Lower Extremity Pathology

Hip
Knee
Foot/Ankle

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Lower Extremity Pathology

Hip
Anterior Capsule

Anterior Longitudinal Approach
Sonographic Anatomy: Intra vs Extra Capsular Structures

**Identifying landmark for hip capsule**

Intra-capsular
Illo-femoral ligament
Pubo-femoral ligament

These are LARGE intra-capsular ligaments!
Bone-to-Bone Hyper-echoic/bright, fibrillar pattern is normal.

**Identifying landmark for hip capsule**

Note the Femoral Neck is parallel with probe. Allows accurate measurements.

[Image of anatomical structures]
Anterior Longitudinal Approach
Sonographic Anatomy: Capsular Effusion
Hip Sonography
Anterior Longitudinal Approach
Sonographic Anatomy: **Extra-Capsular Effusion/Bursitis**

Capsular Effusion with **Ilio-Psoas Bursitis**
Acetabular Labral Tears

Smooth Acetabular and Femoral cortex interfaces with the ligament/capsule “margin”. Hyperechoic labrum is seen overlying the joint space.

Acetabular Labral Tears

The focal, anechoic defect visible in the antero-superior portion of the labrum is fluid infiltrating a small tear. Anterior labral tears are common in athletic individuals over age 30.
Medial probe translation/rotation from capsular-labrum image becoming parallel with hyperechoic fibrillar tendon. Septated, hypoechoic IP muscle is superficial to tendon.

**Ilio-Psoas Tendon**

**Ilio-Psoas Tendon: Long Axis**

Mechanism
- Excessive hip flexion… "tendinitis" (cyclists)
- Sudden contraction of IP muscle… rupture (soccer, rugby)

The tendon is hypoechoic with poorly displayed fibrillar pattern.
Snapping Hip Syndromes

Three Types

1. Internal
   Ilio-psoas tendon snapping over Pectineal brim

2. External
   Ilio-tibial Band Syndrome
   ITB snapping over Greater Trochanter of Femur

Type 1 and 2 may be grouped as "EXTRA-ARTICULAR"!

3. Intra-articular
   Acetabular Labrum tears
Internal Snapping Hip

- Most common of the three types
  - May/not be painful
- Positive Thomas test
  (psoas tendon contracture)
- Positive Faber’s test
  \( F = \) flexion  \( AB = \) Abduction  \( ER = \) External Rotation
- Dynamic “frog leg” test reproduces snap

The snap can also be more subtle and experienced as just a sensation by the patient.
Internal Snapping Hip


**Frog-leg Position**

IP tendon is enveloped by iliacus muscle

**Leg Extension w/ Int. Rotation**

IP tendon “snaps” down onto pubic ridge

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Internal Snapping Hip: Dynamic Test


**Frog-leg Position**

IP tendon is enveloped by iliacus muscle

**Leg Extension w/ Int. Rotation**

IP tendon “snaps” down onto pubic ridge
External Snapping Hip: Ilio-Tibial Band Syndrome

Aberrant... anterior-ward motion or snapping of the ITB OF Gluteus Max. Can be elicited with passive or active internal/external rotation.

Normal
In hip extension /aBduction the ITB (blue) is posterior to the femoral Greater Trochanter (green)
External Snapping Hip Imaging Protocol: Short Axis

Patient in decubitus position. Short axis probe placement at apex/peak of the Greater Trochanter to visualize thick, ellipsoidal ITB in cross-section.

External Snapping Hip: Ilio-Tibial Band Syndrome

Abnormal
In hip flexion the thick... ellipsoidal ITB “snaps” anteriorly to a position in front of the femoral Greater Trochanter.
Lower Extremity Pathology

Trochanteric Region

Gluteal Attachments: Four Trochanteric Facets

Anterior: Gluteus Minimus
Lateral: Gluteus Medius
Superior-posterior: Gluteus Medius
Posterior: Sub-Gluteus Maximus (not the attachment)
Gluteus Minimus: Gmin Long Axis

Normal

Abnormal

Mechanism
Stretching or straining beyond normal range of motion. Soccer, football, baseball players making sudden movements. Hurdles, long jump increase gluteal strain. Not stretching before activity, playing in cold weather.

