ULTRASOUND GUIDED INJECTIONS IN SPORTS MEDICINE – *If you don't use it, you lose it!*

Omer Mei-Dan, MD
Sports injury unit, Meir University Hospital, Kfar-Saba, Israel

Eugene Kots, MD
Radiology department, Meir university hospital, Kfar-Saba, Israel

Barnaby Clark, MBChB, FRANZCR
North Shore Hospital and Auckland Radiology Group, Auckland, New Zealand

Allow us to start with the bottom line, before we move to the science.

If you are injecting suspected pathology without using Ultrasound, it is wrong! Not only may the patient have a painful injection site, but you will have most probably missed the target site by a few millimeters, maybe more, while your precious medication, regardless of its kind, is gone, vanished within healthy surrounding tissues which did not need to be treated. Gone, gone, gone.

Yep, we know. You have performed hundreds of injections before Ultrasound (US) machines were invented. It all went well and you always had 100% success rate, especially when infiltrating 20ml of local anesthetic to the sub acromial bursa. Well my friends, times have changed. We are aiming for better outcomes, better documented results, better understanding of our procedures (both for our patients and ourselves) and there are more options for injectables. At times the required medication volume is so small that it must be placed exactly where it is needed.

Figure 1: *MRI and US images of Tibialis Posterior tenosynovitis and micro-tears in a professional volleyball player. An US guided injection of PRP\PRGF was performed after aspiration of the tendon sheath fluid. The procedure was repeated 3 times and yielded excellent results with 4 years of follow up.*

Yes, in the patellar tendon lesion, not in the fat pad below it!

Ultrasonography has proved to be a useful tool for clinical evaluation and interventional radiology. It is widely advocated in joint and soft tissue aspiration and injection technique in clinical practice. Many clinical, cadaveric and radiological studies have shown that US-guided injections are more accurate than palpation-guided (blind) injections in various joints and soft tissue structures. Even in joints such as the knee where we all "sure" that "we got it all right''.

Ultrasound-guided injection offers a technique with direct visualization, real-time guidance of needle insertion, and confirmation of injectate inside or around the desired location. This optimizes injectate placement when optimal accuracy is

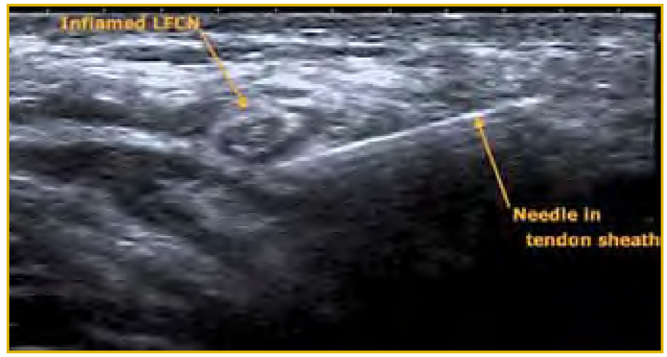

Figure 2: *A national soccer team goalkeeper sustained a hip hyper-extension injury with on-going irritation of the LFCN of thigh. The nerve sheath was injected under direct US visualization which resulted in complete symptom resolution.*

necessary for both diagnostic or therapeutic purposes and can assist in avoiding iatrogenic injury or irritation to adjacent tissues and structures during the procedure. Moreover, the procedure is performed without exposing the patient and physician to the risks of radiation. Once a team work of an MSK radiologist and a sports surgeon is established, it can be done in a quick, reproducible and simple manner.

Technical:

Ultrasound machines range from large full scale units to small laptop based portable machines. Technology has been rapidly progressive and portable units are readily available and can now produce high quality images, adequate for MSK interventions.

