

THE FUTURE OF MUSCULOSKELETAL ULTRASOUND

AN IMAGING SPECIALTY OR A CLINICAL SPECIALTY?

– Written by Wes Cormick, Australia

I would like to start with a cautionary tale for radiologists and an interesting anecdote for sports medicine doctors. Many years ago in Australia, all ultrasound was done by radiologists. About 15 years ago the obstetricians were not satisfied with the level of service they were getting and started to do their own ultrasound. It was problem-based, clinically relevant and started to be a much better service for obstetricians than that which was being provided by general radiologists. Their college set up a credentialed training programme with assessment and qualifications and now, many younger obstetricians do their own ultrasound and, in general, it is a high-end service, much superior to that being provided by general radiologists.

In the future, I can imagine a situation where this is repeated by sports medicine doctors not being satisfied with the level of

service being provided by some radiology practices. You could argue as to whether ultrasound is being taken off radiology groups or, in fact, whether it is being let go. Such ultrasound would be clinically relevant, problem-based and provide a better service to clinicians.

So, can musculoskeletal ultrasound be practiced better than it is being done at the moment? I would argue yes, significantly better, and the answer is to make it an extension of clinical assessment rather than just taking photos. This is summarised in Figure 1.

I was trained as a physician, doing 4 years of clinical medicine in my training, and we have tried to implement this type of ultrasound in the practice where I work. When a patient attends for an ultrasound:

1. they have a relevant history taken,
2. there is a brief physical examination,

3. the ultrasound images are taken, including paying attention to motion and transducer-induced tenderness of the structures which lie at the site of pain,
4. needle tip tenderness is elicited to better define which structures are causing symptoms,
5. the injection of local anaesthetic and steroid is used to determine if the symptoms improve in the short-term and in the long-term.

One of the criticisms I hear of MRI by referring doctors is that several pathologies are found with no ability to determine which are actually clinically relevant and which are not causing symptoms. The cause of this, in part, is that the referring doctors usually only want us to tell them which parts are causing pain. This brings us to the concept of:

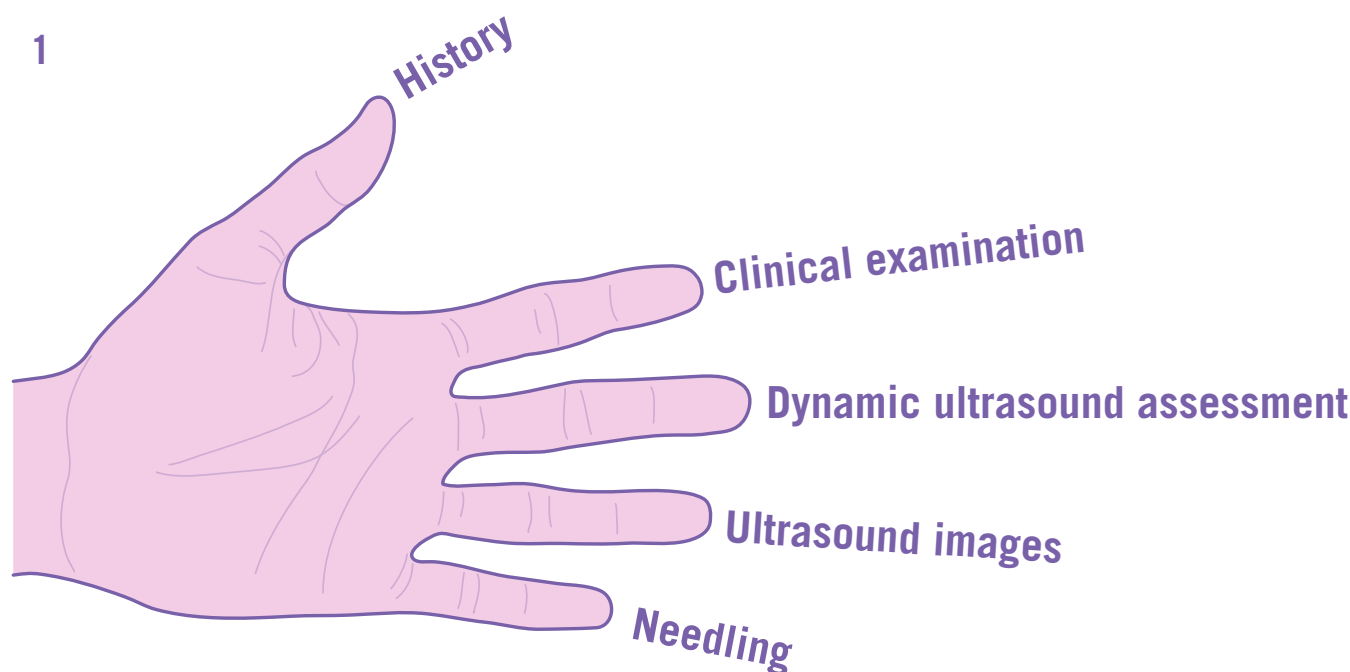


Figure 1: The ‘full hand’ of ultrasound techniques used to maximise its use.

