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The clinical and radiological importance of extraarticular contrast material leakage into adjacent synovial compartments on ankle MR arthrography in patients with OCD and anterolateral impingement

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ABSTRACT

Purpose: To evaluate the tibiotalar joint capacity and the localisation, frequency and amount of extravasation in patients with extraarticular contrast material leakage into adjacent synovial compartments on ankle magnetic resonance (MR) arthrography.
Materials and methods: Sites of extravasation were determined in the ankle MR arthrograms of 69 patients. Thirty-four patients without extraarticular contrast material leakage into locations unrelated to the injection path were included as a control group. Volumetric measurements of extraarticular contrast material leakage and the tibiotalar joint capacity were performed on a three dimensional (3D) volume measurement workstation.
Results: Extravasation of contrast material occurred through the anterior, posterior, and anterolateral recesses of the tibiotalar joint. The most common site of extravasation was along the flexor hallucis longus tendon synovium (24.6%). The amount of extravasation was significantly higher in patients with ankle osteochondritis dissecans (OCD) than in patients with a different diagnosis ($p = 0.039$). Loose bodies were detected in all OCD's patients with insufficient tibiotalar joint distention.
Conclusions: Connections between the ankle joint and neighboring synovial compartments can decrease the diagnostic value of ankle MR arthrography examinations due to inadequate joint distention. Large injection volumes should be used for ankle MR arthrography of patients with OCD (especially OCD's patients with loose body) and impingement syndrome.

1. Introduction

Magnetic resonance (MR) arthrography of the ankle joint is the preferred imaging technique for the evaluation of ligamentous damage, osteochondral lesions of the talus, adhesive capsulitis, impingement syndrome, tarsal sinus structures, and loose bodies [1–4]. Extraarticular contrast material leakage results in artefacts on MR arthrography but sometimes it can help diagnosis. The risk of extraarticular opacification which can complicate diagnosis is well known by radiologists performing ankle arthrographies.

On ankle joint arthrography, such extravasation may also occur along the needle path, depending on the injection technique [5,6]. However, the ankle joint may communicate physiologically with the subtalar joint or adjacent tendon sheaths. In this case, in ankle joint arthrography, the optimal contrast volume depends on the presence or absence of these connections [7]. The extraarticular extravasation of the contrast material in these communicating regions can result in inadequate contrast material volume. In current practice, the accurate volume of contrast to inject into ankle joints is difficult to foresee because of frequent communicating compartments. This paper aims to highlight the importance of extraarticular contrast material leakage into adjacent synovial compartments on ankle MR arthrography in patients with OCD (especially loose body) and anterolateral impingement.

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In this MR arthrography study, we investigated the localisation, frequency, and amount of extravasation in patients with extraarticular contrast material leakage into compartments associated with the ankle joint on ankle MR arthrography, and also evaluated the tibiotalar joint capacity in patients with extravasation.

2. Materials and methods

2.1. Patients

This prospective study included 125 consecutive patients referred to Ataturk University Hospital for ankle MR arthrography between August 2014 and September 2015. Clinical indications for MR arthrography included osteochondral injury, ligamentous damage and impingement syndrome. Furthermore, all patients were examined for imaging findings suggestive of extraarticular contrast material leakage into locations unrelated to the injection path. The exclusion criteria included cases with previous ankle surgery (n = 17 of 22 patients, 77.2%), and those with massive contrast medium extravasation (the extravasation extending from joint capsule to subdermal area and causing inadequate joint image contrast) around the needle insertion point (n = 5 of 22 patients, 22.8%). The inclusion criteria included cases with extraarticular contrast material leakage (n = 69 of remaining 103 patients, 66.9%) and those without extraarticular contrast material leakage into locations unrelated to the injection path (n = 34 of remaining 103 patients, 33.1%) were included as a control group in the study.

Approval for the study was granted by the Ethics Committee of Ataturk University School of Medicine (Decision no: 6/8, 02.10.2014), and written informed consent was obtained from all patients for application of both MR imaging and injection procedures.

