Lesion detectability on T2-weighted liver imaging with parallel RF transmission at 3.0 Tesla: Intraindividual comparison with conventional MR imaging.

G. M. Kukuk[1], J. Gieseke[1,2], S. Weber[1], F. Traeber[1], J. Ullrich[1], N. Morakkabati-Spitz[1], D. Thomas[1], H. H. Schild[1], and W. A. Willinek[1]
[1]Department of Radiology, University of Bonn, Bonn, NRW, Germany, [2]Philips Healthcare, Best, Netherlands

Introduction: The clinical implementation of high field MRI systems has introduced new challenges for body imaging with respect to B1 field non-uniformities, which can result in the generation of standing waves and signal loss particularly in liver MRI. Several approaches have been proposed to achieve a more homogeneous excitation and to avoid degradation of image quality at higher magnetic fields [1-2]. Parallel RF transmission techniques allow for independent adjustment of different RF sources, thus enabling the concept of RF shimming [3-7]. Recently, it has been shown that the use of parallel RF transmission with patient-adaptive B1 shimming results in improved image quality for liver MRI at 3.0 Tesla by reducing or eliminating B1-inhomogeneity artifacts especially in T2-weighted TSE sequences [8]. The aim of this study was to evaluate the effect of parallel RF transmission on lesion detectability for T2-weighted TSE sequences in patients with liver disease.

Methods: Institutional review board approval and informed consent was obtained. 52 patients (32 male, 20 female, mean age 56.6±13.7) suspected of having focal or diffuse liver disease on the basis of ultrasonographic and/or laboratory findings underwent a standardized MR sequence protocol including axial and coronal T2w TSE, axial T1w FFE in- and opposed phase and a 3D-GRE dynamic acquisition after contrast media injection. For all exams, a clinical 3.0T MRI system (Philips Achieva 3.0T TX) equipped with parallel RF transmission was used. For each patient a B1-map was acquired for calibration of the independent RF sources. T2-weighted TSE sequences were acquired with conventional (cTX) and parallel (pTX) RF transmission. For comparison of lesion detection rate with cTx and pTx images were analyzed by two readers independently in a random order in two reading sessions separated by at least 4 weeks. Readers were asked to record a maximum number of 20 focal liver lesions (index lesions) with a diameter of 1 cm or larger on a data sheet on the basis of Coinaud segments. Patients with more than 20 liver lesions were evaluated in direct comparison (lesion per lesion analysis) of cTx and pTX images in a reading session one week after the initial evaluation. The standard of reference was represented by a consensus reading performed 8 weeks after the initial evaluation. The consensus reading included all imaging, clinical history, histopathologic findings and follow-up studies. Image quality and presence of standing wave artifacts were rated in separate reading sessions independently by both readers on a 5-point evaluation scale: (5) excellent, uniform contrast over entire FOV, no standing wave artifacts, (4) good, mild standing wave artifacts, no impairment of image interpretation, (3) moderate, standing wave artifacts interfering with image interpretation, (2) poor, prominent standing wave artifacts, diagnostic quality questionable, (1) non-diagnostic. In addition, readers were asked to rate lesion conspicuity on a three points scale (3= good to 1=poor). P-values were calculated using the non-parametric marginal homogeneity test. Interobserver agreement was calculated using Cohen´s kappa.

Results: According to the reference standard a total of 105 index lesions were identified in 22/52 patients (42%), which were categorized to have up to 20 focal liver lesions. Reader 1 prospectively identified 92 lesions (88%) with cTX and 103 lesions (98%) with pTX. Reader 2 prospectively detected 89 lesions (84%) with cTX and 102 (97%) with pTX. The higher detection rate for focal liver lesions was statistically significant for both readers ($p<0.01$). Six of 52 patients (12%) were categorized to have more than 20 lesions: on a lesion per lesion analysis, Reader 1 detected 19 and Reader 2 detected 17 additional lesions on pTX as compared to cTX. All additionally detected lesions were confirmed by the standard of reference. In 24/52 patients (46%) no focal liver lesions were detected.

Image quality of T2-weighted imaging using pTX was scored to be significantly better as compared to that with cTX by both readers (Reader 1, 2.88±0.73 vs.4.04±0.44; Reader 2, 2.81±0.72 vs.4.04±0.39; both $p<0.0001$). Lesion conspicuity was also scored to be significantly higher at pTX as compared to cTX (Reader 1, 2.02±0.64 vs.2.92±0.27; Reader 2, 2.06±0.67 vs.2.90±0.30; both $p<0.0001$). Interobserver agreement was very good in all tests (kappa > 0.8, respectively).

Conclusion: T2-weighted liver imaging at 3.0 Tesla using parallel RF transmission provides a significantly better lesion detectability of focal liver lesions as compared to conventional MR imaging.

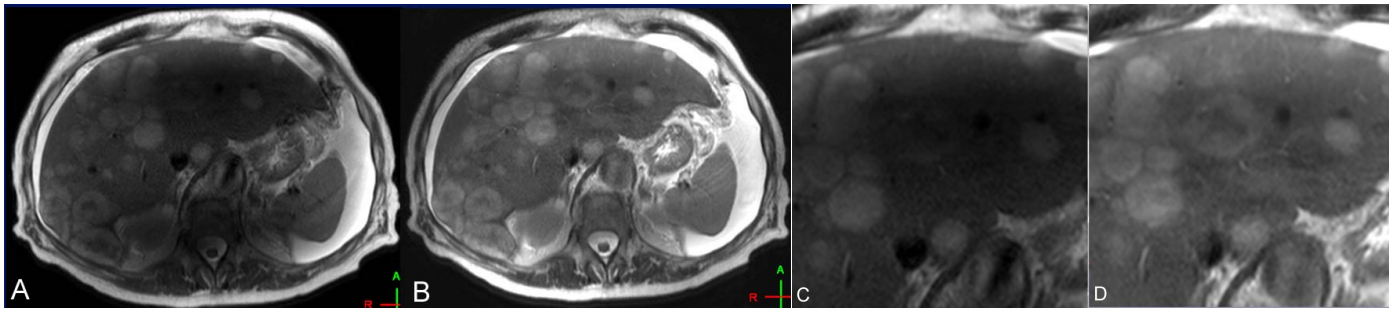

Figure 1: 68 y/o patient with metastasized neuroendocrine carcinoma. [A] Axial T2-weighted images acquired with conventional 3.0 Tesla MRI illustrate that even larger metastases can be missed due to the presence of standing wave artifacts, which severely interfere with image interpretation especially in the left liver lobe and in the dorsal parts of the right liver lobe. [B] Axial T2-weighted images acquired with pTX: standing wave artifacts are markedly reduced and more liver metastases can be delineated. [C] is zoomed in from A, [D] is zoomed in from B.

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