SPORTS ULTRASOUND IN THE FIELD

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DISCLOSURES

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LEARNING OBJECTIVES

After completing this workshop, attendees will be able to

1. Perform a diagnostic sports ultrasound of select structures relevant to the team physician
   1. Pectoralis major, distal biceps, Achilles tendons
   2. UCL of the thumb and elbow, MCL of the knee and ATFL/AITFL of the ankle
   3. Fracture evaluation of the hand and ribs
   4. Pneumothorax evaluation and FAST exam for chest/abdominal trauma

2. Discuss ultrasound characteristics of fractures and soft tissue injuries

3. Describe ultrasound applications in chest and abdominal trauma in athletes
SONOGRAPHIC EVALUATION OF TENDON INJURY

NORMAL TENDON

• High frequency, linear transducer best
• LAX - tightly packed linear echoes
  • Fibrillar pattern
• SAX – stippled clustered dots
  • “broom end”
• Muscle → Bone
TENDINOSIS

- Thickened
- Hypoechoic
- Heterogenous
- +/- Enthesopathy
- +/- Calcification
- +/- Doppler
PARTIAL TENDON TEAR

- Focal defect
  - Well-defined
  - Not anisotropic
  - Seen in two planes
- “Critical Zones”
- Lack of retraction
  - Dynamic imaging
- Background tendinosis
  - Tendon usually thick
  - May be atrophic if chronic/high grade
COMPLETE TENDON TEAR

- Gap vs. Absence
  - Control for anisotropy
- Acute $\rightarrow$ fluid
- Chronic $\rightarrow$ scar
- Identify tendon ends
  - Edge shadowing
  - Dynamic imaging
PITFALLS – ANISOTROPY

- Anisotropy simulates partial tear
  - Rock transducer parallel to fibers

![Diagram of normal and anisotropic tendons](image.png)
EDGE SHADOWING

- Deep to curved interface
  - Refraction
  - Velocity change
- Identifies torn tendon edges in LAX
SONOGRAPHIC EVALUATION OF TENDON INJURY

• 21 y/o NCAA division I Track & Field athlete
• Acute left posterior Achilles region pain during 100m sprint
• Physical exam:
  • Minimal ecchymosis
  • Mild swelling along medial Achilles border
  • Negative Thompson test
  • Achilles tendon palpably intact
ACUTE PLANTARIS RUPTURE
POSTERIOR KNEE PLANTARIS

- Small, fusiform muscle with long thin tendon
- Originates proximal to LFC, deep to lateral gastroc
- Myotendinous junction near origin of soleus
- Continues between medial gastroc and soleus toward medial aspect of Achilles to insert at calcaneus
- Tendon forms medially
- Identify in SAX at proximal calf as triangular structure with soleus at base and MG/LG as sides
POSTERIOR KNEE PLANTARIS

- May tear in isolation (rare, near myotendinous junction)
  - Tennis leg variant
- More commonly source of confusion with complete Achilles ruptures
  - Rarely tears distally
ACUTE ACHILLES TENDON RUPTURE

Dynamic evaluation of acute Achilles rupture

Images courtesy J. Finnoff
DISTAL BICEPS TENDON

- Medial “pronator window”
- Elbow 90 degrees flexion, forearm full supination
- Transducer placed parallel with humeral shaft, distal end at medial epicondyle
- Translate anterior until distal tendon attachment in view
- Dynamic evaluation with pronation/supination
DISTAL BICEPS TENDON

Small avulsion seen with posterior view

Partial tear with peritendinous edema but intact with dynamic imaging
PECTORALIS MAJOR TENDON

Fig. 2 Normal left distal pectoralis major tendon. Illustrations of anterior shoulder show clavicular and sternal heads of pectoralis major, which form anterior and posterior layers. Note fusion (X) of layers prior to tendon insertion on humerus. Illustration by John Hagen
PECTORALIS MAJOR TENDON

- Muscle origin and muscle belly
  - Uncommon
  - Typically non-surgical
- Musculotendinous junction, intratendinous, humeral insertion, bony avulsion
  - Require surgical evaluation
PECTORALIS MAJOR TENDON SCANNING TECHNIQUE

