Musculoskeletal Ultrasound

ACP Sports Medicine Workshop
November 6th, 2015

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Objectives

- Basic ultrasound terminology
- Knowledge of the diagnostic and therapeutic capability of MSK ultrasound
- Skills needed by physicians that perform MSK ultrasound
- The appropriate referral of athletes that may benefit from the use MSK ultrasound

Is Ultrasound the New Stethoscope?


Musculoskeletal Ultrasound

- Understanding of US images requires training
  - Small section of tissue
  - Understand tissue differentiation
  - Learn normal US anatomy to understand pathology
  - Examine bilaterally
  - Take advantage of dynamic nature of US

Basic Ultrasound Terminology

- General Concepts
  - Excellent imaging modality
  - Use is increasing among musculoskeletal clinicians (Sports Medicine, Rheumatology)
  - Recent advances in technology
  - Tendon, Muscle, Nerve, Joint, Bone

Musculoskeletal Ultrasound

- Sound waves used for production of image
- Ultrasound Transducers
  - Linear transducer, High frequency
    - 7 MHz – 15 MHz
    - Higher frequency = Higher resolution, superficial penetration
  - Curvilinear transducer, Lower frequency
    - 5-8 MHz
    - Lower frequency = Lower resolution, deeper penetration

Basic Concepts
Basic Concepts

- Hockey Stick transducer
- High frequency
- Use on smaller joints

General Concepts - Terms

- Hyperechoic = Bright white echo (bone, tendon)
- Hypoechoic = Weak echo, darker (cysts, fluid within tendons)
- Anechoic = No echo, black (ganglion cysts)
- Isoechoic = Equal echogenicity to an adjacent structure

Tendons

- Longitudinally oriented collagen fibrils
- Appear as fine parallel lines (hypoechoic alternating with hyperechoic)
- Better spatial resolution than MRI
  - 150 microns vs 500 microns

Normal Achilles

Common Extensor Tendon
Improving the Quality of Care!

Background and Objective - The aim of this study was to describe the one-stop approach to managing soft tissue and degenerative musculoskeletal conditions using clinic-based musculoskeletal ultrasonography (MSUS).

Methods - A retrospective case record review was carried out of patients assessed and managed in the musculoskeletal clinic by a musculoskeletal and sports physician over a 10-month period.

Results - A total of 1,012 patients (87%) had conditions related to the appendicular system (shoulder girdle, upper limb, pelvic girdle and lower limb) and 154 patients were referred with spinal pain. All patients with appendicular system problems had a definite diagnosis and treatment initiated on the first visit to the clinic.

Conclusions - The use of clinic-based MSUS enables a one-stop approach, reduces repeated hospital appointments and improves quality of care in an outpatient musculoskeletal clinic.


Ultrasound Guided Injections...The Literature

The Medical Literature Shows that Ultrasound Guided Injections are More Accurate Than Clinically Guided Injections, Even Among Experienced Physicians.


Does US Needle Guidance Affect the Clinical Outcomes?

Background and Objective - This randomized controlled study addressed whether sonographic needle guidance affected clinical outcomes of intraarticular (IA) corticosteroid injections.

Methods - 148 painful joints were randomized to IA corticosteroid injection by conventional palpation-guided or sonographic image-guided injection. Baseline pain, procedural pain, pain at outcome (2 weeks), and changes in pain scores were measured with a VAS scale.

Results - Relative to conventional palpation-guided methods, sonographic guidance resulted in 43% reduction in procedural pain (p > 0.001), 58% reduction in absolute pain scores at the 2-week outcome (p > 0.001), 75% reduction in significant pain (p > 0.001), 62% reduction in non-responder rate. Sonography also increased detection of effusion by 200% and volume of aspirated fluid by 337%.

Conclusions - Sonographic guidance significantly improved clinical outcomes.


Evidence for Ultrasound Guided Injections

- Two RCTs met criteria for pain, function and adverse events.
- A meta-analysis demonstrated greater improvement at 6 weeks in both pain [mean difference 2.23 with CI 1.27-3.18] and function [1.09 CI 0.61-1.57].
- More adequately powered trials needed.

Evidence for Ultrasound Guided Injections

- Total of 99 pts with knee OA: 50 US guided and 49 palpation guided (PG) via suprapatellar bursa.
- All had injection with HA and contrast: USG 48/50 (96%) intra-articular, and PG 41/50 (83%).
- US guided intra-articular knee injections thru suprapatellar approach increases accuracy.


