Efficacy of PACE technique MRCP in Choledocholithiasis

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Purpose

Magnetic resonance cholangiopancreatography (MRCP) is a noninvasive imaging technique that provides detailed information on the anatomy and pathology of the pancreaticobiliary tree. T2-weighted MRCP has been essential for both detection and characterization of pancreaticobiliary diseases (1).

The navigator-triggered prospective acquisition correction (PACE) technique is a virtual respiratory monitoring technique. This technique can reduce respiratory motion artifacts by directly monitoring the superior-inferior movement of the right diaphragm with navigator echoes. The PACE technique is a real time gradient recalled echo fast low angle shot navigator sequence for monitoring diaphragmatic movement (2,3).

The purpose of this study was to compare the diagnostic accuracy of navigator-triggered isotropic 3D-MRCP using a parallel imaging technique for choledocholithiasis with that of endoscopic Retrograde Cholangiopancreatography (ERCP) as a gold standard reference.
Methods and Materials

The participants were the patients who presented with clinical signs and symptoms that has suspected pancreaticobiliary disease and performed both MRCP and ERCP at our hospital within 4 years period of time. MRCP was performed before ERCP in each case. The time interval between ERCP and MRCP ranged from 0-30 days (mean 7.2 days). Prior to imaging, the patients were asked to fast for a minimum 6 hours to maximize gallbladder filling and gastric emptying. MR imaging was performed with a 1.5 T (Magnetom Symphony, Siemens Medical Solutions) using a 4-channel body phased-array surface coil as a radiofrequency receiver. A respiratory triggered T2-weighted TSE sequence with the PACE technique (TR/TE: 1600/678 msec; flip angle 90°, field of view 400 mm, matrix size 384x384, section thickness 1.6 mm, gap:0, turbo factor 16) in axial and coronal planes was performed. The source images were obtained in two planes, providing better anatomic orientation. We processed MRCP data sets with maximum intensity projection (MIP) and shaded surface display (SSD) algorithms. A standard defined protocol was used for 3D reformatted images. For the image analysis, a series of 19 projections rotated by 10 intervals from -90° to 90° was created for each rendering algorithm. The reconstructions were obtained in the coronal plane.

For the PACE technique, the 2D-PACE with a standard protocol was used. The gradient echoes of a gradient echo FLASH sequence continuously acquired a coronal 2D image to monitor the movement of the right diaphragm using the following parameters, slice thickness of 10 mm, field of view of 256x512 mm using bandwidth of 260 Hz/pixel and a flip angle of 3 (matrix size= 256x12. TR=7.1 msec TE=3.4 msec) Data of the end-expiratory phase were gathered via navigator-triggering.

ERCP was performed by one of the attending gastroenterologists using standard techniques and fiber optic endoscopes. The papilla of Vater was cannulated using a 5F catheter and 10-15 ml of contrast medium was injected.

Two abdominal radiologists reviewed all MRCP and ERCP images retrospectively at an independent Workstation (Leonardo, Siemens Medical Systems, Erlangen, Germany)

Sensitivity, specificity, positive predictive values, negative predictive values and total accuracy of MRCP technique were calculated using SPSS software (SPSS inc. version 11, 2002, Chicago, IL, USA). The accuracy of MRCP for determining presence of choledocholithiasis was compared with that of ERCP as gold standard by using the McNemar test.
Results

A total of 12 patients had to be excluded from the study, 5 due to inadequate image quality on MRCP and 7 due to unsuccessful cannulation during ERCP. In the remaining 107 patients, both MRCP and ERCP were performed successfully.

The patients were 52 (48.6%) men, and 57 (51.4%) women with a mean age of 61.7 years.

MRCP revealed choledocholithiasis 40 of the 107 patients, whereas ERCP revealed choledocholithiasis 36 of these 40 patients. ERCP revealed choledocholithiasis in 37 of the 107 patients.

