White Paper

High-resolution ultrasound in rheumatoid arthritis and hand osteoarthritis

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Clinical background

Ultrasound with very high-frequency probes allows for a detailed visualization of the morpho-structural features of both joint and periarticular soft-tissues (Figure 1) [1-5].

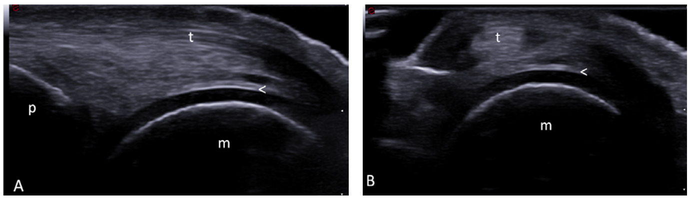

Figure 1. Healthy subject. Longitudinal (A) and transverse (B) dorsal views of a metacarpophalangeal joint in flexed position showing normal features of the metacarpal head hyaline cartilage appearing as an anechoic thin layer delimited by two hyperechoic margins, the superficial margin representing the chondro-synovial interface (arrowhead) and the deep one, the osteo-chondral interface. m = metacarpal head; p = proximal phalanx; t = finger extensor tendon.

Modern high-end machines have a great number of applications in rheumatological clinical practice, allowing for a sensitive detection of the core set sonographic findings indicative of joint inflammation and damage, and providing objective evidence of subclinical synovitis and early identification of cartilage damage and bone erosions compared to conventional radiography (Figure 2) [1,6-11].

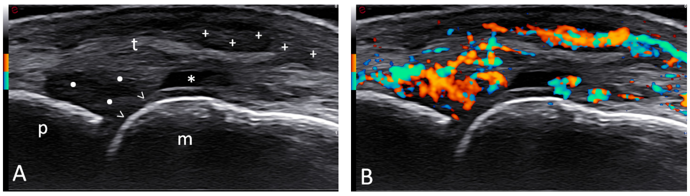

Figure 2. Rheumatoid arthritis. Metacarpophalangeal joint examined on dorsal longitudinal scan in greyscale (A) and color Doppler (B) modes. Active synovitis (•) with evidence of cartilage damage (arrowheads). Intense Doppler signal was detected surrounding the extensor tendon (+). High resolution ultrasound allows for a clear distinction between synovial hypertrophy (•) and synovial fluid (*). m = metacarpal head; p = proximal phalanx; t = finger extensor tendon.

Very-High Frequency transducers – IHX 6-25

As a pioneer and forerunnner in Very-High Frequency Sonography (VHFS), Esaote offers a collection of transducers that are suitable for many different clinical application among which Musculoskeletal and Rheumatology.

A genuine technological breakthrough in very superficial explorations, the IHX 6-25, Esaote's Very-High Frequency hockey stick probe, operating up to 25MHz, delivers outstanding spatial resolution, while due to its advanced design ergonomics, it facilitates the needle access to perform accurate interventional gestures with millimetric precision.

The renowned Doppler technologies, including Power Doppler and microV, offer a very high level of sensitivity, delivering excellent quality blood flow information from large vessels and arteries to the smaller and slower microvascularization. This improved vascular image quality positively impacts diagnosis and therapy planning, with great interest particularly in rheumatologic conditions, for the detection of vascularity in synovial proliferations and in rheumatological inflammatory diseases.

XCrystal technology

Esaote-developed XCrystal technology dramatically increases sensitivity and penetration, to provide sharper images and homogeneity. Esaote, a benchmark for high-performance probe manufacturing, has designed a new generation of transducers to channel Esaote's ClearWave Architecture and to deliver top-class resolution imaging (Figure 3).

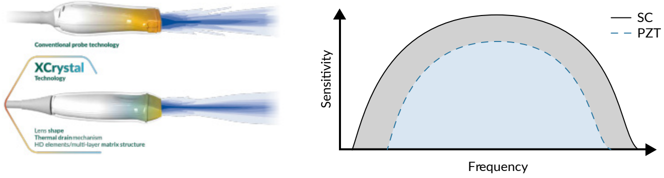

Figure 3. Probes schema comparing conventional and XCrystal technology and sensitivity graph comparing the usage of a single crystal array versus a PZT technology array.

Early rheumatoid arthritis

When early arthritis is suspected, ultrasound can confirm the presence of joint inflammation in joints with doubtful swelling on physical examination and reveal subclinical joint inflammation, facilitating both diagnosis and treatment decisions. Furthermore, ultrasound improves the detection of bone erosions, which traditionally relies on the diagnostic capabilities of conventional radiography, in the very early stages of the disease [9].

In patients with rheumatoid arthritis, several studies have highlighted the prognostic value of subclinical ultrasound synovitis, both in patients without a definite diagnosis and in those with established disease (e.g., in predicting relapses and guiding treatment decisions) (Figure 4, 5) [8,9].

