Ultrasound imaging for the rheumatologist
II. Ultrasonography of the hand and wrist

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ABSTRACT
The hand is one of the anatomical regions most frequently explored by ultrasound (US) in rheumatology. The last generation US systems equipped with high frequency probes allow for a quick and accurate assessment of even minimal pathological changes in patients with rheumatic conditions affecting the small joints and the soft tissues of the hand and wrist. Several studies have demonstrated the great value of US imaging of the hand and wrist in rheumatology but there are still controversial issues which yet have to be adequately addressed, particularly with regard to US semi-quantitative evaluation of synovitis and bone erosions in patients with chronic arthritis. This paper provides the basic knowledge, reviews the available evidence and discusses the potential of US in the evaluation of the hand and wrist.

Indications
There are several clinical settings in which US examination of the hand and wrist may be beneficial (Table I). In early arthritis hand US is a sensitive tool for detecting both synovitis and bone erosions in small joints (13-16). It can also carefully depict sub-clinical tendon involvement in patients with chronic arthritis (17). US of the hand and wrist is also of great use in the identification of underlying pathology responsible for clinical scenarios such as “sausage finger” and “carpal tunnel syndrome” (18). The modality can therefore add vital information to tricky clinical situations in rheumatological practice.

Equipment
The availability of a very high frequency probe is a “sine qua non” for a comprehensive evaluation of the entire US landscape of the hand. The use of linear probes with frequencies > 10 MHz is recommended. Another important feature to consider is the size and the shape of the probe: small “hockey stick” transducers allow an easier multi-planar assessment of the small joints of the hand because they can be readily placed among the fingers. Wide footprint and extended view reconstructions allow panoramic views that are particularly useful while assessing the anatomical structures of the wrist: radio-carpal and
inter-carpal joints, carpal tunnel and extensor tendon compartments. Power Doppler sonography (PDS) and colour Doppler sonography are now essential for assessment which also includes the study of tissue perfusion.

**Scanning technique**

Each anatomical structure must be explored through all the available acoustic windows using a multi-planar scanning technique. In particular, the articular cartilage of the metacarpal head requires maximal flexion of the metacarpophalangeal (MCP) joint to expose the maximal extent of its surface to the US beam. US examination of the II MCP joint must include evaluation of the lateral aspect of the joint where bone erosions, undetectable by conventional antero-posterior hand radiography, are most frequently discovered.

The tendons must be assessed from their musculo-tendinous origin to their distal insertion into bone. Dynamic real time examination is recommended for assessing the hand and wrist and is particularly true for the tendons and the median nerve. Active and passive tendon movement during US examination can confirm the presence of a tendon tear in cases where an intra-tendineous anechoic or hypoechoic area are found. Both greyscale US and PDS mode require very low compression of the probe on the tissues under examination. Fluid collection in small joints can be readily displaced even by minimal external pressure and result in underestimation of joint effusion. Moreover, for proper PD examination of a joint, the patient must be asked to take a position generating the lowest intra-articular pressure. For the small joints of the hand, this position corresponds to the hand resting on the bed with a mild degree of flexion of the joints.

**US anatomy**

**Joints**

The articular surfaces of the small joints of the hand represent the landmarks to be visualised during US examination. In all cases the bone profile appears as a sharp, continuous and hyperechoic line generating an acoustic shadow. Particular attention should be paid during the evaluation of the anatomical neck of the metacarpal bone as it may be misinterpreted as bone erosion. In healthy subjects the joint space is interpreted as bone erosion.

Normal articular cartilage appears as a homogenous anechoic band delimited by sharply defined hyperechoic margins. The superficial chondro-synovial margin corresponds to the interface between the synovial fluid and the cartilage surface. This margin is thinner than the deeper one and its visualisation is optimised by perpendicular insonation of the US beam. In healthy subjects, the thickness of the articular cartilage of the metacarpal head ranges from 0.2 to 0.5 mm (5).