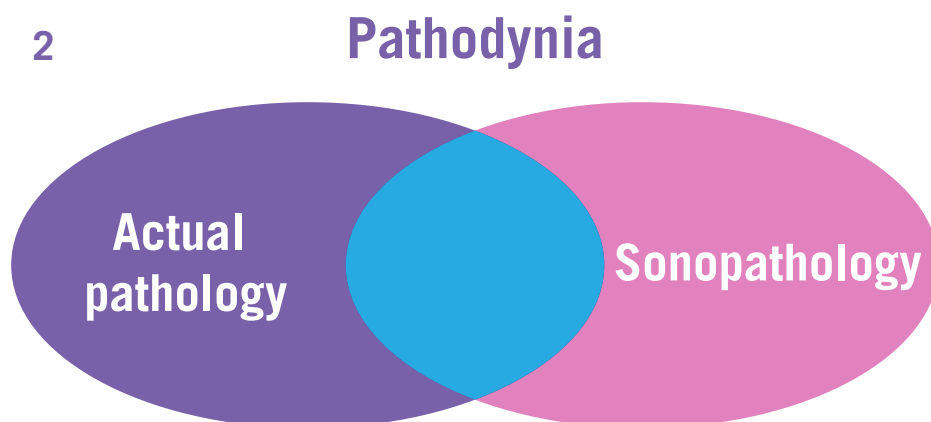


Figure 2: A Venn diagram representing the relationship between actual pathology, sonopathology and pathodynia.

- actual pathology,
- sonopathology and
- pathodynia (painful pathology).

The relationship between these is shown in Figure 2. Actual pathology is pathology which is present but is not necessarily demonstrable with imaging. In the case of ultrasound, I find this includes:

- mild tendinosis,
- chronic ligament strains,
- fat pad inflammation and
- nerve compression/inflammation.

Sonopathology is straightforward in that it presents changes we can see with ultrasound which might or might not be symptomatic. Asymptomatic

sonopathology includes quite a range of actual pathology and includes tendon tears, tendinosis, thickened bursae, calcium deposits and old muscle tears. So pathodynia is what we are being asked to find with ultrasound. If we had a scan that just showed up painful spots it would be very helpful. In the absence of this we are asked to differentiate between:

- Pathology that is painful but does not show up on ultrasound (purple).
- Pathology which is painful and does show up on ultrasound (blue).
- Pathology which shows up on ultrasound but is not clinically relevant (pink).

When we extend the assessment to include needling painful structures to determine if they are painful or not, we gain the ability to differentiate these groups. I will illustrate with some examples.

A simple case is a patient who presents with classic Achilles tendon pain, scores badly on the VISA (Victorian Institute of Sport) scale yet has a normal ultrasound. Because of the clinical suspicion, one might proceed to needle the tendon to see if it is tender. I personally will note:

- if it is tender on needling (revealing tenodynia),
- if it is soft on needling (revealing tenomalacia),
- if local anaesthetic can be easily injected into the tendon (tenomalacia),
- if the local anaesthetic completely abolishes the pain (tenodynia).

In addition, in patients who have no demonstrable colour flow in the tendon at rest (even with the leg dependant over the bed) needling the tendon can cause colour flow to appear. I may then proceed to polidocanol injection to improve the tendon pain. This therefore extends the examination to confirm pathodynia and tendinosis in a tendon that was thought to be normal on isolated ultrasound imaging.

A longer-term example is a patient who presents with carpal tunnel syndrome but has a normal median nerve on imaging and no other ultrasound pathology is demonstrated along the nerve up to the neck. Because of the clinical suspicion I will proceed to needle around the nerve and

inject local anaesthetic and steroid. If there is significant improvement in symptoms I have been able to assist the referring doctor by advancing the diagnosis, and also treating it. If there is no benefit, this is also useful to the referring doctor by advancing the diagnosis by excluding compressive neuropathy at the carpal tunnel. I usually find that the onset of neural pain has a structural change in the nerve and these structural changes persist for some time after the nerve is treated. This therefore may cause a false positive finding where the nerve is abnormal on imaging but is no longer responsible for persisting symptoms.

