Reasons for discordances between ultrasonography and magnetic resonance imaging in the evaluation of the ankle, hindfoot and heel of the patients with rheumatoid arthritis

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Abstract

Aim: To compare the ultrasonography (US) performance with magnetic resonance imaging (MRI) in identifying pathology in ankles, hindfeet and heels of rheumatoid arthritis (RA) patients and to evaluate the reasons for discordances between the two imaging methods. Material and methods: RA patients were enrolled and evaluated using the Clinical Disease Activity Index (CDAI) and the Disease Activity Score 28 with C-reactive Protein (DAS28-CRP). The ankle (tibiotalar joint, tendons), hindfoot (talonavicular, subtalar joints) and heel of the most symptomatic or dominant foot (for the asymptomatic patient) were evaluated by two pairs of examiners using US and contrast-enhanced MRI. Results: Totally, 105 joints, 245 tendons and 35 heels in 35 patients [mean age 59.2±11.25 years old, median disease duration 36 (16.5-114), mean CDAI 19.87±12.7] were evaluated. The interobserver agreements between the two sonographers, and the two radiologists were good and very good (k=0.624-0.940). The overall agreement between US and MRI was very good for subcalcaneal panniculitis (k=0.928, p<0.001), moderate for synovitis (k=0.463, p<0.001) and tenosynovitis (k=0.514, p<0.001), fair for osteophytes (k=0.260, p=0.004), and poor for erosions (k=0.063, p=0.308) and heel’s structures. MRI found more erosions, synovitis, osteophytes, tenosynovitis and retrocalcaneal bursitis, but US found more enthesophytes and plantar fasciitis. Many of the discordances between the two imaging techniques have explanations related to the technique itself or definition of the pathologic findings. Conclusions: US is comparable to MRI for the evaluation of ankle, hindfoot and heel in RA patients and discordances in the interpretation of the pathological findings/normal structures must be carefully analyzed.

Keywords: ankle; hindfoot; heel; rheumatoid arthritis; ultrasound; MRI

Introduction

Rheumatoid arthritis (RA) is a chronic inflammatory disease that usually affects symmetrically multiple joints. Apart from serological and clinical criteria, the imaging techniques increase the diagnosis sensitivity and have a substantial role in RA monitoring [1]. The inflammatory (synovitis, tenosynovitis, bursitis, bone marrow edema) and structural damage (bone erosions) modifications are better evaluated and quantified using X-rays, ultrasound (US) or magnetic resonance imaging (MRI) compared with clinical examination [2-4]. X-rays are considered to be the initial imaging technique used to detect damage, but US, and especially MRI, are able to recognize the erosions in earlier stages [1]. For synovitis or tenosynovitis identification, MRI and US are the preferred imaging techniques.

The US definitions and grading for synovitis, tenosynovitis, erosions, osteophytes, enthesophytes, retrocalcaneal bursitis, and subcalcaneal panniculitis are well established and increases the reliability of imaging examination. The reproducibility of US and MRI definitions is substantially higher than in clinical examination. On the other hand, US and MRI evaluation of the same pathology can show discordances, and the reasons for these discordances must be carefully analyzed.
Discordances between US and MRI imaging in the evaluation of ankle, hindfoot and heel

Patients

Between April and December 2018, consecutive patients with RA presenting in our day-hospital clinic were enrolled. The diagnosis of RA according to the 2010 American College of Rheumatology (ACR)/EULAR classification criteria [21] and age over 18 years old were the inclusion criteria. The exclusion criteria were contraindications for MRI examination (e.g. pacemakers, MRI-unfriendly prostheses or devices). Each patient signed a written consent before enrolment and approval of the Ethics Committee of the University was obtained.

A rheumatologist with 4-years of experience in rheumatology (IP) collected the demographical data and history for each patient, performed the physical examination, counted the tender and swollen joints and established the disease activity calculating Clinical Disease Activity Index (CDAI) and Disease Activity Score 28 with C-reactive Protein (DAS28-CRP).

