Musculoskeletal imaging: which test to choose?

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Radiologists can help GPs choose the most appropriate imaging tests for musculoskeletal and soft tissue conditions.

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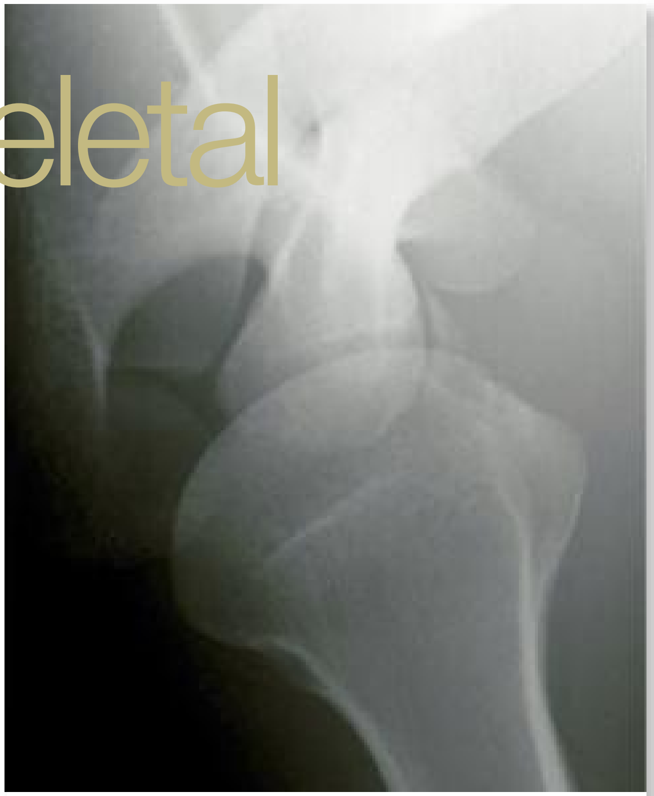

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Figure 1. A West Point view (tangential view) x-ray profiles the anteroinferior glenoid rim, clearly showing the undisplaced fracture that was not seen on the routine x-ray views.

The applications of musculoskeletal imaging continue to evolve, along with technical improvements in equipment and patient expectations of accurate diagnosis of musculoskeletal ailments. The role of each imaging modality in diagnosis can vary from case to case, and in different clinical settings, depending on the available expertise.

Radiologists who are given accurate clinical information can focus imaging procedures by providing appropriate additional views and refining protocols, which improves diagnostic accuracy. Each imaging modality has its own strengths and provides complementary information, and sometimes a combination of tests is required to elucidate a problem.

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X-RAY IMAGING

Plain x-ray imaging remains an excellent test for bony abnormalities, from the acute setting of fracture and dislocation to chronic conditions of arthritis. Clinical history is critical to enable appropriate additional views to be included, illustrated by the following examples.

- In glenohumeral joint dislocation, the addition of a West Point view (a tangential view) can profile a subtle fracture of the anteroinferior glenoid rim usually not visible on the standard x-ray series (Figure 1).
- In the context of an inversion injury to the ankle, an oblique view of the foot will optimally display the anterior process of the calcaneus; a fracture of this bone is often not detected on standard views.
- For chronic bone stress, an x-ray tangential to the focus of pain maximises detection of subtle incomplete stress fractures and periosteal reaction.

Stress views and weight-bearing imaging

Stress views can be helpful in diagnosing ligament disruption in some instances, notably dynamic scapholunate ligament instability can be diagnosed with x-rays taken in ulnar deviation or with a clenched fist. These views stress the scapholunate joint and can demonstrate abnormal joint space widening if there is underlying ligament disruption.

In the evaluation of osteoarthritis, weight-bearing x-rays enable the assessment of joint space narrowing in the large joints of the lower limb, and are also helpful in demonstrating alignment. X-rays clearly show chondrocalcinosis and radio-opaque loose bodies; it is surprising how difficult it can be to see these on magnetic resonance imaging (MRI). MRI is more sensitive for an acute or inflammatory arthritis, being able to demonstrate effusions, synovitis and early erosions.

X-ray imaging is used less frequently for initial investigation of back pain in young people, being replaced by MRI. X-ray imaging is useful in demonstrating weight-bearing spinal alignment.

