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Sonographic criteria for therapy follow-up in the course of ultrasound-guided intra-articular injections of hyaluronic acid in hand osteoarthritis

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ABSTRACT

Objective: To assess the value of sonographic criteria, based on measurements of joint capsule distension and synovial hyperemia, during the course of repeated ultrasound (US)-guided intra-articular injections of hyaluronic acid (HA) in hand osteoarthritis (OA).
Materials and methods: Thirty-three patients (28 females/5 males), with hand OA in 78 joints, were included in this study. Patients underwent sonographic evaluation at baseline and consecutively for 4 weeks at weekly US-guided intra-articular injections of HA (Hyalgan®). Measurements of joint thickening and joint inflammation were performed with Grey-scale and semi-quantitative Power-Doppler US (PDUS). Sonographic values were correlated with weekly patients self-assessment of pain for each treated joint.
Results: The mean (SD) patients self-assessment of pain statistically significantly ($p < 0.0001$) decreased from the first [68.3(22.3)] to the last week [37.3(30.34)]. A steady pain relief could be noticed in 67 (86%) of all treated joints. Over the whole observation period, the mean (SD) joint thickening of all joints markedly decreased from 15.6 mm (5.3) to 13.1 mm (6.4) ($p < 0.0001$). The PDUS-score before initiation of HA treatment was statistically significantly higher than at the end of therapy ($p < 0.0001$). The decrease in pain statistically significantly correlated with the decrease of joint thickening and PDUS-score between baseline and the end of therapy ($p < 0.001$).
Conclusion: In this study, we demonstrate the meaningfulness of sonographic evaluation criteria including measurements of joint capsule distension and PDUS vascularization, both significantly correlating with the decrease of pain, during the therapy follow-up of US-guided intra-articular HA-injections in patients with hand OA.

1. Introduction

Osteoarthritis (OA) is the most common joint disorder, with an incidence increasing above the age of 40 and greater severity in women than in men [1–3]. The fingers are a frequent site of peripheral hand OA causing disability, pain, and a reduction in the quality of life [2]. Although OA is diagnosed in older people more frequently, under certain circumstances younger people can also develop this disease, e.g. secondary to joint injuries, chronic overuse, joint malformation, or genetic defects in joint cartilage metabolism. The most characteristic early features of OA are, besides marked irregularities of the bone margin with bony spur formation, increased synovial fluid, mucous cysts, synovial thickening, and synovial hypervascularity [4–6]. Symptomatic joint involvement is frequently associated with a variable degree of capsular distension due to effusion and/or synovial hypertrophy [7].

In the radiological evaluation of patients with inflammatory and degenerative joint disorders, as hand OA, non-invasive radiation-free ultrasound (US) examinations provide several advantageous features. Small joint effusions in patients with OA can easily be detected with US. Nonhomogeneous echogeneity of synovial fluid or echoic spots with or without acoustic shadowing can be caused by proteinaceous material, cartilage fragments, aggregates of crystals, and calcified loose bodies [8]. Osteophytes are also easily detected with US as irregularities of the bone contour. The skyline view of an OA joint is characteristic and correlates well with radiographic changes [8]. However, the exact meaningfulness of semi-quantitative US in the monitoring of therapy and clinical course in hand OA has not satisfactorily been evaluated yet.

Clinical studies have shown that intra-articular hyaluronic acid (HA) restores rheological homeostasis in joints with OA by improving the viscoelasticity of defective synovial fluid [9]. Moreover,

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for OA patients in whom non-steroidal anti-inflammatory drugs (NSAID) therapy fails, HA is a valuable symptom-modifying alternative and may be used to prevent surgery [10].

To assess the meaningfulness of high-frequency US in monitoring therapy follow-up in hand OA, the objective of this study was to evaluate US measurements of joint capsule distension and synovial perfusion during the course of controlled repeated US-guided intra-articular injections of HA in hand OA and correlate quantitative US parameters with clinical outcome variables.

2. Patients and methods

The study protocol was evaluated and approved by the University ethics committee (#UN3893) and written informed consent was obtained from all participating patients.

All patients fulfilled the diagnostic criteria of OA according to the American College of Rheumatology (ACR) [11]. During the whole study period, all patients remained unchanged on their routine concomitant OA-medication. At baseline, the referring rheumatologists chose the most painful joints to be included for HA treatment.

Between October 2008 and July 2009, each included patient underwent sonographic examinations at baseline and consecutively for 4 weeks at weekly US-guided intra-articular injections of HA (Hyalgan®, FIDIA Farmaceutici SpA, Abano Terme, Padua, Italy). Before each US evaluation followed by US-guided HA-injections, patients self-assessment of pain for each joint that underwent intra-articular HA was documented on a 0-100 visual analogous scale (VAS).

US-evaluation. In each patient, high-frequency sonographic evaluation and US-guided intra-articular HA administration was performed by an experienced Radiology consultant with an eight-years experience in musculoskeletal ultrasound. A My Lab 90 scanner (Esaote, Genoa, Italy) fitted with a linear transducer (LA 435) or a Acuson Sequoia (Siemens, Mountain View, CA, USA) with a linear probe (15 L–8 W) and a stand off gel pad (Sonor Aid Wolhusen, Switzerland) was used. The experienced examiner who performed the US-guided intra-articular injections and sonographic evaluations was blinded to the results of patients self-assessment of pain and clinical parameters, which have been retrieved by a different examiner. However, as mentioned above, at baseline the referring rheumatologists selected the joints that needed sonographic evaluation and HA-injections upon clinical considerations. The duration of US scans was not recorded and varied between patients, depending on the individual patients number of affected joints that needed evaluation and HA injections.

