Overview

- Knee
  - Effusion/Baker’s cyst
  - Bursae
  - Extensor mechanism
  - Collateral ligaments and MPFL
  - Fracture

- Calf
  - Hematoma and variants/mimickers
  - Medial gastrocnemius strain/tear
  - Plantaris tendon rupture
  - Muscle herniation
  - Interosseous membrane

- Ankle
  - Achilles tendon tear
  - Peroneal tendon tear/subluxation
  - Posterior tibialis tendon
  - Ankle ligament injury
Overview

- Knee
  - Effusion/Baker’s cyst
  - Bursae
  - Extensor mechanism
  - Collateral ligaments and MPFL
  - Fracture

- Calf
  - Hematoma and variants/mimickers
  - Medial gastrocnemius strain/tear
  - Plantaris tendon rupture
  - Muscle herniation
  - Interosseous membrane

- Ankle
  - Achilles tendon tear
  - Peroneal tendon tear/subluxation
  - Posterior tibialis tendon
  - Ankle ligament injury
The Knee

- Visible
  - Extensor mechanism
  - Collateral ligaments
  - MPFL
  - Baker’s cyst
  - Joint effusion
  - Cortical bone

- Largely not visible
  - Menisci
  - Cartilage
  - Cruciate ligaments
  - Medullary bone
Joint effusion

- Typically seen in suprapatellar recess, as well as medial and lateral joint recesses
- Layering hyperechoic fat suggest lipothrombosis
Baker’s cyst

- A Baker’s cyst is a synovial recess extending posteriorly through the semimembranosus tendon and the medial head of the gastrocnemius
- US 100% accurate if neck visualized
Baker’s cyst

- Hypoechoic fluid beyond the inferior margin suggestive of rupture
- Fluid extends superficial to gastrocnemius muscle
- Can present with swelling in popliteal fossa and calf, similar to DVT
- May present acutely, with or without preceding trauma
Baker’s cyst mimics

- Vascular
  - Thrombosed varicose veins
  - Popliteal aneurysm
- Neoplastic
  - Myxoid liposarcoma
  - Synovial sarcoma

Ward et al, AJR 2001
Knee bursae

- Bursitis is a confined fluid collection in anatomic location of known bursa
- No internal Doppler flow
- May have thick walls, septations, debris
- Prepatellar bursa anterior to patella
- Superficial infrapatellar bursa anterior to distal patellar tendon

Extensor mechanism

- Extensor mechanism consists of quadriceps tendon and patellar tendon
- Ideally suited for ultrasound given superficial location
- Particularly beneficial in post arthroplasty patients
Quadriceps tendon

- Hyperechoic, fibrillar appearance best seen in long axis with extended FOV
- Slight flexion may improve visualization
- The distal tendon is the convergence of three layers
  - Rectus femoris
  - Vastus medialis and lateralis
  - Vastus intermedius
Fiber interruption at the distal quadriceps tendon is consistent with tear.

Distinguish partial from complete tear.
- Complete tear is typically managed surgically.
- May fill with heterogeneous hemorrhage or scar tissue.

Typically occurs in older patients with diabetes, renal failure, or gout.

Quadriceps tendon
• Dynamic imaging helpful for visualizing tendon stump in the setting of adjacent debris
  • Gentle passive flexion
  • Squeezing anterior thigh muscles
  • Slightly inferiorly displacing the patella
Patellar tendon

- Extends from patella to tibial tuberosity
- Less heterogeneous than quadriceps tendon
- Hoffa’s fat pad posterior to tendon
Patellar tendon

- Tendinosis may have tendon enlargement, hypoechogenicity, and blurring of the fascicular architecture
- Confirm not positional anisotropy
- Particularly common at proximal patellar tendon
  - “Jumper’s knee”
- May have hyperechoic foci from calcification/bone
Patellar tendon

- Tear may occur at either proximal or distal ends of tendon
- Wavy tendon with retraction if complete
- Dynamic maneuvers with flexion or superior displacement of the patella to differentiate from partial tear
Knee ligaments

