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Three dimensional power Doppler ultrasonography confirms early reduction of synovial perfusion after intra-articular steroid injection

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Hyperaemia caused by vasodilatation is one of the earliest detectable pathological changes at the start of synovitis, and angiogenesis is an important feature of pannus formation, which has a crucial role in the maintenance of synovitis. Thus imaging of synovial perfusion and vasculature at the microvascular level by contrast enhanced magnetic resonance imaging (MRI) and power Doppler ultrasonography (PDUS) are promising methods of assessing and monitoring arthritic activity.¹ Several studies have shown a high correlation between MRI and PDUS determination of synovial perfusion.^{2–3} A high correlation has also been found between MRI and PDUS imaging, on the one hand, and the histologically determined blood vessel density, on the other.^{4–5}

Because measurement of synovial perfusion by PDUS is still difficult, most investigators use semiquantitative four step grading: 0 = no flow, 1 = mild flow, 2 = moderate flow, 3 = intense flow. Other approaches such as the computerised analyses of the number of colour pixels and the use of the resistance index have been reported to be helpful tools for measuring synovial hyperaemia.^{6–7}

Recently, three dimensional (3D) PDUS has been described as a method which allows the spatial demonstration of synovial blood vessels in the peri- and intra-articular region of inflamed joints in patients with rheumatoid arthritis.⁸ We used 3D imaging to assess changes in synovial vascularity after intra-articular steroid injection (triamcinolone 20–40 mg). Six patients with rheumatoid arthritis (four female and two male, mean age 54 years; four with wrist arthritis, one with knee arthritis, and one with elbow arthritis) and two patients with psoriatic arthritis (one female and one male, mean age 55 years; one with elbow and one with

acromioclavicular arthritis), who underwent injection during routine treatment, were studied. In a region with high Doppler signal intensity in conventional 2D power Doppler mode, a 3D volume was acquired by a free hand sweep. The online 3D power Doppler software (3D CPA) provided by the HDI 5000 (L12-5/38, ATL/Philips, Bothell, WA, USA) was used to generate a 3D image of a peri- and intra-articular blood vessel tree, in which grey scale information of the surrounding tissue was already subtracted. One of two experienced ultrasound investigators (JS or KS) performed the sonographic examination under supervision of the other before and after therapeutic injection (mean time 6.5 days). The degree of vascularity in the 2D mode was estimated using the above mentioned semiquantitative four step grading from 0 to 3. The architecture of the 3D blood vessel formation was evaluated with regard to morphological vascular patterns and their alterations during treatment.

Comparison of grading levels before and after steroid injection in the 2D mode showed a significant reduction of microvascular power Doppler flow ($p < 0.01$, sign test for paired samples). By means of 3D PDUS it was possible to discriminate between peri- and intra-articular blood vessels and to recognise unchanged periarticular vessels after steroid injection in 5/8 patients. A formerly strong and well established intra-articular 3D blood vessel tree disappeared after intra-articular injection in 7/8 patients.

These findings suggest that glucocorticosteroids may affect very early on, the endothelial cells and synovial blood vessels, because at the time of the second PDUS examination, effusion and joint swelling were still persistent, in contrast with the almost complete reduction of synovial blood flow in the examined region of interest. The opportunity to observe

Figure 1 2D and 3D power Doppler sonographic images of synovial vascularity of a patient. (A) Longitudinal lateral scan demonstrating the caput ulnae (*) with a black cap, which represents joint effusion and synovial proliferation (>). After steroid injection a significant reduction of intra-articular perfusion in the 2D and 3D mode (C and D) was found. In the 3D mode (B and D) an unchanged peri-articular blood vessel could be differentiated from intra-articular blood vessel formation, which had completely disappeared.

synovial blood vessels in patients with inflamed joints by 3D PDUS imaging should be used in further studies not only for the assessment of disease activity but also to investigate the role of synovial blood vessels and angiogenesis in the process of rheumatoid inflammation and joint destruction.^{9 10}

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