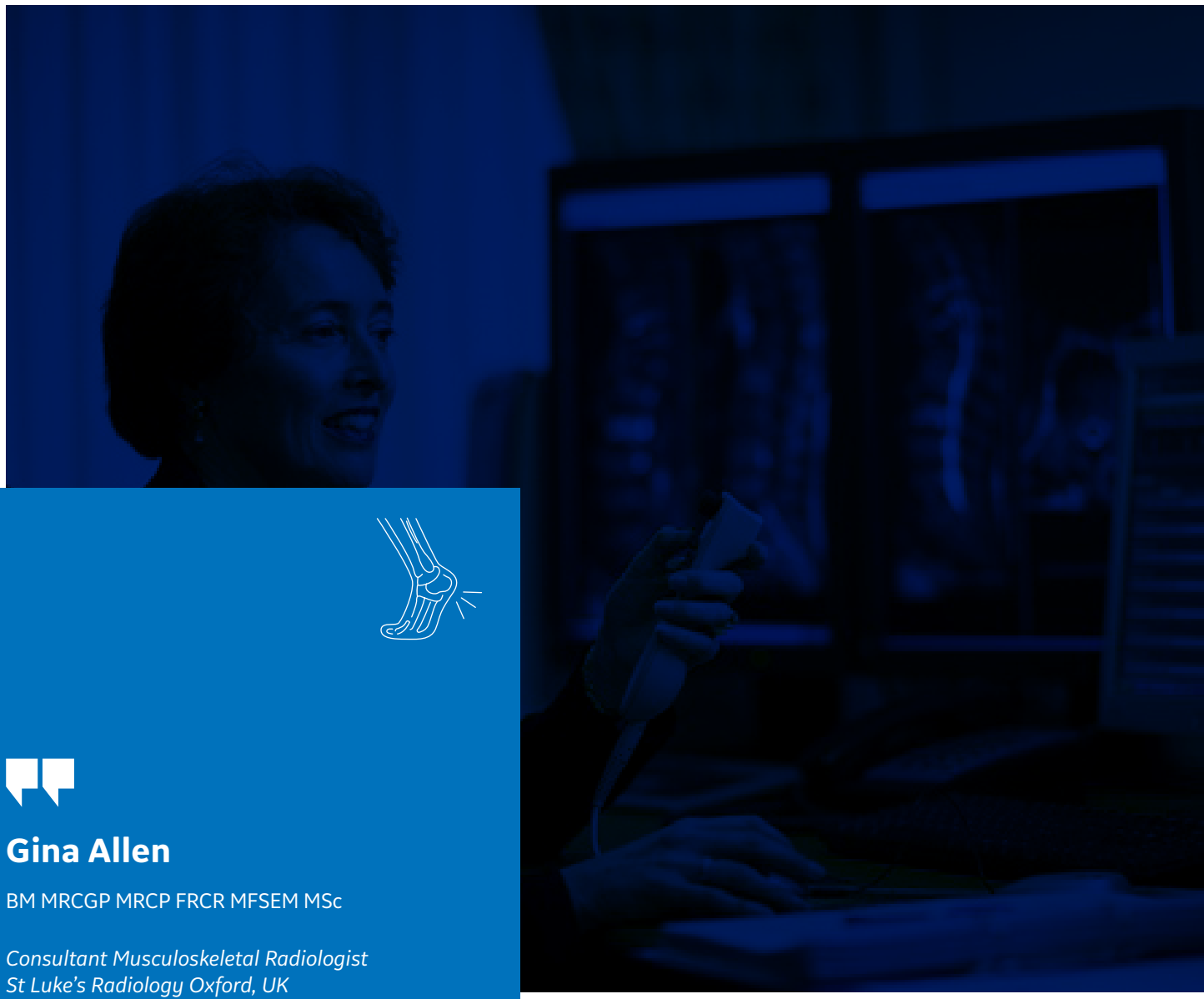

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The clinical impact of **high frequency Imaging** with Radiant*flow*™ and Micro Vascular techniques in musculoskeletal investigations

