

“The use of very high-frequency US probes, both in 2D and in Power Doppler mode, helps to increase diagnostic accuracy in US evaluation of the metacarpal head cartilage.”

DOPPLER SENSITIVITY

SL3116 High-frequency ultrasound & metacarpal head cartilage

Case studies courtesy of

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High-resolution ultrasound (US) using very high-frequency probes (i.e., higher than 16 MHz) provides a detailed morphological evaluation of the hyaline cartilage of the metacarpal head¹.

Healthy hyaline cartilage appears as a thin homogeneous band delineated by continuous clear hyperechoic margins: the superficial (i.e., the chondro-synovial interface) and deep margin (i.e., the osteo-chondral interface) (Figure 1). US morpho-structural abnormalities of metacarpal head cartilage damage include: loss of sharpness of the superficial margin; partial thickness

defect of the cartilage layer; full thickness defect of the cartilage layer with a normal subchondral bone profile; complete loss of the cartilage layer and subchondral bone involvement^{1,2} (Figures 2-4).

In a recent study, Hurnakova et al. used a linear probe with a frequency reaching 22 MHz and found metacarpal head cartilage damage in 35.7% of joints in patients with rheumatoid arthritis and in 43.6% of joints in patients with osteoarthritis². Meanwhile, in patients with rheumatoid arthritis the II and III metacarpal heads of both hands were the most frequently in-

involved, in osteoarthritis the cartilage damage was more homogeneously distributed in all metacarpophalangeal joints².

Validity issues of US in the assessment of the hyaline cartilage in rheumatoid arthritis and healthy metacarpal heads have been investigated. Both qualitative and quantitative US scoring systems were described³⁻⁵ and evidence in favor of inter- and intra-observer reliability was found using very high-frequency probes (up to 25 MHz)⁶. In the near future it seems likely that artificial intelligence will assist sonographers in the assessment of the hyaline cartilage.^{7,8}

