

3T MRI of the liver. Establishing a comprehensive highfield clinical imaging protocol and comparison to 1.5T

M. von Falkenhausen¹, J. Gieseke², N. Morakkabati¹, G. Lutterbey¹, R. Bloehmer¹, C. K. Kuhl¹, H. H. Schild¹

¹Radiologische Universitätsklinik Bonn, Bonn, Germany, ²Philips Medical Systems, Hamburg, Germany

Introduction: Up to now there is limited experience with abdominal imaging at 3T. This is due to several difficulties associated with high field imaging like increased susceptibility, pronounced sensitivity to motion, limited effective field of view, SAR limitations, difficult fat suppression, dielectric resonance effects as well as altered image contrast due to the prolonged T1 and shortened T2/T2*.

Purpose of the study was to develop a protocol which would be comparable to 1.5 T for clinical liver imaging.

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. Advanced homogeneity correction algorithms were used at both systems (standard CLEAR at 1.5T, "body tuned" CLEAR at 3T). T2 weighted images (TSE) were acquired with respiratory triggering with out and with fat suppression (SPIR at 1.5T, SPAIR at 3T) Imaging parameters: 1.5 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). T1 weighted images were acquired using GRE-Sequences (fast field echo) prior and after iv gadopentetate dimeglumine (Magnevist, Schering, Berlin Germany) as well as a turbo field echo sequence for dynamic imaging during contrast injection. Imaging parameters: FFE: 1.5 and 3T: TR/FA: 240ms/ 80deg; FoV/Matrix/slices/slice thickness: 375/240/24/8mm; NSA:1; duration: 17 sec 1.5T: TE: 2.3/4.6ms (opposed phase/in phase); 3T: TE: 2.3/5.75ms (opposed phase/in phase); SENSE factor 2. TFE: 1.5 and 3T: FA: 25deg; FoV/Matrix/slices/slice thickness: 400/272/50/4mm; NSA:1; duration: 17Sec/dyn 1.5T: TR/TE: 3.9/1.1ms; TFE: 90 3T: TR/TE: 4.3/1.4ms; TFE: 89; SENSE factor 2. 7 patients (3 female, 4 male mean age: 58 y) with different focal liver lesions (haemangioma, metastasis, HCC, FNH) were included in an intraindividual study. Image analysis was done in consensus by two radiologists with respect to image artefacts and overall image quality. 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). Susceptibility, motion, fat saturation and dielectric artefacts were graded separately. 3T image quality was rated inferior, equivalent or superior to 1.5T. "Overall image quality" summarizes the image information which is crucial for a correct diagnosis.

Results: All 3 Tesla examinations yielded images of at least diagnostic quality. Comparing 3 T with 1.5 T the following results were obtained: In 6/7 patients, overall image quality was rated equivalent at 3.0T compared to 1.5T. Interestingly, there was no increase of susceptibility artefacts even in the 3T GRE sequences compared to 1.5T GRE. A subcutaneous metal foreign body artefact in one patient was even less pronounced at 3T compared to 1.5T (Fig. 1). Breathing induced motion artefacts were controllable with a precise respiratory triggering and did not impair the diagnostic information. Accordingly, there was no difference regarding susceptibility and motion artefact score at 3.0T compared to 1.5T (mean scores, 1.4 at 3T and 1.7 (susceptibility) and 1.4 vs. 1.3 (motion artefacts)). Fat saturation worked surprisingly well at 3.0T; incomplete fat suppression occurred only in the peripheral parts of the subcutaneous fatty tissue, and was not rated diagnostically relevant. Still, mean score of fat suppression was 2.1 vs. 1.3. Dielectric artifacts (central SI shadowing) occurred at 3.0T in one patient with extensive intra-abdominal fluid collections (ascites); this was the one study that was rated inferior to 1.5T regarding overall image quality (Fig. 2). All pathologic findings, including all focal liver lesions, that were diagnosed at 1.5T were also diagnosed at 3 T. So even though the image contrast was different at 3T due to the altered T1 and T2 relaxation times, this did not influence diagnosis.

Conclusion: Liver MR at 3 T is technically feasible and yields acceptable and diagnostic image quality. Only patients with extensive intraabdominal fluid collections like abundant ascites are challenging to 3T due to the pronounced dielectric resonance effects. Further studies are needed to evaluate the diagnostic potential of 3T liver imaging.

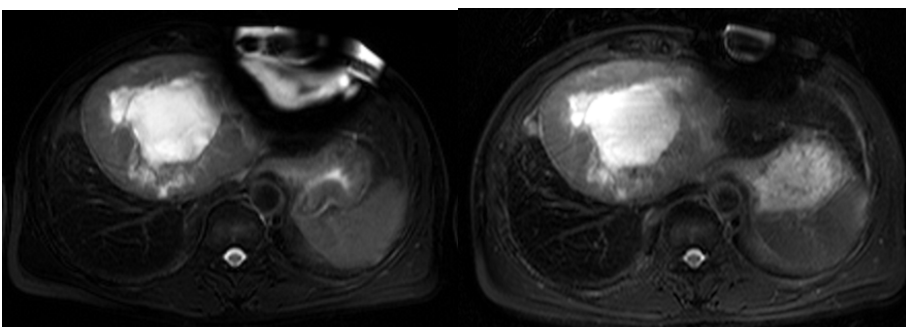


Fig. 1: T2 TSE with fat suppression: 1.5 T (left) versus 3T (middle)

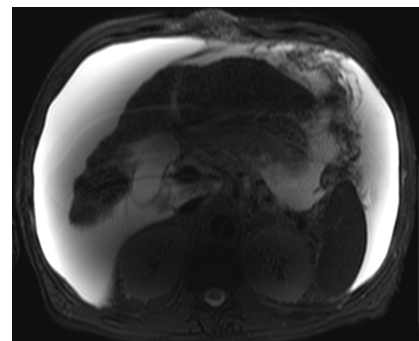


Fig. 2: dielectric resonance artefact at 3T