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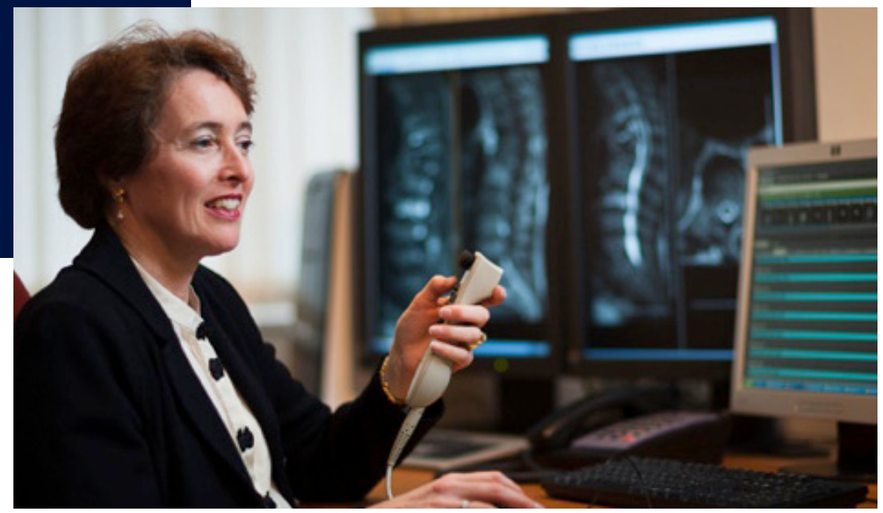
Introduction



CURRENT TRENDS IN MUSCULOSKELETAL ULTRASOUND

Recent developments in musculoskeletal (MSK) ultrasound enable the sonographer to see smaller structures close to the probe, just underneath the skin surface, in more detail, due to higher frequency probes and better overall performance. Peripheral nerves and skin lesions are exceedingly difficult to image with MRI and now high performance high-frequency ultrasound probes with excellent resolution close to the skin are providing new clinical and diagnostic capabilities.

Increased vascularity within a tendon, ligament or nerve or soft tissue lesion indicates that there is a problem. In tendinosis we see neovascularisation as a part of the degenerative and inflammatory process and this can be correlated with the presence of pain. After a ligament is injured there is neovascularisation present for several months afterwards. The presence of increased vascularity can therefore help detect whether the ligament has been recently injured rather than the injury being old. Improved resolution probes with microvascular imaging are now beginning to show what is probably normal vascular supply in these structures. Although enhancing sensitivity this raises the problem of determining which vessels are truly abnormal.

When nerves are substantially compressed they become enlarged and swollen proximal to the compression and vascularity occurs within the nerve. This is commonly seen in the median nerve compressed by the transverse ligament in the carpal tunnel. The ability to see this vascularity in more detail, at lower flow rates will be an advantage in detecting earlier disease.

Soft tissue lesions near to the skin surface can sometimes be related to the hair follicles. A connection with the skin surface is difficult to see without a high-resolution probe. The presence of vascularity in a soft tissue lesion can help in the assessment as to whether the lesion is benign or malignant. It can also help in the diagnosis and staging of a vascular malformation. Ultrasound is frequently being used as a tool for the initial assessment of soft tissue lumps in the general population.

Ultrasound-guided intervention is being used by many clinicians to increase the safety of injections in a patient. It is important to be able to see the needle clearly and avoid adjacent nerves and blood vessels when performing an injection of the joint or tendon sheath. There is evidence that Ultrasound guidance improves the efficacy of injection therapy. This is helped by the use of small “foot” plate probes that allow access to smaller curved structures such as the hand and foot joints.

Currently many ultrasound machines have small footprint probes of a good near field resolution and good colour Doppler. To determine whether new technologies will improve our diagnostic and therapeutic abilities we must look for resolution, frame rate, and the sensitivity of different forms of Doppler imaging.

CLINICAL CHALLENGES

In rheumatology patients being able to look at the small joints of the hands and feet is an important part of musculoskeletal imaging. The early detection of synovitis, neovascularity and erosions opens the pathway for early and effective medication for rheumatological conditions. Modern therapeutic agents can switch off the disease process and stop the patient developing a life changing deformity. A shortened lifespan in someone who is now crippled and confined to a wheelchair was commonplace but now thankfully much less frequent.

Providing an accurate diagnosis in injury, soft tissue lumps and all musculoskeletal problems is important. Being able to provide good imaging in the near field is very important as MRI is very imprecise in these areas. The use of colour or power Doppler to assess vascularity is an important tool as demonstrating this within seconds, at the push of a button. It provides better information on vascularity rather than using MRI examination with intravenous contrast agent. This avoids the risks of allergy and potentially toxic long-term deposition of gadolinium in the brain and other tissues.