Assessing hip and groin pain

X-ray imaging plays a role in assessing hip and groin pain. Apart from depicting the weight-bearing joint space of the hips, x-rays provide information on the bony anatomy of the hip joint, which may relate to conditions such as femoroacetabular impingement. For example, a prominent bony bump at the lateral or anterior aspect of the femoral head–neck junction can impinge on the overlying acetabular cartilage and labrum in hip flexion. Another common cause of groin pain is pelvic instability, which may occur with or without features of osteitis pubis.

ULTRASOUND IMAGING

Ultrasound is a useful test for assessing superficial tendons and is commonly used in assessing the rotator cuff, patellar and Achilles tendons but can be applied to any of the superficial tendons. Ultrasound visualisation is limited by bony structures – for example, the acromion may obscure a portion of underlying rotator cuff. Superficial ligaments can be visualised, such as the commonly injured anterior talofibular ligament at the ankle, and the dorsal scapholunate ligament in the wrist; however, generally MR is used for ligament assessment as it can better visualise all the ligaments and any associated intra-articular abnormalities. Other disadvantages of ultrasound include the presence of a large amount of fatty tissue, which reduces the clarity of the ultrasound image; and the fact that ultrasound is an operator dependant study. The strength of ultrasound lies in soft tissue imaging, dynamic assessment, and ultrasound-guided interventions.

Soft tissue imaging

Ultrasound assessment of superficial tendons is excellent, and can be superior to MRI in diagnosing small tendon tears. Being able to compare with the other (normal) side on ultrasound is helpful in diagnosing the subtle tendon enlargement from tendinopathy, which may not be appreciated on a unilateral MR study. Colour Doppler assists in the diagnosis of tendinopathy by demonstrating tendon hyperaemia that often correlates with symptoms (Figure 2).

Visualising deeply located tendons can be problematic on ultrasound, and consequently the usefulness of ultrasound depends to some extent on the patient's body habitus. Tears of the hamstring tendon origin and adductor origin are often best depicted on MRI. Gluteal tendon tears at the greater trochanter can be difficult to see on ultrasound in a large patient, although usually the tendons are well enough seen to allow a sizeable tear to be excluded and an ultrasound guided injection to be performed.

Ultrasound is useful in providing information about the nature and site of origin of superficial lumps. A definitive diagnosis of a ganglion cyst can be made, providing the contents are anechoic and no atypical features are present. Other cystic structures, such a parameniscal cyst or a Baker's cyst, can be confidently diagnosed. Once the possibility of a solid lesion is raised on ultrasound, there is

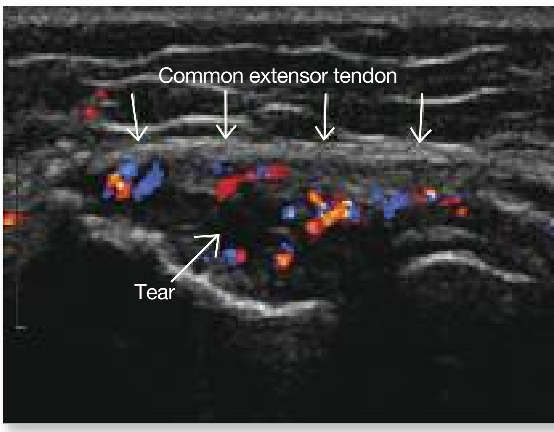

Figure 2. A colour Doppler ultrasound image along the common extensor tendon of the elbow shows tendinopathy with prominent hyperaemia in the tendon, and a central anechoic tear cleft.

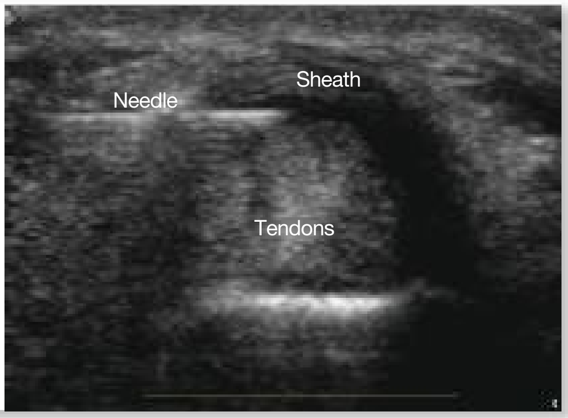

Figure 3. A transverse ultrasound image of de Quervain's tenosynovitis, showing enlarged abductor pollicis longus and extensor pollicis brevis tendons and thickening of the tendon sheath and retinaculum. A needle enters the sheath space superficial to the tendon for cortisone injection.

usually a wide differential diagnosis, and MRI followed by histological diagnosis is the usual pathway to diagnosis. There are exceptions where ultrasound is able to be definitive, and these include small vascular malformations, retained foreign bodies and some superficial lipomas.

