SUPPLEMENTARY MATERIALS

Routine Liver MR Protocol

Routine liver MR sequences include breath-hold T2-weighted imaging, heavily T2-weighted imaging, diffusion-weighted imaging, and dual echo three-dimensional (3D) Dixon gradient-recalled-echo (GRE) T1-weighted imaging. A dynamic contrast-enhanced study was performed with a modified 3D Dixon GRE T1-weighted sequence (mDixon, Philips Healthcare, Best, the Netherlands) (1) after the injection of a standard dose of gadoxetic acid (Gd-EOB-DTPA, Bayer Healthcare, Berlin, Germany) during the arterial phase, portal-venous phase, and delayed phase, 7 seconds, 60 seconds, and 3 minutes after contrast media arrival at the distal thoracic aorta, respectively. The standard dose of gadoxetic acid (0.025 mmol/kg) was intravenously administered at a rate of 1.0 mL/s, immediately followed by a 20-mL saline flush through an antecubital venous catheter using a power injector (Spectris Solaris EP, MEDRAD Inc., Warrendale, PA, USA).

Preliminary Study for Parameter Optimization of Compressed Sensing-3D GRE

Four kinds of hepatobiliary phase (HBP) images were scanned sequentially in a preliminary study (n = 54): (a, b) standard sensitivity encoding (SENSE) mDixon-GRE with an acceleration factor (AF) of 2.8 and 4.48; and (c, d) compressed sensing (CS)-SENSE mDixon-GRE with an AF of 4.48 and 7.17. To explore the maximal feasible AF for SENSE technique, images using a SENSE sequence with a high AF of 4.48 (2 in the phase-encoding direction and 2.24 in the slice encoding direction) and a CS-SENSE sequence with a high AF of 7.17 (2 in the phase-encoding direction, 2.24 in the slice encoding direction, and 1.6 extra reduction factor accomplished with the integrated CS-SENSE algorithm) were additionally acquired. Detailed scan

Table 1. Preliminary Experience: MR Parameters of Four T1-Weighted mDixon GRE Sequences of Hepatobiliary Phase Imaging of Gadoxetic Acid-Enhanced Liver MRI

MR Parameters	SENSE mDixon-GRE		CS-SENSE mDixon-GRE	
	Standard SENSE	Accelerated SENSE	Standard SENSE + CS	Accelerated SENSE + CS
TR/TE (msec)	3.6/1.34 and 2.4		3.6/1.45 and 2.8	
Flip angle (°)	10	10	10	10
Bandwidth (Hz/pixel)	1562.5	1562.5	1562.5	1562.5
Field of view (mm^2)	380 x 380	380 x 380	380 x 380	380 x 380
Slice thickness (ST/gap, mm)	6/3	6/3	6/3	6/3
Matrix size	320 x 290	320 x 290	320 x 290	320 x 290
Acquired voxel size (mm^3)	1.18 x 1.31 x 3.0	1.18 x 1.31 x 3.0	1.18 x 1.31 x 3.0	1.18 x 1.31 x 3.0
Reconstructed voxel size (mm^3)	0.99 x 0.99 x 3.0	0.99 x 0.99 x 3.0	0.99 x 0.99 x 3.0	0.99 x 0.99 x 3.0
Number of excitation	1	1	1	1
AF (phase x slice x extrareduction factor)	2.80 (2 x 1.40)	4.48 (2 x 2.24)	4.48 (2 x 1.40 x 1.60)	7.17 (2 x 2.24 x 1.60)
Acquisition time (sec)	15	9	9	6

AF = acceleration factor, CS = compressed sensing, GRE = gradient-recalled-echo, SENSE = sensitivity encoding, TE = echo time, TR = repetition time

Table 2. Preliminary Experience: Qualitative Analysis Results for Image Quality based on Mean of Two Independent Reviewers

