THE IMPACT OF IMAGING IN SPORTS MEDICINE

– Written by John Read, Australia

Sports medicine is a new, exciting and rapidly expanding discipline which has been fuelled worldwide by an exponential rise in sporting and recreational activities over the past several decades. During this period, imaging has played a key diagnostic role in sports medicine for a number of reasons. These include the importance of early accurate diagnosis to the management of overuse injuries, the rise of arthroscopic surgery with an attendant need to assess injury extent beyond the view of the scope and the development of increasingly sophisticated percutaneous interventions that require imaging guidance for accurate needle placement.

With a strong basis in applied anatomy, the practice of sports medicine naturally aligns with the basic structural information that diagnostic imaging can provide. However, until the late 1980s, only the osseous skeletal structures were well resolved by the available imaging modalities. The assessment of soft tissues such as cartilage, tendon and muscle, would require a technological revolution. Fortunately, the necessary advances in medical engineering and computing capacity were imminent.

MAGNETIC RESONANCE IMAGING

The most important development in imaging relevant to the practice of sports medicine in the last 20 years has been magnetic resonance imaging (MRI). MRI currently provides the most comprehensive cross-sectional demonstration of both hard and soft-tissue skeletal available in one test and is therefore an important and frequently used tool for clinical and surgical decision-making. The history of MRI is one of progressive development over multiple decades. The peripheral joints presented a particular challenge to effective imaging, as small intra-articular structures can only be demonstrated in adequate detail by using appropriately small voxel sizes while maintaining an adequate signal-to-noise ratio.

Detailed extremity MRI first became possible in the mid-1980s with the development of specialised 'surface' coils that could be placed close to the joint or region of interest. However, the routine demonstration of important pathology, such as chondral surface wear, required the development of a pulse sequence that could provide the required level of tissue differentiation and was fast enough to prevent image blur due to patient movement. The standard workhorse sequence now used for this purpose in skeletal MRI is the fast spin echo technique, utilising parameters that provide a 'native arthrographic effect' without the need for injected contrast. This technique was not perfected until the mid-1990s (Figure 1).

The ability of MRI to demonstrate many common and significant internal joint derangements, such as meniscal tears, osteochondral injuries and major ligament injuries, has made it a key diagnostic tool that often directly influences patient management. Nevertheless, a number of limitations remain. MRI does not provide dynamic assessment of joint function. In addition, MRI frequently detects incidental changes, including developmental anomalies, old injuries and age-related degenerative phenomena, which are not clinically relevant but can cause confusion. This makes the requesting physician's judgement of paramount importance, as each finding must be weighed for significance based on the clinical context. Despite excellent overall performance, MRI does not provide perfect sensitivity and specificity, even for lesions such as meniscal tears.

ULTRASOUND

Ultrasound has also significantly contributed to the practice of sports medicine, particularly to the diagnosis and treatment of superficial soft-tissue conditions, such as tendonopathies and ganglion cysts. A major role for ultrasound arose in the late 1980s with the development of sophisticated multi-channel phased array linear 'small parts' transducers that could resolve fine anatomical detail, such as the internal fibrillar architecture of tendons and ligaments (Figure 2).

The most important development in imaging modality to the practice of sports medicine in the last 20 years has been magnetic resonance imaging (MRI).