Another situation where this is very useful is when there are multiple findings on imaging and you want to find out which is the most relevant or causing the most pain. This is particularly the case in athletes where several structures are being stressed to the point of failure or in the elderly where several structures show degenerative changes. A good example is in the hip and buttocks. We often see changes in the hamstring origins and external rotators of the hip simultaneously. If one gently needles all three of the hamstring

origins, the deeper adductor magnus and the external rotators, it becomes possible to grade each on a modified analogue scale. I ask the patient to tell me:

- how bad the pain is on a 1 to 10 scale.
- Is the elicited pain similar or different to their usual pain?
- Do they feel pain where the needle is or referred elsewhere?

This allows me to grade all the findings I can see with ultrasound and prioritise them for the treating doctor. I may find large obvious tears that are not actually causing any pain and small subtle pathologies that are actually very painful. This is very helpful in the case of calcium in muscles or tendons that might be painful and need treating, or might be old burned-out calcium of no concern. I find the spatial resolution of needle tip tenderness is a few millimetres and it is very helpful in discriminating between deep structures when conventional palpation is limited. This is, of course, even more limited in obese patients.

Once we start doing this with different tendons we realise it can also be done within a given tendon. Figure 3 is an example. This was an elite athlete who had previous

hamstring rupture and repair and now has ongoing hamstring pain. Within the one tendon there was:

- fibrosis at its upper attachment at the site of surgery,
- a small focus of tendinosis with increased flow medially,
- several foci of calcification laterally.

By gently needling each spot we were able to ascertain:

- The origin was not painful with a good surgical result.
- Below the surgery the focal tendinosis was quite painful at 8/10 on an analogue scale.
- Lateral to this the 3 mm focus of calcium was also tender with score of 7/10.
- Further lateral to this there was a larger focus of calcium which was not tender.

When we find mixed pathologies within a tendon we plan a mixed treatment strategy tailored to the pattern of painful abnormalities that are present. In this case we opted to dry needle the tendinosis and instil steroid around the tender calcification. We then planned for the patient to have platelet rich plasma into the tendinosis about a week later.

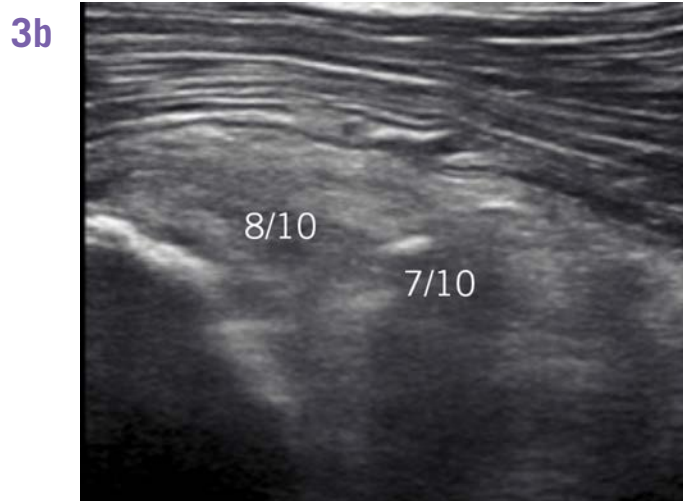
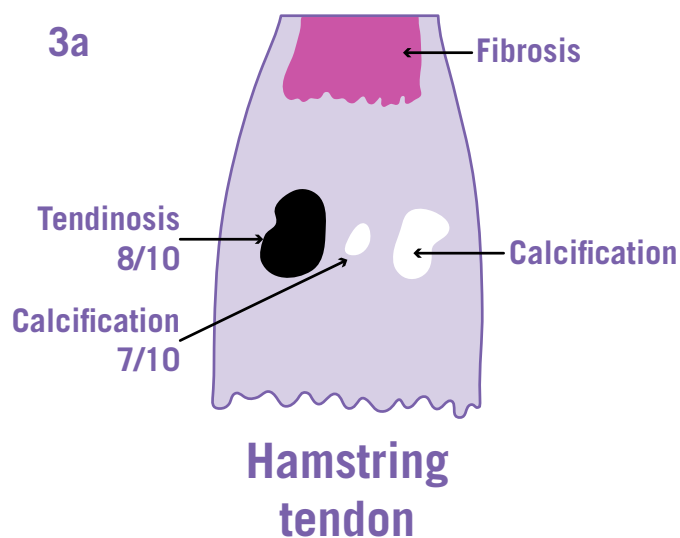


Figure 3: a) A diagram indicating the patient's hamstring pathology. The tendon is represented by the light purple area. There is fibrosis from the prior surgery, represented by the pink region at the top that was not painful. Below this and lateral, the black area represents focal tendinosis which scored 8/10 on an analogue pain scale. Medial to this the two white regions represent calcification, one of which scored 7/10 on a pain scale and the other was not painful. b) A corresponding transverse ultrasound image of the proximal hamstrings showing the tendinosis at the left which scored 8/10 and one of the calcific foci at the right of the image which scored 7/10.



