Musculoskeletal Ultrasound: Lower Extremity Dynamic Imaging

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Objectives:
- To demonstrate musculoskeletal pathologies requiring:
  - Joint movement or positioning
  - Muscle contraction

Dynamic Imaging:
- Shoulder
- Elbow
- Wrist and Hand
- Hip and Thigh
- Knee
- Ankle and Foot
- Soft Tissues

Hip and Thigh:
- Snapping hip syndrome
- Muscle tear: pseudomass
  - Rectus femoris
  - Hamstring
- Inguinal region hernias

Snapping Hip Syndrome
- Painful snap with hip motion
- Intraarticular
- Extraarticular:
  - Anterior: iliopsoas tendon
  - Lateral: iliotibial tract or gluteus maximus
Snapping Hip Syndrome: iliopsoas

- Long axis to inguinal ligament superior to femoral head
- Extension of flexed abducted and externally rotated hip
- Abrupt movement of iliopsoas as iliacus muscle interposed between tendon and bone moves

Deslandes et al. AJR 2008; 190:576
Snapping Hip: iliobibial tract
- Transverse over greater trochanter
- Hip external rotation / flexion
- Abrupt motion of iliobibial tract over greater trochanter

Snapping Hip Syndrome: iliobibial tract

Muscle Tear
- Rectus femoris
- Hamstring
- Active muscle contraction:
  - Palpable pseudomass

Rectus Femoris Tear: full tear, pseudomass
- Transverse
- Axial T1w post-gado

Rectus Femoris Tear: full tear, pseudomass
- Longitudinal
Inguinal Region Hernia:
- Indirect inguinal
- Direct inguinal
- Femoral
- Spigelian
- Scan with Valsalva maneuver, then patient upright

Jamadar et al. AJR 2006; 187:185
**Indirect Inguinal Hernia:**
- Extends through deep inguinal ring
- Lateral to external iliac artery
- Courses medial within inguinal canal
- Parallel to skin surface
- May contain fat or less commonly bowel
- Confirm in **two planes**

**Indirect Inguinal Hernia:**

**Indirect: Pitfall**
- You must also scan area in the sagittal plane short axis to inguinal canal
- Inguinal canal may move out of plane relative to transducer
Direct Hernia: Pitfall

- If only scanning long axis to inguinal canal in Hesselbach’s triangle
- Intra-abdominal contents may move inferior
- Simulate direct hernia
- True hernia shows focal movement in two planes
**Femoral Hernia:**
- Extends through femoral ring
- Usually medial to femoral vein
- Protrudes inferior to inguinal ligament
- May contain fat or less commonly bowel
- Confirm in **two planes**
- Femoral vein should distend with adequate Valsalva!

**Spigelian Hernia**

**Dynamic Imaging:**
- Shoulder
- Elbow
- Wrist and Hand
- Hip and Thigh
- Knee
- Ankle and Foot
- Soft Tissues
Knee:
- Tendon tear: extensor mechanism
- Snapping meniscus
- Intra-articular body
- Snapping nodular synovitis
- Patellar clunk syndrome
- Snapping semitendinosus

Joint Abnormalities:
- Evaluation for clicking or popping of joint
- Direct correlation with imaging
- Intra-articular bodies
  - Mobile
  - Movement with joint positioning

Patellar Tendon: full thickness tear

Meniscal Displacement: dynamic imaging

Buckle Handle Tear: medial meniscus

Intra-articular Body
Intra-articular Body

Synovitis

- Diffuse:
  - Inflammatory: infection, rheumatoid
  - Proliferative: pigmented villonodular synovitis
- Focal:
  - Focal nodular synovitis
  - Dynamic imaging: snapping

Nodular Synovitis: Snapping

Focal Synovitis: Snapping

Patellar Clunk Syndrome:

- After total knee arthroplasty
- 1% to 7.5% incidence
- Fibrous nodule: intercondylar notch
- Pain with flexion - extension

Snapping Semitendinosus Tendon over Semimembranosus Muscle

Snapping: sartorius over pes anerinus bursa

Snapping: seimitendinosus over semimembranosus

Dynamic Imaging:
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Ankle and Foot:
- Peroneal tendon subluxation and dislocation
- Tendon impingement
- Muscle hernia
- Achilles tendon tear
- Morton neuroma
Peroneal Tendon: \textit{dislocation}

- Implies retinaculum injury
- Associated with tendon tear
- Examine with dorsiflexion and eversion
- Lateral subluxation / dislocation

Rosenberg et al. AJR 2003; 181:1551

Peroneal Subluxation: \textit{dynamic imaging}

Intrasheath Peroneal Subluxation

- Abnormal snapping of peroneal tendons
- No lateral displacement, intact retinaculum
- Associations:
  - Convex posterior fibula in 92%
  - Tendon tear in 86%
  - Low lying peroneus brevis muscle in 71%