Case 1

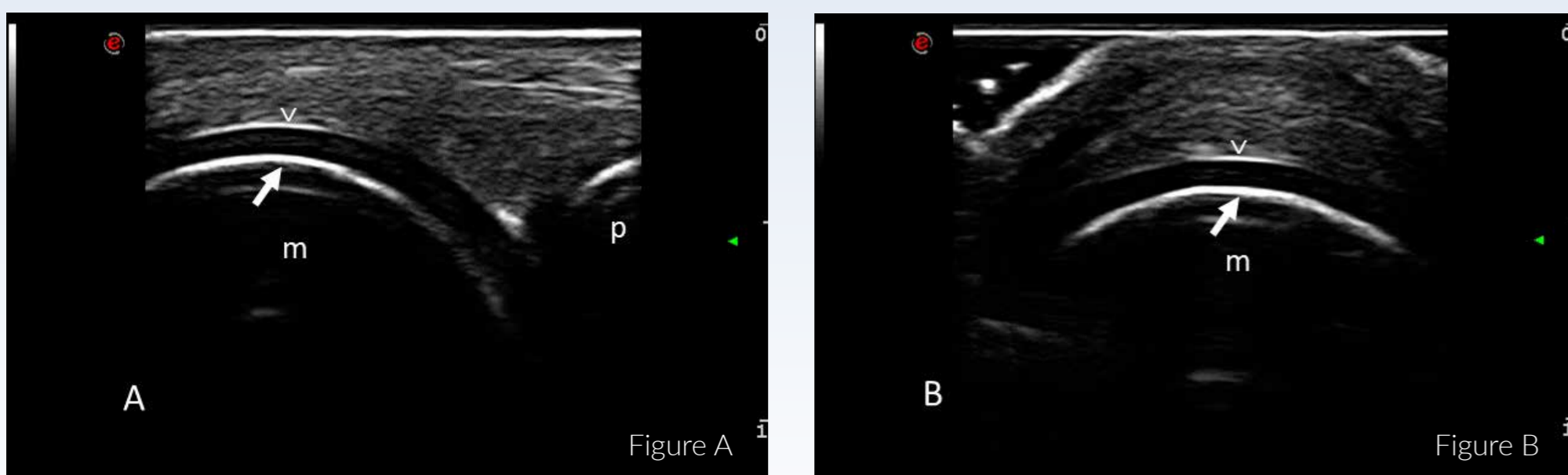


Figure 1. Healthy subject. Normal ultrasound features of the metacarpal head cartilage in longitudinal (**figure A**) and transverse (**figure B**) dorsal views. The hyaline cartilage appears as a homogenous band delineated by two hyperechoic margins: the superficial chondro-synovial interface (arrowhead) and the deep osteo-chondral interface (arrow). *m=metacarpal head; p=proximal phalanx.*

Case 2

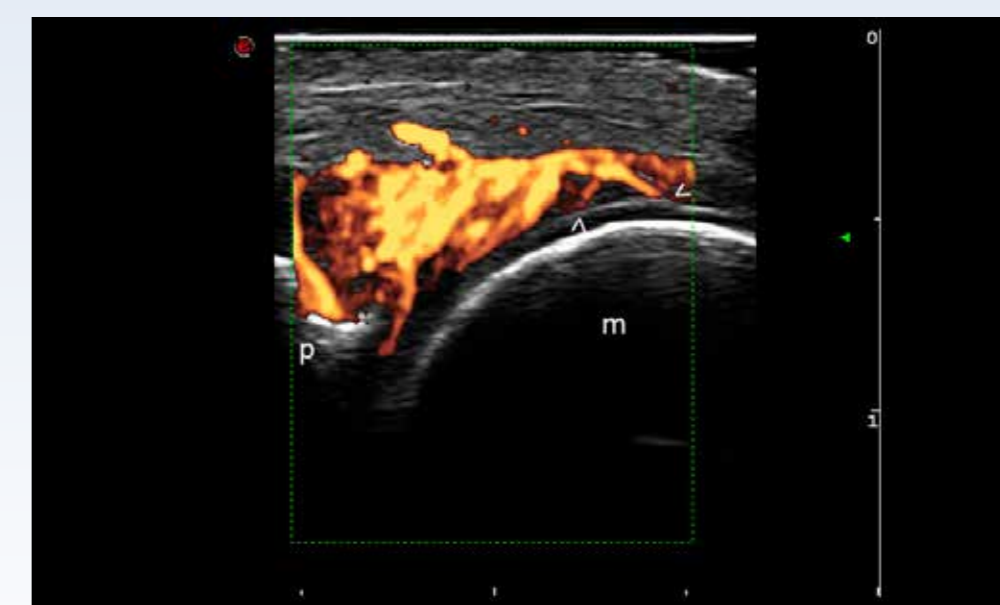


Figure 2. Early rheumatoid arthritis. Longitudinal dorsal scan showing an example of active synovitis of a metacarpophalangeal joint. Note the loss of the sharpness of the superficial margin (arrowheads) where the inflamed rheumatoid pannus sticks to the cartilage surface. *m=metacarpal head; p=proximal phalanx.*