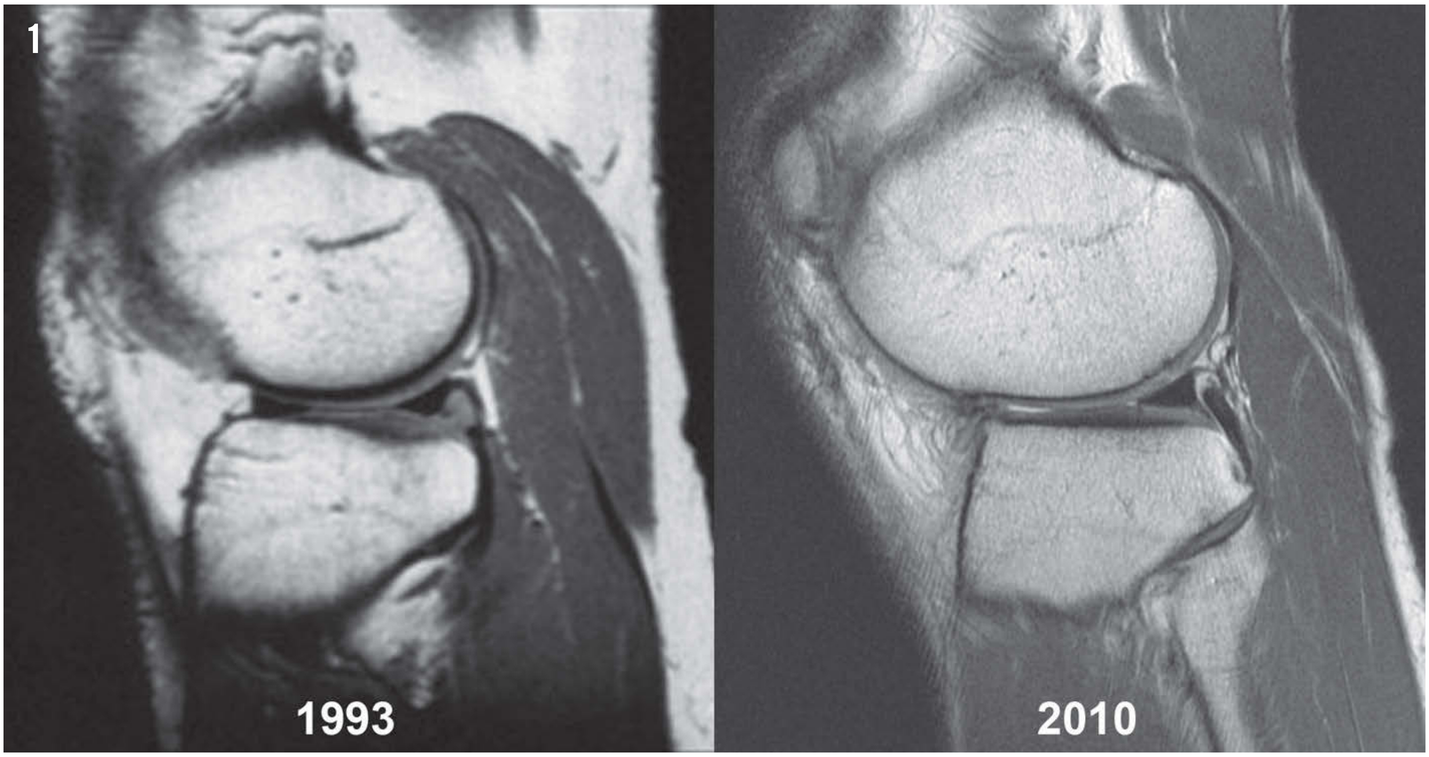

Figure 1: MRI of knee showing improved tissue differentiation and resolution with optimised pulse sequence. 1.5T image from 1993 is a proton density weighted spin echo sequence. 1.5T image from 2010 is a proton density weighted fast spin echo sequence using an echo time of approximately 34 m/sec for arthrographic effect. Note the improved appreciation of articular cartilage surface contour and deep chondral fissure above the posterior horn of meniscus on the more recent image.