- Identify bicipital groove
- Translate distal until LAX view of pectoralis major tendon identified over biceps
- Translate medial to appreciate musculotendinous junction
- Rotate 90 degrees for SAX view
- Identify sternal and clavicular heads
- Clavicular head forms majority of anterior layer
- Sternal head forms posterior layer

Chiavaras Skel Rad 2015
PECTORALIS MAJOR TENDON
PITFALL – FULL WIDTH STERNAL HEAD TEAR

Complete tear of sternal and clavicular heads with tendon retraction

Note intact distal tendon at humeral attachment

Chiavaras Skel Rad 2015
PECTORALIS MAJOR TENDON PITFALL – FULL WIDTH STERNAL HEAD TEAR

40 year old 3 days post acute Bench Pressing injury
SONOGRAPHIC EVALUATION OF LIGAMENT SPRAIN

- Appearance similar to tendons
- Grade I-III
- Retracted edges uncommon
- Loss of tension → wavy appearance

Complete ATFL rupture
ULNAR COLLATERAL LIGAMENT SPRAIN OF THE ELBOW

- Anterior band
- Hyperechoic, compact fibers from medial epicondyle to sublime tubercle
- Dynamic valgus stress testing @ 30°
  - > 0.5 - 1 mm difference resting and stress suggests full thickness involvement
  - Side to side comparison most helpful
  - Asymptomatic pitchers may have > 2 mm difference

Ciccotti AJSM 2014; DeSmet Skeletal Radiol 2002
ULNAR COLLATERAL LIGAMENT SPRAIN OF THE ELBOW
1st MCP
ULNAR COLLATERAL LIGAMENT

- Rolled towel or US bottle helpful
- Coronal image over 1st MTP joint
- Subject to anisotropy → uniformity is key
- Identify adductor pollicis aponeurosis
  - Thin structure over UCL
  - Passive IP flexion
1st MCP UCL Sprain

- Gamekeeper’s or Skier’s thumb
- Side to side comparison helpful
- Note subtle decreased echogenicity and loss of fibular pattern
- Gentle dynamic valgus stress views
  - Don’t create a surgical lesion!
1ST MCP UCL SPRAIN

Bianchi and Martinoli 2007
1st MCP UCL STENER LESION

- Distal full-thickness tear with displacement proximal to adductor pollicus aponeurosis
- Requires surgical intervention
- Yo-yo on a string
  - String → aponeurosis
  - Yo-yo → balled-up displaced proximal portion of UCL

Bianchi and Martinoli 2007
NORMAL MEDIAL (TIBIAL) COLLATERAL LIGAMENT (MCL)

- Fibrillar
- Hyperechoic
- Medial femoral condyle → Tibia
- Superficial layer
  - Tibial collateral ligament
- Deep layer
  - Meniscofemoral & meniscotibial ligaments
MCL SPRAIN

- Typically proximal
- LAX most helpful
- Deep vs. superficial
- Thick & hypoechoic
- Defect uncommon
- Valgus stress prn
- Chronic ➔ +/- calcium
SONOGRAPHIC EVALUATION OF ANKLE SPRAINS

Consider dynamic stress evaluation for all ankle sprains
- Anterior drawer
- Talar tilt
- External rotation stress

Normal ATFL

Chronic complete ATFL rupture
SONOGRAPHIC EVALUATION OF ANKLE SPRAINS

Normal AITFL

Acute AITFL Tear

Images courtesy J. Finnoff
SONOGRAPHIC EVALUATION OF FRACTURES

- On-site/when X-ray unavailable
- Radiographically occult fractures
- Unsuspected fractures during routine exam
- Early stress fractures
- Interruption of smooth cortical surface
- Periosteal thickening
- Hyperemia
- Soft tissue edema
- Pain on sonopalpation
- Early callus formation

Hoffman BJSM 2015
HOOK OF HAMATE

View at distal Guyon tunnel

Celi J Ultrasound Med 2008
HOOK OF HAMATE

BH ➔ Body of Hamate
HH ➔ Hook of Hamate

Medial view demonstrates cortex of ulnar surface as continuous regular hyperechoic line (arrows)