Case 3

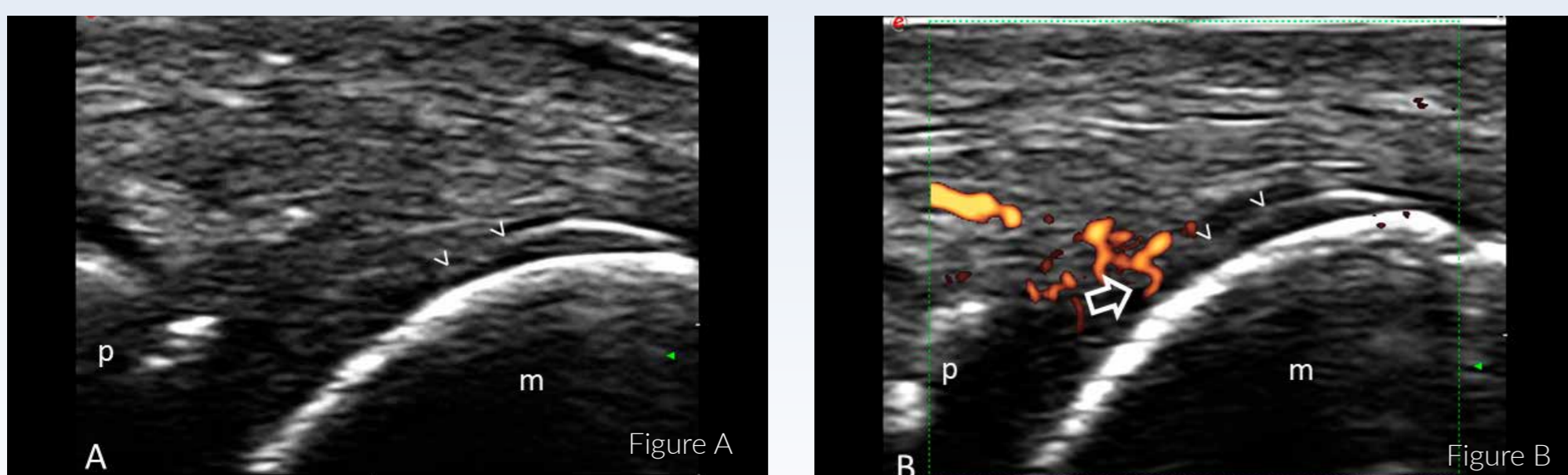


Figure 3. Established rheumatoid arthritis. Longitudinal dorsal scan in B-mode (**figure A**) and corresponding power Doppler mode (**figure B**) showing loss of the sharpness of the superficial margin (arrowheads) together with partial thickness defect of the cartilage layer, which is invaded by an active rheumatoid pannus (empty arrow). *m=metacarpal head; p=proximal phalanx.*