Guiding needles into structures that are found at increasing depth during the current epidemic of obesity is challenging. The hip is a particularly difficult target without greater penetration whilst maintaining resolution.

In Summary, in Musculoskeletal Ultrasound scanning we are looking for:

- Good near field and far field resolution
  - To see small superficial structures such as nerves
  - To see the spine and deep joints like the hip
- Sensitive Colour Doppler
  - To detect early vascularity in a tendon or joint synovium
- Good detection of a needle
  - To make intervention safer

ULTRASOUND OPPORTUNITIES

There are new Opportunities with new High frequency imaging and new flow modes in the latest ultrasound machines. This will allow us to:

- see structures more clearly in the near field with better resolution will enhance the detection of lesions near the skin such as in the hands and feet.
- see more vascularity at an earlier stage of disease process thereby enhancing the detection of subtle injury or early abnormality.

New Solutions for MSK Ultrasound investigations

IMPROVEMENTS IN B-MODE STUDY: **HIGH FREQUENCY IMAGING WITH NEW SRI ALGORITHM**

The new L6-24-D high frequency probe provides great clinical achievements in musculoskeletal investigations. The new improvements regarding the SRI algorithms, contributes to an excellent fiber and border continuity (visible at 2-3 mm) than the previous hockey stick probe L8-18i-D). It enhances also the contrast resolution for nerves studies and the definition of the bone surface.

IMPROVEMENTS IN FLOW MODE STUDY: **MICRO VASCULAR IMAGING & Radiant*flow*™**

The new Micro Vascular Imaging (MVI) combined to Radiant*flow*™ technology provides for clinicians a High-definition flow mode with a near 3D look.
It supports visualization of tiny vessels, helping clinicians to have:

- A clearer definition of vessels with Radiant*flow*™.
- An easier display of interconnecting smaller vessels; detects more vascularity than Colour Doppler and Power Doppler.
- A better detection of subtle abnormality in these areas.

Clinical Cases

01

CASE 01

PATIENT'S HISTORY

A 38-year-old female portrait painter developed pain, swelling and stiffness in the hands and feet over several months.

She presented for ultrasound with a swollen right dominant wrist and had developed a lump on the ulnar aspect her right index finger distal interphalangeal joint and on the radial aspect of her left little finger proximal interphalangeal joint.

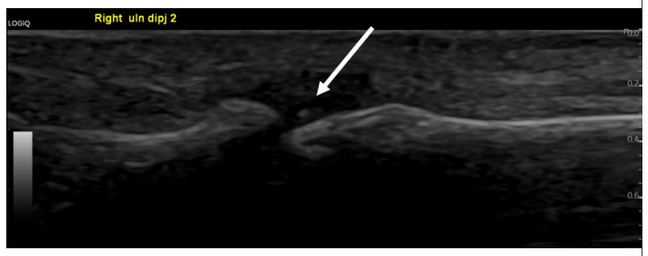
She was sent for ultrasound to establish whether there was an inflammatory arthropathy and to diagnose whether the lumps were soft tissue or bony in origin.

CHALLENGE

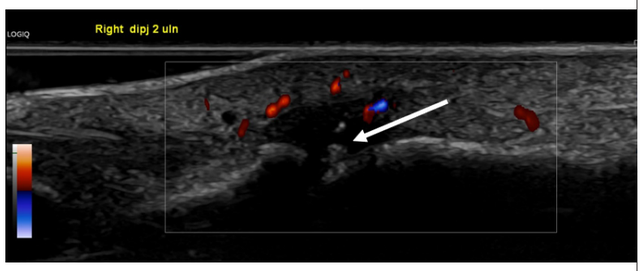
To detect early joint disease:
- Synovitis
- Neovascularity
- Erosion

SOLUTION

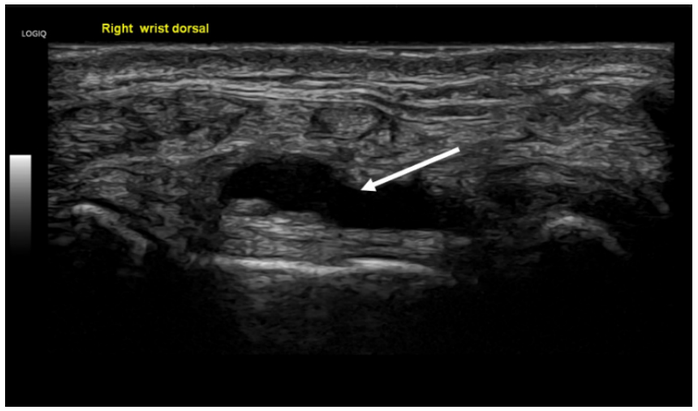
- L8-18i-D has been a good probe for detecting small joint disease
- L6-24-D with Radiant*flow*™ and MVI is even better