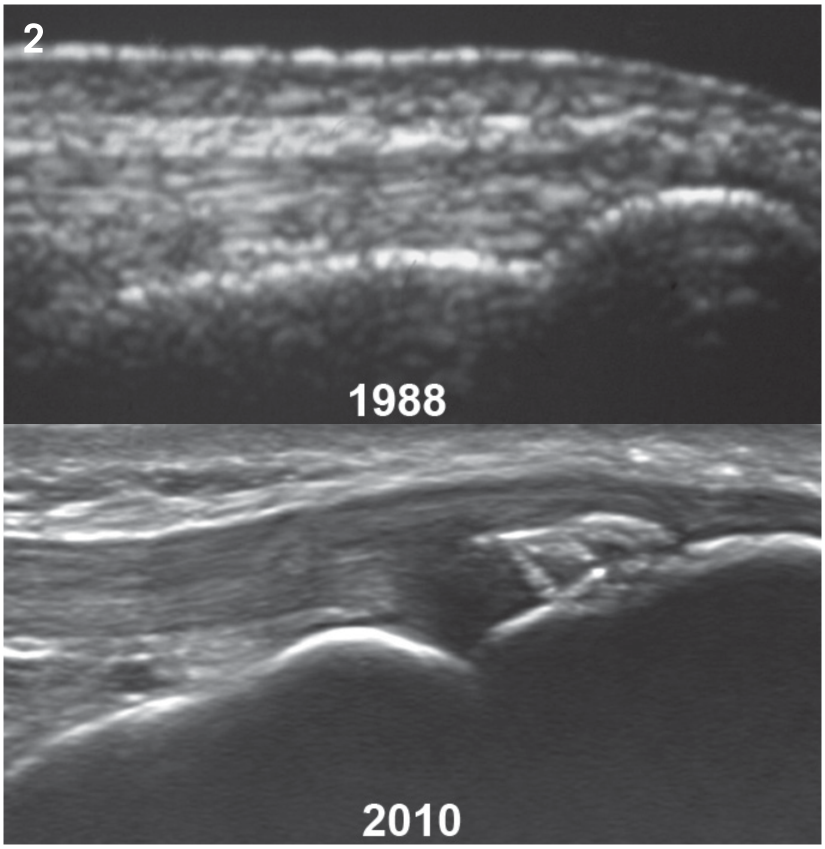

Figure 2: Ultrasound of distal patellar tendon showing greatly improved anatomical resolution with advances in transducer design and signal processing over time.

Ultrasound also adds an extra clinical dimension to imaging. It is an interactive real-time modality that allows a skilled examiner to correlate sites of localised tenderness with tissue appearances, permits a dynamic assessment of moving tissues, gives Doppler information about tissue vascularity and can be used to guide needles into specific anatomical compartments with great accuracy and with no exposure to hazardous ionising radiation (Figure 3).

Ultrasound has an exciting future as new engineering capabilities and increases in computing power open new frontiers for diagnosis and treatment. Elastography is one example of a new development currently being explored, which may help to quantify tissue healing or assess ligament quality. Other developments include image fusion (with computed tomography [CT] and MRI), volume scanning that allows panoramic multiplanar imaging analogous to CT and MRI, and real-time three-dimensional imaging that may permit the dynamic assessment of moving and physiologically loaded joints.

> ***Ultrasound has an exciting future as new engineering capabilities and increases in computing capacity open new frontiers for diagnosis and treatment.***

X-RAY

The importance of the traditional plain X-ray should never be forgotten. Although X-ray provides limited soft-tissue differentiation, it gives important information that other imaging tests may fail to appreciate or misinterpret. Examples include joint malalignments, soft-tissue calcifications, unexpected bone and/or joint lesions (including loose bodies, spurs, fractures, erosions, osteopaenia and tumours), normal variants and foreign bodies (Figure 4). A negative X-ray immediately excludes or renders unlikely many diagnostic considerations. There is a growing trend for clinicians to bypass the plain film and proceed straight to MRI, which I believe is a serious mistake.

We are indeed privileged to be working in an era of great advances in technology. As these sophisticated imaging tools continue to develop, so too will our understanding of both normal and abnormal skeletal function. However, these advances will only be made if we, as interested physicians, surgeons and radiologists, work in close collaboration – with insight more astute than that of any one individual alone – to exploit fully the new capabilities. Sports medicine clinics with a multidisciplinary approach to diagnosis and treatment are well placed to undertake this mission.

