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Musculoskeletal Ultrasound

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Introduction

Ultrasound is a validated, excellent imaging tool for the diagnosis and assessment of musculoskeletal (MSK) diseases, and in particular inflammatory and non-inflammatory joint diseases. Musculoskeletal ultrasound (MSK US) plays an important role in visualising both soft tissue structures as well as cartilage and bone, and can detect a variety of pathological changes. In rheumatological practice linear transducers are predominantly utilised. Generally used frequencies range between 5 MHz and 22 MHz, depending on the tissue or joint under investigation. MSK structures are assessed dynamically in real-time and statically with the advantage of multiplanar views. Furthermore, MSK US is a useful tool to guide interventions in the MSK system. Limitations of this technique include limited acoustic windows, difficulty in detecting pathology in large/deep joints, limited view and operator experience.

Anatomy

MSK structures have different echogenicity and therefore different degrees of reflectivity that determine their specific MSK US appearance. In this chapter, ultrasound patterns of normal MSK tissues are discussed [1-5].

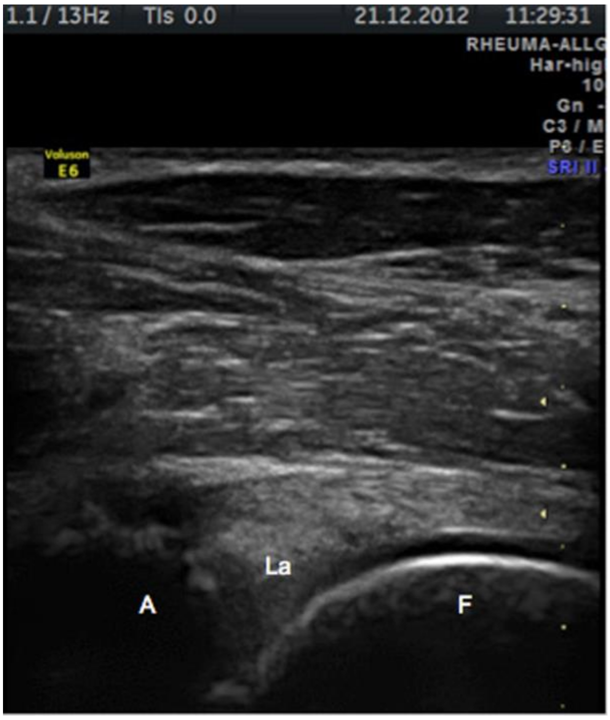
Cartilage

In the MSK system we primarily visualise two types of cartilage, hyaline cartilage and fibrocartilage. Typical examples of fibrocartilage are the triangular fibrocartilage complex (TFCC) of the wrist [Figure 1], the menisci of the knee [Figure 2], the labrum of the hip [Figure 3] or the labrum of the glenohumeral joint. A small fibrous cartilage layer also lies at the insertions of ligaments or tendons onto bone as part of fibrocartilaginous entheses. Normal fibrocartilage appears iso- to hyperechoic depending on the insonation angle.

Figure 1 Triangular fibrocartilage complex of the wrist. Extensor carpi ulnaris tendon (ECU); ulna (Ul); triangular fibrocartilage complex (TFCC).

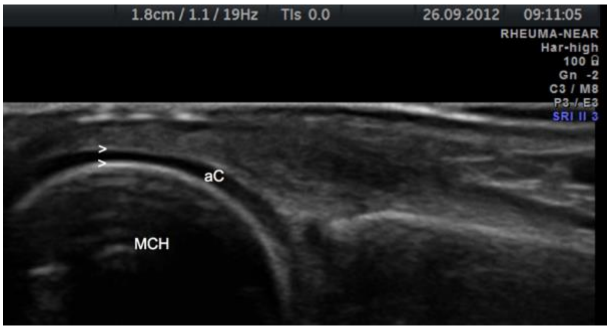
Figure 2 Meniscus of the knee. Femur (F); meniscus (Me); tibia (T).

Figure 3 Labrum of the hip. Labrum (La); acetabulum (A); femur (F).