For further evaluation we chose the most symptomatic foot or the dominant foot in asymptomatic patients.

Ultrasound

The ultrasound evaluation was performed using a GE Logiq 7 ultrasound machine (GE Healthcare, Chicago, USA) with ML6-15 transducer. The frequency and the focus were set according to the structure of interest. For PDUS, the frequency was set to 9 MHz, the color box was large enough to include entirely the region of interest and the upper margin of the image, the gain was set as to obtain maximal blood flow with minimal noise, and the pulse repetition frequency (PRF) to 800 MHz. The US examination was performed by two sonographers (with 5 and 20-years of experience in musculoskeletal US), in the same day, blinded for each other’s results, and images for each assessed structure were stored. The disagreements between the two examiners were resolved by a third examiner with more than 15-years of experience in musculoskeletal US.

The examination was realized with the patient in a supine position, with the knee flexed 90° and the sole resting on the bed for ankle, hindfoot joints and tendons. For the heel’s structures the patients was in a prone position with the foot hanging at the edge of the bed in a neutral position. Based on a preestablished protocol and according to EULAR-OMERACT recommendations, definitions and grading [5-11,22,23], tibiotalar (TT), talonavicular (TN) and subtalar (ST) joints synovitis, erosions and osteophytes were assessed, as well as tibialis anterior (TA), extensor hallucis longus (EHL), extensor digitorum communis (EDC), tibialis posterior (TP), flexor digitorum communis (FDC), flexor hallucis longus (FHL) and peroneal tendons tenosynovitis. In the heel region, the Achille’s tendon, the presence of entheseophytes, retrocalcaneal bursitis, posterior and inferior calcaneal erosions, plantar fasciitis, perifasciitis and subcalcaneal panniculitis were evaluated.

Material and methods

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We considered the tibiotalar joint (TT) for the ankle region, talonavicular joint (TN) and subtalar joint (ST) for the hindfoot region and Achille’s tendon and plantar fascia with their surrounding structures for the heel’s region.

**MRI**

All the examinations were performed on a 1.5 T MRI equipment (Signa Explorer, GE Healthcare, France). The patient was placed in supine position with the foot pointing towards the magnet (feet first supine), with the ankle flexed at 90° and the knee extended. The ankle coil (HD T/R Knee/Foot Coil by Invivo) was placed over the foot and ankle and locked properly. The laser beam localizer was centered over the hindfoot (approximate head of the talus). The image protocol for the ankle, hindfoot and heel comprised the following sequences: sagittal T1-weighted fast spin echo (FSE) with a FoV of 240x260 mm, Matrix size 320x224, slice thickness 3 mm (TR 450 ms, TE 9 ms), sagittal T1-weighted fast spin echo with fat saturated (FS) with a FoV of 240x260 mm, Matrix size 320x224, slice thickness 3 mm (TR 560 ms, TE 9 ms), coronal STIR-sequence with a FoV of 180x180 mm, Matrix size 256x160, slice thickness 3 mm (TR 2314 ms, TE 43 ms, TI 150 ms), axial STIR-sequence with a FoV of 260x210 mm, Matrix size 192x152, slice thickness 3 mm (TR 3017 ms, TE 46.5 ms, TI 150 ms), coronal 3 dimensional T1-weighted fast spoiled gradient echo (FSPGR) sequence with a FoV of 180x108 mm, matrix size 192x192, slice thickness 1 mm (TR 6.8 ms, TE 3.2 ms) prior-to and after intravenous injection of contrast material [0.2 ml/kg bodyweight of Gd-DTPA (Omniscan)]. The three-dimensional (3D) T1-weighted FSPGR sequences of the ankle were additionally reconstructed in axial and sagittal planes.

