MSK Ultrasound: The Basics and The Future

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Disclosures

- I have no commercial or financial interests to disclose

Educational Objectives

1. Discuss the advantages and disadvantages of ultrasound for evaluation of the MSK system
2. Identify the normal appearance of structures commonly encountered in MSK imaging
3. See common pathologies that can be assessed with US
4. Learn about current experimental MSK applications of HIFU

Advantages

- Low-cost (1)
- Patient friendly (2)
- Focused exams
- Dynamic, real time exams
- Excellent spatial resolution – 150 microns vs 450 microns (MRI)
- Even greater resolution with up to 70 MHz probes – 30 microns
- Contralateral comparisons
- Portable
- No ionizing radiation or contrast

Disadvantages

- Operator dependent
  – Good technique, transducer selection, setting, etc.
- Dependent on body habitus
  – Advances in tissue harmonics have helped in these challenging cases (5)
- Artifacts that mimic pathology

Anisotropy

- Property of all tendons
- Occurs when US beam not 90°
- Can simulate pathology


Cases and Problem solving

Shoulder Pain

Rotator Cuff
Normal US appearance
- Homogeneous echotexture
- Convex external contour
- Smooth bony margins

Complete Tear of Supraspinatus Tendon

De Jesus et al. AJR 2009; 192:1701-1707
Partial Thickness Articular Sided Tear

Arm weakness, elbow pain

Complete Distal Biceps Tendon Rupture

Medial Elbow Pain

Make the Diagnosis: Tendinosis/Tendinopathy

- Thick, heterogeneous tendon
- Nodular, hypoechoic areas
- Calcification
- Interstitial splits
- Increased Doppler flow (variable)
Calcific Tendinosis, Subscapularis

Lateral Epicondylosis

Intrasubstance tearing

Joints

Advantages

- More accurate, potentially more therapeutic joint injections
  - Blind knee joint injections may miss the joint in up to 29% of cases (3)
  - Blind subacromial injections may miss 24-31% of the time (4)

References:
Aspiration of Shoulder Effusion

Elbow Effusion

Ulna

Hip Effusion

Knee Effusion from OA

Head

Neck

Where should I tap this joint?

Ultrasound guides successful aspiration
**Bursae**

- **Common locations**
  - Subacromial, greater trochanteric, olecranon, semimembranosus/medial gastrocnemius
- **Compressible**
- **Thin, hypoechoic structures, <1-2 mm when not distended.**
Direct trauma

Destroyed fibers
Irregular intramuscular cavities
Hematomas

Nerves
Fascicular Pattern of Nerves

Transverse  Longitudinal

Hand Tingling

Carpal Tunnel Syndrome

Radial nerve
Screw tip abrading the nerve

Successful perineural injection

Ligaments

Pitcher with medial elbow pain

Valgus Stress on Elbow

Ankle Sprain

Bone
- Brightly echogenic line with acoustic shadowing
- Things that can be seen
  - Unsuspected stress fractures
  - Degenerative changes
  - Erosions from rheumatic disease or osteomyelitis

Persistent Shoulder Pain (6 months after MVA)
- Unsuspected Humeral Impaction Fracture

Rib Fracture Missed on Plain Film
- Non-tender
- Tender

Targeted problem solving
Child with foot pain and swelling

Power Doppler of Foreign Body Reaction

Intraoperative tendon injury
index digit

Intraoperative tendon injury
long finger
The Future.
Surgery without knives

• “Focused ultrasound is an early-stage, non-invasive therapeutic technology with the potential to transform the treatment of many medical disorders by using ultrasonic energy to target tissue deep in the body without incisions or radiation”
  
  -Focused Ultrasound Foundation

The Technology

• High intensity focused ultrasound—provides the energy to target and treat deep tissues in the body precisely and noninvasively

• MRI – used to identify and target the tissue to be treated, guide and control the treatment in real time, and confirm the effectiveness of the treatment.

Focused Ultrasound Physics

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Summary

- Ultrasound is a robust tool, complimentary to MRI, in the diagnosis of MSK pathology
- Relative low cost, portability, real-time imaging for on the spot clinical decision making and the ability to guide intervention are driving increasing popularity
- While in its relative infancy, HIFU is capable of becoming a revolutionary new, totally non-invasive, radiation free, treatment option