Ultrasound in rheumatology

**Introduction**

Musculoskeletal (MSK) ultrasound was once the sole province of the radiologist but in recent years it has been introduced into routine clinical practice by an increasing number of rheumatologists. It is a powerful tool not only for evaluating joint and soft tissue pathology but also for facilitating interventions such as aspiration and injection. Its applications continue to grow.

The first report on the use of ultrasound in a rheumatology clinic – to assess the knee in rheumatoid arthritis (RA) – was published over 30 years ago. Ultrasound assessment of small joints only became feasible much later in the 1990s with the advent of high-frequency transducers. Since then, further technical advances and the falling cost of equipment have paved the way for MSK ultrasound to become an integral part of routine clinical practice. Today training in ultrasound is a compulsory part of rheumatology postgraduate medical education in Germany and Italy and courses and programmes have been established in most American and European countries. In 2005 up to 93% of UK rheumatologists reported that they used ultrasound in the management of rheumatology patients, with 33% performing it themselves.³
Ultrasound allows real-time imaging that can be carried out in the clinic or at the bedside. It is non-invasive and non-radioactive and allows the assessment of several joints in a relatively short space of time. The running costs are low and it is largely immune to the metal artefacts that can cause difficulties with magnetic resonance imaging (MRI) and computerised tomography (CT). Ultrasound also enhances the doctor–patient consultation in that it provides an immediate visual aid to help educate the patient about their disease.

These advantages are counterbalanced by the initial cost of equipment, the time and cost of training and the lack of available time to perform ultrasound in a busy clinic. Ultrasound cannot see into or beyond bone. It has limited resolution for deeper joints (such as the hip) and the patient’s body habitus may sometimes make examination difficult. There are also valid concerns about the standardisation of examinations by different ultrasonographers and how best to assess and certify competency.

**Technical aspects**

Ultrasound uses reflected pulses of high frequency sound to assess soft tissue, cartilage, bone surfaces and fluid-containing structures. The basic principle of ultrasound is that the denser the material the sound wave is passing through, the more reflective it is and the whiter (or echoic) it appears on screen. Water is the least reflective body material. Sound waves pass straight through water and it appears black (or anechoic) on screen. Grey-scale or B-mode ultrasound displays the different intensities of echoes in black, white and shades of grey (Figure 1).

Doppler ultrasound uses the principle that sound waves increase in frequency when they reflect from objects (such as red blood cells) that are moving towards the transducer (red signal) and decrease when they are moving away from the transducer (blue signal). Power Doppler ultrasound measures the amplitude of the Doppler signal (which is determined by the volume of blood flow) and superimposes it on the grey-scale image, thereby depicting increased microvascular blood flow (Figure 2).

![FIGURE 1. Grey-scale scan of early osteoarthritis of the 1st metatarsophalangeal joint](image1)

There is a small anechoic effusion with some hypoechoic synovial thickening within the joint capsule. The bony cortex is hyperechoic (arrow). [A anechoic effusion; H hypoechoic synovium]

![FIGURE 2. Power Doppler scan of the 1st metatarsophalangeal joint](image2)

There is a small anechoic effusion surrounded by grade 3 Doppler signal that represents florid synovitis. [A anechoic effusion; D Doppler signal; M metatarsal head; P proximal phalanx]
A subjective assessment of the degree of vascularity present can be made by scoring on a semi-quantitative scale of 0–3 in which the score is assigned according to the number of vessels or the percentage area of vascularity within the joint tissue:

Grade 0: no Doppler signal
Grade 1: signal is <10% of the field
Grade 2: signal is 10–50% of the field
Grade 3: signal is >50% of the field

Some researchers have developed software that gives a fully quantitative score for Doppler activity but this is not yet widely available.4 [SEE VIDEO CLIPS 1, 2 AND 3.]

Ultrasound scans are defined by two views and all examinations should include both planes:

- **Transverse or short axis** (similar to axial views on CT/MRI). A consistent orientation is important for the recording of ultrasound pictures. Some ultrasonographers recommend that the transverse view should display medial anatomical structures to the left of the screen and lateral to the right. Others prefer to localise the left side of the patient to the left side of the screen. This is a matter of personal preference and as long as there is consistency either method is valid.