Ultrasound machines generate electrical impulses which are converted to ultrasound waves by transducers in the ultrasound probe. Conducting material, typically a water based gel, allows transmission of the sound wave into tissue. Sound waves travel through the body with partial reflection of the wave at each tissue

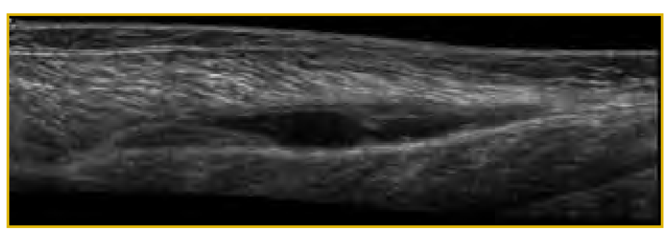

Figure 3: *A professional basketball player developed a seroma after an acute gastrocnemius tear. The seroma was evident and easily measured on US. It was evacuated under direct visualization, followed by a therapeutic PRP injection.*

interface. This reflected sound wave (echo) is converted back into an electrical pulse by the transducer forming the image. Doppler and Color imaging uses the frequency shift in returning echoes to assess movement (usually blood flow). The red and blue colors depict the direction of flow relative to the transducer, rather than arterial versus venous flow.

For all machines selection of the ultrasound probe (transducer) will have a key bearing on image quality and needle visualization. Transducers come in curved or linear arrays. Linear arrays are used for most musculoskeletal imaging and have greater resolution. This is explained by higher frequency sound having a smaller wavelength which allows reflection from smaller structures, optimal for tendons, ligaments and tissues in the superficial musculoskeletal system. Spatial resolution in superficial tissues can be less than 1mm giving exquisite detail. The trade-off is high frequency US has reduced tissue penetration and poor visualization of deeper Tissues. For deeper structures and/or larger patients, curved arrays using a lower frequency may be needed for sites such as hip joint injections. Most systems will also require the operator to select an imaging algorithm suited to the target site (e.g. 'MSK', 'MSK superficial', 'venous assessment'). This software will aid image optimization.

In the musculoskeletal system ultrasound images are usually described as in 'short axis' or 'transverse' and 'long axis' to the imaged structure rather than axial, Sagittal or coronal, such as with MRI. This simple method of annotation also works well for curvilinear structures such the distal biceps or iliopsoas which require imaging in oblique planes. Imaging planes for injection are less determined by true orthogonal planes but by a balance of visualization of the target site, comfort for the patients and avoidance of adjacent neurovascular structures. Injection is ideally performed using real time visualization with the ultrasound probe over or near the area of interest. The needle is placed lateral to the probe but is directed into the field of vision. Visualization of the needle is improved with keeping the ultrasound probe as close to 90 degrees / perpendicular to the plane of the needle as possible. Small fine needles such as 25G remain readily visible for superficial procedures. Sometimes due to anatomical limitations the injection may be performed using the "short axis", inserting the needle "over the probe"– in the transverse plane. This specific technique is more difficult to manage and visualization of the needle is less confident, but in some instances it is the most convenient way to hit the target (Fig 4 adjacent).

Figure 4: *PRP guided injection for long standing Achilles paratenonitis of an ironman.*

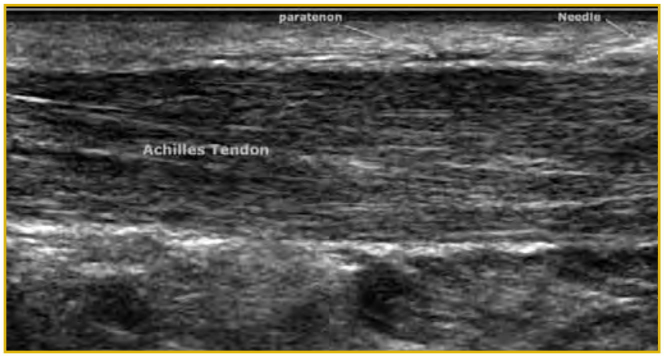

Figure 4A: *Long section view of heterogenous and swollen tendinopathic right Achilles tendon. Arrow indicates 22G needle at paratenon.*

Figure 4B: *Short axis view right Achilles tendon. Arrow indicates needle tip. PRP injectate fills paratenon space.*

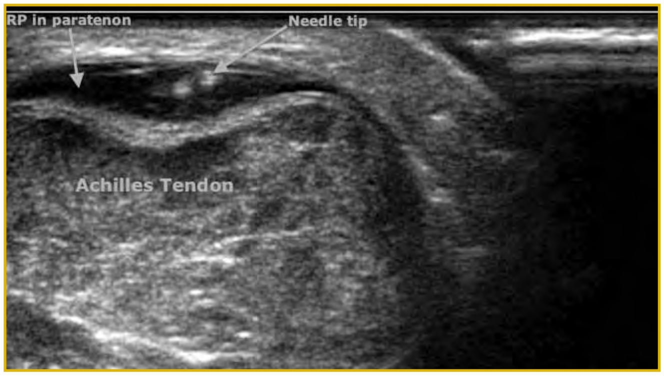

Figure 4C: *Right Achilles tendon long section. Arrow indicates needle. Hypoechoic (black) PRP injectate fills paratenon space.*

