Ultrasound of Muscle Sports Injuries

**Learning Objectives**
- Ultrasound imaging technique
- Normal muscle anatomy and ultrasound appearance.
- Imaging appearance of:
  - Strains, tears, hematomas
  - Fascial defects/muscle hernias
  - Myositis Ossificans/Heterotropic Ossification

Ultrasound Imaging Technique

**Advantage of ultrasound**
- Cost
- Availability
- Spatial resolution
- Dynamic Imaging
- Clinical correlation

Ultrasound Imaging Technique

- High frequency linear transducer- highest frequency that will allow desired depth (7-15 MHz)
- Comfortable positioning for the patient, to allow both relaxation and active/passive contraction of muscle of concern.
- Doppler – vascular injury or hypervascularity
- Comparison with contralateral side

Normal Muscle Anatomy

- Medial Gastroc
- Soleus
- Transverse
- Long
- subcut tissues
- epimysium
- perimysium
Normal Muscle Anatomy

• Muscle morphology
  – Strap/Parallel
  – Fusiform
  – Triangular/Convergent

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Long biceps

Long, SCM

Patellar tendon
Trochlea

Tendon and muscle anisotropy
Normal Muscle Anatomy

- Muscle morphology
  - Unipennate
  - Bipennate
    - "feather"
    - Two rows of muscle fibers oblique oriented in opposite directions towards central tendon
    - Rectus femoris
    - Multipennate

Normal Muscle Anatomy

- Dynamic Imaging
  - Accentuates abnormality in muscle architecture, fascial defects/weakness, length of gap in cases of muscle tear.
  - With flexion muscle appears thicker, shorter and more hyperechoic.
  - Overlying fascial contour should remain smooth.
**US categorization of muscle strains**

**Grade 0** - Normal US appearance, with clinical findings.

**Grade 1** - Subtle US findings, with hyper or hypoechoic intramuscular areas or tendinosis (<5% involvement).

US categorization of muscle strains

**Muscles are prone to injury if:**
- Cross two joints
- Used for high speed activities and rapid acceleration with high percentage of fast twitch fibers
- Rectus femoris, biceps femoris and medial head of gastrocnemius

**Strains/Tears**

- When too much tensile force is applied.
- Injury will occur at the weak link of the muscle-tendon-bone unit.
  - In skeletally immature → avulsion fracture
  - Teens/young adults → myotendinous junction
  - Older adults with tendinosis → tendon tear

**Tran rectus femoris**
16 yo female with muscle pull during soccer game
Muscle Injuries

• Strains/Tears

US categorization of muscle strains

Grade 2: Partial tear with >5% muscle fiber disruption. Cavity from retracted fibers fills with blood/hematoma. Muscle contraction may increase measured size of the tear. May see surrounding hypervascularity.

Grade 3: Complete tear of muscle. Retraction of fibers may be palpable defect or soft tissue mass. Muscle stump is rounded with retracted muscle fragment floating in hematoma.

Management:

Grade 1 - Low risk of extension. Heal in 2 weeks with conservative management.

Grade 2 - Four weeks of conservative management. 6 weeks if >50% cross sectional involvement. May have extension of injury if return to sports too early.

Indication for surgery

– Large hematoma
– Grade 2 involving more than ½ of muscle.
– Grade 3

16 yo male lacrosse player strained quadriceps several weeks earlier with lump at right anterior thigh. Not painful.

Rt rectus, long

Lt rectus, long

Transverse rectus

19 yo male, lacrosse player. Four days earlier was bench pressing 235 lbs. During maximal contraction, developed acute onset of burning and tearing sensation of left pectoralis muscle.

R

L

Trans. pectoralis major, arm in extension

Pectoralis major

– Broad muscle, arises from clavicle and sternum, inserts at lateral aspect of greater tuberosity.
– Injured at MTJ or humeral insertion.
Muscle Injuries

• Strains/Tears

• Pectoralis major
  - Young male weightlifters, bench press, fall on abducted and extended arm.
  - Abduction and external rotation elongates muscle and shows injury.
  - Often managed surgically.