- **Longitudinal or long axis.** The longitudinal view should display proximal anatomy to the left of the screen and distal anatomy to the right.

The correct probe size and frequency should be selected according to the size and depth of the joint to be examined. Most ultrasound systems now have presets for different joints allowing the appropriate settings of the ultrasound equipment (e.g. gain, focus, depth, zoom) to be adjusted accordingly. A number of views should be obtained using both transverse and longitudinal planes.5 Right and left side comparisons should be made where appropriate. Representative images should be recorded on a digital storage system and a report of findings documented.

There are a few ultrasound artefacts to be aware of:

- **Anisotropy** (Figure 3). This is the property of certain tissues to change their reflectivity with changes in the angle of the ultrasound beam. If the beam is not perpendicular to the tissue being scanned, the sound waves are scattered rather than being reflected back to the transducer. This causes the structure to appear darker than it should and can result in the inaccurate diagnosis of, for example, tendinosis or tendon tears.

- **Edge artefact** (Figure 4). An anechoic (black) line may be seen at the edge of a spherical structure such as a tendon or fluid collection giving an edge artefact or refractile shadow.

- **Reverberation artefact** (Figure 5). This occurs when the ultrasound beam is repeatedly reflected backwards and forwards between two closely spaced reflective surfaces such as the two sides of a hollow injection needle. The multiple echoes give rise to a series of parallel artefactual images beneath the needle surface. This effect can be used to advantage when performing an ultrasound-guided injection.

- **Acoustic shadowing** (Figure 6). This occurs when the ultrasound beam hits a highly reflective surface such as bone, air or calcified tissue. The region beyond the reflective surface appears anechoic or hypoechoic as very few sound waves can reach it.

- **Power Doppler scoring** (Figure 2). Caution has to be exercised when scoring power Doppler signal – it is extremely operator- and machine-dependent. Doppler signal is very sensitive to the slightest movement of the transducer and too much pressure on the transducer can occlude small vessels, thus giving a false-negative power Doppler signal. Overextension or flexion of the joint can also lead to a false-negative finding by tightening the joint capsule, thereby compressing the surrounding vasculature.6

The key to mastering the technique of MSK ultrasound is constant practice, which usually requires unrestricted access to an ultrasound machine.

There are several basic requirements for successfully introducing ultrasound into your clinical practice:

- a basic knowledge of the physics of ultrasound
- a detailed knowledge of relevant anatomy
- an ability to evaluate ultrasound findings in a clinical setting
- ready access to ultrasound equipment
- suitable equipment for imaging small joints
- access to a mentor.

**Equipment**

There has been a progressive improvement in imaging definition and the size, portability and cost of sonographic equipment over the last 10 years. There are several important considerations when selecting a machine:7
• **Cost.** Cost relates directly to image resolution and quality but the cost of equipment is falling and the quality is improving. A basic system can be purchased for approximately £30,000 but a top-of-the-range machine, with several different transducers, may cost as much as £150,000. It is a good rule of thumb to try to purchase the best machine that you can afford, but before you buy insist on borrowing a demonstration model for several days so that you can try it out on a number of your patients. This way you will be able to compare the machine’s performance with its competitors in a number of different clinical situations.

• **Image resolution and quality.** The choice of probe size and frequency depends on the size and depth of the structures of interest. A higher-frequency probe (10–20 MHz) will have a smaller field of view with high resolution but poor tissue penetration, making it ideal for small superficial structures. The reverse is true for lower-frequency probes (<7.5 MHz). Modern machines are equipped with multifrequency transducers. 3D probes are now available but are not yet widely used in general rheumatological practice.

• **Transducer design.** Probes may be annular, radial or linear. Linear array transducers are the preferred option for most MSK scanning.

• **Equipment size and portability.** Portability is an advantage for multi-site use. However, larger, less mobile systems can achieve better image quality for not much more cost.