Gluteal Medius: Gmed Long Axis

Normal

Abnormal

The tendon is hypoechoic... thickened with poorly displayed fibrillar pattern.
Gluteus Medius: Gmed Long Axis

Gluteus Medius tendon rupture

Normal

Abnormal

Gluteus Maximus: Largest Trochantric Bursa

Proximal

Distal

Posterior facet ... sub-gluteal space of Greater Trochanter
Anechoic fluid visible in the Trochanteric Bursa
Trochanteric Syndrome

- Routinely involves only Gmin and Gmed
  - Trochanteric Bursitis ... rare
  - If fluid is seen typically “simple fluid”
    ( anechoic with no debris)

Lower Extremity Pathology

Sciatic Nerve
**Hip Sonography**

**Piriformis Imaging**

- Sciatric Nerve immediately deep to Piriformis

Dynamic Maneuver: Internally/Externally rotate

The hip/foot. Piriformis moves.

Overlying GM does not.

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**Sciatic Nerve: Piriformis**

- More “compact” and echogenic Piriformis fibers are deep to “coarse” septations of Gmax.

- Ovoid “starry night” of Sciatic nerve is deep to Piriformis.
Sciatic Nerve: Piriformis Syndrome

Neuro-muscular disorder causing Sciatic nerve irritation by compression or encroachment of the overlying Piriformis muscle.

Symptoms:
Deep buttocks pain
Radiating pain along course of nerve
Stretching the gluteal muscles reproduces pain

Ultrasound imaging mainly for blocking the nerve

Lower Extremity Pathology

Hamstring Attachments
**Conjoined Hamstrings Imaging Protocol: Long Axis**

Prone patient. Feet extending off end of table. Ischial tuberosity is palpable. Long axis probe placement on inferior-medial aspect.

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**Semimembranosus Imaging Protocol: Long Axis**

Prone patient. Feet extending off end of table. Ischial tuberosity is palpable. Long axis probe placement on superior-lateral aspect.
Semitendinosus Tendinosis: Long Axis

Recent injury following a history of hamstring pain. Compatible with repetitive micro-tears. Typical of enthesopathy.

Loss of normal fibrillar echotexture

Hamstring Syndrome

An insertional tendinopathy at the ischium.
Exacerbated by activity that stretches the Hamstrings.
Common in runners.

Partial thickness tear and fluid accumulation (red arrow) involving the Semitendinosus/Biceps Femoris complex in a male long distance runner. Note cortical depression (white arrow), suggestive of avulsion.
Hamstring Tear

Mechanism:
Rapid acceleration activity… when initiating running

Clinical: Tender at origin
Spasm…tightness
Reporting a “pop” sound or sensation
Visible bruising
Walk with a limp

Lower Extremity Pathology

Knee
Anterior Compartment
Suprapatellar Longitudinal

Identifying three interfaces is helpful in using suprapatellar pouch/bursa for intra-articular injections.

OA with minimal bursal effusion
Ultrasound guidance adds increased accuracy

Check tendon pattern!


Suprapatellar Effusions

LAX view pre-aspiration

SAX view post-aspiration
**Quadriceps Tendinosis**

1. Increased cellularity…
   - thickened and…
   - “inhomogeneous”…
   - Not homogeneous…
   - Mixed echoes of hyper and hypo echoic tissue.