This image has been performed on the L8-18i-D probe. It is an image of the right distal interphalangeal joint ulnar aspect. It shows a high signal dot (arrow) within the joint space. This could be a small loose body or fibrous debris.



This image has been taken with the L6-24-D probe of the same area. Here we see continuity of the high signal dot (arrow) with the adjacent bone of the middle phalanx's head. This means that what we are seeing is an erosion of the bone at this site. This makes a diagnosis in inflammatory arthropathy more compelling.



This image taken with the L6-24-D probe shows the dorsum of the wrist at the site of the patient's swelling. This is a ganglion arising from the scapholunate joint (arrow). There was no synovitis present.

DIAGNOSIS

- Inflammatory arthropathy
- Dorsal wrist ganglion

CONCLUSION

The L6-24-D probe made the difference of giving a definite diagnosis of an erosion and an inflammatory arthropathy which would not be made with the L8-18i-D probe. This means that the patient can be started on appropriate treatment earlier to switch off the disease and stop joints being destroyed.

CASE 02

PATIENT'S HISTORY

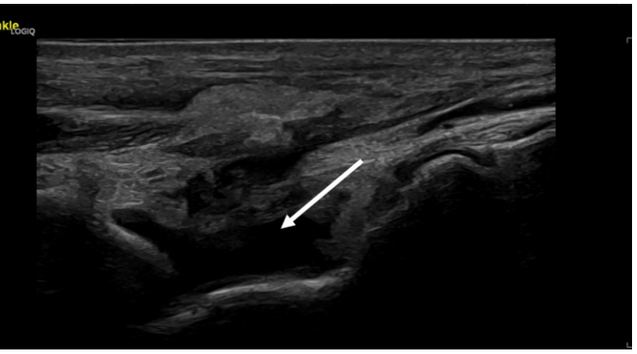
19-year-old male post an ankle sprain 8 weeks previously. He developed immediate pain and swelling with bruising several days later.
The x-ray was reported as normal. He attended for ultrasound examination as he was still in pain and had swelling and weakness of the ankle with a lateral clicking sensation.

CHALLENGE

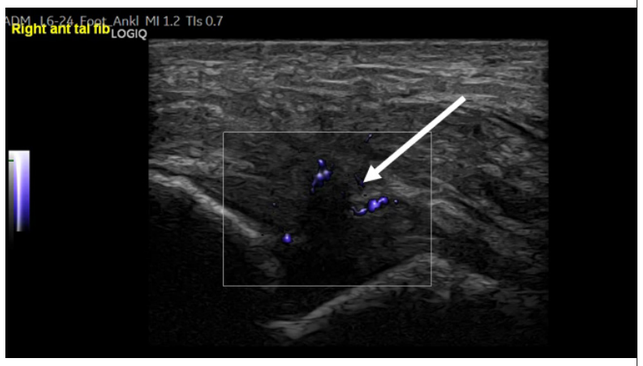
To determine the extent of injury and the reason for the lateral clicking sensation.

SOLUTION

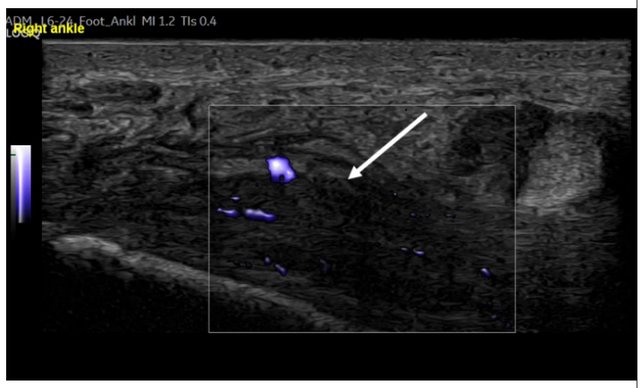
- The L8-18i-D has been a good probe for detecting ligament damage.
- L6-24-D with Radiant*flow*™ and MVI is even better
- A probe with a larger footprint and a lower MHz is also useful in looking at the ankle overall.



