Comparison of optimized Breath-hold 3D FR-FSE MRCP, Respiratory-triggered 3D MRCP with ASSET using an 8 channel phase array coil, and 2D SSFSE for the Evaluation of Pancreatobiliary System.

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Introduction: 3D imaging acquisition for MRCP can provide high spatial resolution in three orthogonal dimensions. Respiratory-triggered (RT) 3D MRCP can be used with parallel imaging technique for the evaluation of the pancreatobiliary system. However, in approximately 20% of cases, image quality of RT 3D MRCP may be not acceptable. Breath-hold (BH) 3D MRCP may provide information of pancreatobiliary system in a short period of time especially with an 8 channel phased array coil. However, still lower SNRs and smaller coverage of BH 3D FSE MRCP should be resolved (1). To overcome these problems, longer duration of breath holding with oxygen administration may allow using longer repetition time (TR) with higher SNRs and more imaging coverage. Thus, the purpose of the study was to compare the abilities of optimized BH 3D fast recovery (FR) FSE MRCP with oxygen administration and RT 3D FR-FSE MRCP in combined use of array spatial sensitivity encoding technique (ASSET) for the visualization of the pancreatobiliary system. Single thick-section 2D single shot (SS)FSE MRCP was obtained for the comparisons.

Materials and Methods: Sixty-one consecutive patients were included for the current study, who underwent MRCP of the pancreatobiliary abnormalities (32 males and 29 females; mean age, 59.8 years). Preliminarily, one of the volunteers was studied for confirmation of the image quality by increase of TRs and coverage of the imaging volume. ***MR Imaging*** All MR imaging was performed with a 1.5-T system (Horizon Excite; GE Medical Systems, WI) using an 8 channel body phased array coil. After reference scan for sensitivity map, RT 3D FR FSE and BH 3D FR FSE, and BH 2D SSFSE images were obtained. Scans for MRCP was acquired in an oblique coronal plane with the following imaging parameters; RT 3D FR-FSE 3000-8000/475ms [TR/effective TE]; echo train length, 123; field of view, 30 x 30-35 x 35 cm; matrix, 256 x 224 (with ZIP 512); bandwidth, 31.5 kHz; section thickness, 3 mm (ZIP2, apparent 1.5mm); 72-90mm-thick volume; fast recovery pulse, and image time,3-5 minutes; BH 3D FR-FSE the same as RT method except TR, 1800ms; eTE, 390ms; matrix, 256x192; 60mm thick volume and image time, 38sec: 2D thick single-section SSFSE;infinite/975; 136; 30 x 30 - 35 x 35 cm; matrix, 256 x 256; bandwidth, 31.5 kHz; section thickness, 40-60 mm, and image time, <2 seconds; half Fourier type of acquisition.

Imaging process Post processing of the source images obtained with RT and BH 3D FR FSE sequence was performed by using multiplanar volume reformation (MPVR) with MIP. ***Evaluation*** All images were evaluated on a display monitor. The image quality, blurring or ghosting effects were evaluated using five-point scale (1, severe to 5, absent). Overall quality of images was ranked as 1, poor to 5, excellent. The delineation of the pancreatobiliary ducts were also evaluated regarding the following points: the first- and second-, hepatic bile ducts; the extrahepatic bile duct, the gallbladder and cystic duct. The following grading system was used: 5, excellent for complete delineation to 1, not visualized).

Results; In preliminary study, TR increased from 1500ms to 1800ms with an increase in breath holding time from 24sec with 36mm imaging coverage to 38sec with 60mm thick volume. In 61 patients, BH 3D MRCP in 3 patients and 3 patients in RT 3D MRCP were undiagnostic. In 2D SSFSE images, artifacts were least identified among the three sequences (4.9 +/- 0.7, p<.05, Table). Among the three types of MRCP, BH 3D MRCP provided the highest rating of the overall quality of images (4.5 +/- 0.8, p<.05, Figs). When breath holding and respiratory triggering worked well, identical information was obtained from each MRCP (Fig1). Blurring effects were less on BH 3D MRCP than on RT 3D MRCP (Table, Fig1, 2). Unstable respiration caused obvious burring effects on RT 3D MRCP compared with BH 3D MRCP and 2D SSFSE MRCP (Fig.2). Visualization of pancreatic ducts, 2nd order branches of the hepatic ducts were well visualized with 3D FSE technique among the three MRCP sequences (3.1 +/- 1.5 for 3rd branches and 4.0 +/- 1.4 for 2nd branches with 3D FSE, respectively, p<.05, Fig2a). Single slice MRCP provided less confidence of the visualization of the 1st to 2nd order branches of the hepatic ducts (p<.05). Extrahepatic bile ducts were equally visualized with three MRCP sequences however although the cystic duct and gallbladder were better with 3D FSE (Table).