2. Neovascularization

3. Disrupted fibers within the tendon

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**The Knee**

“Sunrise” View for Osteoarthritis

- Supine patient with full flexion.
- Supra-patellar … SAX Probe
- Cortical outline of Femoral Trochlea and ANECOIC hyaline cartilage should be smooth, homogeneous
US Data: Femoral Trochlea

Cartilage Clarity/Thickness

Sulcus Angle: ~ 130 degrees
Patello-Femoral joint conformation

Deeper (less than 130°) Early life
Flatter (more than 130°) Later life

Slide Courtesy
Victor Ibrahim, MD
Bipartite Patella

a “non-ossification”… synchondrosis found in 1% of population (boys)

Three types… based on location of cleft

I: inferior pole of the patella
II: lateral margin type
III: supero-lateral type

Image adapted from JAAOS August 2008 vol. 16 no. 8 455-46

Bipartite Patella

Considered Normal Variant

50% +/- … are bilateral

2% … become symptomatic

Symptoms may mimic fracture

Trauma can cause irritation of fibrous tissue between two osseous segment

Surgical Intervention (rare)

1. Excise smaller portion
2. Patellar retinaculum release to reduce stress on larger portion
Bipartite Patella

LAX Suprapatellar View

Demonstrating either...
Type II: lateral margin cleft
or
Type III: Supero-lateral margin cleft

Patellar Tendonitis aka…”Jumper’s “Knee

Mechanism
Repeated eccentric contraction of Quads... when landing from a jump.
Characterized as “tendinitis” of deep side proximal region of tendon

Doppler flow may be seen

65% of patellar insertional cases

Slide courtesy Victor Ibrahim, MD
Case Study: Patellar Tendinosis (chronic)

LAX image of the patellar tendon.
47 y.o., osteoartrhritic male. Two debridements.
Chronic patello-femoral pain.
Note irregular contour of patella, and scar tissue between arrows.

Success rate is low when activity is resumed

Osgood Schlatter Syndrome

Mechanism
Thought to be combined events of growth spurts and repeated quad contraction
“Traction epiphysitis” at the immature tibial tubercle
“knobby knees’
Self-Limiting
Up to 21% of Athletic Youth

US Characteristics:
1) Tibial edema and
2) Neovascular flow
**Hoffa's Impingement Syndrome**

**Mechanism**

Hyper-extension (genu recurvatum)
Fat pad is *intra-articular* but *extra-synovial*...

Exposing it to compression between the patella and femoral condyle

Enlarged medial and/or lateral portions may extend to the mid-joint line

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**Hoffa's Impingement Syndrome**

LAX view patellar tendon. *Notice landmarks of patella and femur*

Hypoechoic, edematous fat pad with focal calcification is deep to tendon
Lower Extremity Pathology

Knee

Medial Compartment

Meniscal Tears: Classifications

Non-Displaced or...

- Longitudinal
- Horizontal
- Radial

Displaced

- Bucket Handle
- Flap
- Parrot Beak
Meniscal Tears

**US Findings**

1) Hypoechoic “cleft” or line?

2) Displacement... detached fragments?

3) Cyst Formation?
   - Well-defined (it has a synovial lining)
   - May/may not be irritant
   - Secondary finding to tears.

Tears are more visible as they extend to peripheral margin

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Ultrasound and Meniscal Tears

**Sensitivity:** 86.2% (true positives)

**Specificity:** 84.9% (detecting tears)

Dynamic and Static Testing is needed

*MRI is still "gold standard" (1.5T)*
Meniscal Tears and MCL Injury
Part of “unhappy triad”?
(ACL not well insonated)

Anterior and posterior portions give it a “tri-laminar” appearance, best seen at its proximal portion.