In longitudinal scan, the triangular ligament of the carpus appears as a homogeneous echoic or hyper-echoic structure between the head of the ulna and the triquetrum bone and is best seen during abductions and adduction of the hand (20, 21).

**Tendons**

Morphostructurally, the finger flexor and extensor tendons appear on longitudinal scans, as tightly packed echoic bands with thin parallel linear echoes (fibrillar pattern) separated by fine anechoic lines. On transverse view, they have an oval-to-round shape and their echo-texture is characterised by tightly packed echoic dots with a homogenous distribution (17, 22).

US examination of the tendons of the hand and wrist is relatively easy due to the absence of acoustic barriers and their relatively straight course. Active and passive movements of the fingers are very helpful when examining the carpal tunnel or the IV compartment of the wrist where more than four tendons lie next to one another.

The flexor and extensor tendons of the fingers are enveloped by a synovial sheath for the majority of their course. A subtle anechoic layer, indicating synovial fluid surrounding tendons with synovial sheath, can be visualized with very-high frequency transducers (>13 MHz). The size of this virtual space for the finger flexor tendons is 0.3 mm at the level of the MCP joints. The tendons and their tracts with synovial sheaths are listed in Table II (17). Mild tendon sheath widening on the dorsal aspect of the IV compartment of the wrist, proximal to the extensor retinacular ligament is detectable in healthy subjects.

**Median nerve**

At the entrance to the carpal tunnel the median nerve is located between the tendon of flexor carpi radialis and the tendons of the flexor digitorum superficialis, deep to the tendon of palmaris longus, when present, and superficial to the flexor pollicis longus tendon.
The median nerve is similar in shape to a tendon on both longitudinal and transverse views. It can however, be recognised by its typical echo-texture with discrete hyper-echoic bundles on a hypo-echoic background delimited by a hyper-echoic margin (23). It is distinguished from tendons on real-time US examination where they run during finger flexion-extension movements in longitudinal views and change their echogenicity according to the angle of insonnation because of anisotropy on transverse scans.

In healthy subjects, the cross-sectional area of the median nerve can extend up to 10 mm² when measured at the level of the pisiform bone (24, 25).

**US pathology**

**Joints**

Joint cavity widening is the US hallmark of synovitis. Enlargement of the joint space can be related to joint effusion and/or synovial proliferation. PDS is of value in the evaluation of synovial perfusion which may be patchy in its distribution, requiring an accurate multi-planar examination to assess its full extent. With the advent of the three-dimensional US, PDS interpretation will become simpler since a single three-dimensional image is able to con-

**Table II. Tendons of the hand and wrist with synovial sheath.**

<table>
<thead>
<tr>
<th>Tendons</th>
<th>Site where tendons are surrounded by synovial sheath</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abductor pollicis longus and extensor pollicis brevis</td>
<td>I compartment of the wrist</td>
</tr>
<tr>
<td>Extensor carpi radialis longus and brevis</td>
<td>II compartment of the wrist</td>
</tr>
<tr>
<td>Extensor pollicis longus</td>
<td>III compartment of the wrist</td>
</tr>
<tr>
<td>Extensor digitorum</td>
<td>IV compartment of the wrist</td>
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<tr>
<td>Extensor digiti minimi</td>
<td>V compartment of the wrist</td>
</tr>
<tr>
<td>Extensor carpi ulnaris</td>
<td>VI compartment of the wrist</td>
</tr>
<tr>
<td>Flexor carpi radialis</td>
<td>At the level of the distal epiphysis of the radius and scaphoid bone</td>
</tr>
<tr>
<td>Flexor pollicis longus</td>
<td>Carpal tunnel, thenar eminence, thumb</td>
</tr>
<tr>
<td>Finger flexor tendons superficialis and profundus</td>
<td>There are two synovial sheaths: a common synovial sheath within the carpal tunnel and a single digitalis synovial sheath for each finger from the II to the V.</td>
</tr>
<tr>
<td>Flexor carpi ulnaris</td>
<td>Guyon canal</td>
</tr>
</tbody>
</table>