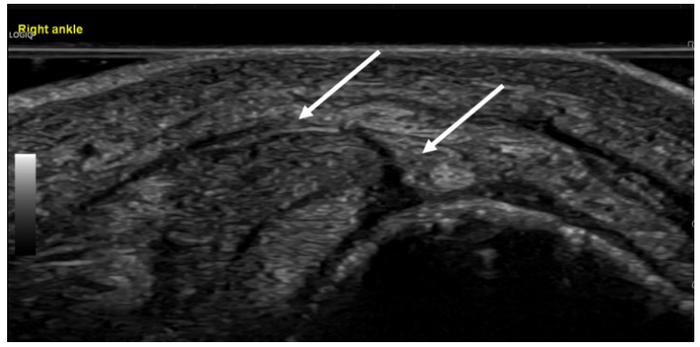
There is clear definition of the ankle effusion (arrow) that is present using the ML6-15-D probe with the new speckle reduction algorithm of 4.



This is an image of the anterior talofibular ligament using the L6-24-D probe. You can clearly see there is a defect in the central ligament (arrow) which is surrounded by neovascularisation using MVI with Radiant*flow*™.



This is an image of the calcaneofibular ligament using the L6-24-D probe.
You can clearly see areas of low echogenicity within the ligament (arrow) indicating partial tearing and neovascularisation using MVI with radiant flow.



This is an image of an intact peroneal retinaculum (arrow) and peroneal tendons underneath using the L6-24-D probe.

In the case of an ankle sprain and lateral ankle clicking, one of the common causes is an injury to the peroneal retinaculum allowing the peroneal tendons to move inappropriately and sometimes over the lateral malleolus with tendon dislocation.

It can be clearly seen that the peroneal retinaculum is intact. This means that the patient does not have dislocating tendons. It also means that the patient does not need surgery. The patient was noted to have a pseudosubluxation of the Peroneus brevis and longus tendons, which is when the tendons move in an abnormal way against one another within the tendon sheath, which was causing a sensation of clicking.

CONCLUSION

By demonstrating the extent and nature of the disease more precisely we can predict that the patient should recover with rehabilitation rather than surgery.

CASE 03

PATIENT'S HISTORY

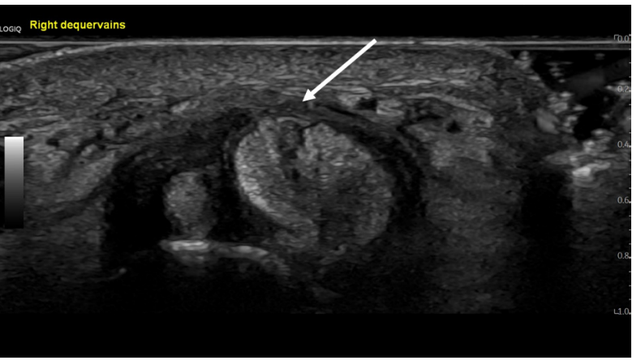
This 60-year-old lady with Parkinson's disease had a very painful thumb base and was finding it difficult to look after herself. The differential diagnosis was a tendinosis or joint problem.

CHALLENGE

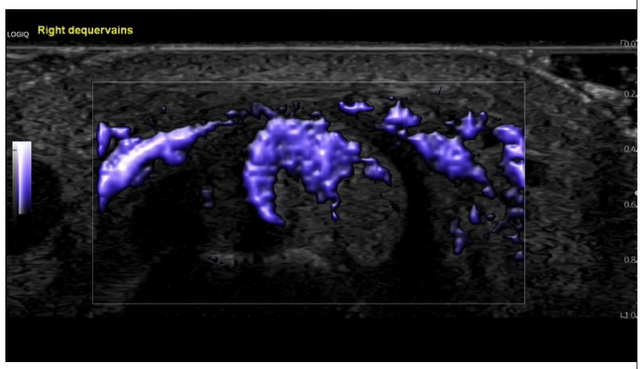
To make an accurate diagnosis and guide an injection.