MCL tears
LAX MCL View
Multiple defects in MCL
Menisco-femoral portion (A) and Tibial side (B)
Dynamic Valgus stress required to determine full or partial thickness tears.
Ancient MCL Tear with Calcification

LAX panoramic view
Post traumatic calcifications (1) are common
Medial meniscus defect (2) also present

Case Study: MCL Injury @ tibial attachment

Untreated MCL rupture after skiing accident.
Note irregular distal end of MCL. Pes Anserinus superficial
Pes Anserine Bursitis

Remember the anatomy…
Conjoined tendon of

\( Sartorius \)

\( Gracilis \)

\( Semitendinosus \)

“Say Grace before Tea”

Gracilis and Semitendinosus are deep to Sartorius

Presence of Bursa is Minimal in Healthy Adults

Sonopalpation helpful
(Applying light pressure with ultrasound probe)

Anatomically specific palpation

Bursal interface is between the superficial Pes and the deeper MCL
Tibial cortex deep to MCL
Medial Plica Syndrome

Young Adolescents
30° Knee Flexion
Translate Patella Medially
Accumulation retro-patellar
Loss of retro-patellar cartilage
(anechoic interface @ patellar margin)

A ribbon-like fold of synovium
Embryologic remnant

Lower Extremity Pathology

Knee
Lateral Compartment
Ilio-Tibial Band

Most superficial fibrous structure on LAX image of lateral knee. Stabilizer of hip and knee in weight-bearing position. Inserts on Gerdy’s tubercle of Tibia

ITB Friction Syndrome

**Mechanism**
- Repetitive flexion/extension (running)
- Friction between condyle and ITB

**US Findings**
1) Fluid above and/or below ITB
2) Tendinosis (thickening)

**3) Dynamic Testing**
Visible Notable Compression Test
- *slight decubitus patient
- *SAX probe @ lateral condyle
  - Compress w probe
  - flex/extend knee
- *ITB moves A to P causing pain at +/- 30°
ITB Friction Syndrome

Fluid above ITB

Fluid below ITB (yellow arrows)
Hyperechoic ITB (white arrow)

ITB Friction Syndrome

ITB not thickened

ITB Thickened… tendinotic
Contra-lateral image may be helpful to compare
**Tibio-fibular Joint...the forgotten joint**

aka...Proximal tibio-fibular articulation
A true cartilage lined joint
Has it’s own articular capsule
Communicates: 10%

**Function:**
Alleviate torsion stress

**Mechanism of Injury**
Susceptible to indirect trauma resulting from severe ankle stress.
Direct trauma is an impact to lateral knee while weight-bearing and flexed.

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**Tibio-fibular Joint Image**

Supine patient +/- 30° flexion
SAX oblique probe
Tibio-fibular Ganglion Cyst

Peroneal Nerve

SAX probe at postero-lateral Fibula demonstrates PN Smaller of the two terminal branches of the Sciatic nerve.

SN= Sciatic Nrv  TN= Tibial Nrv  PN= Peroneal Nrv
Lower Extremity Pathology

Knee
Posterior Compartment

Popliteal Fossa in Cross-section

Baker’s cysts have a “tell-tale” conformation by displaying a unique neck of origin as effusion enlarges between the MG and SM.
**Popliteal Fossa: Baker’s Cyst**

Prone patient position
SAX probe @ crease
scanning thru the joint space.

The medial Gastroc
is seen in cross-section.
The Nerve...Vein... Artery
in a “Stack” formation

**The Knee**

**Popliteal Fossa: Baker’s Cyst**

True Baker’s cyst ...
* is INTER-MUSCULAR
* originates on medial side
* has a distinct neck of origin

What is this lump!
...on my knee?
The Knee

Popliteal Fossa: Neuro-Vascular Bundle
The Nerve – Vein – Artery “Stack”

Sonopalpation allows localization of the...
HYPER-echoic Tibial nerve
Compressible Popliteal vein
Non-compressible ... Pulsatile Popliteal artery

Lower Extremity Pathology

Foot/Ankle
Anterior Compartment
Ankle Joint Effusions

Normal LAX view anterior ankle

Ankle Joint Effusions

Mechanism
Trauma, inflammation, infection
Ankle Ligament Sprain and/or Rupture

The Ankle and Foot
Antero-lateral Ankle
Anterior Talo Fibular Ligament

Long axis /oblique probe crosses the joint space.

