Respiratory triggered high-spatial resolution T1-weighted MR imaging of liver and biliary tree in the hepatobiliary phase

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Purpose:

Hepatobiliary contrast media have the potential to extend the diagnostic performance of magnetic resonance imaging (MRI) of the liver, as enhancement of liver parenchyma, biliary tree and liver lesions originating from liver tissue can be seen in the hepatobiliary phase [1, 2]. Especially for detailed visualization of biliary structures, a preferably high spatial resolution is advantageous [3]. Using breath-hold imaging techniques, compromises in spatial resolution and restrictions in anatomic coverage are inherent due to the limited capability of the patient to hold the breath. Multi-breath-hold acquisitions have the disadvantage of misregistration between the slabs due to different depths of inspiration. To extend the acquisition time beyond the breath-hold period respiratory triggering is a useful approach [3]. The hypothesis for this study was that respiratory triggered high-spatial resolution images acquired in the hepatobiliary phase provide significantly improved image quality compared to breath-hold images.

Materials and Methods:

Prospective evaluation of 20 consecutive patients referred for MR imaging of the liver. The study was approved by the local ethical review board. All patients were examined on a 1.5 Tesla system (MAGNETOM Avanto, Siemens Medical Solutions, Erlangen, Germany) using a 6-channel phased array surface coil and the spine-array coils. During the hepatobiliary phase beginning 10 minutes after intravenous application of the hepatobiliary contrast medium gadoxetic acid (Gd-EOB-DTPA, Primovist, Bayer-Schering Pharma AG, Berlin, Germany) at a dosage of 0.025 mmol per kilogram body weight the following sequences were acquired in coronal slice orientation: respiratory triggered T1w inversion prepared spoiled gradient echo (turbo-flash, TFL) sequence (RT-TFL) with water-excitation for fat saturation and selective slice excitation; breath-hold T1w spoiled gradient echo (fast-low-angle shot, FLASH) sequence (BH-FLASH). The sequence parameters are given in table 1. In 10 patients, the turbo-flash sequence was also repeated without respiratory triggering. A clear decrease of image quality due to respiratory motion was observed and therefore no further investigation of the TFL sequence without respiratory triggering was performed. The signal-to-noise ratio of the liver parenchyma in the 6th segment of the right hepatic lobe was calculated for the quantitative evaluation. In the qualitative evaluation, image quality was rated on a 5-point scale regarding depiction of hepatobiliary ductal structures and sharpness of liver vessels and liver contour. The non-parametric Wilcoxon signed rank test was used for the statistical analysis.

Table 1: Sequence parameters

Sequence	TR (ms)	TE (ms)	TI (ms)	Flip (°)	BW Hz/Px	Voxel Size	TA
RT-TFL	one respiratory cycle	2.32	550	15	490	1x1x1.5	5.5 min*
BH-FLASH	3.04	1.13		25	490	1x1x1.5	21 sec

(TR: time to repeat; TE: time to echo; TI: inversion time; ms: millisecond; Flip: flip-angle; BW: bandwith; Hz: Hertz; Px: pixel; TA: acquisition time)
* mean acquisition time of the 20 patients (1 min 20 sec standard deviation)

Results:

The SNR was significantly higher ($p < .05$) for the respiratory triggered TFL sequence (46.7 ± 14.1; mean ± SD) compared to the breath-hold FLASH sequence (24.8 ± 4.5; mean ± SD). In the qualitative evaluation, the RT-TFL sequence revealed significantly higher ($p < .05$) scores for depiction of the hepatobiliary ductal structures (3.8 ± 0.7), sharpness of liver vessels (4.3 ± 0.8) and liver contour (4.1 ± 0.65) in comparison to the BH-FLASH sequence (2.4 ± 0.8; 2.8 ± 0.6, 3.0 ± 0.6, respectively).

Conclusions:

In terms of MR imaging of the liver in the hepatobiliary phase, respiratory triggered high-spatial resolution images significantly improve the image quality compared to breath-hold images on the expense of extended acquisition time.

References:
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