3T MRI of the liver after SPIO application. A comparison to 1.5T

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Introduction: Superparagmagntic ironoxide containing contrast media (SPIO) were successfully administered in liver imaging for tumour characterization and improved lesion detectability. Storage of the ironoxide in the reticulo–endothelial system (RES) leads to a marked signal decrease in healthy liver parenchyma in T2 and T2* weighted images, resulting in an enhanced contrast between liver tissue and liver tumours or metastasis. The stronger susceptibility effects at 3T should lead to a further decrease of the SI of the liver parenchyma. This should increase the liver vs. tumour contrast. Due to various difficulties occurring at higher field strength, like SAR limitations, pronounced motion artefacts or RF deposition, liver imaging at 3T is still considered a challenge. Purpose of the study was to (1) demonstrate feasibility of SPIO enhanced liver imaging at 3.0T, and (2) to intra-individually compare the diagnostic yield of SPIO enhanced liver MRI at 3.0T compared to 1.5T.

Material and Methods: Investigations were done with a 1.5T and a 3T Intera System (Philips MS, Best NL) using a 6 elements synergy cardiac coil at 3T and a 4 element synergy body coil at 1.5T. T2 weighted images (TSE) were acquired with respiratory triggering and fat suppression (SPIR at 1.5T, SPAIR at 3T) after bolus injection of SPIO (Resovist, Schering, Berlin Germany). Image parameters: 1.5T and 3T: TR/TE: resp.trig/ 80ms; FoV/Matrix/slices/slice thickness: 350/256/24/8mm 1.5T: TF 22, 4 NSA; 3T: TF 24, 1 NSA). 22 patients (9 female, 13 male mean age: 54 y) with 38 focal liver lesions (haemangioma, metastasis, HCC, CCC, FNH) were investigated at 1.5T first in the routine clinical workup, followed by the 3T scan within 30 minutes. Image analysis was done in consensus by two radiologists with respect to lesion detectability, visual contrast behaviour of the lesions, image artefacts and overall image quality. The visual lesion contrast as well as the overall image quality was rated inferior, equivalent or superior to 1.5T. Artefacts were graded on a 5 point scale (1 = no artefacts, 2 = minor artefacts, 3 = moderate artefacts without diagnostic relevance, 4 = strong artefacts with diagnostic relevance, 5 = non diagnostic study). Contrast ratios were calculated for water vs. liver tissue as well as for muscle vs. liver tissue by $(S1-S2)/(S1+S2)$. Statistical analysis was done with the paired t-test, normal distribution was prior tested by the Kolmogorov-Smirnov test.

Results: All studies were successfully performed at 3T. All 38/38 liver lesions were detected at 3T. Upon clinical film reading, the lesion-to-parenchyma contrast appeared equivalent at 3.0T compared to 1.5T. Overall image quality was rated equivalent in 20/22 patients. In 2 patients with severe ascites, image quality was rated inferior at 3.0T due to a marked signal drop in the center of the image, probably secondary to dielectric resonance effects. Image artefacts were graded slightly more pronounced at 3T, but were all rated as minor and without any diagnostic relevance (mean artefacts 1.5T = 2.0; 3T = 2.3). The calculated contrast ratios showed a significant signal decrease of the liver tissue compared to muscle tissue at 3T versus 1.5 T ($p = 0.015$) but not between water and liver tissue ($p = 0.1$).

Discussion: SPIO-enhanced liver MRI with a fat saturated (SPAIR) T2 TSE is feasible at 3T with an equivalent image quality compared to 1.5T – with the exception of patients with extensive intra-abdominal fluid collections, where image degradation due to dielectric resonance effects occur. As expected, iron load of the liver tissue leads to a significant stronger signal drop at 3T compared to 1.5T, indicated by the reduced muscle/liver ratio, however there was no difference in visual lesion vs. liver contrast. So in this cohort, the expected effect regarding lesion-versus-liver contrast did not translate into a clinically relevant difference regarding lesion detectability. Possibly, this may be due to the prolonged T1 relaxation time which inhibits full relaxation of the water protons at the given TR.

63 year old female with ovarian cancer metastasis. Left: 3T T2 TSE SPAIR, Right: 1.5T T2 TSE SPIR