The ligament interdigitates with the deeper, anterior joint capsule and may appear to dip into the joint space.
Mechanism
Bleeding and inflammation post-trauma often results in hyperechoic calcification at the “stump”. Note posterior shadowing deep to calcific margin.
Talo-Fib ligament Tear

Probe is positioned on the Antero-Superior aspect of the fibular malleolus, AND turned obliquely enough to have the tibia as the right-side osseous landmark.

Anterior Tibio-fibular Ligament

Tibio-fibular Ligament in interosseous margin. The overlying EDL muscle is not seen.
Tibio-fibular Ligament

- **Normal**
- **Abnormal**

**Mechanism**
Severe inversion injury with torsioning of lower leg.
Symptoms differ from ATFL sprain...
Pain with external rotation of foot.
Positive “squeeze” test of lower leg

Calcaneo-Fibular Ligament

- **Normal**
- **Abnormal**
  - **PB** = Brevis
  - **PL** = Longus

**Largest of the lateral collateral ligaments. A strong, cordlike structure. Lies deep to the peroneal tendons**

**Mechanism**
Often injured with ATFL
Responds well to conservative tx.
Lisfranc Ligament: Mid-foot disruption

Deeply situated on the plantar aspect. It has broad attachment to the plantar surface of the medial cuneiform. Then runs distally and laterally to attach to the base of the second metatarsal.

Disruptions are determined sonographically from dorsal images.

Mechanism

Direct trauma: Crush injury. Heavy object falling on foot
Indirect: Rotational stress applied to plantar flexed foot

Ultrasound findings: Increased space between Medial Cuneiform and 2nd Metatarsal
Lisfranc Ligament: Mid-foot disruption

Mechanism
Direct trauma: Crush injury. Heavy object falling on foot
Indirect: Rotational stress applied to plantar flexed foot

Ultrasound findings: Increased space between Medial Cuneiform and 2nd Metatarsal

Medial Ankle
Posterior Tibial Tendon Longitudinal

Posterior Tibial Tendon Rupture

LAX Image
Excessive fluid within tendon sheath
The “stump” of the tendon is seen with scarring at right.

Mechanism
Gradual onset of “flat foot” deformity
Posterior Tibial Tendon Rupture

SAX Image

“Halo“ sign. Excessive fluid within tendon sheath

The dissecting tear is seen in perpendicular view

Posterior Ankle
SAX image of ACH tendon from a distance runner. Note loss of normal contour (not reniform). Loss of homogenous echo-density.

Linear, anechoic area which is insertional rupture.
Achilles Tendinosis

Long Axis Image
- Hypoechoic, fusiform shape
- Tendon bulging into area of muscle

Short Axis Image
- Plump, "ball-like" appearance of tendon

Plantar Foot
Lipomas are most common form of benign soft tissue tumor.

Foreign Body: Glass Fragment in Heel Pad
Foreign Body: Splinter in Heel Pad

Plantar Fasciitis

Measurement is done in long axis by placing the cursor at the apex of The calcaneal convexity, and measuring to superficial /upper interface of fascia.

Normal is 3-4 mm
Distal thickening is not normal.
Identifying Neuromas

• Note homogenous interdigital echoes from deep transverse and accessory ligaments
  * The plantar plate or ligaments are immediately superficial to the joint capsule or above the cortical outline of the met heads.

  A hypoechoic ovoid area between the ligament boundaries may be a neuroma. Anechoic fluid are bursal effusions.

  SAX view: Mulder’s Maneuver

  LAX view: dorsal or plantar compression may reveal collapse of BURSA.

  Neuroma is NOT compressible

Plantar Plate FX
Hyper-extension injury of 1st MPJ

Normal

Abnormal

Plantar ligament is avulsed, and displaced toward the plantar aspect
Thank You!

Ancora Imparo...
I’m still learning...