Volumetric MR Cholangiopancreatography with 3D Turbo Spin Echo and Parallel Acquisition Technique

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Introduction/Background

MR cholangiopancreatography (MRCP) is widely used as a noninvasive diagnostic tool for hepatobiliary and pancreatic pathologies. 2D turbo spin echo (TSE) and half-Fourier acquisition single-shot turbo spin echo (HASTE) sequences are commonly accepted techniques. 3D MRCP has potential advantages over 2D imaging, due to its capacity to provide thinner sections, no gaps, higher signal-to-noise ratio and multiplanar reconstructions. However, previous efforts with 3D MRCP have been hindered by either long acquisition time, or relatively limited spatial resolution. We hereby report a T2-weighted 3D TSE with parallel acquisition technique (PAT) that can produce near isotrophic high resolution MRCP images. This technique can be performed within a breathhold or in conjunction with respiratory triggering.

Purpose

To compare breath-hold and respiratory-triggered isotropic (~1 mm) 3D TSE MRCP images with conventional 2D imaging.

Materials and Methods

16 consecutive patients were imaged at 1.5T using a 6-element body array coil with three different MRCP techniques: (1) free-breathing T2-weighted 3D TSE with PAT and respiratory triggering (1300/680/180°, 218-256 x 256 matrix, FOV 250-300mm, 1mm slices, typical acquisition time 1.5-2 min); (2) breath-hold T2-weighted 3D TSE with PAT (same parameters as above, typical acquisition time 28 sec); (3) coronal HASTE in conjunction with oblique coronal thick-slab 2D TSE without PAT (2800/1100/150-180°, total acquisition time approximately 1 min). The source and reconstructed images of the 3D data sets were compared to the coronal HASTE and thick-slab 2D TSE images by two independent reviewers in a blinded random fashion who qualitatively graded image quality and intrahepatic ductal anatomy definition using a 4-point grade (0, non-visualization; 4, easy to visualize). Friedman nonparametric and Wilcoxon rank sum tests were performed for statistical analysis. Quantitative assessment of image quality (signal-to-noise ratio [SNR], contrast-to-noise ratio [CNR] and CNR normalized for voxel size and acquisition times) on free-breathing 3D TSE, breath-hold 3D TSE and thick-slab 2D TSE was also performed using analysis of variance and paired t-tests.

Results

Qualitatively, the image quality of intrahepatic biliary ducts and overall image quality were better for the 3D imaging than the 2D methods (Figure 1), although this difference did not reach statistical significance. The breath-hold 3D TSE had poorer visualization of the (non-dilated) pancreatic duct compared with the other two techniques (p<.05). But both free-breathing and breath-hold 3D TSE techniques showed advantages over 2D technique in their multiplanar and postprocessing capabilities (Figures 2, 3). Quantitatively, the free-breathing 3D TSE had a significantly higher SNR and CNR than breath-hold 3D TSE and thick-slab 2D TSE (p < 0.001). There was no significant difference in the SNR or CNR between breath-hold 3D TSE and thick-slab 2D TSE (p = 0.54). However, the normalized CNR values were significantly higher in both free-breathing and breath-hold 3D TSE techniques than thick-slab 2D TSE (p < 0.001). There was no significant difference in normalized CNR values between the free-breathing and breath-hold 3D TSE techniques (p = 0.11). Average values for quantitative measurements of image quality are given in the Table.

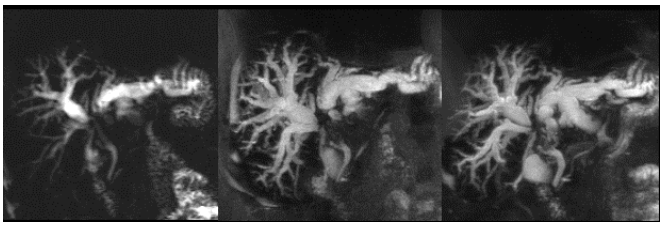

Fig 1. Coronal thick-slab 2D TSE (*left*) *and* maximal intensity projections (MIPs) from breath-hold (*middle*) *and* free-breathing 3D TSE (*right*) in a patient with an obstructing mass at the hepatic duct confluence and marked intrahepatic biliary dilatation.

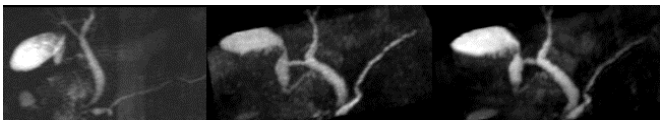

Fig 2. Coronal thick-slab 2D TSE (*left*) and oblique axial MIPs from breath-hold (*middle*) and free-breathing 3D TSE (*right*) show layering gallstones, cystic duct insertion, common bile duct bifurcation and pancreatic duct tortuosity.

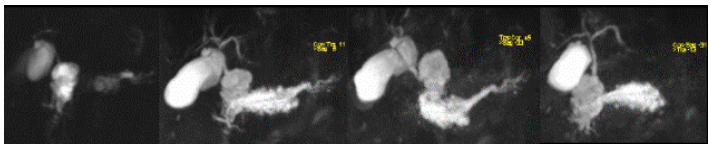

Fig 3. Coronal thick-slab 2D TSE (*left*) and MIPs from free-breathing 3D TSE in three different projections in a patient with diffuse intraductal papillary mucinous tumor (IPMT) of the pancreas. The origin of the right lateral duct can also be clearly depicted on this study.

Table. Quantitative measurements of image quality (data are mean +/- standard deviation).

Technique	SNR	CNR	Normalized CNR
Free-breathing 3D TSE	168.93 +/- 66.36	163.98 +/- 66.15	79.86 +/- 29.33
Breath-hold 3D TSE	85.92 +/- 34.78	81.25 +/- 34.59	65.34 +/- 19.96
HASTE and thick slabs	77.60 +/- 38.36	74.74 +/- 37.99	0.93 +/- 0.39

Conclusion

3D volumetric MRCP images have higher quantitative parameters of image quality with advantages of multiplanar and postprocessing capability compared to conventional 2D imaging. Further studies are needed to verify that these improvements translate into improved diagnostic accuracy.

References

1. Wielopolski PA, et al. Radiology 1999; 210:247-252 2. Textor HJ, et al. Endoscopy 2002; 34(12):984-990