Evidence for Ultrasound Guided Injections

- 80 fresh cadaveric shoulders injected with contrast: 40 under US guidance and 40 blind.
- 37/40 (92.5%) accuracy with US; 29/40 (72.5%) accuracy with blind injections.
- US guided GH joint injections are more accurate than blind.


Ultrasound Guided Injections: Technical Considerations

“So easy, a caveman could do it!”

Before you consider doing ultrasound guided injections:

- You must know what you are looking at on the ultrasound before you stick a needle in it.
- You must be sure you will not hit anything you should not on the way to your target tissue.
- You need to know how to use sterile technique with your equipment.
- You need to have reasonable skill in handling the transducer.
- You must have reasonable needle driving skill.

Basic Competency

- Know key ultrasound anatomy for your target area.
- Study the view before you attempt to inject.
- Learn the anatomic relationships in the cut you are looking at.
- Significant learning curve.

- Use clinical landmarks…
  - Feel for a pulse and mark significant vessels.
  - Standard anatomy.
- Use ultrasound landmarks…
  - Using color Doppler to clear your needle path of significant vessels is very useful.
  - Use ultrasound anatomy of target area to avoid key structures.
  - Nerves / peritoneum / lungs / solid organs / etc.
Basic Competency: Sterile Technique

- Wide skin prep
  - chlorohexidine gluconate x 1
  - Widespread prep where ever the probe, gel or needle may go
- Disinfect probe and cable with appropriate disinfectant
  - (see manufacturer recommendation)
- Cavicide, T Spray II, PDI, etc.
- Probe condoms
- Sterile packets of ultrasound transmission gel
  - 20 gram packets usually sufficient
- Foot pedal control for US machine
  - To take US images and video clips while your hands are occupied

Basic Competency: Skill in Handling the Transducer

- KEEP 2-3 FINGERS OF YOUR PROBE HAND IN CONTACT WITH THE PATIENT’S SKIN to control probe.
- Short axis slides to keep needle in view.
- Subtle movements
- Always be aware of how anisotropy is working for or against you.

Injection Preparation and Procedure

- Lay out injection supplies
- Widely treat the injection area skin with chloroprep swab x 1
- With 2 Cavicide wipes in hand, wipe the probe head with one wipe, then while holding the probe head with that same wipe, use the second wipe to wipe off the probe cord and the probe cradle
- Put the probe in the cradle
- Place sterile gel onto prepped skin on injection site
- Don sterile gloves
- Using non-dominant hand, pick up probe and scan target

Needle Selection

- For ultrasound guided injections use a significantly longer needle than you initially think you will need.
  - You are entering the skin at a significant angle to get under the probe, whether in long or short axis.
  - Superficial injections will need a 1.5” to 2” needle:
    - AC joint injection
    - Finger
    - Wrist
    - Elbow
    - Subacromial – subdeltoid bursa
**Needle Selection**
- For other than superficial structures, use a 3.5" spinal needle.
  - 18 gauge for aspirations
  - 20 gauge
    - Glenohumeral
    - Hip
    - Spine
  - 22 gauge
    - Intraarticular knee
    - Greater trochanteric bursa
    - May need longer needle for thicker individuals

**Needle Driving**
- 22 gauge spinal needles take practice to re-direct
  - Must have good visualization of needle to redirect.
  - "Bent needle" technique
  - Use bevel to deflect needle
  - Not necessarily intuitive
    - Withdraw needle
    - Indirectly curve needle to re-direct needle
  - Practice technique in tissue model

**Injection Approach...Long Axis Injections**
- Able to track needle into Target Tissue

**Injection Approach...Short Axis Injections**
- Can not see needle tracking into target.
- Needle appears as a hyperechoic “dot” once in target.

**Common Lower Extremity Ultrasound Guided Injections**
- Common injection for visco-supplementation
- Long axis injection
- Targets the suprapatellar pouch
- Avoids repeated insults to remaining hyaline cartilage which occurs with other needle approaches to the knee joint.
- An excellent model for learning US guided technique to apply to other joints as your skill grows.