The images were analysed and graded according to the OMERACT RAMRIS system model adapted for the evaluation of the ankle and hindfoot [13,24,25]. The pathological changes were assessed at 3 joints level (TT, TN and ST) and 7 tendons level (TA, EHL, EDC, TP, FDC, FHL and peroneal tendons), but also at the level of intertarsian joints (quantified as present/absent). The evaluation of the heel included the identification of Achille’s tendon enthesophytes, the retrocalcaneal bursitis, the posterior and inferior calcaneal erosions, subcalcaneal panniculitis and the measurement of the plantar fascia (insagittal T1 images). All MRI studies were interpreted separately by two musculoskeletal radiologists with more than 10-years of experience, blinded for each other’s results. The discordance between the two radiologists was solved by a third radiologist with more than 10-years of experience.

The US and MRI definitions of the evaluated abnormalities and their quantifications are detailed in supplementary Table I, on the journal site.

**Statistical analysis**

The interobserver agreement between the two examiners for each imaging technique (US and MRI) was measured by calculating Cohen’s kappa coefficient (k). The interpretation of the k coefficient values was as follows: 0–0.20 poor, 0.20–0.40 fair, 0.40–0.60 moderate, 0.60–0.80 good, and 0.80–1 very good. The concordance between the two imaging techniques (US and MRI) was measured by calculating the percent of agreement (PA) signifying the number of concordances divided by the number of cases. A PA of less than 40% was interpreted as poor concordance, 40-60% as moderate, 60-80% as good, and more than 80% as very good. The agreement between US and MRI results was also measured by calculating k coefficients.

**Results**

We enrolled 35 patients with RA, 85.7 % females, mean age 59.2±11.25 years old, mean BMI 26.5±5.65 kg/m², median of disease duration 36 (16.5-114) months, mean CDAI 19.87±12.7 and mean DAS28-CRP 3.5±1.35. Totally, 105 joints and 245 tendons were examined.

**Ultrasound and MRI concordances and discordances**

The overall agreement between US and MRI was moderate for joint synovitis (k=0.463, p<0.001) and tendosynovitis (k=0.514, p<0.001), poor for erosions (k=0.063 but non-significant, p=0.308) and fair for osteophytes (k=0.260, p=0.004).

The concordances and discordances between US and MRI at joint / tendon and heel level are shown in Table I.

**Interobserver agreement for US and MRI**

The interobserver agreement between the two sonographers and the two radiologists for the ankle, hindfoot and heel’s modifications are shown in Table I.
Discordances between US and MRI imaging in the evaluation of ankle, hindfoot and heel cases grade 1, mild, peritendinous fluid). On the contrary, US found tenosynovitis when MRI showed normal aspect in 3/245 tendons. In 11/35 cases, US identified Achille’s tendon enthesophytes (fig 2), and in 4/35 cases calcaneal erosions (fig 3), none of these being visualized by MRI. The poorest concordances between US and MRI for the evaluation of heel’s structures were found for retrocalaneal bursitis and plantar fascia thickness (fig 4). The subcalcaneal panniculitis had the best concordance and agreement between US and MRI (fig 5).

Discussion

Our study found good and very good interobserver agreement between the two sonographers, and the two radiologists. The concordances of the findings between US and MRI were very good for tenosynovitis and subcalcaneal panniculitis, and good for joints synovitis and osteophytes. Moderate concordances were found for bone erosions (except for calcaneal erosions where the
We have two explanations for the superiority of MRI over US for synovitis evaluation in the ankle and hindfoot region found in our study. First comes from the MRI ability to visualize the entire joint and the deep part of the synovium, irrespective of the body fat tissue amount [26], while the US can visualize only the superficial joint recesses, not necessarily involved in cases of mild joint synovitis (as were the cases with synovitis not-identified by US). Second comes from the difficulty of US to differentiate synovial hypertrophy from fluid, especially in old, long-standing effusions, when fluid becomes hypoechoic in US scan [27]. Differentiation of fluid from synovitis can be done by applying compression with the transducer (synovial fluid is compressible and displaceable, while synovial hypertrophy is poorly compressible and non-displaceable) and by the presence of the PD signal in the

<table>
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<tr>
<th>Joint</th>
<th>Parameter</th>
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<th>US*</th>
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<th>US only*</th>
<th>PA</th>
<th>k</th>
<th>p-value</th>
<th>Se</th>
<th>Sp</th>
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<td>5</td>
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</table>

*Data are presented as number of patients; MRI: magnetic resonance imaging; US: ultrasonography; PA: percent agreement; k: Cohen’s kappa coefficient of agreement; Se: sensitivity; Sp: specificity; TT: tibiotalar joint; TN: talonavicular joint; ST: subtalar joint.