• **Colour and power Doppler.** These options are essential. It is important to test the Doppler tool on a system before purchasing to see if it is sensitive enough for the detection of small joint synovitis. A good sign of a very sensitive system is the ability to detect blood flow in the normal nail bed or small distal arterioles in normal fingers.

• **Software options.** On most machines there is a variety of software options available that enable the user to develop a personalised system. Most MSK ultrasonographers will be happy with a basic package but more advanced options include panoramic imaging, contrast-enhanced software, vascular packages and 3D scanning.

• **Other equipment.** Acoustic gel will be needed for general scanning, and sterile gel with a probe sheath for ultrasound-guided injection.

Many variables can influence the image obtained with ultrasound, including the type of machine, transducer settings, transducer pressure and patient position. It is best to adopt a standard scanning...
protocol to ensure reproducibility. All images should be interpreted in the light of the clinical history and examination.

**Variability**

An important concern is that ultrasound is highly dependent upon the skill and experience of the operator. The Outcome Measures in Rheumatoid Arthritis Clinical Trials (OMERACT) ultrasound task force has addressed many of the complex issues arising from the development of MSK ultrasound and has looked specifically at variability. This group showed that among 24 rheumatologists considered to be expert in MSK ultrasound there was moderate to good inter-observer variability which depended on the structure being examined. The highest level of agreement was in the diagnosis of joint effusion, synovitis and tendon lesions (91%) and the lowest in the assessment of power Doppler signal (83%). Intra-observer variability was also shown to be moderate to good.

Concerns have also been raised regarding inter-machine variability, but with current high-end systems this is now less of a concern. D’Agostino et al showed that there is good reliability between experts using different types of ultrasound machine.

**Uses of ultrasound**

Ultrasound has many uses in the diagnosis and management of MSK disorders. It can (a) measure the extent of anatomical damage and inflammation in early arthritis, (b) assess the course of inflammatory disease, (c) determine therapy efficacy, and (d) allow direct guidance for joint and soft tissue injection.

MSK ultrasound is consistently superior to clinical examination at a variety of locations, even in the performance of basic clinical skills such as detecting the presence of knee effusion. However, MSK ultrasound complements clinical examination but does not replace it and all findings should be interpreted in the light of the clinical examination.

A significant advantage of MSK ultrasound over MRI, CT and scintigraphy is the ability to home in on the area of symptoms or clinical abnormality with the ultrasound probe immediately after clinical examination. This has the further advantage of improving the operator’s knowledge of regional and functional anatomy, leading to a better understanding of pathological processes and improved clinical examination skills.

Not only does MSK ultrasound consolidate our existing knowledge of rheumatic disease but also it can offer new insights. Polymyalgia rheumatica was previously believed to be an extra-articular disease but MSK ultrasound has demonstrated hip and shoulder synovitis and subdeltoid bursitis in 68–100% of patients, confirmed on MRI. Similarly, the imaging of abnormalities in vasculitis, scleroderma and Sjögren’s disease has been pioneered by rheumatologists who developed ultrasound in these clinical settings.