**US Guided Knee Injection**
US Guided Knee Injection

- Document informed consent
- Enter patient data into the ultrasound, pre-label the image
  - “L suprapatellar pch trans inj”
- Confirm indicator on probe to see where your needle will enter the screen
- Disinfect probe and cable
  - Linear array high frequency probe

US Guided Knee Injection

- Position patient
  - Laying supine on exam table, leg extended, knee bent 20-30 degrees
- Prep skin widely for transverse view (ventral to lateral)
  - Chloroprep x 1

US Guided Knee Injection

- Prepare Equipment
  - If doing an aspiration first, use an 18 gauge 3.5” spinal needle on a 60 ml Luer-Lok™ syringe.
  - If injection only, use a 22 gauge 3.5” spinal needle on a 10 ml normal saline flush syringe.
  - Injectate (visco-supplementation or corticosteroid-lidocaine mix in appropriate syringe).

US Guided Knee Injection

- Place sterile gel onto prepped skin over suprapatellar pouch
- Sterile glove at least on hand holding the ultrasound probe
- Place probe on skin above the suprapatellar pouch in transverse view and locate target
  - Resist the urge to look in long axis view
  - It will not help you with the injection
  - Keep 2-3 fingers of your probe hand in contact with the patient’s skin to control probe.
  - Think pool cue

US Guided Knee Injection

- Locate suprapatellar pouch, it may be hard to pick out definitively.
  - Use very light pressure on the probe
  - Look for the tissue plane between the quadriceps tendon and the pre-femoral fat
  - This is usually a potential space
  - It is readily seen if an effusion is present
  - Look for small pockets of fluid
**Tips for finding the suprapatellar pouch**
- Use light pressure on probe
- Subtle movements of the probe
- short-axis slides and tilts
- Stay on prepped skin
- Try milking fluid up by having assistant compress the caudal aspect of knee joint
- Try having patient flex quadriceps
- If in doubt, aim for the tissue plane between the pre-tibial fat pad and the quadriceps tendon

**US Guided Knee Injection**
- Once you have located the suprapatellar pouch, inject the anesthesia
  - Inject the skin weal at the needle entry point
    - Deeper than you may initially think
  - Inject deeper along the estimated needle track to anesthetize the nerve rich lateral retinaculum
  - Give the anesthesia at least 45 seconds to take effect

**Initial needle entry**
- DO NOT LOOK AT THE SCREEN
- Look at the probe and perfectly line up your needle
- Enter the anesthetized skin into pouch with ONE SURE CONFIDENT STROKE to a point under the ultrasound probe.
  - Usually you will be very close to your target
US Guided Knee Injection

- Look up and find your needle on the screen.
- Use subtle movements of the probe (short axis slides, tilts).
- Advance into pouch, if not in already, using the ultrasound to guide your movements as you advance into the bursa.
- Start with needle bevel facing the probe to increase ultrasound wave reflection.
- Take “multi-beam” function off, this may help you see the reverberation shadow from the needle.

 Confirm needle placement in bursa

- Aspirating a significant effusion is like hitting the side of a barn.
- Take image of needle in the effusion before and after aspiration, or take a video clip.
- If no effusion, once the needle tip is in what you think is the suprapatellar pouch, inject some normal saline.
  - You should see the bursa moderately inflate (hypoechoic) then immediately deflate as it flows away with very little plunger pressure. It may not inflate visibly because it is flowing away.
  - It should not “sausage out” away from the needle tip, you are in a tissue plan and not the bursa.
  - If you see a “ball of speckles” around the needle tip, you are not in a bursa or a tissue plane.

 If not convincingly in the bursa, pick another layer and reposition needle

- If after repositioning several times you can not confirm placement in the bursa, bail out to a clinically guided injection.
- Once convinced you are in the bursa, use forceps to secure the hub of the needle.
  - Use an assistant to do this.
  - Twist off flush syringe.
  - Twist on syringe with injectate and inject.
  - Don’t forget to save and label image.
US Guided Knee Injection
- Pull needle out gently, yet swiftly
- Wipe off gel with 4x4 sponge
- Band-aid
- Flex knee several times
- Always give and document precautions to patient
  - Signs of infection, drug reaction, bleeding, etc