Using ERCP as the gold standard, the statistical results for MRCP in detection of choledocholithiasis were as follows: PPV: 90%, NPV: 98.5%, Sensitivity: 97.3%, Specificity: 94.3%, and total accuracy: 95.3%.
Fig. 0: Fig.: a) An endoscopic retrograde cholangipancreatography image shows 16 mm sized stone in the common bile duct; b) coronal c) axial d) 3-D maximum intensity projection magnetic resonance cholangiopancreatography images show the filling defects as choledocholithiasis.

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**Fig. 0:** Fig.: a) Coronal; b) axial magnetic resonance cholangiopancreatography images show small stone in the common bile duct; c) endoscopic retrograde cholangiopancreatography image shows choledocholithiasis in the distal common bile duct.

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**Fig. 0:** Fig.: a) An endoscopic retrograde cholangipancreatography image shows 13 and 15 mm sized stones in the common bile duct; b) coronal c) axial d) 3-D maximum intensity projection magnetic resonance cholangiopancreatography images show the filling defects as choledocholithiasis.

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**Fig. 0:** Fig.: a) An endoscopic retrograde cholangipancreatography image shows a filling defect in distal the common bile duct; b) coronal c) axial d) 3-D maximum intensity projection magnetic resonance cholangiopancreatography images show the filling defects as choledocholithiasis.

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Conclusion

With recent advances in the development of high performance gradient coils and phased-array torso coils and evaluation of software, numerous pulse sequences have become available for T2 weighted MRCP imaging.

Artifacts caused by respiratory motion are one of the major problems with these pulse sequences because the artifacts can produce image blurring, ghosting, loss of signal intensity and misregistration, thereby obscuring important anatomic structures and lesions (4).

Various techniques have been used to reduce respiratory artifacts (5-11). A straightforward strategy is to use fast imaging. Because the typical breathing cycle of adult humans lasts 4-5 seconds, respiratory motion is essentially frozen if all of the k-space data can be acquired faster than that. However, these images are usually poor, and artifacts inherent to fast imaging often become troublesome.

Another strategy for addressing respiratory motion is the respiration-triggering method. We investigated patients with 3D heavily T2-weighted MRCP using PACE technique. This TSE technique provides thin slices that display ductal filling defects as areas of signal void surrounded by bright bile (12). There was an optimal contrast between the hyperintense signal of the bile and the hypointense signal of the stone.

Our results revealed total accuracy rate 95.3 % for MRCP in detection of choledocholithiasis in suspected pancreaticobiliary disease cases that suggests a high accuracy rate. Respiratory triggered TSE acquisition combines high SNR and contrast of images and minimal motion artifacts comparable to breath-hold techniques.

We found that the T2W-PACE-TSE sequence with navigator echo triggering is able to significantly delineate the pancreaticobiliary anatomy and detect the stones in the biliary tract.

Our study results show a comparable diagnostic performance of 3D-MRCP with ERCP for evaluating common bile duct stones probably due to the navigator triggered isotropic 3D-TSE sequence for MRCP.

Stone disease can be diagnosed using several different MR techniques, including 3D heavily T2-weighted TSE MR sequences, HASTE and single-shot RARE sequences. These are currently considered optimal because they provide thin sections with higher spatial resolution, higher signal-to-noise ratios and comparable image contrast in a single-breath time frame (13,14). However there is no clear consensus about which sequence is most appropriate for MRCP imaging and for detecting stones in the bile duct (14,15).
The literature indicates that MRCP is a highly sensitive (50-100%) and specific (83-100%) tool for diagnosing biliary stone disease. (15-18) The corresponding values in our study with 3D heavily T2 weighted TSE MR sequence were very high too (97.3%, 94.3% respectively).

One limitation of our MRCP technique with respect to detecting gall stones is that the slice thickness requires partial volume averaging. This can lead to false negative results when a stone is smaller than slice thickness in diameter.

Another limitation is that it is not always easy to distinguish between stones and pneumobilia, tortuous common bile duct, compression of the hepatic duct by the right hepatic artery and origin of the cystic duct mimicking common bile duct stones can be all confusing. These situations can lead false positive results.

In conclusion, T2 weighted isotropic 3D MRCP using PACE technique can accurately show the presence of choledocholithiasis and since no breath-holding is necessary it can be used effectively in elderly patients who can not do breath-holding.
References


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