Musculoskeletal Ultrasound (MSKUS)
Point-Of-Care Imaging in the Hemophilia Treatment Center
Disclosures

The following have no relevant financial relationships to disclose:

- Cheryl McShea, PT, DPT
MSKUS TRAINING

- UC San Diego School of Medicine and the Hemophilia & Thrombosis Treatment Center at UC San Diego Health

- Faculty:
  - Annette von Drygalski, MD, Pharm D, Assistant Clinical Professor of Medicine, Director of Hemophilia and Thrombosis Treatment Center at UC San Diego Health
  - Bruno U.K. Steiner, PT, Washington Center for Bleeding Disorders
  - Eric Y. Chang, MD, Assistant Professor of Radiology, VA San Diego Healthcare System, University of California, San Diego Medical Center
  - Randy E. Moore, DC, RDMS, RMSK

- Disclosures:
  - Pfizer – partial funding for tuition
  - GE provided US equipment
MSKUS TRAINING

- Small group training
- Physicians, PTs and RNs
- Didactic and hands-on practice
- Index joints (elbows, knees and ankles)
- 25 hours over 2.5 days
- Learning support available through weekly, web based discussions led by Dr. von Drygalski and Dr. Chang
MSKUS Concepts

- Series of pictures displayed in rapid sequence
- Sound waves that are echoed back at varying time intervals depending on tissue density
- Brightness of tissue is proportional to amplitude of returning echo
  - Soft tissue is darker
  - Hard tissue is brighter
MSKUS Uses

- Frequently used in rheumatology and sports medicine

- Relatively new to hemophilia:
  - Differentiate between hemorrhagic and inflammatory process
  - Longitudinal joint health assessment
  - Guided joint aspiration/injections
  - Research
MSKUS in the HTC

ADVANTAGES:

- **Convenient**: portable, < 10 minutes, immediate results
- **Cost**: less expensive than MRI
- **Patient friendly**: non-invasive, minimal discomfort, open
- **Highly sensitive to soft tissue**: tendon, muscle, nerve, joint
- **Real time, dynamic**: observe structures with patient movement
- **Patient engagement**: ↑ interest, understanding, adherence to POC
- **Interventional**: ↑ accuracy with joint aspiration/injection
- **Provider**: can be performed by (trained) PT, RN or or MD
- **Reimbursement**: currently billable without certification (technical component + professional component)
CHALLENGES:

- **Training & initial cost**
  - ~$5–10K for training; $60–70K
  - appropriate use of 340B money

- **Proficiency**
  - need extensive time & practice to become proficient with obtaining quality images and with interpreting results

- **Pediatrics**
  - fear, restlessness, different tissue quality than adults

- **Very obese or muscular patients**
  - can be difficult to see deep tissues

- **Anisotropy**
  - Artifacts from transducer not at 90 degree angle to tissue

- **Correlation with MRI (gold standard)?**
  - MRI interpretation depend on radiologist experience with vascular disorders
  - MSKUS & MRI are complementary
## COMPARISON: POC MSKUS vs MRI

<table>
<thead>
<tr>
<th>POC MSKUS</th>
<th>MRI</th>
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<tbody>
<tr>
<td>Less expensive</td>
<td>More expensive</td>
</tr>
<tr>
<td>Portable</td>
<td>Not portable</td>
</tr>
<tr>
<td>Non-invasive</td>
<td>May need contrast dye</td>
</tr>
<tr>
<td>Unenclosed</td>
<td>Enclosed</td>
</tr>
<tr>
<td>No sedation</td>
<td>Children may need to be sedated</td>
</tr>
<tr>
<td>Results immediate</td>
<td>Delay in scheduling, reporting</td>
</tr>
<tr>
<td>Dynamic image</td>
<td>Static image</td>
</tr>
<tr>
<td>Better identifies joint bleeds, synovial hyperplasia, joint erosions</td>
<td>Better identifies bone cysts and cartilage loss</td>
</tr>
<tr>
<td>Not interpreted by Radiologist</td>
<td>Interpreted by Radiologist</td>
</tr>
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</table>
SUCCESSFUL IMAGING

