of blunt or penetrating trauma and is an important cause of morbidity and disability. Ultrasound is also an indicated modality.

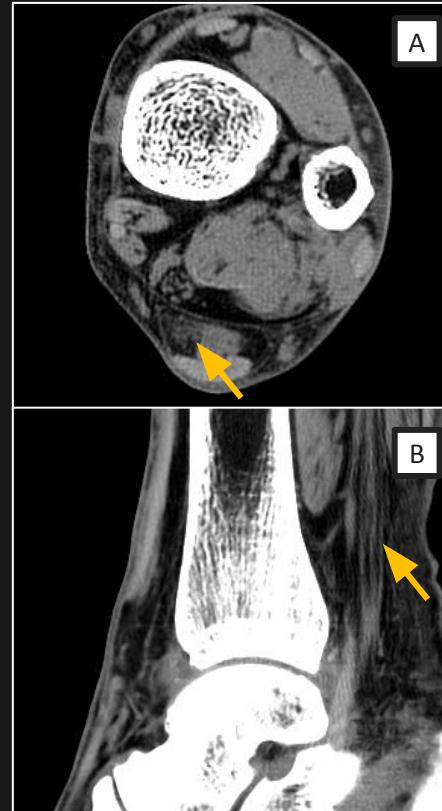


Fibrolipomatous Hamartoma

History: 53 year old female with chronic ankle pain after a remote fracture. Noted to have subtalar joint pain on exam.

Findings: CT axial and sagittal soft tissue windows image (A and B) of the right ankle demonstrates **fusiform, fatty enlargement of the posterior tibial nerve**.

Discussion: Fibrolipomatous hamartoma is a benign neoplasm of nerves due to proliferation of fibroadipose tissue. Resultant separation of nerve fascicles creates classic “coaxial cable” appearance. Can present as asymptomatic mass or with symptoms including pain and paresthesia. Typically seen in children under 10 and in the upper extremity (median nerve).



Takeaways and Conclusion

- The ubiquity of CT, given faster examination times and superior patient tolerance compared with MRI, make it an important tool for identifying additional soft tissue findings, especially in the traumatic setting.
- Always assess for tendon or muscular entrapment on soft tissue windows with comminuted or complex fractures, which is important for surgical planning.

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