Fluid distribution in Ankle Joint and Midfoot: MRI-findings in Normal Volunteers

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Aims and objectives

Although ultrasound is the most requested study when dealing with acute or chronic ankle pain, it is often followed by an MR of the ankle. When interpreting MR studies of the ankle and midfoot, a common diagnostic pitfall is the presence of fluid in the different joints and joint recesses. Asymptomatic individuals may have considerable amounts of fluid in some joint recesses. Radiologists need to be aware of the normal amount and distribution of fluid. Standard values of amount and distribution are needed.

A variety of disorders associated with joint effusions may affect the joints of ankle and midfoot. The articulations of ankle and midfoot are frequent target areas for degenerative disorders, systemic disorders, crystal-induced arthritis and infection. Degenerative disorders are the most frequent cause of joint effusion in ankle and midfoot. Systemic diseases including rheumatoid arthritis and spondyloarthropathies, and may also affect ankle and midfoot. Crystal-induced arthritis, include gout and CPPD. Eighty per cent of gouty attacks occur in the lower extremity, the first metatarsophalangeal joint involved as most common site, followed by interphalangeal joints, and ankle and midfoot.

Over the last ten to fifteen years there has been a significant increase in MR exams of the ankle. Although presence of fluid in the normal joint is widely accepted as a normal finding; standard reference values are sparse. Nazarian et al. investigated in 1995(1) the presence of fluid in the anterior and posterior joint recess of the ankle in the asymptomatic patient. In 2003 Schmidt et al.(2) investigated in healthy volunteers several ultrasonographic 'normal ranges' for different fluid collections around the body, including three joint recess of the ankle (the anterior and posterior tibiotalar joint recess and the talonavicular joint). To our knowledge, the only study investigating the normal visible fluid on MRI was published by Schweitzer et al. (1994) (3). The study was performed on a 1.5T-scan with a slice thickness of 5mm. The technological advances after 1994, increasing image resolution, allow an update of these values.

In this study we tried to define a reference 'normal' range for fluid in the joint recess around ankle and midfoot. We studied the anterior and posterior tibiotalar joint, the talonavicular joint, the anterolateral recess, the anterior and posterior aspect of the posterior subtalar joint, the middle subtalar joint, the anterior subtalar, and the tibiofibular joint.
Methods and materials

Our study protocol was approved by the ethical committee of our institution. Written informed consent was obtained. Twenty-one healthy volunteers (42 ankles) were evaluated with MR imaging. Volunteers with a history of trauma or other ankle injuries were excluded from the study group. The MR examinations were performed on a 3T MR unit (Philips Achieva, Best, The Netherlands) using proton density weighted images with fat saturation (TR: 2969, TE: 30ms, NA:2, slice thickness 2.5mm, field of view of 24cm, a matrix of 256x256). Images were obtained in 3 orthogonal planes. The volunteers were placed in a supine position; the scans were performed with a neutral position of the ankle using a dedicated ankle coil. All studies were archived on a picture archiving and communication system (Impax; Agfa, Mortsel, Belgium) and reviewed on a six-megapixel medical display (Barco, Kortrijk, Belgium). The images were interpreted by consensus of 2 radiologist, one experienced musculoskeletal radiologists and a fellow. The maximum size of the joint effusion was measured in the tranverse plane for the anterolateral recess, and the coronal plane for the tibiofibular joint. The other measurements were made in the sagittal plane. Descriptive statistics were obtained. Right-left symmetry was studied using a paired sample t-test.
Results

There were 13 men and 8 women. The mean age was 24.7 years (range 19-42). In the 42 ankles investigated in this study, fluid was common in all joint recesses.

The largest amount of fluid was found in the distal tibiofibular joint with a mean height of 8.1 mm, and a quite large range between 0.0 and 16.4 (table 1). The second largest fluid collections were measured in the posterior tibiotalar joint with a mean size of 3.1 mm, ranging between 0.6 and 6.3 mm. Fluid in the anterior tibiotalar joint had a mean size of 2.0 mm, ranging between 0.0 and 5.5 mm. Fluid in the posterior aspect of the posterior subtalar joint had a mean size of 2.6 mm, range (0.0-9.4 mm). Fluid was somewhat less common in the anterior aspect of the posterior subtalar joint with a mean size of 1.9 mm, (range 0.0-6.6 mm). Fluid in the talonavicular joint had a mean size of 0.7 mm, ranging from 0.0-2.9 mm. In 17 of the 42 ankles (40%) fluid was absent in this joint. Fluid at the anterior subtalar joint had a mean size of 1.6 mm, ranging from 0.0-5.8 mm. The smallest fluid collection was found in the middle subtalar joint; fluid in this joint was only found in 3 ankles (7%) with a mean size of 0.1 mm, ranging from 0.0-1.7 mm. Fluid in the anterolateral recess had a mean size of 2.0 mm, ranging from 0.0-4.3 mm.