**TABLE 1. Comparison of musculoskeletal ultrasound practices of a rheumatologist and a radiologist.**

<table>
<thead>
<tr>
<th></th>
<th>Rheumatologist</th>
<th>Radiologist</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Referral source</strong></td>
<td>Rheumatology, self-referral, GP</td>
<td>Orthopaedics, podiatrist, GP</td>
</tr>
<tr>
<td><strong>Referral to scan time</strong></td>
<td>Immediate scan available in clinic</td>
<td>Waiting time following referral from clinic</td>
</tr>
<tr>
<td><strong>Number of anatomical regions scanned per visit</strong></td>
<td>Multiple joints scanned in half of patients</td>
<td>Predominantly single joint scanned</td>
</tr>
<tr>
<td><strong>Most commonly scanned regions</strong></td>
<td>Small joint studies predominate (hand, wrist, foot)</td>
<td>Medium and large joint studies predominate (shoulder, knee, foot and ankle)</td>
</tr>
<tr>
<td><strong>Indications for ultrasound scan</strong></td>
<td>Inflammatory disease predominates</td>
<td>Mechanical/trauma predominates</td>
</tr>
<tr>
<td><strong>Rate of injection following ultrasound</strong></td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td><strong>Follow-up appointment in clinic</strong></td>
<td>Not necessary</td>
<td>Necessary</td>
</tr>
<tr>
<td><strong>Time from initial assessment to diagnosis and implementation of treatment</strong></td>
<td>Reduced</td>
<td>Unchanged</td>
</tr>
</tbody>
</table>
Ultrasound by rheumatologists is complementary to that of MSK radiologists but does not replace it. Patients who undergo an ultrasound examination by a rheumatologist often have different clinical characteristics and diagnostic targets to those seen on an MSK radiology list. Ultrasound by an experienced MSK radiologist is still invaluable in cases of diagnostic uncertainty and for the selection and interpretation of other imaging modalities such as MRI and CT. (See Table 1.)

**Distinguishing between normal and pathological tissues**

MSK ultrasound needs to be performed with reference to external standards in order to allow comparisons between different operators, different patients and different time-points in the same patient. Standard reference values for the size and shape of normal anatomical structures have therefore been compiled to help distinguish between normal and pathological tissues. The high resolution of modern ultrasound machines means that synovial fluid can often be detected in healthy joints. Hypoechoic rims within joints (corresponding to normal synovial fluid or cartilage or both) and around tendons, fluid in bursae and ‘erosions’ at the humeral head are common findings in healthy subjects. At the OMERACT 7 meeting an international panel of experts agreed the first definitions of sonographic pathology (published in 2005). The definitions detailed below are derived from the OMERACT consensus and more recent studies.

**Joint and bursal effusion with synovitis**

Joint-space widening is characteristic of joint inflammation. Ultrasound can distinguish between joint effusion, synovial hypertrophy and homogeneous synovial thickening.

- **Joint effusion** (Figure 1). Synovial fluid is compressible and displaceable. Ultrasound allows localisation of fluid collections within a joint, improving the chance of successful aspiration; this is particularly helpful in deeper joints such as the hip. In most cases ultrasound cannot identify definitively whether a fluid collection is inflammatory, infectious or haematogenous. Aspiration remains the key diagnostic manoeuvre to determine the cause of an effusion.

- **Bursal effusion** (Figure 7). Ultrasound depicts a bursa as an anechoic or hypoechoic collection between two hyperechoic lines. The most common bursae assessed by ultrasound are the subacromial/subdeltoid and the semimembranosus (Baker’s cyst).

**Synovitis** (Figure 2). MSK ultrasound can reliably discriminate between inflammatory and non-inflammatory joint disease. Synovium is not visualised in healthy joints. The presence of joint, bursal or tendon sheath effusion may point to synovial inflammation, but in the absence of an effusion synovitis is diagnosed by the presence of abnormally thickened hypoechoic intra-articular tissue. Ultrasound can detect synovitis not apparent on clinical examination; this subclinical synovitis can predict radiographic progression. Power Doppler scanning has become an important part of the sonographic assessment for synovitis. It can detect minimal increases in perfusion in the synovium and is comparable to dynamic MRI. Power Doppler signal correlates well with the histological assessment of the microvascular density of the synovial membrane. Power Doppler signal in synovitic joints is reduced following intra-articular steroid injection and treatment with disease-modifying drugs such as methotrexate. Intra- and inter-observer variability is moderate for power Doppler scoring with a k score of 0.72 and 0.57 respectively using the 0–3 scoring system. MRI is comparable in terms of sensitivity in the assessment of joint inflammation but cost and availability greatly restrict its use.

**Bone**

Bone cortical abnormalities and periosteal reactions can be detected in conditions such as fracture, osteomyelitis and bone neoplasms. No structures can be seen beneath an intact bone surface.