<table>
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<tr>
<th>Tendon</th>
<th>MRI*</th>
<th>US*</th>
<th>MRI only*</th>
<th>US only*</th>
<th>PA</th>
<th>k</th>
<th>p-value</th>
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*Data are presented as number of patients; MRI: magnetic resonance imaging; US: ultrasonography; PA: percent agreement; k: Cohen’s kappa coefficient of agreement; Se: sensitivity; Sp: specificity; TA: tibialis anterior; EHL: extensor hallucis longus; EDL: extensor digitorum longus; TP: tibialis posterior; FDL: flexor digitorum longus; FHL: flexor hallucis longus.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Parameter</th>
<th>MRI*</th>
<th>US*</th>
<th>MRI only*</th>
<th>US only*</th>
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<th>k</th>
<th>p-value</th>
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Discordances between US and MRI imaging in the evaluation of ankle, hindfoot and heel synovial hypertrophy [5,28]. During the US examination of the ankle and hindfoot joints, the compression with the transducer is impossible and the PD sensitivity is lower in profound joints, especially in low activity synovitis. This can explain the misinterpretation by US of the synovial fluid as being synovial hypertrophy. In this regard, non-contrast MRI is also unable to differentiate between inflamed synovium and synovial fluid as both display the same signal intensity even in fluid-sensitive sequences. Only the use of contrast-enhanced MRI can make the distinction - the inflamed synovium enhances after contrast injection [26]. However, gadolinium administration raises the cost and duration of the MRI examination and adds considerable discomfort to the patients [29].

It was demonstrated that US and MRI are useful and reliable imaging techniques in identifying tenosynovitis [5,12]. As we expected, we found very good concordance between US and MRI in identifying the ankle’s tenosynovitis. Analyzing the discordant cases, we observed that in some cases the US showed normal aspect and MRI found tenosynovitis. The presence of normal synovial fluid within the tendons sheath was demonstrated using MRI over 25 years ago [25], but for ankle tendons the subject was not developed until later. Willekens et al [30] evaluated the normal distribution of fluid within the tendon sheath of the ankle using MRI and found fluid in the retromalleolar or inframalleolar part of the tendons in healthy volunteers (apart from the anterior tendons), most commonly in medial tendons (the study that was published after our study was finished and we could not take into consideration their results for our MRI interpre-

Fig 2. A 42-years old RA patients where MRI could not identify Achille’s tendon enthesophytes in a) sagittal T1-weighted fat saturation (FS) and b) sagittal 3D T1 FSPGR. US identified two small enthesophytes (arrows) in c) longitudinal scan of the Achille’s tendon.

Fig 3. A 44-years old RA patient where MRI could not identify the retrocalcaneal bursitis and calcaneal erosions in a) axial STIR sequence and b) sagittal T1-weighted fat saturation (FS); c) longitudinal and d) transverse US of the Achille’s tendon showed retrocalcaneal bursitis and calcaneal erosions.

Fig 4. A 64-years old RA patient where MRI showed small retrocalcaneal bursitis (arrow) in a) axial STIR sequence and US showed normal aspect of retrocalcaneal bursa as a thin anechoic line (arrow) in b) longitudinal scan of the Achille’s tendon.