Dynamic assessment

The dynamic component is integral to most ultrasound examinations. Some tendon tears become more visible when the tendon is stretched and the edges of the tear separated, such as in a tear of the rotator cuff. Longitudinal splits, such as of the peroneal tendons at the lateral malleolus, may only be visible with a rotational movement that allows the torn components to move in different directions, thus revealing the tear. Tendon subluxations out of their groove, such as of the long head biceps tendon at the shoulder, may only occur with movement. A dynamic ultrasound study can be helpful in trigger finger to locate the site and cause of triggering.

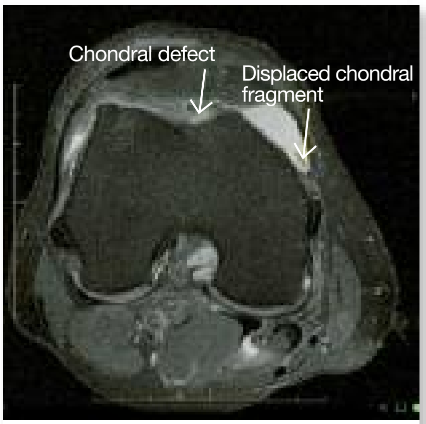

Figure 4. An axial fat-suppressed proton density MR image through the patello - femoral compartment shows a deep chondral defect on the medial side of the femoral groove, and the displaced chondral fragment in the medial joint recess. Also present is a flat femoral groove associated with chronic full thickness cartilage loss laterally.

Diagnosis of inguinal and femoral hernias takes advantage of the dynamic component of ultrasound because many hernias appear only with certain straining manoeuvres. An added advantage of the dynamic interaction is being able to determine if an abnormal area seen on ultrasound is symptomatic with pressure from the ultrasound transducer, and whether it corresponds to the patient's symptoms.

Dynamic ultrasound can also be particularly helpful in distinguishing the common conditions of subacromial impingement and adhesive capsulitis, for which the treatment is quite different.

Interventions

Ultrasound-guided injections of cortisone and local anaesthetic are used with increasing frequency, replacing x-ray and computed tomography (CT) guidance wherever possible, due to the relative ease of performance and the lack of ionising radiation concerns. Ultrasound guidance is also replacing clinically guided injections in some circumstances. The advantage of ultrasound guidance is the confidence provided in the placement of the injection, which is particularly helpful with a difficult target, in large patients or in the context of a diagnostic dilemma where management plans will be determined by the response to injection.

Common locations for injections are superficial bursae, tendon sheaths (Figure 3) and peritendon, the joints of the appendicular skeleton, Morton's neuromas and deep to the plantar fascia (perifascial injections). The appropriateness or otherwise of an ultrasound-guided injection can be determined at the time of the diagnostic study. Recently, ultrasound-guided autologous platelet rich plasma injections into chronically damaged tendons have been trialled in an attempt to promote healing, with mixed results.

COMPUTED TOMOGRAPHY

CT is generally used as an ancillary modality in musculoskeletal imaging. It is useful in situations where greater bony detail is required, where other imaging tests are not possible, or for guided deep interventions. The situations where greater bony detail is required usually relate to trauma and further definition of fracture anatomy, or an abnormal result on another study – for example, increased bone marrow signal on MRI where an occult lesion such as an osteoid osteoma is suspected.

CT provides superior detail of small osteophytes, which can be helpful in the cervical spine. Depending on local availability, CT and/or fluoroscopically-guided injections are the method of choice when injecting the spine or sacroiliac joint.

MAGNETIC RESONANCE IMAGING

MRI is an excellent test for most musculoskeletal applications. It allows visualisation of joints without hindrance from

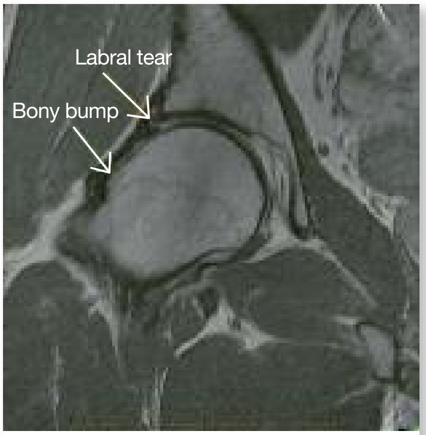

Figure 5. A coronal proton density MR image of the hip joint shows features of femoroacetabular impingement, with a bony bump at the lateral femoral head–neck junction, and a high signal tear cleft through the overlying acetabular labrum.