SOLUTION

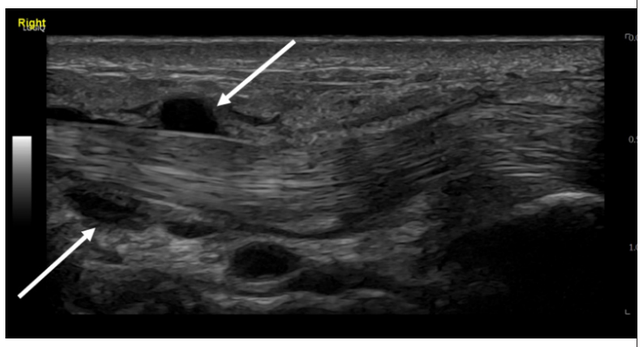
- The L8-18i-D has been a good probe for detecting tendinosis and guiding injections.
- L6-24-D with Radiant*flow*™ and MVI is even better



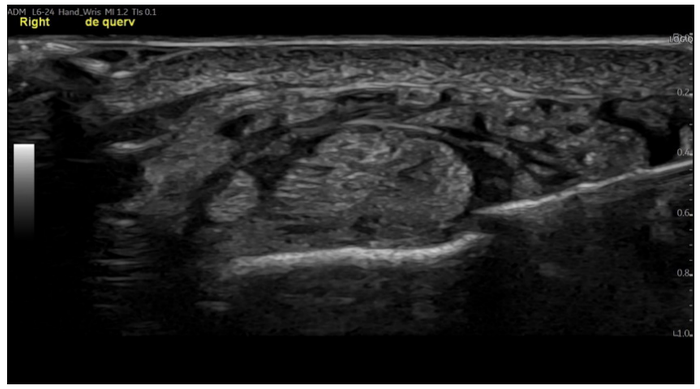
This is a transverse image of the abductor pollicis longus (large tendon) and extensor pollicis brevis using the L6-24-D probe. There is thickening of the overlying retinaculum (arrow).
We can clearly see areas of low echogenicity within the abductor pollicis longus tendon which could be tearing indicating partial tearing or be a normal variant.



There is neovascularisation using MVI with Radiant*flow*™ within this area indicating disease.



There is ectasia of the tendon sheath with pockets of fluid evident (arrow) on the longitudinal view in keeping with De Quervain's tenosynovitis.



This is an image of the De Quervain's tenosynovitis using the L6-24-D probe with a needle insitu in readiness for an injection of steroid to help her symptoms.

CONCLUSION

The L6-24-D probe has enhanced the visualization of area and the surrounding structures, allowing the diagnosis to be clearly made and an injection safely completed.

CASE 04

PATIENT'S HISTORY

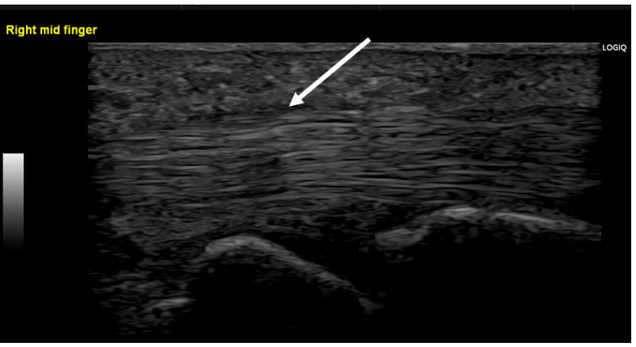
A 38-year man had triggering of his right middle finger that was interfering with life. He had thickening of the A1 pulley which was causing the triggering with a nodule in the superficial element of the flexor tendon.

CHALLENGE

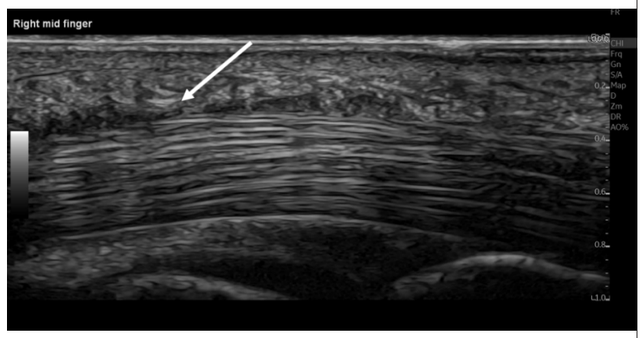
To see the A1 pulley and cut it using a percutaneous needle.