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Tips and Pearls

Obtain consent and discuss expectations of the procedure before preparation of materials. Discussion of the procedure while your back is turned while drawing up medication can lead to distraction and mistakes. It may also seem unprofessional. A relaxed patient makes for a better procedure for everyone.

- Ensure the patient does not have a rash over the target area or a current infection (if you don't ask they won't tell). Infectious complications are rare but particularly with steroid injections, patients should be screened for risk factors. If injecting steroid, check if the patient is diabetic.
- Scan and review the area of interest before marking the patient. Confirm the expected pathology is present and matches with any preceding US, MR or other imaging. Mark the plane of imaging and entry site after this target area review.
- Position the patient for your comfort as well as theirs. 15cm of increased table height and moving the patient closer to you can seem minor for 1 procedure, but can be the difference between no problems and a sore back at the end of the day, or a lumbar fusion at the end of the decade!
- If initially giving lignocaine, note the plane of entry to guide needle placement for the following therapeutic injection.
- If planning to swap syringes rather than withdraw the lignocaine needle (i.e for steroid/ ropivacaine injection), make sure the needle is not screwed on too tight, as this risks losing the needle tip position.
- Ensure you prepare the proper equipment such as the correct needle and syringe size if aspirating body fluid (joint effusions, tendon sheath effusions or muscle hematoma), especially if planning to send for lab work.
- Plan what volume you need to inject and prepare accordingly. For example with a volume less than 2ml (such as with jumper's knee lesion) take less blood and prepare the PRP concentrate accordingly.
- As PRP needs to be activated immediately prior to injection, ensure all the equipment is ready and the needle is in place so you can activate and apply within seconds.
- Use a luer lock type syringe, especially if injecting into soft tissue that may have resistance, such as tendon lesions. This saves wasting injectate and avoids spraying it over your face!
- Patients can be anxious around the time of procedure and may not remember everything you say. A sheet of post-procedure care instructions for each procedures is good practice. This should include return to activity, pain relief (e.g. no NSAIDS for PRP), infection risk and follow-up.
- A pain chart with set times for recording response to the injection over a given time period is also useful for assessing diagnostic versus therapeutic effect.

Equipment Used:

- Examination bed. Many injections can be performed with patient seated. However even the young and fit can have vagal reactions. Having the patient supine or prone makes management easier.
- Ultrasound machine (portable or full scale system)
- Transducers: Linear high frequency (small and larger FOV), Curved array
- Permanent type marker pen for marking injection site
- Conducting agent: Standard gel for initial assessment and marking. Sterile water based gel or chlorhexidine solution for the injection.
- Sterile probe cover: Not used in all centers, but use is good practice
- Drapes / Keyhole drape: Use is good practice
- Local anesthesia: Lignocaine 1% (adrenaline usually not required)
- Syringes: luer lock generally, 3, 5 and 10ml. (20ml can be required for calcium aspiration)
- Antiseptic solution (iodine or chlorhexidine based)
- Gauze swabs
- Small tegaderm or similar dressing for end of procedure
- Connecting tubing: bore of tubing should be appropriate for needle size
- Needles:
  - 25G local anesthesia, steroid injection (avoid small diameter for PRP)
  - 22G: autologous blood /PRP, steroid injection/ local anesthesia in deeper tissues where spinal needle required.
  - 20G: Autologous blood / PRP.
  - 18G: joint aspiration for infection, calcific tendinosis aspiration, ganglion aspiration, Hematoma aspiration.
  - 16G and 14G: ganglion and calcium aspiration (less commonly but ganglia contents are often semi-solid)