Often where MRI cannot demonstrate a pathology, a well-performed clinical ultrasound assessment can find the diagnosis



When a given structure has mixed pathologies one should use a mixed treatment plan

In addition to the clinical component of needling a soft tissue structure there can be additional imaging findings upon injection. Many tendons are subject to lateral compression in their normal state and if there is a small tendon tear it is hard to demonstrate as the fibres are so tightly packed together. Examples of this include the gluteal tendons, supraspinatus tendon and lateral epicondyle. If I inject local anaesthetic into the tendon it allows me to see if there is a tear in the tendon substance as it opens up to allow the fluid into it. In addition I can assess if there is a simple linear tear, a complex Swiss-cheese type of tear or just widespread tenomalacia. I may mix a small amount of air into the solution which better shows up on ultrasound images and allows me to show the referring doctor when there is a tear which was not realised and determine its extent and communications.

Figure 4 shows a supraspinatus tendon with calcification at its insertion and a suspected tear at the insertion and also at the musculotendinous junction. I injected steroid and gas around the calcium which confirmed a tear in the tendon around the calcium and also at the myotendinous junction. The image shows the echogenic gas within the tear and also appearing in the subdeltoid bursa confirming the tear communicates with the bursa. The focal

calcification was painful but the two tears were not.

Many times we have had patients where MRI was not able to demonstrate pathology but by utilising a well-performed clinical ultrasound assessment we were able to find the diagnosis and treat it. An example is a young elite gymnast with a painful lateral ankle. She had a normal ultrasound and MRI performed previously. Both her

and her mother claimed the painful region was directly over the anterior tibiofibular ligament which was normal on imaging. Due to clinical suspicion, I needled it and it was very painful to needle tip. Injection of local anaesthetic showed longitudinal clefts through most of the ligament parallel with the collagen fibres. This was amenable to platelet rich plasma injection which settled it down.

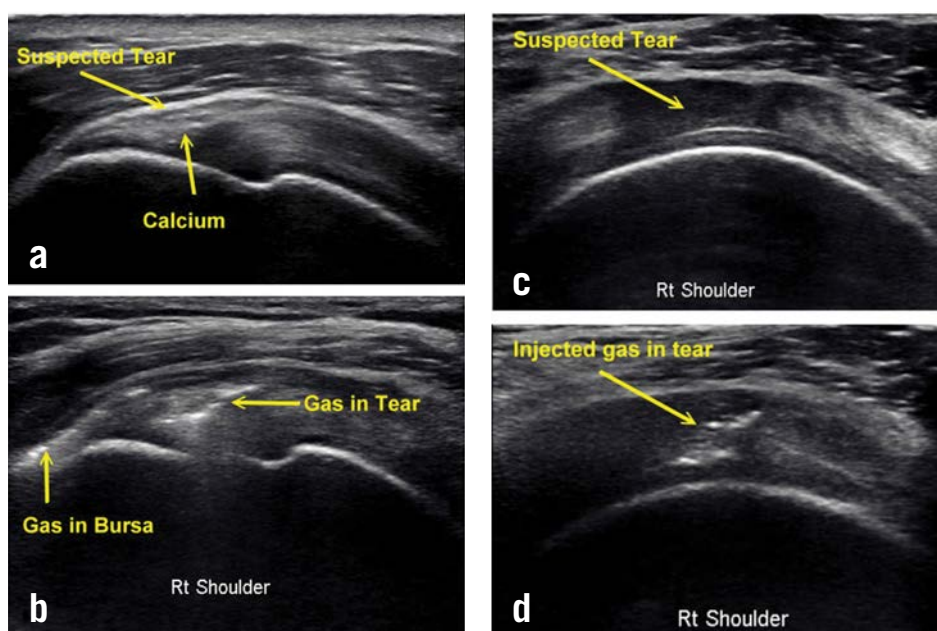


Figure 4: a) An ultrasound image of a supraspinatus insertion with a contour defect suggesting a tear and calcification within the tendon. b) The image after insertion of gas which shows up as white spots and delineates the extent of the tear in the tendon. It has also appeared in the bursa. c) Ultrasound image of the musculotendinous junction of the same tendon in. There is contour loss, change in the tendon texture and a 'bare cartilage' sign at the deep part of the tendon. d) The image after injection of gas with white regions delineating the extent of the tear in the tendon.