Intra-Articular Hip Joint Injection

Hip Joint Injection
- Deeper injections require more skill
- Tracking the needle is more challenging and demands better technique to increase sound wave reflection from needle
  - Beam steer
  - “Toe” probe back to get better reflection
  - Start with needle bevel facing up
  - Scare needle tip with a scalpel
  - Ultrasound reflective (facet tip) needles
  - Anisotropy may make visualization of distal part of needle challenging
- Must have clear understanding of the anatomy

Hip Joint Injection
- Probe
  - 2.5 MHz (low frequency) curved probe
  - Long axis injection
  - Probe long axis femoral neck over femoral head
- Patient position
  - Lying supine
- Needle
  - 3.5” long 20-22 gauge spinal needle
- Anesthesia
  - 5 ml buffered lidocaine skin weal and along needle track

Hip Joint Injection
- Injection
  - Anterior longitudinal approach
  - Clear the needle path with color Doppler to avoid vasculature (ascending branch of lateral circumflex artery)
  - Enter the hip capsule of the proximal femoral neck just caudal to the femoral head
  - The patient may twitch when you enter the hip capsule
  - Watch for the hip capsule to slightly inflate when you inject
    - You may have to rotate the needle bevel or redirection
    - It should inject fairly easily
Common Upper Extremity Ultrasound Guided Injections

**Anatomy**
- Superficial
- “Sea gull”

**Probe**
- High frequency linear probe
- Short axis injection
- Probe along long axis of clavicle centered over ACJ

**Patient position**
- Sitting up, reclined or lying down

**Needle**
- 2" long (1.5" will work) 25 gauge

**Anesthesia**
- 1ml buffered lidocaine skin wheal

AC Joint Injection

**Anatomy**
- Superficial
- “Sea gull”

**Probe**
- High frequency linear probe
- Short axis injection
- Probe along long axis of clavicle centered over ACJ

**Patient position**
- Sitting up, reclined or lying down

**Needle**
- 2" long (1.5" will work) 25 gauge

**Anesthesia**
- 1ml buffered lidocaine skin wheal
Subacromial-Subdeltoid Bursa Injection

- **Probe**
  - 6-13 MHz (high frequency) linear probe
  - Long axis injection
  - Probe long axis perpendicular to edge of acromion

- **Patient position**
  - Sitting up

- **Needle**
  - 2" long 25 gauge needle

- **Anesthesia**
  - 2 ml buffered lidocaine skin wheal along needle track or none.
Subacromial-Subdeltoid Bursal Injection

- **Injection**
  - Find the bursa between the supraspinatus and deltoid (hypoechoic line)
  - More lateral than you think, you do not have to go under the acromion
  - Start with needle bevel up (facing probe) then once in bursa turn bevel 180 to facilitate infiltration
  - Watch fluid track up and under the acromion

Glenohumeral Joint Injection

- **Probe**
  - Medium frequency linear probe or low frequency curved probe
  - Long axis injection
  - Probe long axis over posterior humeral head / glenoid fossa with probe oriented generally along spine of scapula

- **Patient position**
  - Lying on side with shoulder up, patient facing away

- **Needle**
  - 3.5” long 20 or 22 gauge spinal needle

- **Anesthesia**
  - 5 ml buffered lidocaine skin wheal along needle track

Glenohumeral Joint Injection - Anatomy

- **Injection**
  - Inject from lateral to medial
  - (It is also possible to inject medial to lateral)
  - Start with needle bevel facing down to avoid deflection going through the infraspinatus
  - Place needle tip between posterior labrum and humeral head articular cartilage inside the posterior capsule
  - Rotate the needle bevel down to face the joint to reduce injection resistance
  - Watch for expansion of the capsule and flow of fluid as you inject to ensure proper placement

• Start with the more straightforward injections/aspirations that you routinely do in your clinic.
  - Knee
  - Aspirations
  - Shallow structures
• Work in GT bursa (gluteus medius tendonopathy) injections: good low risk model to learn techniques for deeper injections.
• Consider adding in hip and glenohumeral injections after you have consolidated your ultrasound and needle driving skills.

Conclusion

- Do not be too hard on yourself, there is definitely a learning curve
- Be conservative and safe as you gradually expand your repertoire
- Seek out continuing education from physicians skilled in ultrasound guided procedures
- Document your training
- Keep a record of your procedures
- This is a skill worth learning and will have synergy with your practice of musculoskeletal medicine

How do you get good at US?
Questions ?