2.2. Injection technique

All injections were performed by a single radiologist on an outpatient basis, without sedation or premedication and using an ultrasonography (US) system (Applio 500 Ultrasound System; Toshiba Medical Systems, Tokyo, Japan) equipped with a broadband 7.5–12 MHz linear array transducer. The injections were performed under US control using a 22 G needle via an anterior approach, medial to the anterior tibialis tendon as described by Cerezal [8]. Diluted contrast medium (0.5 mmol/L gadopentetate dimeglumine, Magnevist, Bayer Schering Pharma, Germany) at a concentration of 1:200 was injected (0.1 mL contrast medium diluted in 20 mL normal saline). A volume of 3.5–5 mL gadolinium based solution was injected until the joint capsule was distended appropriately. This procedure was performed by the same radiologist who had 10 years of experience in ankle joint injections.

2.3. MR arthrography technique

MR arthrography imaging examinations were performed using a 3T MR (Magnetom Skyra; Siemens Healthcare, Erlangen, Germany) within 10–15 min after the ankle joint injection. Our MR arthrography protocol includes spinecho (SE) T1weighted (TR/TE, 650/15 ms; echo train length, 8; section thickness, 3 mm; spacing, 0.3 mm; field of view, 130–200 mm; matrix, 256 × 256; three signals acquired) and fat-suppressed SE T1weighted images. Arthrographic images were performed in the axial, oblique coronal, and oblique sagittal planes with surface coils placed around the ankle joint. In our clinical practice, a fat-suppressed 3D volumetric interpolated breathhold examination (VIBE) sequence (TR/TE, 13.2/4.7 ms; flip angle, 11°; 130 × 150 mm FOV; matrix, 512 × 512; one slab of 112 slices with a slice thickness of 0.6 mm; one acquisition) was also added to the ankle MR arthrography imaging protocol.

2.4. Image analysis

All MR arthrography images were analysed on high resolution monitors of a picture archiving and communication system (Syngo Via console, software ver. 2.0; Siemens Medical Solutions, Erlangen, Germany). Two staff radiologists with 10 and 4 years of experience in musculoskeletal imaging, respectively, who were blinded to the diagnosis of the patients, independently analysed the MR arthrography images in random order. All MR arthrograms were evaluated in a randomised fashion (according to the order of the workstation) followed by evaluation of the same MR arthrography Images 4 weeks later in a different randomised order for assessment of intra- and interobserver agreements for the extravasation volume and capsular distention measurements on the same MR arthrography images. Volumetric measurements of extraarticular contrast material leakage and the tibiotalar joint capacity were performed on a 3D volume measurement workstation (Myrian Pro, Intrasense, France; Fig. 1). Capsular distention was assessed to determine whether there was sufficient tibiotalar joint distention on axial MR arthrography images. The perpendicular line located between the anterior intermalleolar line (from fore of the medial malleolus to fore of the lateral malleolus) and the furthest point of the anterior tibiotalar joint capsule was measured at the level of the talar dome as an indicator of sufficient capsular distention.

We evaluated the sufficiency of tibiotalar joint distension between observers 1 and 2 using κ values. We detected very high agreement (κ = 0.86 Table 1) between observers 1 and 2, in that the length of the perpendicular line described in the image analysis section was ≥ 7.2 mm. However, we detected only fair agreement (κ = 0.38) when the length of the perpendicular line was < 7.2 mm. Thus, a capsular distention diameter of the tibiotalar joint ≥ 7.2 mm was classified as sufficient tibiotalar joint distension.

2.5. Statistical analysis

Statistical analyses were performed using SPSS software (ver. 20.0; SPSS, Inc., Chicago, IL, USA). The normality of the data was analysed by the Kolmogorov-Smirnov test. The Mann-Whitney *U* test was used to compare the relationship between extravasation volume and sufficient/insufficient tibiotalar joint distention and between sex and extravasation volume. The Kruskal-Wallis test was used to compare the relationship between extravasation volume and the arthrography diagnosis and between age and extravasation volume. The Mann-Whitney *U* test was also used to compare the relationship between the mean length of the perpendicular line measurements in cases with sufficient and insufficient capsular distension; and the mean tibiotalar joint volumes in cases with sufficient and insufficient capsular distension in both study and control group. Additionally, the relationships between extravasation volume and joint distention, capsular distension and the arthrographic diagnosis, extravasation localisation and the arthrography diagnosis, were assessed by the $\chi 2$ test.

Table 1
Appropriate Kappa value and agreement levels used in this study.

Kappa value	Agreement
<0	Less than chance agreement
0.01–0.20	Slight agreement
0.21–0.40	Fair agreement
0.41–0.60	Moderate agreement
0.61–0.80	Substantial agreement
0.81–0.99	Almost perfect agreement