Hyaline cartilage can be assessed in almost all accessible joints. Hyaline articular cartilage can be visualised as a sharp anechoic band (using low gain) coating the bony cortex. Normal hyaline cartilage is homogeneous, regular and has continuous margins. The hyaline cartilage can be well separated from the overlying soft tissue by a hyperechoic interface. Another hyperechoic interface is found between the cartilage and the subchondral bony cortex [Figure 4].

Figure 4 Articular cartilage of the finger joint. Hyaline articular cartilage (aC); metacarpal head (MCH); interfaces (>).



Bone

In assessing bone structure, one of the limitations of MSK US becomes apparent; the bright bony cortex reflects most US waves and appears as a hyperechoic structure. This leads to a limited acoustic window and therefore a limited acoustic view. This is due to the higher acoustic impedance of bone compared to adjacent soft tissue. Visualising structures deep to the bony cortex, such as bone marrow is therefore not possible [Figures 5 and 6]. Generally, we are unable to visualise the normal periosteum.

Figure 5 Bone. Hyperechoic bone surface of the metacarpal head (arrows).

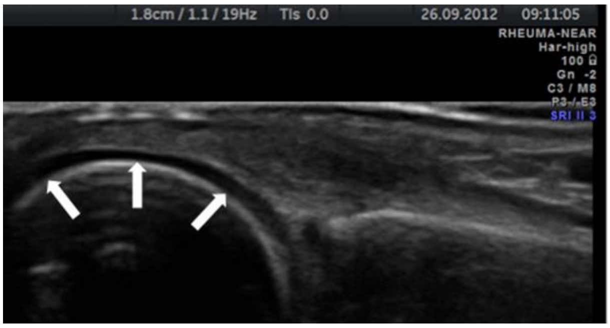
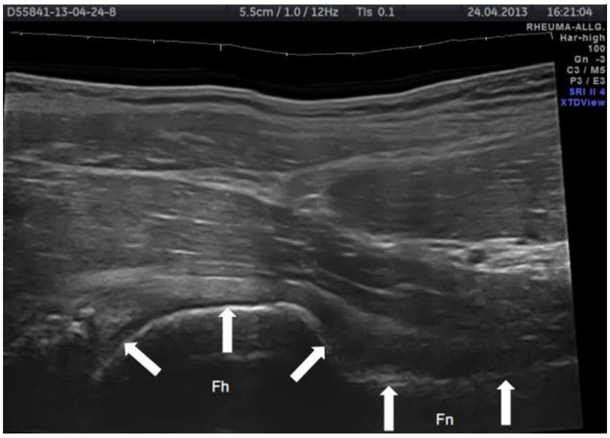


Figure 6 Bone. Hyperechoic bone surface of the femur (arrows); femoral head (Fh); femoral neck (Fn).



Tendons and ligaments

Tendons and ligaments of joints appear as hyperechoic linear structures with echogenic fibrils corresponding to endo- and peritendineal septa [Figure 7]. Depending on the insonation angle, tendons and ligaments change their echogenicity from hyper- to hypoechoic [Figure 8]. This phenomenon is called anisotropy and can be used to identify structures with this property within challenging anatomical areas. Examples include distinguishing the median nerve from the flexor tendons in the volar wrist and assessing the semimembranosus tendon and the tendon of the medial head of the gastrocnemius muscle in the popliteal fossa, when searching for a Baker's cyst.

Figure 7 Flexor tendons of the finger. Hyperechoic deep flexor tendon (dFT); hyperechoic superficial flexor tendon (sFT); A1 pulley (pu); volar plate (vP).