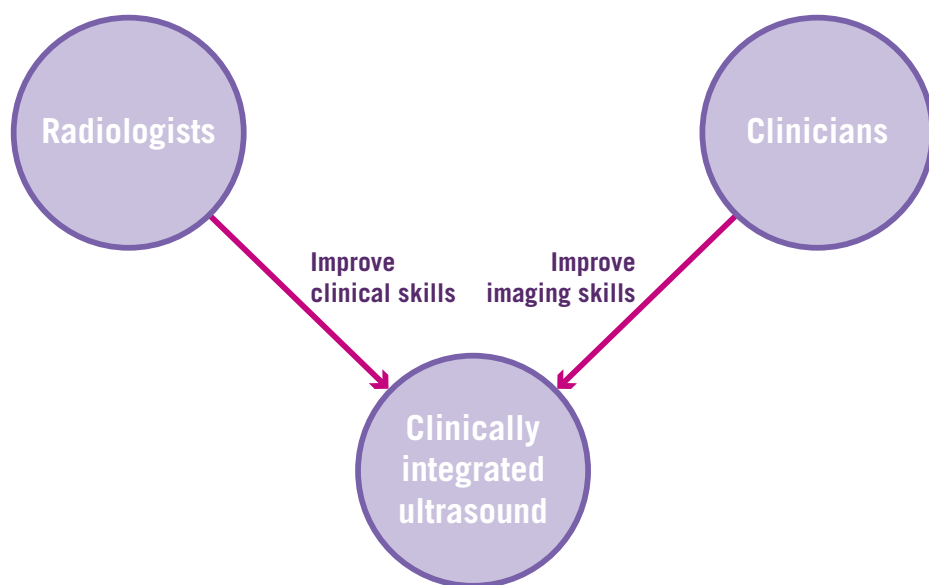


Figure 5: A diagrammatic representation of the author's idea of the way forward for musculoskeletal ultrasound in the future, where imaging skills are combined with clinical skills. Either radiologists improve clinical skills or clinicians improve imaging skills.

There are certain pathologies that I see frequently when a patient attends with a painful structure but a normal MRI. I specifically search for:

- neural pathology
- subtle tendinosis
- muscle boundary lesions
- referred pain from somewhere else.

We particularly find a large number of brachial plexopathies presenting as shoulder pains.

Lastly, the issue of sonopathology that is not painful is worth mentioning. This does not always mean it is not clinically relevant. We can see large partial tears that are not painful, but it can be very important to notify the referring doctor so that treatment can be started, to prevent it turning into a complete tear. We can also easily follow progress of healing lesions to decide when players can recommence play. It is very helpful in acute muscle injuries where we

can use ultrasound to triage injured players, and decide which of two injured players are able to recommence play and which should be sidelined. With a portable machine this can potentially be done on the sidelines during a game.

LIMITATIONS

The described procedure may appear time-consuming. While it does take some extra time, with practice it only adds about 3 to 5 minutes to the exam. Of course, in our practice we see many patients with straightforward problems and do not go to all of the above lengths in every case; in depth investigation is only undertaken for difficult cases, or where a patient has had normal imaging results but symptoms have not resolved.

As ultrasound units get cheaper and smaller there is a temptation for many clinicians to buy one, complete a 2-day

weekend course and start imaging. The downside to this is a lack of depth of knowledge. The analogy would be the obstetrician who images but does not diagnose a fatty liver of pregnancy or metastatic lymph nodes or ovarian cancer as they have only been skilled at doing obstetric ultrasound and nothing else. We have seen similar problems with sports medicine doctors who enthusiastically pick up ultrasound probes and misdiagnose simple fat necrosis, soft tissue tumours and infections which they have injected steroids into. To properly use ultrasound, sports medicine clinicians should set up a proper credentialed programme with assessments and qualifications and ongoing education, no different to what radiologist do now.

CONCLUSION

What will the future hold for musculoskeletal ultrasound? Will it stay a specialty owned and operated by radiologists or will it become a specialty owned by sports medicine doctors? Ultimately it will not matter who 'owns' it but the future is that it will become more relevant and problem-based and better suited to solving clinical problems. This means that radiologists improve their clinical skills or that clinicians improve their imaging skills.

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