- ACL and PCL are not well seen by US
  - Indirect signs of injury at US have been reported
  - MRI remains the study of choice
- MCL and LCL can be visualized with US
  - US uncommonly requested as there is typically concern for concurrent meniscal or cruciate ligament injury

Knee ligaments

- Medial Collateral ligament
  - MCL arises from the medial femoral condyle and extends distally
  - Can extend up to 5 cm beyond the level of the joint line before inserting on tibia
  - Overlying pes anserine tendons distally demonstrate anisotropy
Knee ligaments

- MCL sprain
  - Grade 1 = Fluid along MCL
  - Grade 2 = Thickening and hypoechoic signal in ligament, partial tearing
  - Grade 3 = Complete tear with lax fibers

Razek, Journal of Ultrasound, 2009
Easiest parts of posterolateral corner to visualize by ultrasound are the biceps femoris, LCL, and popliteus.

LCL attaches proximally at femoral condyle overlying popliteus.

Distal LCL attachment blends with biceps femoris to produce conjoined tendon insertion on the fibular head.

Similar injury grading as MCL.
Medial Patellofemoral Ligament

- Associated with patellar dislocation/relocation injury
- Extends from medial patellar facet to adductor tubercle
- Frequently disrupted at either patellar or femoral attachment
- Reported accuracy of 90%
- May be difficult to evaluate for osteochondral injury

Zhang et al, Injury, 2013
Fracture

• Most, but not all, patients have radiographs as part of a trauma evaluation
• Sometimes ultrasound is the first modality utilized
• Bones should be evaluated in all patients following trauma, particularly if no prior radiographs
Many fractures can be detected on US by cortical disruption. US can be targeted to area of focal tenderness. Greater accuracy for fractures in the straight diaphyseal region of bone.
Overview

- **Knee**
  - Effusion/Baker’s cyst
  - Bursae
  - Extensor mechanism
  - Collateral ligaments and MPFL
  - Fracture

- **Calf**
  - Hematoma and variants/mimickers
  - Medial gastrocnemius strain/tear
  - Plantaris tendon rupture
  - Muscle herniation
  - Interosseous membrane

- **Ankle**
  - Achilles tendon tear
  - Peroneal tendon tear/subluxation
  - Posterior tibialis tendon
  - Ankle ligament injury
Hematoma

- Palpable mass with bruising after trauma
- In subcutaneous tissues or muscle
- May be minimal or no trauma in patients on anticoagulation or bleeding diathesis
- Initially hypoechoic but more heterogeneous over time
- No internal Doppler flow
Hematoma

- Typically resorb over time
- May form chronic hematoma with thick hemosiderin rim
- May calcify over time, forming hyperechoic shadowing foci
Myositis Ossificans

- Typically follows traumatic hemorrhagic muscle contusion
- Majority in thigh, can occur in calf
- Early on appears as hypoechoic mass with potential Doppler flow
- Later may see mature ossification
- Radiographs helpful for identifying maturation of bone
Morel Lavallee lesion

- Shear injury at junction of superficial fat and underlying fascia
- Fluid collection with hemorrhage, lymph, and fat
- Common locations in the leg include overlying greater troch and prepatellar region
- Tends to flatten and become more homogeneous with time
Soft tissue tumor

- Patients may first feel a palpable abnormality following trauma
- Tumor can overlap in grayscale appearance with hematoma
- Utilize Doppler to look for flow
- Biopsy ultimately needed of any area with flow/enhancement on MRI
- Tumor can also have internal hemorrhage following trauma
  - Short interval imaging or clinical follow up
Muscle strain

- Strain vs sprain
  - Strain = muscle injury
  - Sprain = ligament injury
- Myotendinous junction is the weak point of the myotendinous unit
- Muscle traits associated with strain
  - Extend across two joints
  - Fusiform
  - Frequently have eccentric contraction
- Medial gastrocnemius most frequently strained in the calf
  - “Tennis leg”

Palmer et al, AJR 1999
Calf Muscle structure

- Skin and fat are superficial
- Epimysium are the two brightest reflectors, one superficial to gastrocnemius and one between soleus and gastrocnemius
- Perimysium is thinner linear reflectors within muscle tissue surrounding fascicles
- Background muscle is hypoechoic
Calf Muscle structure