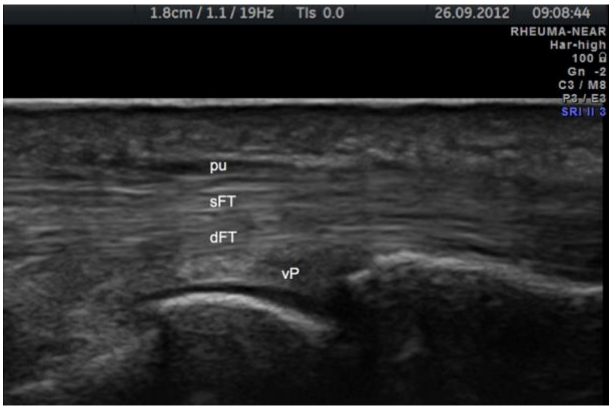
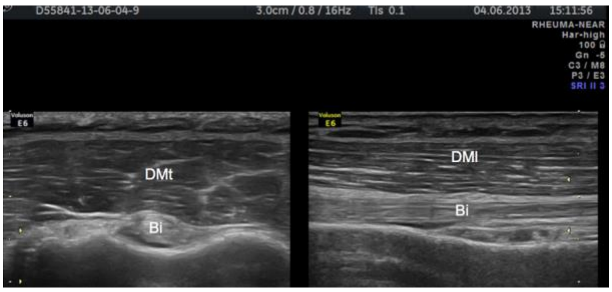


Figure 8 **Anisotropy in the biceps tendon: hyperechoic appearance when the insonation angle is 90 degrees (arrow head in the left image) or hypoechoic appearance when changing the angle (arrow head in the right image).**

Muscles

Typically, muscles have a hypoechoic pattern. In old age, the echotexture of muscle becomes more echoic due to loss of water, atrophy and progressive fatty infiltration. When a muscle is scanned in the transverse plane, several echoic to hyperechoic dots can be seen corresponding to endo-, peri- and epimysium. In the longitudinal view we can visualise these as parallel and oblique echoic fibres [Figure 9].

Figure 9 **Hypoechoic deltoid muscle on transverse view and on longitudinal view with parallel and oblique echoic fibres. Deltoid muscle on transverse view (DMt); deltoid muscle on longitudinal view (DMl); biceps tendon (Bi).**



Skin and fat

Using high frequency transducers (18 to 60 MHz) the skin appears as a hyperechoic band [Figure 10], whilst subcutaneous fat appears as a hypoechoic lobulated structure with iso- or hyperechoic connective tissue fibres [Figure 11].

Figure 10 Skin. Skin (Sk); flexor tendons (FT); metacarpal head (Mc).

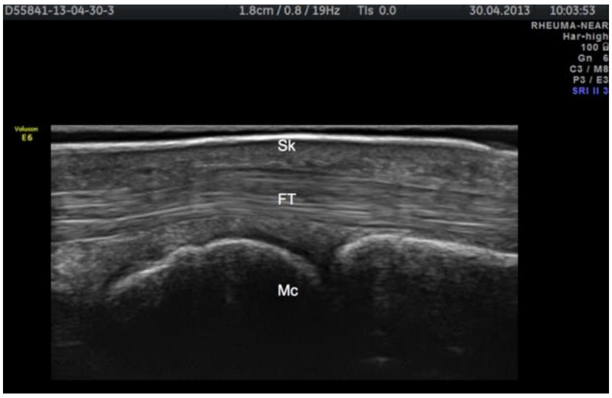
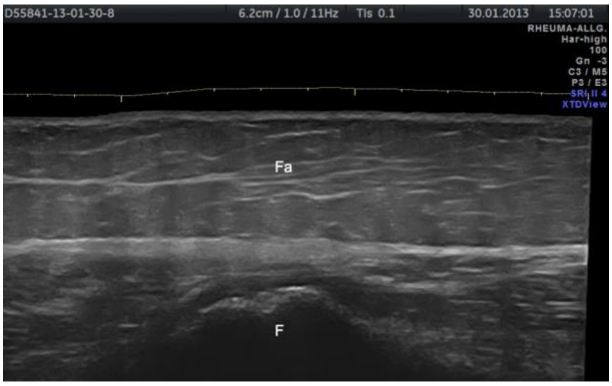


Figure 11 Hypoechoic fat at the lateral hip. Subcutaneous fat (Fa); femur (F).



Nerves and vessels

Using high frequency transducers we can see peripheral nerves [Figure 12]. Typically we see linear hypoechoic fascicles surrounded by the hyperechoic endoneurium and perineurium. The epineurium of a nerve appear as parallel hyperechoic band. Blood vessels appear as anechoic compressible tubular structures (longitudinal view) or as round structures (transverse view) [Figure 12].