Requires a systematic, standardized approach

1) Image GENERATION
2) Image RECOGNITION
3) Image INTERPRETATION
1) Image GENERATION

- **Patient position**
  - Ideal positions optimize ability to see specific structures***

- **Probe position & orientation**
  - Use bony landmarks***
  - Reference end of probe
  - LAX: long axis, longitudinal axis, left side of image is cephalad
  - SAX: transverse views, left side of the image is patient right (or lateral depending on policy)

- **Follow the protocol!***

***May not always be possible with hemarthropathy
1) Image GENERATION, cont.

- Optimization of image
  - Focus on getting the best image possible; don’t look for pathology
  - Begin with US machine presets, adjust as necessary
  - Always start with identifying bony cortex (bright white)
  - Use Doppler to visualize vascularity
  - Consider HIPAA when storing for future reference or comparison
2) Image RECOGNITION

- Knowledge of anatomy critical
- Good spatial perception helpful
- Practice, learn to recognize ‘normal’ first
- Participate in web based discussions – excellent dialogue, opportunity to ask questions, get feedback on images
2) **Image RECOGNITION, cont.**

**Fibrocartilage** – homogenous, no anechoic areas, triangular in shape

**Bursae** – a potential space, normally not visible (except Suprapatellar Bursa); anechoic/black line < 2mm surrounded by hyperechoic peribursal fat

**Peripheral nerves** – on LAX, parallel hyperechoic lines with dark separations often adjacent to anechoic vascular bundles; on SAX, ‘Starry Night’ or ‘honeycomb’ appearance

**Tendons** – parallel fibers, brighter than ligaments, attach muscle to bone

**Ligaments** – less bright than tendon, attach bone to bone

**Skeletal muscle** – on LAX, uniform bands and bundles; on SAX ‘speckled’ with bright curvilinear lines

**Hyaline cartilage** – homogenous, anechoic layer that mirrors the bone surface

**Bony cortex** – highly echogenic, bright, smooth, intact
3) Image INTERPRETATION

- View at least two different planes
- Measure for comparison to contralateral joint or for serial joint assessments

1. Is bony cortex bright, continuous and smooth?
2. Is hyaline cartilage present throughout and appropriate thickness?
3. Does muscle have a normal striation pattern?
4. Are ligaments and tendons intact?
5. Is bursa invisible/barely visible?
   - If no, are the contents consistent with effusion, bloody effusion, synovial proliferation?
6. Are fat pads seated properly?
7. Is vascularity of the soft tissue as expected?
3) Image INTERPRETATION, cont.

- **Initial image**: do findings correlate with history, patient report and clinical findings?
  - Yes → discuss treatment options with patient
  - No → consider referral for additional imaging and/or to specialist

- **Serial image**: is joint showing improvement, no change or deterioration?
  - Improvement → treatment regimen may be optimal
  - No change → POC will depend on patient goal(s)
  - Deterioration → discuss alternative treatment and/or diagnostic options with patient
MSKUS RESEARCH @ HWCP

- LONG-US:
  - Longitudinal Ultrasound Evaluation of Joint Pathology in Severe Hemophilia.
  - Wisconsin Blood Center (Dr. L Malec) & Hemophilia Center of Western Pennsylvania (Dr. M Ragni)
  - Studying feasibility of performing MSKUS on index joints during comprehensive clinic visits
  - Patients age 4–30 with severe heme A or B
POC MSKUS:
- Quick, convenient, less expensive than MRI
- $75–100K upfront cost
- Significant time/practice to become proficient
- Improves the ability to diagnose and treat
- May improve patient ‘buy in’ & adherence to POC
- Identifies more joint changes than a physical joint examination
- Best used as a complement to MRI
THANK YOU!!!

Olivia

Natalie
Resources


- Moore RE. Sonography of the extremities; techniques and protocols, 4th edition.

- Von Drygalski A. Musculoskeletal ultrasound in hemophilia training manual.


- https://cme.ucsd.edu/muh/index.html