Imaging Quality Parameter	SENSE mDixon-GRE		CS-SENSE mDixon-GRE		ICC
	Standard SENSE	Accelerated SENSE	Standard SENSE	Accelerated SENSE	
Image blurring					
Liver edge sharpness	4.38 ± 0.69 (3–5)	4.41 ± 0.70 (3–5)	4.39 ± 0.65 (2–5)	4.41 ± 0.70 (3–5)	0.649 (0.541–0.731)
Pancreas margin	4.06 ± 0.69 (3–5)	3.37 ± 0.66 (2–5)	4.05 ± 0.69 (2–5)	3.77 ± 0.68 (2–5)	0.481 (0.321–0.603)
Hepatic vessel conspicuity	4.10 ± 0.97 (1–5)	4.11 ± 1.04 (1–5)	4.09 ± 0.97 (1–5)	4.11 ± 1.03 (1–5)	0.835 (0.784–0.874)
Bile duct conspicuity	3.86 ± 1.06 (1–5)	3.89 ± 1.03 (1–5)	3.90 ± 1.02 (1–5)	3.91 ± 1.02 (1–5)	0.988 (0.592–0.761)
Noise & Artifact					
Image noise	4.33 ± 0.82 (2–5)	3.26 ± 0.79 (2–5)	4.33 ± 0.78 (2–5)	3.58 ± 0.94 (2–5)	0.621 (0.505–0.710)
Aliasing artifact	2.98 ± 0.14 (2–3)	2.00 ± 0.15 (1–3)	2.94 ± 0.22 (2–3)	2.40 ± 0.55 (1–3)	0.619 (0.502–0.708)
Motion artifact	4.35 ± 0.75 (2–5)	4.41 ± 0.73 (2–5)	4.60 ± 0.58 (3–5)	4.34 ± 0.82 (2–5)	0.390 (0.203–0.534)
Overall artifact level	4.26 ± 0.91 (2–5)	3.22 ± 0.76 (2–5)	4.32 ± 0.70 (2–5)	3.61 ± 0.91 (1–5)	0.711 (0.622–0.779)
Fat suppression deficiency	4.71 ± 0.35 (4–5)	4.71 ± 0.35 (4–5)	4.71 ± 0.35 (4–5)	4.71 ± 0.35 (4–5)	-
Overall image quality	3.93 ± 1.05 (2–5)	3.25 ± 0.75 (2–5)	4.06 ± 0.88 (2–5)	3.48 ± 0.93 (2–5)	0.741 (0.661–0.802)

Values are mean ± standard deviation (range), ICC with its 95% confidence interval. ICC = intraclass correlation coefficient

parameters for the preliminary study are listed in Supplementary Table 1.

Among the four HBP sequences with AFs of 2.8–7.17, two image techniques using an accelerated SENSE (AF of 4.48) only and combination of accelerated SENSE and CS (AF of 7.17; 4.48 from SENSE and 1.6 from CS extra-reduction factor) tended to show increased image noise and overall artifact level resulting from increased aliasing artifact compared to those of the two sequences using a standard SENSE technique (AF of 2.8) or a combination of Standard SENSE and CS (AF of 4.48; 2.8 from SENSE and 1.6 from CS extra-reduction factor) (Supplementary Table 2). Other parameters reflecting spatial resolution remained equivocal among the four sequences, but overall image quality was limited in the accelerated SENSE mDixon images (Supplementary Table 2). Thus, in the formal review, we only compared two sequences using the standard mDixon-GRE with a standard AF of 2.8 for the SENSE technique, and CS-SENSE mDixon-GRE images with a standard AF of 2.8 for the SENSE technique and 1.6 CS acceleration.

The Characteristics of the Nodules Used in Solid Focal Liver Lesion Detectability Analysis

In total, 193 nodules were under review, including 186 hypointense nodules and seven hyperintense nodules. Of those 193 nodules in 91 patients, the following confirmed diagnoses for 108 nodules were made either radiologically (n = 97) or pathologically (n = 11): hepatocellular carcinoma (HCC) or probable HCC (n = 90), metastasis (n = 5), cholangiocarcinoma (CC) or combined HCC-CC (n = 5), focal nodular hyperplasia (FNH, n = 3), hepatic abscess (n = 2), lymphoma (n = 1), neuroendocrine tumor (n = 1), and lipoma (n = 1). The radiologic determination of HCC or probable HCC was made based on the basis of LI-RADS 4 or 5 lesions (2). Diagnosis of FNH was established based on a typical imaging findings such as iso- or hypointensity on T1-weighted images with slight hyper- or isointensity on T2-weighted images, and with intense homogeneous enhancement in the arterial phase, and absence washout, as well as enhancement of the central scar in the later phases of gadolinium-enhanced imaging (3). Other diagnoses were established pathologically. In addition, there were also 85 other benign cirrhotic nodules greater than 1 cm in diameter that were presumably degenerative or large regenerative nodules based on stable imaging features present for more than 1 year either on previous or follow-up MRI.

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