Summary BH 3DFR-FSE MRCP with administration of oxygen in combined use of ASSET using an 8 channel phased array coil can provide competitive information of RT 3D FR-FSE MRCP. Image quality of BH 3D MRCP is shown to be good enough to evaluate pancreatobiliary system. Compared with RT 3D MRCP, BH 3D MRCP requires shorter imaging time. Thus, when BH 3D MRCP is not diagnostic, RT 3D MRCP may be additionally obtained for the evaluation. Since thick section 2D SSFSE images and multiple thin section images from 3D acquisition compensate for each other, single thick section 2D SSFSE MRCP may be also required.

Fig1a.BH 3DFSE

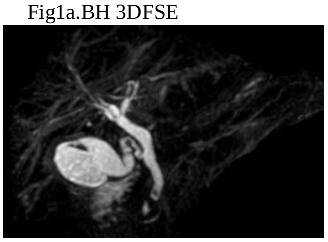


Fig 1b, RT 3DFSE

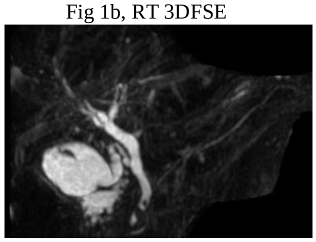
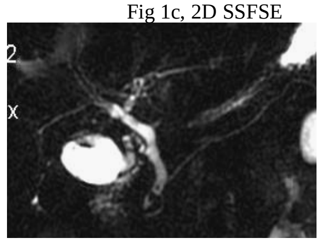


Fig 1c, 2D SSFSE



CBD stones 26y-woman

Fig2a.BH 3DFSE

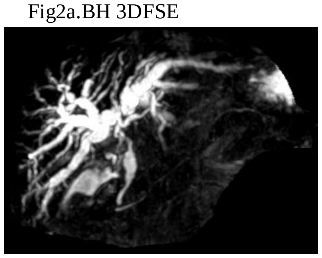


Fig 2b, RT 3DFSE

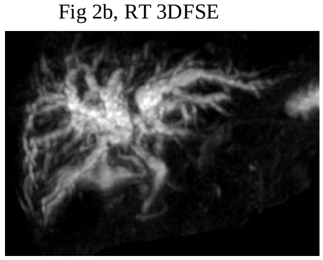
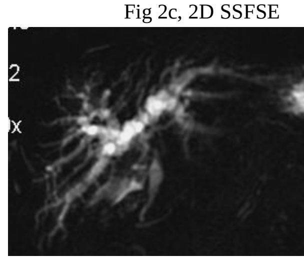


Fig 2c, 2D SSFSE



Hilar Cholangioma 80y-man

Table Image Quality and Visualization of the Pancreatobiliary System on 3D MRCP

			hepatic		Extrahepatic bile duct						Pancreatic	
	Blurring	Quality	1st	2nd	U	M	L	GB	Cystic	Head	Body	Tail
RT 3D FRFSE	4.3	4.3	4.5	3.7	4.5	4.5	4.2	3.1	3.5	3.7	3.6	3.4
BH 3D FRFSE	4.6	4.5	4.6	3.8	4.3	4.5	4.3	3.1	3.7	3.7	3.8	3.2
2D SSFSE	4.8	4.2	4.0	3.5	4.2	4.2	3.8	2.3	3.2	4.0	3.8	3.6

1st and 2nd indicates 1st and 2nd branches of hepatic ducts. U,M, L stands for upper, middle, lower.
GB and cystic are gallbladder and cystic duct, respectively.