**Erosions** (Figure 8)

A key diagnostic criterion and outcome measure in RA is the presence of bone erosion on plain x-ray. An erosion is defined as an interruption of the bone surface in two planes perpendicular to each other. Ultrasound can detect up to seven times more metacarpophalangeal (MCP) erosions than plain x-ray in early RA. Ultrasound has also been shown to be superior to plain x-ray in the sensitivity to change in bone erosions over time. Cartilage

Normal hyaline cartilage is anechoic. Degenerative cartilage may have increased echogenicity and an irregular surface. Ultrasound can only partially examine most articular cartilage due to the limited acoustic window of most joints.
Ultrasound of cartilage is particularly useful in the diagnosis of the crystal arthropathies. Gout can produce characteristic ultrasound appearances (double contour) in both clinically affected and unaffected joints due to the deposition of monosodium urate crystals on the surface of the hyaline cartilage (Figure 9). In calcium pyrophosphate deposition disease, the crystals are found within the substance of hyaline cartilage and are seen as linear hyperechoic deposits. They may also be detected in fibrocartilage as hyperechoic deposits that persist even when the gain (i.e. the volume) of the ultrasound beam is markedly reduced.

Tendons and ligaments

MSK ultrasound is the best technique for imaging tendons. It allows dynamic tendon examination which gives it a distinct advantage over MRI. Tendinosis is characterised by inhomogeneous hypoechoic areas within the tendon substance. Tendon rupture is characterised by a complete absence of signal between the free edges of the tear and the lack of synchronous movements of the tendon on dynamic imaging (Figure 10). Power Doppler ultrasound can help grade tenosynovitis.

[SEE VIDEO CLIP 5.]

FIGURE 7. Small effusion in the deep infrapatellar bursa (longitudinal scan). [A anechoic effusion; L patellar ligament; Tib tibial tubercle]

FIGURE 8. Cortical bone erosion of the 2nd metacarpophalangeal joint in rheumatoid arthritis (dorsal longitudinal scan). The erosion is sited at the anatomical neck of the metacarpal head. [E erosion; M metacarpal head; P proximal phalanx]

FIGURE 9. Double contour sign demonstrated in the tibiotalar joint (dorsal longitudinal scan). The upper line depicts urate deposits on the surface of the hyaline cartilage of the talar dome; the lower line depicts the cortical bone profile of the talus. [C double contour; D dome of talus; Tib tibia]
Enthesitis (Figure 11)
Ultrasound is, again, more sensitive than clinical examination at detecting enthesitis. Common findings include thickening of the enthesis, erosion, enthesophyte formation and adjacent bursitis. Increased power Doppler signal is another important feature. These features are well described in a recent report on the sonographic assessment of Achilles enthesopathy.

Dactylitis
Ultrasound findings include tenosynovitis, synovitis, tendinitis and subcutaneous oedema. Bone oedema is a feature of dactylitis that is well depicted by MRI but not by ultrasound.

Peripheral nerves
MSK ultrasound is ideal for assessing peripheral nerves and allows superior image definition when compared with MRI or CT. Ultrasound is useful for assessing nerve entrapments, the commonest of which is carpal tunnel syndrome (CTS). Ultrasound of the carpal tunnel (Figure 12) can reveal causes of extrinsic compression such as anatomical anomalies, tenosynovitis or a ganglion. An increase in the cross-sectional area of the median nerve as it enters the
tunnel supports a clinical diagnosis of CTS. This can easily be measured on an axial scan of the volar aspect of the wrist. There is some debate as to what constitutes an abnormal scan and several different methods of measurement have been proposed.\textsuperscript{29,30} Ultrasound is certainly more acceptable to patients than nerve conduction studies, which are currently regarded as the most accurate investigation for diagnosing CTS.