Case 4

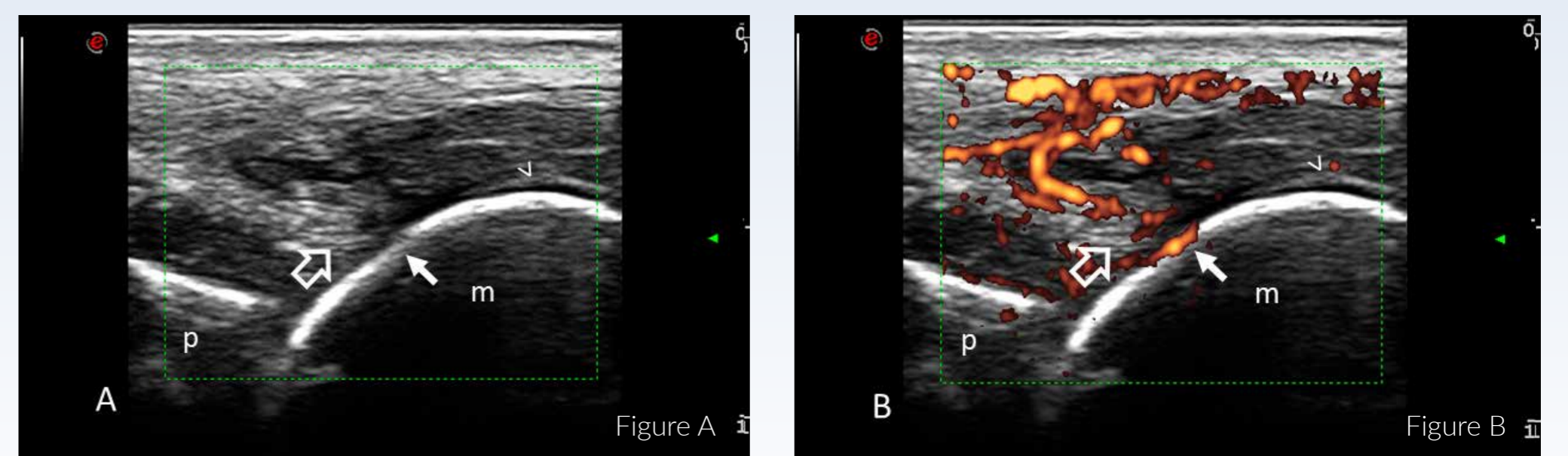


Figure 4. Late rheumatoid arthritis. Longitudinal dorsal scan in B-mode (**figure A**) and corresponding power Doppler mode (**figure B**). An active rheumatoid pannus has invaded and completely reabsorbed the cartilage layer (empty arrow). Note the presence of Doppler signal close to both the loss of the sharpness of the superficial margin (arrowhead) and subchondral margin involvement (arrow). *m=metacarpal head; p=proximal phalanx.*

References 1. Cipolletta E, Hurnakova J, Di Matteo A, Di Carlo M, Pavelka K, Grassi W, Filippucci E. Prevalence and distribution of cartilage and bone damage at metacarpal head in healthy subjects. *Clin Exp Rheumatol*. 2021 Nov-Dec;39(6):1394-1401. 2. Hurnakova J, Filippucci E, Cipolletta E, Di Matteo A, Salaffi F, Carotti M, Draghessi A, Di Donato E, Di Carlo M, Lato V, Horvath R, Komarc M, Pavelka K, Grassi W. Prevalence and distribution of cartilage damage at the metacarpal head level in rheumatoid arthritis and osteoarthritis: an ultrasound study. *Rheumatology (Oxford)*. 2019 Jul 1;58(7):1206-1213. 3. Cipolletta E, Mandi P, Di Matteo A, Mirza RM, Passarini G, Grassi W, Filippucci E. Sonographic assessment of cartilage damage at metacarpal head in rheumatoid arthritis: qualitative versus quantitative methods. *Rheumatology (Oxford)*. 2021 Jun 7;keab472. doi: 10.1093/rheumatology/keab472. 4. Mathiessen A, Hammer HB, Terslev L, Kortekaas MC, D'Agostino MA, Haugen IK, Bruyn GA, Filippou G, Filippucci E, Kloppenburg M, Mancarella L, Mandi P, Möller I, Mortada MA, Naredo E, Delle Sedie A, Sexton J, Wittoek R, Iagnocco A, Ellegaard K; OMERACT Ultrasound working Group. Ultrasonography of Inflammatory and Structural Lesions in Hand Osteoarthritis: An OMERACT Agreement and Reliability Study. *Arthritis Care Res (Hoboken)*. 2021 Jun 16. doi: 10.1002/acr.24734. 5. Gessi I, Balne PV, Filippucci E, Keen HI, Pineda C, Terslev L, Wildner B, D'Agostino MA, Mandi P. Structural damage in rheumatoid arthritis assessed by musculoskeletal ultrasound: A systematic literature review by the Structural Joint Damage Task Force of the OMERACT Ultrasound Working Group. *Semin Arthritis Rheum*. 2021 Jun;51(3):627-639. doi: 10.1016/j.semarth.2021.02.010. 6. Cipolletta E, Filippucci E, Di Matteo A, Tesse G, Cosatti MA, Di Carlo M, Grassi W. The Reliability of Ultrasound in the Assessment of Hyaline Cartilage in Rheumatoid Arthritis and Healthy Metacarpal Heads. *Ultraschall Med*. 2020 Oct 30. doi: 10.1055/s-01285-4602. 7. Cipolletta E, Fiorentino MC, Moccia S, Guidotti I, Grassi W, Filippucci E, Frontoni E. Artificial Intelligence for Ultrasound Informative Image Selection of Metacarpal Head Cartilage: A Pilot Study. *Front Med (Lausanne)*. 2021 Mar 18;589197. doi: 10.3389/fmed.2021.589197. 8. Fiorentino MC, Cipolletta E, Filippucci E, Grassi W, Frontoni E, Moccia S. A deep-learning framework for metacarpal head cartilage-thickness estimation in ultrasound rheumatological images. *Comput Biol Med*. 2021 Dec 23;141:105117. doi: 10.1016/j.cmbiomed.2021.105117. Online ahead of print.