J Bone Joint Surg Am 2008; 90:992
J Foot Ankle Surg 2009; 48:323

Intrasheath Peroneal Subluxation

- Type A:
  - Peroneal tendon switch position within sheath
  - No coexisting peroneal tendon tear
- Type B:
  - Subluxation of peroneus longus tendon into longitudinal split of peroneus brevis tendon

J Bone Joint Surg Am 2008; 90:992
Intrasheath Peroneal Subluxation: Type A
Short Axis

Intrasheath Peroneal Subluxation: Type B
Short Axis

Dislocation: posterior tibial tendon
Transverse

Tendon Impingement
- Orthopaedic hardware
- Dynamic evaluation:
  - Deviation of tendon course
  - Discontinuous movement of tendon
  - Point tenderness with transducer pressure

Flexor Hallucis Longus: impingement
Longitudinal

Extensor Hallucis Longus: impingement
Longitudinal
Muscle Hernia

- Cause: trauma, activities, weak fascia
- Lower leg: especially anterior tibialis
- Swelling with muscle contraction
- US: muscle bulge, possible fascial defect
  - Site of perforating vessel

Beggs, AJR 2003; 180:395

Muscle Hernia: anterior tibialis

Muscle Hernia: anterior tibialis

Muscle Hernia (extensor digitorum): superficial peroneal nerve entrapment

Longitudinal

Tendon Evaluation:

- Partial vs. complete vs. healing tear
- Dynamic imaging: look for
  - Widening of gap: passive or active motion
  - Lack of tendon movement across tear
Achilles Tendon: full-thickness tear

Achilles Tendon: *Dynamic Imaging*
- Increase accuracy for full-thickness tear:
  - Widening of gap with passive dorsiflexion
  - Lack of tendon movement across tear
- Determine if ends approximate
  - Conservative versus surgical treatment

Achilles Tendon: dynamic imaging

Achilles Tendon: partial thickness tear

Achilles Tendon: healing tear

Assessing Tendon Stump Approximation
Morton Neuroma:
• Interdigital nerve entrapment
• Edema, fibrosis, necrosis
• 3rd intermetatarsal space > 2nd
• Sharp, burning pain from metatarsal head to toes
• Females: pliable foot, high-heeled narrow-toed shoes

Technique:
• Interdigital space
  – Transducer:
    • Plantar
    • Dorsal
  – Normal digital nerve difficult to visualize
  – Correlate with symptoms

Normal Interdigital Space

Morton Neuroma
• Hypoechoic 5 mm mass
  – Sensitivity: 100% ; Specificity: 83%
  – Accuracy equal to MRI
  – Nerve continuity: sagittal plane
• Intermetatarsal bursa
  – Associated with neuroma
  – "Neuroma-bursal complex"

Quinn T et al. AJR 2000; 174:1723
Dynamic Evaluation

- Compression
  - Between transducer and palpation
  - Bursae (dorsal) compress, neuromas (plantar) do not
- Sonographic Mulder Sign
  - Scan plantar: coronal plane
  - Neuroma displaces: plantar
  - Palpable click

Torriani M et al. AJR 2003; 180:1121
Zanetti M et al. Radiology 1997; 203:516

Dynamic imaging: Mulder’s Maneuver

Morton Neuroma + Bursa

Longitudinal Axial T2w

Anterior Talofibular Ligament

Anterior Talofibular Ligament Tear

Patient #1 Patient #2 Patient #3

Anterior Talofibular Ligament: Partial Tear

Long Axis: Dynamic Anterior Drawer Test
Anterior Talofibular Ligament: Partial Tear

Long Axis: Dynamic Anterior Drawer Test

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Soft Tissues:
- Complex fluid versus synovitis
- Bursa versus ganglion cyst
- Lipoma
- Hemangioma
- Chest wall / ribs

Rheumatoid Arthritis + Infection

Sinus Tarsi Bursa of Gruberi:
- Between extensor digitorum longus and distal talus
- Commonly asymptomatic
- Shouldn’t be confused with ganglion
  - Bursa: unilocular, compressible
  - Ganglion: multilocular, non-compressible

Sinus Tarsi Bursa of Gruberi

Short Axis
Long Axis
Lipoma

Compression  
Sonopalpation

Hemangioma

Slipping Rib Syndrome

- Abnormal mobility of cartilaginous rib
- Slips over adjacent rib with muscle contraction or activity
- Visible with dynamic ultrasound


Dynamic Imaging: summary

- Dynamic pathologic conditions
  - Limited number
  - Involve specific structures
- Consider ultrasound for any snapping or painful dynamic situation

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