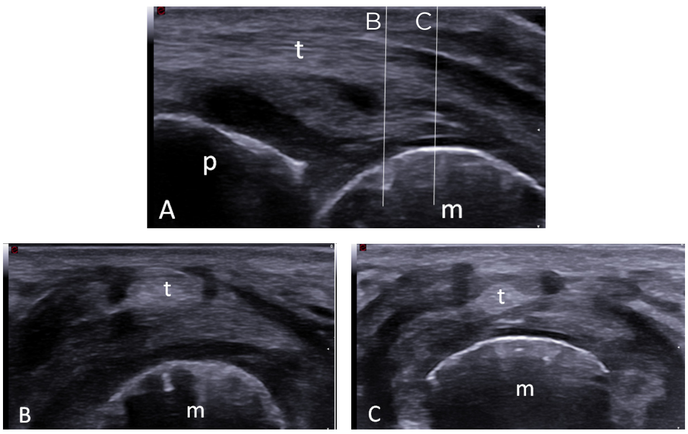

Figure 4. Rheumatoid arthritis. Longitudinal (A) and transverse (B-C) dorsal views showing proliferative synovitis of a metacarpophalangeal joint with evidence of cartilage damage and subchondral bone erosion (B). m = metacarpal head; p = proximal phalanx; t = finger extensor tendon.

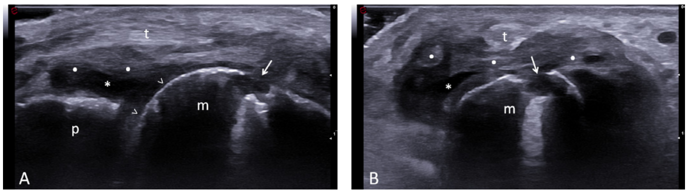

Figure 5. Rheumatoid arthritis. Metacarpophalangeal joint examined on dorsal aspect using longitudinal (A) and transverse (B) views. Proliferative synovitis (•) with evidence of joint damage characterized by bone erosion (arrows) and cartilage damage (arrowheads). High resolution ultrasound allows for a clear distinction between synovial hypertrophy (•) and synovial fluid (*). m = metacarpal head; p = proximal phalanx; t = finger extensor tendon.

Hand osteoarthritis

In patients with hand osteoarthritis, ultrasound findings indicative of structural damage at the joint level include osteophytes and cartilage damage (Figures 6-7) [12-18].

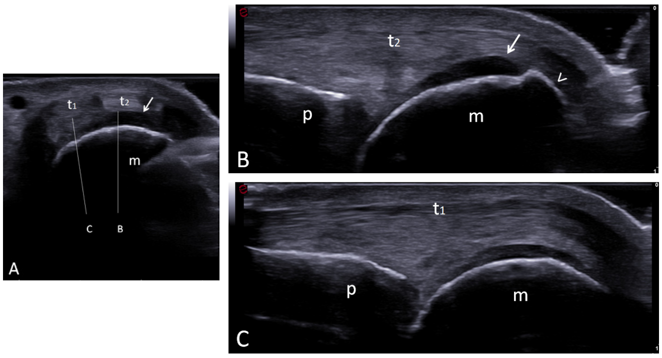

Figure 6. Early osteoarthritis. Focal swelling of the cartilage layer (1.1 mm) of a metacarpal head (arrows) documented in both transverse (A) and longitudinal (B) views. The longitudinal view (B) shows that such a swelling is close to the osteophyte (arrowhead). In fact, when moving the probe away from the osteophyte in the longitudinal view (C), both the osteophyte and the cartilage swelling disappear. m = metacarpal head; p = proximal phalanx; t1 and t2 = extensor tendons of the second finger.

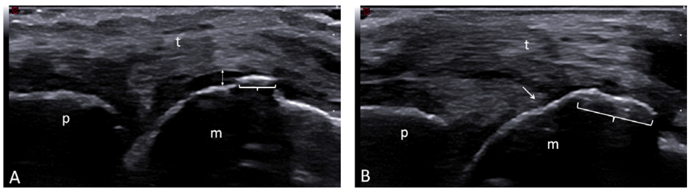

Figure 7. Early and long-standing osteoarthritis of the metacarpophalangeal joint in the dorsal longitudinal view. A. Early stage of the disease: focal swelling of the cartilage layer (0.9 mm) of a metacarpal head (double-headed arrow) and small osteophyte (curly bracket). B. Long-standing osteoarthritis: diffuse cartilage thinning (arrow) and large osteophyte (curly bracket). m = metacarpal head; p = proximal phalanx; t = finger extensor tendon.

Osteophyte formation is considered a key feature of osteoarthritis, leading to pain and loss of joint function [12,13]. Cross-sectional studies of both hands and knees have shown that ultrasound is more sensitive than conventional radiography in detecting osteophytes, but little is known about the implications of ultrasound-detected osteophytes in the absence of radiographic or clinical findings indicating osteoarthritis [14-16]. Based on these premises, Norwegian authors conducted a five-year prospective study and demonstrated that the ultrasound detection of osteophytes (in joints without clinical and radiographic findings indicating osteoarthritis) is predictive of radiographic and clinical signs of osteoarthritis in the same joints after five years [17]. The prevalence of cartilage damage at the metacarpal heads of patients with hand osteoarthritis was estimated in a more recent cross-sectional study evaluating 266 metacarpophalangeal joints in 34 patients with hand osteoarthritis. Ultrasound findings indicative of cartilage damage were recorded in 43.6% of the joints examined, homogeneously distributed among the different fingers analysed [18].

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