Fig 5. A 45-years old RA patient with subcalcaneal panniculitis and calcaneal erosions on MRI sequences a) sagittal T1-weighted fat saturation (FS) and b) sagittal T1-weighted fast spin echo (FSE) (arrows); c) longitudinal and d) transverse US scan of the plantar aspect of the heel showing the subcalcaneal panniculitis and calcaneal erosions.
measurements were performed at the same level, near the ankle, using US compared with MRI, despite the fact that the flamed pre-Achilles fat pad can be difficult for MRI, while the differentiation of retrocalcaneal bursitis from inflammation is supplementary revealed. The retrocalcaneal fluid collection, but using contrast-enhanced MRI, the in both imaging techniques imply the presence of bursal fluid proximally and posteriorly and this can be seen on more than 3 consecutive slices as Schweitzer et al [35] demonstrated.

Bone marrow edema or osteitis (inflammation of the subchondral trabecular bone), findings specific for inflammatory arthropathy, denotes a severe and aggressive disease phenotype, and predicts the structural damage progression of the disease [29,36]. MRI is the only imaging technique capable of visualizing this abnormality.

The heel region, being superficial, can be easily evaluated by US, with comparable performance with MRI [37]. The thickness of the slices is an important factor for small abnormalities MRI visualization [38]. Comparing the MRI result obtained by using slices with 3 mm thickness with US results, we found that US found more enthesophytes and calcaneal erosions compared with MRI, similar with Aguila Maldonado et al [37] (thickness of slice not specified) and Baraliakos et al [39] (3-4 mm slice thickness) in spondylarthritis patients.

In our study, MRI found considerably more cases of retrocalcaneal bursitis than US. The bursitis definition in both imaging techniques imply the presence of bursal fluid collection, but using contrast-enhanced MRI, the inflammation is supplementary revealed. The retrocalcaneal bursitis could be accompanied by the inflammation of the surrounding tissues, especially the Kager’s fat pad, that displays the same MRI findings as the retrocalcaneal bursitis, including the enhancement [40]. For this reason, the differentiation of retrocalcaneal bursitis from inflamed pre-Achilles fat pad can be difficult for MRI, while US can easily discriminate between the two situations.

We found significant more thickened plantar fascia using US compared with MRI, despite the fact that the measurements were performed at the same level, near the calcaneus insertion. Plantar fascia is a superficial structure, easily approachable by the US. Moreover, US being a real-time examination, it allows the lateral sweep of the transducer for identification of the thickest section through the plantar fascia. In MRI, the identification of the thickest sagittal section could be influenced by the thickness of the slices used for examination. Moraes do Carmo et al [41] performed a study on cadaveric specimens and compared the thickness of the plantar fascia using US, MRI and anatomic specimen. The authors found that both imaging techniques encountered a variability of the values, slightly higher for MRI.

Subcalcaneal panniculitis (or inflammatory-edematous lesion of the heel fat pad) is frequent in RA, more frequent than in spondylarthritis, and is associated with talalgia [42]. US and MRI are both capable of visualizing this lesion [19]. In our study, the agreement between US and MRI in identifying subcalcaneal panniculitis was very good.

The present study has some limitations. The small number of the patients included and the lack of comparison of RA patients US and MRI evaluations with healthy subjects are probably the most important limitations of our study. The main reason for these limitations is related of the high cost of the contrast-enhanced MRI. The use of a magnetic field strength of 1.5 T and the 3-mm thickness of the slices contributed substantially to some of the encountered discordanoses. In some cases, the interpretation of the results was challenging for the radiologists due to the existence of movement artifacts in the patients that found it difficult to stand still for 40-45 minutes. Probably the use of dedicated musculoskeletal MRI machine could have avoided this limitation.

**Conclusion**

Both US and MRI are reliable and reproducible imaging techniques, with good and very good interobserver agreement for ankle, hindfoot and heel evaluation in RA patients. US has comparable performances with MRI for the identification of synovitis, tenosynovitis, erosions, osteophytes, retrocalcaneal bursitis and subcalcaneal panniculitis, having even more utility for the evaluation of enthesophytes and plantar fascia. The discordanoses between US and MRI could be explained in part by the equipment performances and settings and the diagnostic performances of the methods, but also by the different position of the lower limb during the examination, the different definitions for the same pathology, and the lack of consensus regarding the normality status.

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References


