MR imaging of the liver on multi-channel MR systems at 1.5 and 3Tesla - Initial experiences

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Abstract

Rationale and Objectives: Due to the higher signal-to-noise ratio (SNR) MR imaging at 3Tesla (T) systems offers new perspectives; however, there are a number of challenges for abdominal MRI at 3T despite the obvious advantage of a higher SNR, including a fourfold higher specific absorption rate as well as the presence of dielectric artifacts [1, 2]. The objective of this study was to compare image quality and diagnostic accuracy of liver MRI with liver-specific contrast agents at 1.5T and 3T using multi-channel MR-systems.

Methods: 26 patients, which were referred for clinical reasons to a MR examination of the liver with the approved liver-specific contrast agent Primovist® (Schering AG, Berlin), were evaluated. MR examinations were performed on 1.5T (Magnetom Avanto) and 3T (Magnetom Tim Trio) 32-channel MR systems with parallel imaging (Siemens Medical Solutions, Erlangen). The sequences were adjusted according to the specific requirements of the corresponding field strength. The spatial resolution on the 3T system was increased up to 45% by increasing the in-plane matrix and decreasing the slice thickness (for example for the T1-w 3D GRE sequence: 1.5T: 4mm slice thickness (sl), Matrix 256 x 180; TR 5.16 / TE 1.93 / FA 15, 19 seconds breath-hold; 3T: 2mm sl, matrix 320x260, TR 4.36 / TE 1.59 / FA 15, 17 seconds breath-hold). Patients were randomized with regard to field strength of the pre-contrast examination and the order of the double examination in the liver-specific phase (1.5T first and then 3T or vice versa). In a blinded reading two experienced readers evaluated image quality and delineation of lesions on a 5-point scale (1=not interpretable; 5=excellent image quality / delineation). Moreover, the frequency of specific artifacts was evaluated.

Results: Image quality was very good to excellent at 1.5 and 3T and did not show significant differences for both readers. Delineation of lesions was also not significantly different for 1.5 and 3T (exact results in Table 1). The frequency of specific artifacts is shown in Table 2.

Table 1:

	Image quality		Lesion conspicuity	
	Right Liver Lobe (LL)	Left LL	Right LL	Left LL
Reader 1 @ 1.5T	4.2 ± 0.6	4.2 ± 0.6	4.5 ± 0.5	4.5 ± 0.6
Reader 1 @ 3T	4.2 ± 0.8	3.9 ± 0.8	4.6 ± 0.7	4.3 ± 0.7
	n.s (p=0.85)	n.s (p=0.07)	n.s (p=0.66)	n.s (p=0.50)
Reader 2 @ 1.5T	4.2 ± 0.7	4.3 ± 0.7	4.8 ± 0.5	4.6 ± 0.8
Reader 2 @ 3T	4.2 ± 0.8	4.0 ± 0.7	4.6 ± 0.7	4.5 ± 0.6
	n.s (p=1.0)	n.s (p=0.17)	n.s (p=0.60)	n.s (p=0.8)

Results of the blinded reading for reader one and two. A 5-point scale was used, with 5 being the most desirable score in both categories.

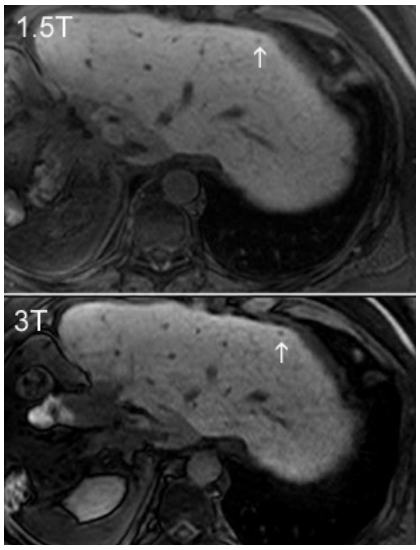

Figure 1: T1-w 3D GRE sequence in the liver-specific phase with Primovist® at 1.5T and 3T in a 49 year-old (y/o) female patient after resection of a Klatskin´s tumor. The arrow is indicating a tiny metastasis, which can be delineated faintly at 1.5T; due to the increased spatial resolution (2mm slice thickness; matrix 320x260) with maintained high signal the lesion can be appreciated more clearly at 3T.

Table 2:

	Inhomogeneous Fat-sat (Yes / No)	Dielectric artifact (Yes / No)	Susceptibility Artifacts (Yes / No)	Motion Artifacts (Yes / No)
Reader 1 @ 1.5T	0/26	0/26	6/20	11/15
Reader 1 @ 3T	5/21	9/17	7/19	10/16
Reader 2 @ 1.5T	2/24	1/25	11/15	15/11
Reader 2 @ 3T	2/24	11/15	7/19	16/10

Frequency of specific artifacts in the blinded reading for reader one and reader two.

Conclusion: First results on multi-channel MR systems show that MR examinations of the liver are feasible with high quality at 1.5T as well as 3T. High-field specific artifacts as dielectric artifacts or inhomogeneous fat-saturation were more frequent at 3T; however, image quality in general and delineation of lesions were not negatively affected. Further studies have to investigate whether the possibility to increase the spatial resolution at 3T can lead to an increased detection rate for focal liver lesions.

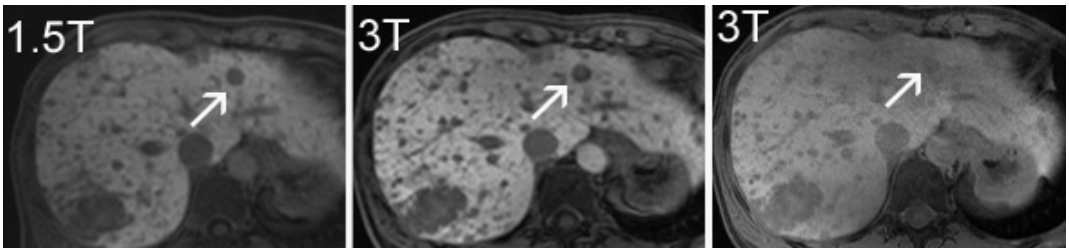

Figure 2: T1-w 3D GRE sequence at 1.5T (left) and 3T (middle) in comparison to a 2D GRE FLASH sequence at 3T (right) in a 43 y/o female patient with multiple liver metastases from a carcinoid tumor in the liver-specific phase after injection of Primovist®. Note the sharper delineation of the innumerable lesions in the 3D-GRE sequence at 3T. The corresponding slice of the 2D FLASH sequence at 3T shows signal distortion due to dielectric artifacts obscuring even the large metastasis marked with an arrow.

Literature:
[1] Zech CJ, Schoenberg SO, Herrmann KA, et al. Modern visualization of the liver with MRT. *Radiologe* 2004;44:1160-1169.
[2] Uematsu H, Takahashi M, Dougherty L, Hatabu H. High field body MR imaging: preliminary experiences. *Clin Imaging* 2004;28:159-62.