**Blood vessels**

Ultrasound of the temporal arteries may show vessel wall oedema in giant cell arteritis. This appears as a hypoechoic ring around the circumference of the artery lumen (halo sign). Meta-analysis has confirmed the sensitivity and specificity of this test to be 68% and 91% respectively.\textsuperscript{31} The gold standard remains temporal artery biopsy and the results of further studies comparing the two procedures are awaited. In Takayasu’s arteritis ultrasound can localise areas of arteritis in extracranial vessels, but only a limited number are accessible.\textsuperscript{32}

**Muscle**

Ultrasound can be used in sports medicine to localise and define the extent of partial or complete muscle rupture. Dynamic testing at the site of muscle symptoms enhances the sensitivity of ultrasound in the detection of tears. It can also demonstrate features of oedema in inflammatory muscle disease, although MRI is more sensitive.

**Skin**

Ultrasound assessment of skin thickness in scleroderma shows remarkably good interobserver variability.\textsuperscript{33,34} Oedema, cellulitis, subcutaneous abscess and cystic/solid dermal masses can be reliably detected by ultrasound.

**Salivary glands**

Ultrasound can be used to assess salivary gland parenchyma and size. This can be helpful in differentiating healthy individuals from patients with Sjögren’s syndrome.\textsuperscript{35} A recent study has suggested that submandibular gland ultrasound might be a practical alternative to sialography in the classification of Sjogren’s syndrome.\textsuperscript{36}

**Ultrasound as a tool for monitoring disease activity**

MSK ultrasound is increasingly being used as a tool to monitor disease activity in RA and to assess response to treatment. Power Doppler ultrasound is a valid method for monitoring response to anti-TNF therapy in RA. It is reproducible and sensitive to change. It may have predictive value in relation to radiological outcome.\textsuperscript{37} Taylor et al looked at patients with early RA and used ultrasound to measure synovial thickening and vascularity in the MCP joints.\textsuperscript{6} They were able to demonstrate marked improvement following treatment with infliximab compared to controls and found ultrasound assessment to be more sensitive to change than the clinical disease activity score (DAS).

To scan all peripheral joints for evidence of synovitis would be extremely time-consuming. Several different groups have developed sonographic scoring systems for assessing synovitis in a limited number of key joints.\textsuperscript{38,39} A recent study looked at a number of these measurement tools and found that ultrasound evaluation was an outcome measure ‘at least as relevant as physical examination’.\textsuperscript{40} The OMERACT ultrasound task force is currently developing the Global OMERACT Scoring System (GLOSS) for use in RA and sonographic scoring systems for quantifying enthesis and osteoarthritis.\textsuperscript{31}

**Ultrasound as a predictor of disease outcome**

There is still a paucity of evidence that ultrasound is a reliable predictor of long-term outcome in RA. For this reason, ultrasound was not recommended as the preferred imaging modality in the recent National Institute for Health and Clinical Excellence (NICE) Clinical Guideline on the management of RA (http://www.nice.org.uk/CG79).\textsuperscript{42} Studies in this area are ongoing and over the next few years the utility of MSK ultrasound in the assessment of early synovitis will become clearer. The authors all use ultrasound in the initial assessment and follow-up of patients with inflammatory arthritis on the basis that numerous studies demonstrate that it is more sensitive than clinical examination in detecting synovitis.

**Interventional MSK ultrasound**

Corticosteroid joint injections are widely used in rheumatology but there are few well-designed randomised studies that demonstrate their efficacy. Traditionally joint aspiration, intra-articular injection and soft tissue injection are performed using palpation of bony landmarks as guidance. Palpation-guided injections may result in inaccurate needle placement in up to 50% of cases\textsuperscript{43} and this may have an adverse effect on the clinical outcomes.\textsuperscript{43,44} Inaccurate placement of corticosteroid can also
contribute to local tissue damage, though this can be difficult to quantify. [SEE VIDEO CLIP 6.]