Standardized machine settings, which remained unchanged throughout the examination, were used for Grey-scale US with a frequency range of 13–16 MHz and Power-Doppler US (PDUS) with a frequency of 12 MHz, a pulse repetition frequency of 750–1.000 kHz, a low wall filter, and medium persistence. Appropriate color velocity scale of the musculoskeletal US program was used. After visualization of color-flow signals, pulsed wave spectral Doppler imaging was performed using the lowest filter setting and the smallest scale available to display Doppler waves without aliasing. A spectral Doppler tracing was obtained to confirm that the PDUS signals represented true vascular flow. Depending on which diagnosed OA hand joint with radiographic, clinical, and functional evidence of OA was clinically symptomatic, as reported by the referring physician, and needed HA treatment, distal interphalangeal (DIP), proximal interphalangeal (PIP), metacarpophalangeal (MCP), or carpometacarpal (CMC) joints were scanned in two perpendicular planes, i.e. in sagittal and axial planes. The articular capsule was measured in millimeter (mm) lengthwise (Fig. 1), widthwise (Fig. 2), and in depth (Fig. 3) to evaluate the maximum capsule distension. As previously described by Keen et al. [12] and Klauser et al. [13] PDUS assessed the number of detectable blood vessels and was semi-quantitatively graded using a 4-point grading on a 0–3 scale, where 0 represented no detectable signal from blood vessels and a score of 3 maximum hyperemia (Fig. 4).

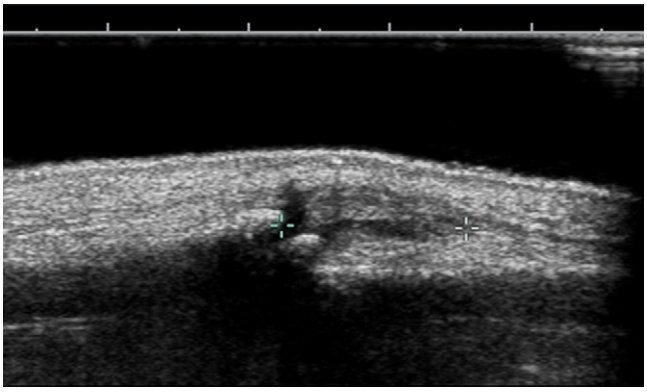

Fig. 1. Sagittal dorsal high-frequency ultrasound image showing lengthwise measurement of the articular capsule of a proximal interphalangeal (PIP) 3 joint of a 54-years old female patient with hand OA to evaluate the maximum capsule distension. Left side of image is the distal portion of the joint.

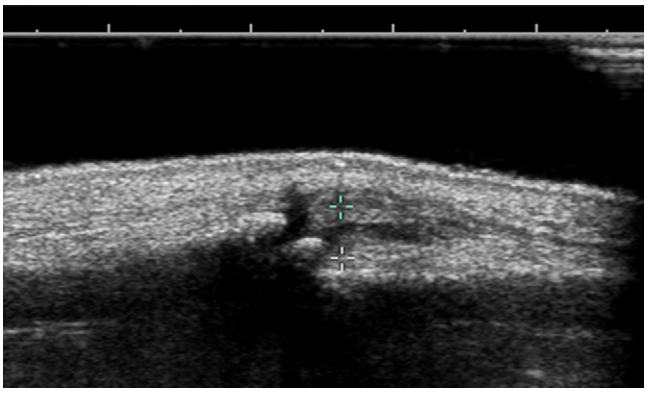

Fig. 2. Sagittal dorsal sonographic widthwise measurement of the articular joint capsule distension of a proximal interphalangeal (PIP) 3 joint of a 54-years old female patient with OA. Left side of image is the distal portion of the joint.

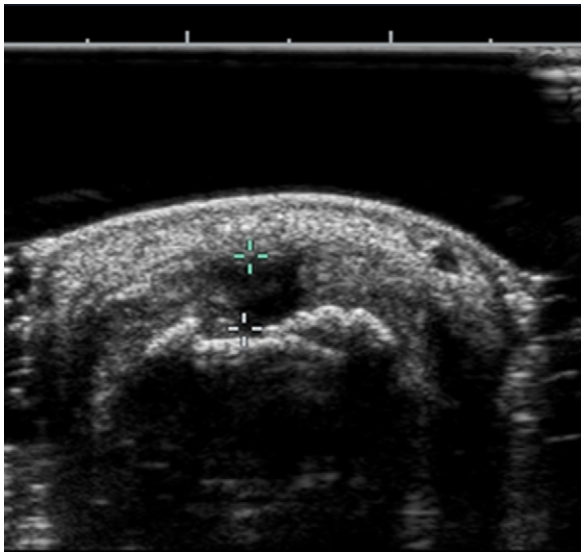

Fig. 3. A representative dorsal axial high-frequency ultrasound image assessing the articular capsule distension in depth of a proximal interphalangeal (PIP) 3 joint of a 54-years old female patient with OA.