- Proximal aspect of medial gastrocnemius has a superficial aponeurosis
- Distal aponeuroses of medial gastroc (deep to muscle) and soleus (superficial to muscle) abut each other
- Soleus and gastroc aponeuroses continue distally beyond gastroc muscle for a variable length before beginning to fuse
Calf Muscle structure

- Typical linear bright/dark/bright appearance secondary to:
  - Distal gastrocnemius aponeurosis (deep to medial gastroc muscle)
  - Interaponeurotic space
  - Distal soleal aponeurosis (superficial to soleus muscle)
- Distal aspect of medial gastrocnemius particularly prone to injury
  - Normal triangular appearance
Medial gastrocnemius muscle strain

- Grade 1 strain
  - Edema and infiltrating hemorrhage within muscle produce hyperechogenicity near myotendinous junction
  - Contrast with normal muscle or contralateral side
  - Centered on myotendinous junction
  - Similar appearance as muscle contusion or delayed onset muscle soreness
Medial gastrocnemius muscle strain

- Grade 2 strain
  - Hypoechoic areas of partial muscle tissue disruption/tear
  - Background muscle hyperechogenicity from edema and hemorrhage
  - Perifascial edema
  - Potential hematoma between soleus and gastroc in interaponeurotic space
  - Muscle fibers at triangular myotendinous junction are partially disrupted, aponeurosis usually intact
Medial gastrocnemius muscle strain

- Grade 3 strain
  - Complete disruption of myotendinous junction
  - Confirm that the entire width of the tendon is disrupted on transverse images
  - Frequently large hematoma that extends cephalad
  - Distal gastroc aponeurosis typically disrupted with complete or significant partial muscle tears
Plantaris tendon

- Plantaris tendon arises from lateral aspect of posterior femur, next to lateral gastroc
- Moves from lateral to medial as it extends distally
- Passes in interaponeurotic space between medial gastrocnemius and soleus
- Eventually inserts onto calcaneus just medial to the Achilles tendon
- Short muscle belly and long tendon segment
- Present in 80%

Plantaris tendon

- Can be seen along the medial aspect of the Achilles tendon at its insertion
- In the lower calf, it lies along the superficial aspect of the medial soleus
- In between medial gastroc and soleus more proximally
- Can be seen in interaponeurotic space as a third echogenic line between the gastrocnemius and soleus aponeuroses
Plantaris tendon

- Previously thought to be cause of “tennis leg” as opposed to medial gastroc tear
- Tubular hematoma between medial gastroc and soleus aponeuroses
  - Med gastroc tear hematoma typically wider
- May be able to trace tendon stump, but difficult
- Typically rupture at myotendinous junction which is proximal to typical medial gastroc tear

Jamar et al, AJR 2002
Muscle herniation

- Most common location in the body is anterior shin along the tibialis anterior muscle
- Muscle protrudes through a fascial defect and presents as a painful mass
- May be associated with a point of fascial weakness from a perforating vessel
- Traumatic disruption of the fascia has also been implicated
Muscle herniation

- Dynamic imaging is critical, thus US is test of choice
- Typically worse with contraction of the muscle or standing
- Apply light pressure with transducer to allow the hernia to be demonstrated
Interosseous membrane

- Interosseous membrane is a thin sheet connecting the tibia and fibula
- Echogenic line on ultrasound
- Potentially disrupted in “high ankle” sprain along with anterior and posterior tibiofibular ligaments
- Disrupted in Maisonneuve fracture
  - Proximal fibular fracture with medial malleolar fracture or deep deltoid ligament disruption

Overview

- Knee
  - Effusion/Baker’s cyst
  - Bursae
  - Extensor mechanism
  - Collateral ligaments and MPFL
  - Fracture
- Calf
  - Hematoma and variants/mimickers
  - Medial gastrocnemius strain/tear
  - Plantaris tendon rupture
  - Muscle herniation
  - Interosseous membrane

- Ankle
  - Achilles tendon tear
  - Peroneal tendon tear/subluxation
  - Posterior tibialis tendon
  - Ankle ligament injury
Achilles tendon