**Fig. 1.** Representative examples of hand and wrist US pathological findings. **A-B.** Rheumatoid arthritis. Proliferative synovitis (s) of a MCP joint on dorsal longitudinal (A) and transverse (B) views. **C.** Heberden node. Dorsal longitudinal scan showing osteophytes (arrowheads). **D.** Rheumatoid arthritis. Partial rupture (arrow) of the extensor carpi ulnaris tendon (t). **E-F.** Carpal tunnel syndrome. Marked thickening of the median nerve (n) at the proximal entrance of the carpal tunnel both on transverse (E) and longitudinal (F) views. m = metacarpus; pp = proximal phalanx; mp = middle phalanx; dp = distal phalanx; u = scaphoid bone; lu = lunate bone; ca = capitate bone; r = radius.

For further ultrasound images, please go to: www.clinexprheumatol.org
Tendons

Tenosynovitis is the most frequent pathological condition involving the tendons of the hand and wrist in patients with chronic arthritis. The typical US finding in this setting is tendon sheath widening (17). This widening can be due to several factors including: increased amount of synovial fluid, increased volume of synovial tissue or a combination of synovial effusion and proliferation. On greyscale scanning the severity of tenosynovitis can be estimated by the extent of both sheath widening and synovial hypertrophy. The distribution of PDS signal further characterises the severity of the tenosynovitis by providing information relating to the perfusion status of both the peri-tendineous synovial tissue and the tendon itself (31). A broad spectrum of changes in tendon echotexture can be depicted in patients with hand arthritis including: diffuse tendon swelling with multiple small anechoic areas, focal anechoic and/or hypo-echoic loss of substance surrounded by an area of fibriallar derangement and sub-tendinous tendon rupture (17). In patients with RA, US can show pannus within the synovial sheath breaching and invading the integrity of the tendon.

In chronic gout, tophaceous deposits can be depicted in the peri-articular soft tissues both surrounding or within the tendons. Tendino-tendinous monosodium urate crystals deposits appear as circumscribed areas of loss of normal fibril-lar echotexture replaced by inhomogeneous echogenic material covered with bright hyper-echoic spots. Depending on their size and/or density, tophaceous deposits may or may not generate an acoustic shadow (29).

**Median nerve**

The most relevant pathological finding relating to the median nerve is the change of its cross-sectional area. An increment of the transverse area of the nerve at the proximal entrance to the carpal tunnel is the most frequent and non-specific sign of high pressure within the tunnel. US can also identify secondary causes of carpal tunnel syndrome (18). These include tenosynovitis of the finger flexor tendons, synovitis of the radiocarpal and/or inter-carpal joints, aberrant muscle and tophaceous deposits. A circumscripted reduction of the thickness of the median nerve is also a morphological change indicative of a secondary cause of carpal tunnel syndrome. This condition is almost invariably related to the presence of a post-surgical connective adhesion band.

**Sonographic guided procedures**

The value of US as a tool for the accurate positioning of a needle into the small joints of hand and wrist for injection of therapeutic substances, joint fluid aspiration and for synovial biopsy has been documented in several studies (32-34). It may also be used for diagnostic aspiration of distended tendon sheaths in cases where sepsis must be excluded in the differential diagnosis.

Controversial issues

In spite of the wealth of available evidence supporting the value of US in the detection of synovitis and bone erosion in patients with RA, quantitative assessment of these specific entities remains a matter of debate. Agreement on these US parameters of inflammation will be the topic of future research particularly in terms of therapeutic monitoring. Currently, a four point scoring system appears to be the most widely used and appropriate method for semi-quantitative evaluation of both greyscale and PDS findings in synovitis. Consensus upon the quantitative assessment of bone erosion still has to be reached. It seems likely that the hand and wrist will continue to be one of the main anatomical targets for research and development in the field of US worldwide.

**Link**

For further ultrasound images, go to www.elincexpertumatologol/radiultrasound

**References**


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