

Optimization of MR Cholangiopancreatography at 3T: Comparison of 2D Thick Slab Acquisitions to 3D Strategies

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Purpose: A combination of 2D thin and thick slab T2-weighted single shot sequences are the most common approach in a magnetic resonance cholangio-pancreatography (MRCP) imaging protocol. With the improved signal-to-noise ratio (SNR) of 3 Tesla (3T) imaging systems and increased imaging speed of parallel imaging techniques, such as Array Spatial Sensitivity Encoding Technique (ASSET), clinically feasible 3D MRCP imaging sequences can be performed. 3D imaging sequences have the inherent benefit of improved SNR compared to 2D methods, but the drawback that motion during image acquisition can “contaminate” the entire 3D data set. Motion effects may be minimized by breath hold (BH) or respiratory-gated non-breath hold (NBH) methods. In this study, a commonly used 2D thick slab half-Fourier single shot fast spin echo (SSFSE) sequence was compared to both 3D BH and 3D NBH imaging sequences for evaluation of the biliary system.

Methods: 20 consecutive, unselected patients (age 36 - 98; 12 female, 8 male) scheduled for clinical MRCP on a GE 3T system (Waukesha, WI) underwent thick slab SSFSE (TE 600 – 1400ms, slice thickness 60mm, 5 radial slices separated by 15° centered about the distal common bile duct) and 3D BH (TR 3750, TE 600, matrix 256x224, section thickness 1.8mm, scan time 24 sec) and 3D NBH (TR 1200, TE 525, matrix 256x224, section thickness 3.0mm, respiratory gated using a bellows, scan times 3 to 7 min) Fast Recovery FSE (FRFSE) imaging, all using ASSET. Maximum intensity projections (MIPs) were reconstructed from the 3D data. All images from each sequence and MIPs were evaluated and rated independently by 2 observers using a scale from 1 (worst) to 5 (best) for visualization of the following: 1st, 2nd, and 3rd order intrahepatic bile ducts, common hepatic duct (CHD), cystic duct, common bile duct (CBD), and pancreatic duct (PD). Images were also rated for “graininess” (SNR) and overall image quality. Statistical analysis was performed with a paired Student t-test with P values < 0.05 considered statistically significant.

Results: Tables 1 and 2 display the ratings for each category and imaging technique and the statistical analysis results. 3D NBH significantly outperformed 3D BH in all categories and was significantly better than 2D thick slab SSFSE for evaluation of 2nd and 3rd order intrahepatic bile ducts, cystic duct, CBD, SNR and overall image quality. 2D thick slab SSFSE was significantly better than 3D BH for visualization of the pancreatic duct, SNR, and overall image quality.

Discussion: The 3D NBH technique generally performed best and the 3D BH method worst. The 3D BH technique also frequently had limited anatomic coverage, with parts of the intrahepatic bile ducts and gallbladder excluded; a major limitation for clinical practice and a factor only partially reflected in the rating system under “overall” image quality. Inaccuracies in respiratory gating with NBH MRCP may lead to image blurring, which may cause artifactual dilation of the biliary ducts, and other imaging artifacts. While the NBH method

allows for complete anatomic coverage of the biliary system, image scan times are relatively long compared to other MRCP methods. More data are required to determine whether 3D MRCP strategies may replace or serve as useful adjuncts to current 2D MRCP methods.

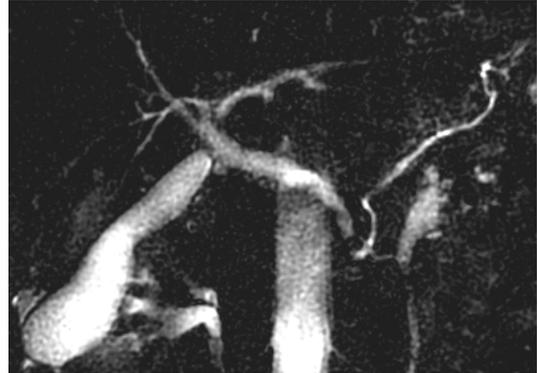


Figure 1. 2D thick slab (60mm) SSFSE.



Figure 2. 3D BH FRFSE.



Figure 3. 3D NBH FRFSE.

Table 1 Average rating values for each category and imaging technique:

Sequence	1st order	2nd order	3rd order	CHD	Cystic duct	CBD	PD	SNR	Overall
2D thick slab	3.9	2.7	1.8	4.2	2.8	3.8	3.4	3.5	3.5
3D BH	3.6	2.6	1.7	3.8	2.8	3.3	2.3	3.0	3.0
3D NBH	4.1	3.2	2.1	4.4	3.3	4.3	3.6	4.3	3.9

Table 2 P values from the paired Student t-tests for each rating category (< 0.05 statistically significant):

Comparison	1st order	2nd order	3rd order	CHD	Cystic duct	CBD	Pancreatic duct	SNR	Overall
Thick slab vs 3D BH	0.30	0.58	0.28	0.13	0.22	0.03	<0.001	0.02	0.016
3D NBH vs 2D thick slab	0.21	0.028	0.048	0.08	0.0026	0.030	0.24	<0.001	0.045
3D NBH vs 3D BH	0.0041	0.0033	0.0041	<0.001	0.027	<0.001	<0.001	<0.001	<0.001