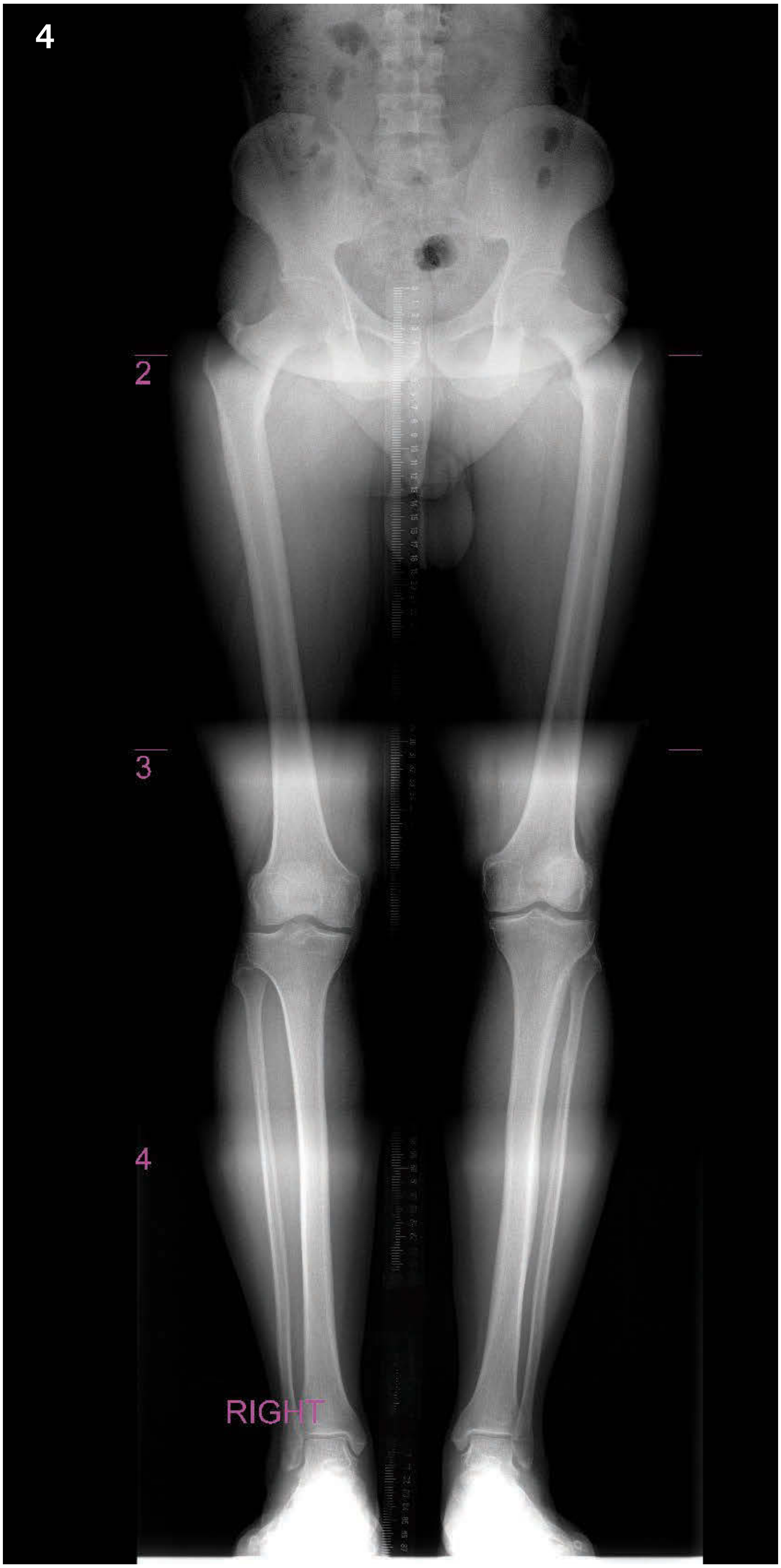

Figure 3: Ultrasound also adds an extra clinical dimension to imaging

Figure 4: X-ray. Single standing frontal view of the lower extremities obtained for measurement purposes.

John W Read
M.B., B.S., F.R.A.N.Z.C.R., D.D.U.

Castlereagh Imaging
Sydney, Australia

Contact: johnwread@me.com