The use of ultrasound to localise joint and soft tissue fluid collections significantly improves the rate of diagnostic aspiration, particularly in small and medium-sized joints (32% v 97%). There is conflicting evidence as to the benefits of ultrasound-guided joint injections with corticosteroid. A recent study showed that ultrasound guidance significantly improved both pain scores (p<0.001) and overall response rate (p<0.01) when compared to conventional palpation-guided injection. A positive response to ultrasound-guided shoulder injections has also been reported. However, another recent study comparing comparing palpatation versus ultrasound-guided injection in inflammatory arthritis demonstrated a significant improvement in the accuracy of injection but no significant difference in clinical outcome. Ultrasound-guided injections were more likely to be accurate (83% v 66%) but there was no significant difference for any of the major outcome variables at either 2 or 6 weeks. This second study did confirm that corticosteroid injection into an inflamed joint regardless of guidance method or accuracy resulted in significant improvement in self-rated function, pain and stiffness at 2 and 6 weeks. Elsewhere it was reported that ultrasound-guided sacroiliac (SI) joint injection had 40% accuracy (verified by MRI) but there was no significant difference in clinical outcome between the accurate and inaccurate injection groups.

Nevertheless, ultrasound can alter clinical practice. Injections may fail because the physician injects an unaffected site or fails to inject all the affected sites. A French study showed that diagnostic ultrasound employed to localise pathology in the ankle, hind- and midfoot prior to injection was more efficacious than intra-articular injections given on the basis of clinical examination alone.

Further studies in this area are needed but our clinical experience suggests that injections using direct ultrasound guidance may be preferable in situations where:
- there are nearby vital structures (e.g. blood vessels or nerves)
- accuracy is imperative (e.g. radiation synovectomy)
- there are no bony landmarks to guide injection (e.g. bursa or tendon sheath)
- the target joint is deep (e.g. SI joint or tendon)
- the anatomy is distorted by disease process or obesity
- palpation-guided injection has already failed.

**MSK ultrasound in primary care and the allied health professions**

Ultrasound is becoming increasingly popular in the primary care setting. Many GPs perform obstetric ultrasound but as yet there have been no publications regarding the use of MSK ultrasound in primary care. As in secondary care, the main barriers to progress are the initial cost of the ultrasound equipment and the considerable amount of time that needs to be devoted to training and competency assessment. Some GPs have had mentorship from trained ultrasonographers and have gone on to obtain a postgraduate certificate recognised by the Royal College of Radiologists.

Rheumatology specialist nurses have already been trained to perform clinical assessment of disease activity in RA. It has been suggested that they could be trained in the ultrasound assessment of the wrists and hands. Specialist nurses are already performing ultrasound assessments in other specialties such as obstetrics. Some physiotherapists and podiatrists use ultrasound in their everyday clinical practice. The Dynamic Ultrasound Group is a clinical interest group of the Chartered Society of Physiotherapy that runs ultrasound training courses for physiotherapists at both basic and advanced levels (http://dynamicultrasound.org/index.html).

It is essential for everyone using MSK ultrasound to have access to suitable training and mentorship. At all times, trainees need to be aware of their limitations and be ready to refer difficult cases to a more experienced colleague.

**Education and training**

The single biggest obstacle to performing ultrasound in rheumatology is the length of time required to develop the necessary practical skills. For the last 10 years, both national (British Society for Rheumatology – BSR) and international (European League Against Rheumatism – EULAR) rheumatological societies have organised basic, intermediate and advanced ultrasound courses and these are a useful learning point for the would-be ultrasonographer. Recommendations for the content and conduct of EULAR MSK ultrasound courses have been published and this is a useful step towards the standardisation of training. Short courses can be a stimulus to learning and web-based packages a useful adjunct to face-to-face teaching. Neither is a substitute for continuous learning with an experienced mentor.
A recent survey has shown that there has been a considerable uptake of MSK ultrasound across Europe. There is, however, huge variation in training and practice between different European countries. MSK ultrasound training is already integrated into the postgraduate rheumatology curriculum in a number of European countries, including Germany and Italy. There are varying opinions as to what constitutes adequate training and competency. The American College of Radiology recommends that their trainees perform 500 supervised scans to achieve an acceptable standard (http://www.acr.org/accreditation/Ultrasound/ultrasound_reqs.aspx). The Royal College of Radiologists has published guidelines for non-radiologist-operated ultrasound and suggests weekly mentorship by an experienced ultrasonographer with at least 250 scans performed (http://www.rcr.ac.uk/docs/radiology/pdf/ultrasound.pdf). There is a need for a single consensus on MSK ultrasound training in rheumatology in order to promote the international development of ultrasound in rheumatology.