SOLUTION

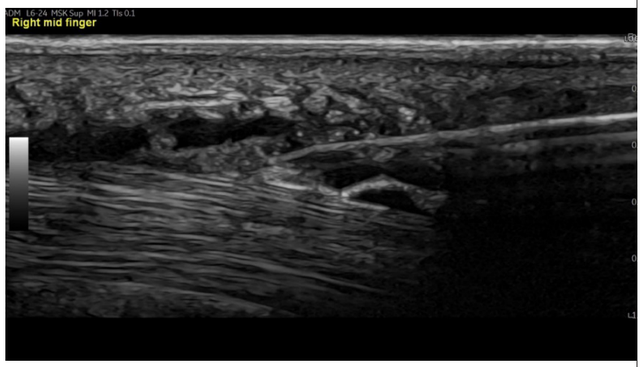
- The L8-18i-D has been a good probe for detecting the A1 pulley and guiding injections.
- L6-24-D with Radiant*flow*™ and MVI is even better



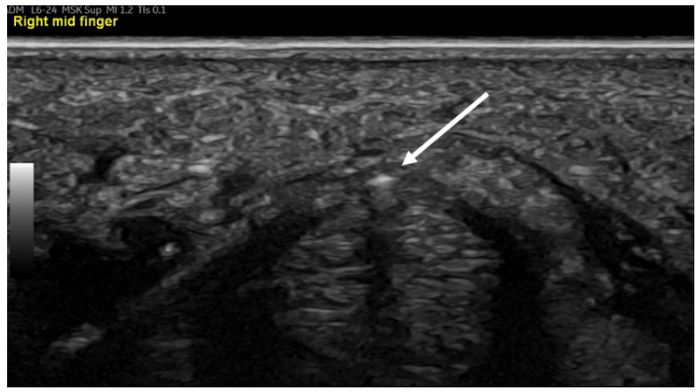
This is an image of the flexor tendon and A1 pulley (arrow) using the L8-18i-D probe.



This is an image of the flexor tendon and A1 pulley (central thickening) (arrow) using the L6-24-D probe. Note the greater definition of the A1 pulley.



This is a longitudinal image of the flexor tendon and A1 pulley being injected using the L6-24-D probe. Note the local anaesthetic in the tendon sheath giving greater definition of the A1 pulley.



This is a transverse image of the flexor tendon and A1 pulley being injected using the L6-24-D probe. Note the needle tip in the A1 pulley seen as white speck centrally (arrow).

CONCLUSION

The A1 pulley was successfully divided using a cutting needle by this percutaneous technique. I have never been able to see the A1 pulley as clearly before using this probe, this undoubtedly makes the procedure of greater precision and safer.

Conclusion

The L6-24-D probe with MVI combined to Radiant*flow*™ has improved my:

Imaging capability in seeing

- near field structures
- early vascularity

Needle visualisation

Using this new performance has just made intervention easier as I can see all the detail of the surrounding vessels and nerves

Gina Allen

Currently:

- ***Consultant Musculoskeletal Radiologist and Director at St Luke's Radiology Oxford Ltd***
- *Teaching Associate and Student Advisor at Green Templeton College,* ***University of Oxford***
- *Member of the* ***International Skeletal Society***
- *Run MSK US training courses including intervention with* ***St Lukes Radiology***
- ***Section editor*** *European Journal of Radiology*
- ***Section editor*** *Orthopaedic Journal of Sports Medicine*
- ***MSK Editor*** *for Acta Scandinavica*
- ***Medical Director of Imaging*** *for* ***InHealth***
- *Member of ESSR subcommittees on Ultrasound, Intervention, Sports Imaging.*

Previously:

- ***General Practitioner***
- ***Fellow in Orthopaedic Radiology*** *at Nuffield Orthopaedic Centre, Oxford*
- ***Honorary Consultant*** *at Nuffield Orthopaedic Centre, Oxford*
- ***Consultant Radiologist*** *at the Royal Hospital Haslar, Gosport*
- ***Squadron Leader in the Royal Air Force*** *(now retired)*
- *Physician in charge of Day Ward,* ***RAF War Hospital, Muharraq****, First Gulf War*
- ***Consultant Radiologist*** *at the Royal Orthopaedic Hospital, and University Hospitals, Birmingham*
- ***London Olympic Games 2012*** *radiology organising committee and volunteering*
- *Lead Clinician for* ***Oxford Soft Tissue Injury Clinic***
- ***Consultant Radiologist*** *Oxford University Hospitals*
- ***Chair*** *of the* ***ESSR Ultrasound Subcommittee.***

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