- Visualize from level of gastrocnemius musculotendinous junction to the calcaneal insertion
- Extended FOV image helpful for global overview
- Flat or concave anterior margin in short axis
Achilles tendon

- Tendon thickening and hypoechogenicity consistent with tendinosis
- Hyperemia on Doppler imaging
- Loss of anterior concavity on short axis imaging
Achilles tendon

- Usually at the watershed zone 2-6 cm proximal to the insertion
- Insertional tears are typically associated with Haglund’s deformity/syndrome from ill-fitting shoes
- Heterogeneous hemorrhage or scar tissue may be seen at the site of rupture
- Typically shadowing artifact is seen at tendon stumps from refraction
- 92% accuracy differentiating complete from partial tears
Achilles tendon

- Important information for surgeon includes:
  - Partial or complete
  - Size of tendon gap
  - Change in tendon gap with plantarflexion
  - Distance of distal stump from calcaneal insertion
  - Degree and length of tendinosis at margins of tear
Achilles tendon

- Plantaris tendon inserts into the calcaneus along the medial aspect of the Achilles tendon
- The plantaris tendon is stronger than the Achilles tendon and is often intact following Achilles rupture
- Don’t mistake plantaris for intact Achilles fibers
Peroneal Tendons and Superior Peroneal Retinaculum (SPR)

- Peroneal tendons lie within common tendon sheath along retromalleolar groove behind distal fibula
- Held in place by superior peroneal retinaculum (SPR)
- Peroneus brevis (PB) anterior to peroneus longus (PL)
Peroneal Tendons and Superior Peroneal Retinaculum (SPR)

- SPR injury often clinically mistaken for lateral ankle sprain
- SPR typically stripped from fibula with formation of pouch along lateral fibula
- May alternatively have SPR tear with or without osseous fragment
- Look for extension of peroneal tendons along lateral aspect of fibula
- Usually a dynamic phenomenon, so may be better seen with US than MRI

Wang et al, Radiographics 2005
Peroneal tendon tear

- Peroneus brevis is particularly prone to tear
- Tendency for PB to form partial split tears that wrap around the PL
  - “Boomerang sign”
- Peroneal tendon tears associated with:
  - SPR injury/subluxation
  - Peroneus quartus
  - Low lying peroneal brevis muscle belly
  - Shallow retromalleolar groove
Medial tendons

• Order of tendons beyond the medial malleolus remembered by the mnemonic:
  • Tom (Posterior Tibialis Tendon)
  • Dick (Flexor Digitorum Longus)
  • A Very Nervous (Posterior tibial artery and vein, Tibial Nerve)
  • Harry (Flexor Hallucis Longus)
• PTT is the primary stabilizer of the medial arch
Posterior tibialis tendon

- PTT abnormalities more typically chronic and associated with flatfoot deformity
- PTT should normally be twice as big as FDL
- Tendon thickening, hypoechogenicity in tendinosis
- Surrounding fluid in tenosynovitis
- Anechoic clefts or tendon thinning in tearing
Ankle ligaments

- Anterior and Posterior tibiofibular ligaments superiorly
  - Injured in “high ankle sprain”
- Anterior talofibular and posterior talofibular ligaments inferiorly
- Calcaneofibular ligament deep to peroneals
- Typical tear sequence Anterior talofibular > Calcaneofibular > Posterior talofibular
Ankle ligaments

- Superficial and deep deltoid ligaments on the medial side
  - Image in coronal plane
  - Deep frequently anisotropic
  - Superficial easier to delineate
Ankle ligaments

- Ankle ligament injuries all appear similar by US
- Ligamentous disruption = tear
- Adjacent hypoechoic edema if acute
- Swollen, hypoechoic ligament if sprained
Conclusion

- US is well suited to evaluate certain post traumatic lower leg conditions
  - Baker’s cyst
  - Extensor mechanism
  - Medial gastrocnemius tear
  - Muscle herniation
  - Achilles tear
  - Peroneal subluxation
- Other conditions may be encountered unexpectedly
  - Fracture
  - Tumor
References

References

Thanks for your attention