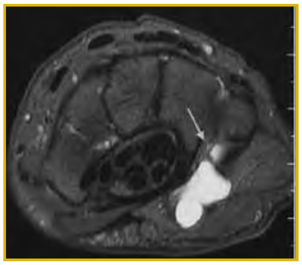

Figure 5: *Ultrasound Guided Aspiration of Guyon's canal ganglion compressing the ulnar nerve.*

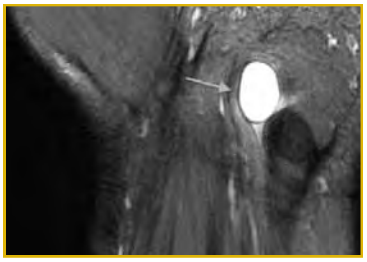

Figure 5B: *Axial and coronal PDFS MR image of wrist. Ganglion arising from pisotriquetral joint compresses the ulnar nerve (arrow) in Guyon's canal.*

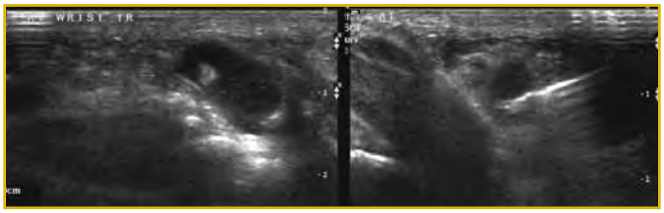

Figure 5C: *Short axis US of volar wrist. 18G needle placed to ganglion for aspiration, which has reduced in size from previous picture. Large needles have potential for neural laceration. Ultrasound allows clear visualization of needle tip away from ulnar nerve (arrow).*

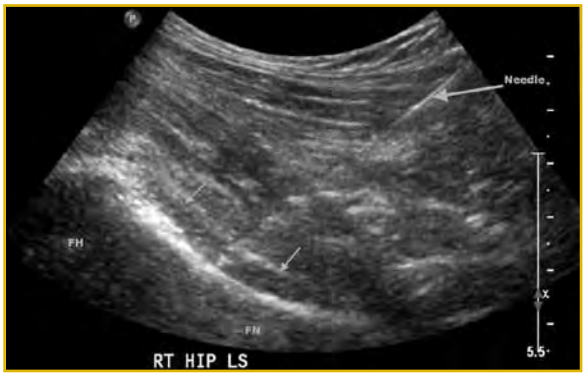

Figure 6: *A. US image in long section to the femoral neck (FN) using a curved transducer. Hip joint capsule marked with 2 small arrows while a 22G spinal needle placed to the femoral neck. (FH = femoral head).*

Figure 6B: *A. US image in long section to the femoral neck (FN) using a curved transducer. Hip joint capsule marked with 2 small arrows while a 22G spinal needle placed to the femoral neck. (FH = femoral head).*

Figure 7: *Mid Achilles Tendinosis with Neo-Vascularity.*

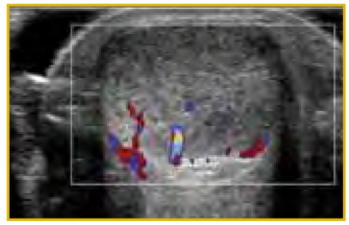

Figure 7A: *US short axis view of Achilles tendon with changes of tendinosis (swelling and a heterogenous, reduced echotexture). There is neo-vascularity with feeding vessels arising at the deep tendon border.*

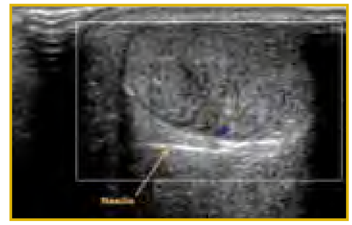

Figure 7B: *Short axis Achilles tendon. Arrow indicates 22G needle with a reduction in neo-vascularity post polidocanol injection.*

Figure 8: *Supra-Spinatus Calcifying tendinitis aspiration.*

Figure 8A: *Short axis US view of calcific tendinosis of supraspinatus. The tendon is distended with echogenic material (white), representing the calcium deposits. A 25G needle has been placed to the calcification for local anaesthetic injection, prior to attempted aspiration.*

Figure 8B: *Short axis ultrasound of supraspinatus tendon. 18G needle placed to calcification for aspiration. Note the bevel of the needle is visibl.*

Full article and references also available online at www.isakos.com.