Published scans are available with a complete collection of all images of standard scans online (http://www.e-sonography.com). Using this website an untrained novice was able after 24 non-consecutive hours of mostly self-directed learning to obtain acceptable MSK images in both healthy subjects and patients with arthritis.

Certification of competency is desirable and European guidelines for certification are in development. A recent report from Northern Ireland described a modular training programme for rheumatologists that used logbook validation and an exit exam to assess basic competency in ultrasound. [SEE VIDEO CLIP 7.]

**Proposed model for ultrasound service implementation**

When establishing an ultrasound service in a rheumatology department, the authors would recommend that a high-end ultrasound system is first installed in a dedicated room in the rheumatology outpatient area or day unit. The first ultrasound system purchased should be of the highest quality possible as the superior imaging definition will make training much easier and most of these systems will have a minimum working life of 7 years. If the system is to be shared with other services for economic reasons then adequate provision should be negotiated for access to the system whenever the clinic is operational. Placing an ultrasound system in the centre of the clinical area is necessary to ensure that the advantages of immediate ultrasound are realised for patients but also to maximise the opportunities for training and practice.

It is best to nominate an ultrasound lead who is a permanent member of staff and who undertakes first to train in ultrasound and then to assist in training other members of the department. If possible, trainees should be taught together as a group so that they can provide support for each other during their training. If the benefits of in-clinic ultrasound are to be fully realised then there must be an ultrasonographer present continuously in the department. In an average UK department of 3–4 consultants one would envisage a minimum of 2 permanent members of staff training in ultrasound to provide an adequate service. This will ensure that there is less disruption to services through such considerations as leave.

**Future advances**

Contrast-enhanced ultrasound may be used to help assess active synovitis. Intravenous microbubble contrast can enhance images of structures poorly visualised by current ultrasound systems and, in particular, increase the sensitivity of power Doppler signal.

3D ultrasound offers the ability to measure volumes accurately, which may be useful in, for example, assessing the size of erosions. It can reproduce any plane of the anatomy with precision and takes no longer than a 2D assessment. 2D ultrasound is very operator-dependent and images are best interpreted in real time. 3D ultrasound is less operator-dependent and should allow different observers access to the same reconstructed images. Raw data can be reorientated into different planes at a later date. 3D volumetric ultrasound may improve inter-observer reliability in multicentre RA studies.

**Conclusion**

MSK ultrasound has revolutionised the practice of many rheumatologists in the past decade but significant resources are required to establish a credible service. The initial investment in equipment and training is substantial and it can be difficult to find time in a busy outpatient clinic to perform ultrasound. However, the application of ultrasound has the potential to deliver accurate and early diagnoses, monitor disease and facilitate intervention in the
Ultrasound video clips

This review is further illustrated by a number of short video clips that demonstrate some typical features of ultrasound in rheumatology.

They may be accessed at: www.arthritisresearchuk.org/topical_reviews_ultrasound_video.

References


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**DVD: Musculoskeletal ultrasound – a beginner’s guide to normal peripheral joint anatomy**

This DVD has been produced as an aid to rheumatologists and other musculoskeletal practitioners who wish to begin training in musculoskeletal ultrasound. It may also be of interest to medical students and others studying or working in a related area.

The aim of the DVD is to allow the ultrasonographer to become familiar with the appearances of the standard scans in normal subjects as recommended by the EULAR Working Group for Musculoskeletal Ultrasound.

Copies of this item can be obtained via our online order system (www.arthritisresearchuk.org/order-pubs).
FORTHCOMING AUTUMN 2011

Osteoarthritis – more than just ‘wear and tear’

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Copeman House, St Mary’s Court
St Mary’s Gate, Chesterfield
Derbyshire S41 7TD

Tel 0300 790 0400 Fax 01246 558007
Email info@arthritisresearchuk.org
www.arthritisresearchuk.org
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