Muscle Injuries

• Strains/Tears
  • Hematomas

US appearance of hematoma (Grade 2 and 3)
  Hyperacute phase - Hypoechoic with perhaps hyperechoic clot
  Evolves into echogenic with hyperechoic walls and septa of granulation tissue

Hematoma versus mass
  Lack of enhancement on MRI argues against mass, but fibrovascular tissue around hematoma can enhance.
  Can have hematomas with underlying tumor
  Follow-up for a few weeks to assess for resolution → biopsy

Muscle Injuries

• Strains/Tears
  • Hematomas

18 year old male sprinter- tear of right hamstring 3 days before, while running 400 m

Muscle Injuries

• Strains/Tears
  • Hematomas

18 year old male, active in basketball and football with no specific injury. Noticed mass of left thigh 3 weeks prior to US. Initial pain, that has resolved.
Muscle Injuries

- Strains/Tears
- Hematomas

14 yo male. Pain in right thigh one month earlier while running bases. 1.5 weeks ago, mother noted firm mass in anterior thigh.

Muscle Injuries

- Strains/Tears
- Hematomas

1.5 yo female who was hit with wiffle ball 3 days earlier, now with lump of right calf at site of injury. Minimally tender. Warm to touch. Evaluate for hematoma.

Muscle Injuries

- Strains/Tears
- Hematomas

Intramuscular hemangioma

16 yo male with trauma and bruising 10 weeks prior.
Muscle Injuries

- Strains/Tears
- Hematomas

Other Mimics
Venous Malformation

6 yo male with remote history of trauma

Muscle Injuries

- Fascial defects/muscle hernias
- Present with palpable lump,
- Can changes in prominence with muscle contraction and relaxation.
- Painful or asymptomatic.
- Often referred to radiology to evaluate for vascular anomaly, cyst, lipoma, neoplasm

Muscle Injuries

- Fascial defects/muscle hernias
- Hernias result from protrusion of muscle through acquired or congenital fascial defects.
- Classically described in the lower extremities of young athletic adults, usually men.
- In our practice, see not infrequently in young children.

Muscle Injuries

- Fascial defects/muscle hernias
- Dynamic imaging with provocative maneuvers is key for the ultrasound diagnosis.
- MR can miss the diagnosis.
- Before ultrasound imaging, exam patient and determine which position/maneuvers cause the mass to increase in size.

Muscle Injuries

- Fascial defects/muscle hernias

15 year old male, soccer player and wrestler, with lump on left leg, lateral to tibia for 1 year. Clinical evaluation raised concern for vascular malformation.
**Muscle Injuries**

- Fascial defects/muscle hernias

15 year old male, soccer player and wrestler, with lump on left leg, lateral to tibia for 1 year. Clinical evaluation raised concern for vascular malformation.

- No treatment necessary in asymptomatic patients.
- Some patients have fatigue or pain with activity. Radiating pain due to nerve entrapment associated with herniation. Cosmetic deformity.
- Conservative tx: rest, activity modification, compression sleeve.
- Surgical management- fasciotomy through site of herniation (versus repair of defect either primary or with patch – though may lead to compartment syndrome.

**Muscle Injuries**

- Heterotopic Ossification/ Myositis Ossificans

- Benign intramuscular ossification, may be ossified hematoma.
- Most commonly large muscles of the extremities.
- Pathophysiology not well understood.
- Post-traumatic…but may not have history of trauma.
- Matures over 6 to 18 months. Resorbs over 1-5 years.

- Myositis Ossificans

- Commonly assessed with radiographs and CT- soft tissue mass which develops peripheral calcifications.

**Myositis Ossificans**

- Ultrasound Appearance
  - Peripheral calcifications apparent weeks before visible by radiographs.
  - Increased hypoechogenicity and heterogeneity with time.
  - Internal vascularity seen by Doppler.

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