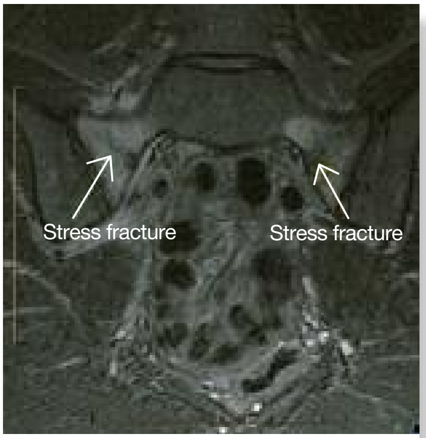

Figure 6. A coronal fat-suppressed proton density MR image shows bilateral sacral stress fractures, visible as incomplete dark lines within the high signal marrow oedema.

bony structures, and can show cartilage loss, meniscal tears and osteochondral change (Figure 4). Labral tears and any associated paralabral cysts in the shoulder or hip joint can be clearly demonstrated (Figure 5). Muscles, tendons and bony structures are all well visualised. MRI is very sensitive to bone marrow hyperintensity associated with bone stress, fracture and other pathology (Figure 6).

Fields of view and resolution

MRI has an adaptable orientation of the plane of image slices, enabling the images to be aligned to the anatomy of the structure of interest, and an adaptable field of view. A long field of view can be used when looking for a muscle tear in the thigh, providing an overview of the whole muscle, which is difficult to achieve with ultrasound.

When imaging a small structure such as an metatarsophalangeal joint, a small field of view and high-resolution techniques enable the chondral surfaces and supporting structures to be well visualised. With techniques optimised for cartilage, small chondral flaps can be seen; however, there are limits to the resolution of cartilage abnormalities and even large chondral flaps may not be seen on MRI if they are undisplaced and there is no subchondral bony reactive change.

Intra-articular contrast

Intra-articular gadolinium is sometimes instilled into the large synovial joints, especially the shoulder, to improve detection of cartilage defects, labral tears and articular side tears of the supporting structures of the joint. This technique relies on the contrast entering the defect, which is not always the case. A drawback of intra-articular contrast is that it may obscure foci of synovitis that can indicate underlying pathology. If a choice is available, the least invasive technique is preferable.

Spinal imaging: MRI versus CT and nuclear medicine

In the spine, MRI visualisation of the spinal cord and nerve roots has a distinct advantage over CT, and the intervertebral disc is better defined, with disc protrusions being more conspicuous and early changes of disc degeneration more apparent. MRI has greater sensitivity than CT, and inflammatory, infective and proliferative conditions are depicted earlier than on CT. Postoperatively, MRI with intravenous gadolinium is the test of choice in differentiating between recurrent disc protrusion and fibrosis.

MRI is sensitive to bone stress, and has the advantage over nuclear medicine bone scan of being able to provide anatomical detail of addition to findings of bone stress, whereas nuclear medicine bone scan has the advantage of providing an overview of the whole body. CT SPECT is a recent imaging adaptation that overlays the functional information of nuclear medicine with the anatomical information of CT, providing more accurate anatomical localisation of abnormalities detected on nuclear medicine studies.

Tumour imaging

MRI is the test of choice for imaging musculoskeletal tumours, being sensitive in differentiating a solid from a cystic lesion and in determining tumour extent. For solid tumours, an exact diagnosis is the role of the pathologist, but MRI can indicate if the lesion displays aggressive features, give a reasonable differential, and provide details on tumour size and location to aid the surgeon.

Cost to patients

MRI is a relatively expensive test but can be the most cost effective as it may take multiple other tests to reach the diagnosis that MRI makes in one study.

SUMMARY

It is not always straightforward to choose the best imaging test in a particular clinical situation. Radiologists are happy to discuss with GPs and advise as to the most appropriate course, and are able to tailor the examination when accurate clinical information is available. MT

COMPETING INTERESTS: None.