<table>
<thead>
<tr>
<th>Joint</th>
<th>Mean (mm)</th>
<th>Range (mm)</th>
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<tbody>
<tr>
<td>Anterior tibiotalar joint</td>
<td>2.1</td>
<td>0.0 - 5.6</td>
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<tr>
<td>Posterior tibiotalar joint</td>
<td>3.2</td>
<td>0.0 - 6.4</td>
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<tr>
<td>Anterolateral recess</td>
<td>2.12</td>
<td>0.0 - 4.4</td>
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<tr>
<td>Posterior aspect of the posterior subtalar joint</td>
<td>2.18</td>
<td>0.0 - 9.5</td>
</tr>
<tr>
<td>Anterior aspect of the posterior subtalar joint</td>
<td>1.10</td>
<td>0.0 - 6.7</td>
</tr>
<tr>
<td>Talonavicular joint</td>
<td>0.5</td>
<td>0.0 - 2.10</td>
</tr>
<tr>
<td>Middle subtalar joint</td>
<td>0.11</td>
<td>0.0 - 1.8</td>
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<tr>
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<td>Tibiofibular joint</td>
<td>8.2</td>
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The only study investigating the normal fluid distribution on MR in asymptomatic volunteers was published 23 years ago by Schweitzer et al. and was performed on a 1.5T system with a slice thickness of 5 mm. Our exams were performed on a 3T MR
system with a slice thickness of 2.5mm. Schweitzer et al. also used 3 measurements in 3 orthogonal planes to calculate the volume of the fluid collections. These authors only reported the volumetric values, making it difficult to compare their study results to ours. In our opinion volume calculations will not improve the accuracy of assessing fluid distribution in the ankle, since joint recess often has complex volumes and are not always comparable to an ellipsoid volume. In addition a single measurement is clinically more practical. Schweitzer et al looked for fluid in four locations, the anterior and posterior recess of the tibiotalar joint, the posterior recess of the posterior subtalar joint and the anterior subtalar joint. The trend in our measurements are quite similar.

We detected fluid (considered as > 1mm fluid) in 88% of the posterior recess of the tibiotalar joint, comparable to their 77%. We detected fluid in the anterior recess of the tibiotalar joint in 79% (60% in their study), in the posterior recess of the posterior subtalar joint in 79% (72% in their study), and 55% in the anterior subtalar joint (compared to 29% in their study).

To our knowledge, this is the first study demonstrating the presence and distribution of the fluid in all the joint recess of the midfoot. In the middle subtalar joint we could only detect fluid > 1mm in one ankle (Range: 0.0 - 1.77mm). The anterior subtalar joint showed a high prevalence of fluid (57%). Fluid was even more present in the anterior recess of the posterior subtalar joint (74%).

Schmidt et al. in 2003, investigated several ultrasonographic 'normal ranges' in healthy volunteers for different fluid collections around the body, including three joint recess of the ankle (the anterior and posterior tibiotalar joint recess and the talonavicular joint). It is difficult to compare our measurements to those of Schmidt et al. due to the fact that they included the cartilage thickness in their measurements. Of importance, we detect more fluid in the anterior and posterior recess of the tibiotalar articulation (2.0 and 1.8mm respectively) compared to the talonavicular joint (0.7 mm), contrasted to these authors study that showed that the talonavicular joint contained more fluid (1.4mm) than anterior and posterior recess of the tibiotalar joint (1.1mm and 1.2mm respectively).

In the study of Nazarian et al, the distinction between cartilage and fluid was clearly made .In this work; we obtained similar results, for the anterior recess. These authors measured 1.8mm (range 1 - 3mm) comparable to our mean value of 2.0 (range: 0.0 - 5.5mm). They could not detect any fluid in the posterior recess, in contrast to our work that showed a mean value of 3.1 mm (range: 0.0 - 6.3mm) in this location. The observed difference may be related to the different imaging modality. Fluid may actually be more difficult to demonstrate in the posterior recess of the ankle, on ultrasound, given its deep location. During ultrasound fluid can also be compressed leading to underestimation of the intra-articular fluid. Another possible discordance may be caused by the position of the ankle. The measurements with ultrasound of the posterior recess in the study of Nazarian et al were performed in dorsiflexion.
Our study has some limitations. The study group is relatively small, only 42 ankles were examined. Second, we did not study effusions in different ankle positions. There may be a shift between recesses in different positions. In addition, fluid was correlated with recent with physical activity.
Images for this section:

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**Table 1:** Fluid distribution in ankle joint and midfoot.

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Fig. 1: Fluid in the anterolateral recess.

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Fig. 2: Fluid in the distal tibiofibular joint.

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**Fig. 3:** Fluid in the talonavicular joint.

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Fig. 4: Fluid in the anterior tibiotalar joint.

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Fig. 5: Fluid in the posterior tibiotalar joint.

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Fig. 6: Fluid in the anterior subtalar joint.

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**Fig. 7:** Fluid in the middle subtalar joint.

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Fig. 8: Fluid in the anterior aspect of the posterior subtalar joint.

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Fig. 9: Fluid in the posterior aspect of the posterior subtalar joint

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Conclusion

Fluid is common in several joint recesses of ankle and midfoot, and most pronounced in the distal tibiofibular joint, the anterior and posterior tibiotalar joint, the anterolateral recess and the posterior subtalar joint. Even when unilateral or asymmetric, this should not be mistaken for evidence of a pathological condition. With this study we tried to provide a range of normal values of intra-articular fluid measured in ankle and midfoot.
References