Celi J Ultrasound Med 2008
HOOK OF HAMATE FRACTURE

Focal interruption in hyperechoic cortical line → fracture of base of hook

Celi J Ultrasound Med 2008
SCAPHOID

- Peanut-shaped contour of scaphoid deep to long axis view of FCR
- Evaluate for cortical step-off fracture

Note hypoechoic hematoma surrounding fracture site

Normal appearance of palmar scaphoid

Table 1 Diagnostic performance of the US with regard to CT findings in the diagnosis of occult fractures of the scaphoid

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive predictive value</th>
<th>Negative predictive value</th>
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</thead>
<tbody>
<tr>
<td>All scaphoid fractures$^a$</td>
<td>92% (12/13)</td>
<td>71% (35/49)</td>
<td>46% (12/26)</td>
<td>97% (35/36)</td>
</tr>
<tr>
<td>High-risk fractures$^a$</td>
<td>100% (8/8)</td>
<td>67% (36/54)</td>
<td>30% (8/26)</td>
<td>100% (36/36)</td>
</tr>
</tbody>
</table>

Platon Skeletal Radiol 2011; Senall J Hand Surg 2004
SONOGRAPHIC EVALUATION OF CHEST/ABDOMINAL TRAUMA
RIB FRACTURE

- US more sensitive than X-ray
- Direct signs
  - Discontinuity of cortex
  - Acoustic edge shadowing
  - Localized pain
- Indirect signs
  - Local hematoma
  - Reverberation artifact
  - Pneumothorax

- Scanning technique
  - Palpate region(s) of maximal tenderness
  - Identify rib in SAX
  - Evaluated length of rib in LAX
  - Don’t forget to include costochondral junction

Subacute rib fracture with callus formation
Note posterior shadowing
RIB FRACTURE

LT T5 TR

COSTOCHONDRAL JUNCTION

LT T5 LG

MED
PNEUMOTHORAX (EFAST)

- **Criteria**
  - Absence of lung sliding
    - Identification of lung sliding on anterior chest wall in supine patient → 100% NPV
  - Disappearance of “B-lines”
    - Comet tail reverberation artifact
  - Identification of lung point
    - Specificity → 100%
PNEUMOTHORAX

- In M-mode, change from “sea-shore” to “stratosphere”
PNEUMOTHORAX

- Moderate sensitivity (~75%)
  - Better than CXR (~40% sensitive)
  - Improves if more IC spaces sampled

- High specificity (~99%)
  - Lung point identification is pathognomonic
PNEUMOTHORAX

- Patient supine
- High-frequency, linear transducer preferred
- 3rd or 4th intercostal space in mid clavicular line
FOCUSED ASSESSMENT WITH SONOGRAPHY IN TRAUMA (FAST) EXAM

- Used to identify free fluid (blood) in blunt trauma
- 4 views:
  - Morison’s pouch (hepatorenal recess)
  - Splenorenal recess
  - Bladder
  - Pericardial
- FREE FLUID IN ANY VIEW IS A POSITIVE EXAM!
FOCUSED ASSESSMENT WITH SONOGRAPHY IN TRAUMA (FAST) EXAM

- Low sensitivity (~40-50%)
  - Free fluid may not accumulate
  - Retroperitoneum not imaged!
  - Negative scans do NOT exclude injury!

- High specificity (~95-99%)
  - False positives from ascites, fat, physiologic fluid, etc.
  - In correct setting, can shorten time to OR
MORISON’S POUCH
PERICOLIC RIGHT
SPLENORENAL RECESS
PERICOLIC LEFT

Ultrasound Abdominal Pericolic Left

Ultrasound FAST Trauma Exam Coronal LUQ Pericolic
SUPRAPUBIC

Small amount of free fluid is normal in Pouch of Douglas for premenopausal females
SUBXIPHOID PERICARDIAL
ON SITE SPORTS ULTRASOUND

THANK YOU

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