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Comparison of 3D Maximum intensity projection (MIP) reconstruction and 2D T2 Half-Fourier Acquisition Single-Shot Turbo Spin-Echo (HASTE) sequence in magnetic resonance cholangiopancreatography

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ABSTRACT

Introduction: Magnetic resonance cholangiopancreatography (MRCP) is a method that allows noninvasive visualization of pancreatobiliary tree and does not require contrast application. It is a modern method based on heavily T2-weighted imaging (hydrography), which uses bile and pancreatic secretions as a natural contrast medium. Certain weaknesses in quality of demonstration of pancreatobiliary tract can be observed in addition to its good characteristics. Our aim was to compare the 3D Maximum intensity projection (MIP) reconstruction and 2D T2 Half-Fourier Acquisition Single-Shot Turbo Spin-Echo (HASTE) sequence in magnetic resonance cholangiopancreatography.

Methods: During the period of one year 51 patients underwent MRCP on 3T „Trio" system. Patients of different sex and age structure were included, both outpatient and hospitalized. 3D MIP reconstruction and 2D T2 haste sequence were used according to standard scanning protocols.

Results: There were 45.1% (n= 23) male and 54.9% (n=28) female patients, age range from 17 to 81 years. 2D T2 haste sequence was more susceptible to respiratory artifacts presence in 64% patients, compared to 3D MIP reconstruction with standard error (0.09), result significance indication (p=0.129) and confidence interval (0.46 to 0.81). 2D T2 haste sequences is more sensitive and superior for pancreatic duct demonstration compared to 3D MIP reconstruction with standard error (0.07), result significance indication (p=0.01) and confidence interval (0.59 to 0.87)

Conclusion: In order to make qualitative demonstration and analysis of hepatobiliary and pancreatic system on MR, both 2D T2 haste sequence in transversal plane and 3D MIP reconstruction are required.

Keywords: 3D MIP reconstruction, 2D T2 haste sequence, MRCP, pancreatic duct

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INTRODUCTION

Magnetic resonance (MR) imaging allows clear demonstration of whole body organs, as well as their pathological changes (1). Magnetic resonance cholangiopancreatography (MRCP) is the method

which allows noninvasive visualization of pancreato-biliary tree and does not require contrast agent application (2). It is increasingly being used as a noninvasive radiological method and a high percentage of the diagnostic results of MRCP are comparable with those obtained by ERCP for various hepatobiliary tract pathologies.

Basic principle of MR cholangiopancreatography is heavily T2-weighted imaging (hydrography) that uses bile and pancreatic secretions as a natural contrast medium. The current most popular sequences for MRCP are single-shot fast spin-echo sequences, which are divided into three types: 2D single slice, 2D multiple slice and 3D methods (3).

Gating is a new addition to MR. It is a process that allows MR image high resolution, despite motion presence. Real-time navigator echo gating is a comfortable technique without breath hold that can be used to compensate various motion types (4). This technique is applied in MR hepatobiliary and pancreatic systems imaging. In addition to this imaging technique, other imaging techniques can be applied as well, such as breath hold imaging technique. Miyazaki et al. introduced HASTE (half-Fourier acquisition single-shot turbo spin-echo) sequences for acquiring MRCP images. With HASTE acquisitions, Miyazaki et al. were able to generate projection MRCP images using very short scanning time: 2 seconds for the single-slice technique and 18 seconds for the multi-slice technique (5).

Three dimensional (3D) images have increasingly important role in modern diagnostic radiology. With program improvement 3D volumetric data sets can easily be transformed in coronal, sagittal, oblique or curved cross section planes, which can help in lesion detection and localization. Maximum intensity projection (MIP) and multiplanar reconstruction (MPR) are generally used algorithms for MR cholangiopancreatography (MRCP). MIP allows three dimensional demonstration of biliary and pancreatic systems. Because of its resemblance to ERCP images, MIP reconstruction is widely accepted by clinicians. In spite of its usefulness, MIP may be misleading without a proper reference to source images or a guidance of MPR. Opacification defects that reflect intra-ductal or intra-cystic pathologies are notably erased through the process

of MIP reconstruction. Diagnosis based only on MIP images is therefore not clinically feasible. Use of any multi-section image is essential, or at least use of source images (6).

MIP is the projection of highest intensity pixels onto an arbitrarily oriented plane. MIP images have an aspect similar to that of conventional angiograms and are commonly used for angiographic display such as vascular anatomy evaluation. The drawback of MIP images is the lack of depth information so that the objects lying in the same projection plane of high intensity structures cannot be visualized (7).

The aim of this study was to compare the 3D MIP reconstruction and 2D T2 (HASTE) sequence techniques in magnetic resonance cholangiopancreatography.

METHODS

Research was conducted at the Clinic for radiology, Clinical center of University of Sarajevo, during the period from January to December 2013. The study included 51 patients of both sex and different age structure, both outpatient and hospitalized, admitted to a scheduled date of hepatobiliary and pancreatic tract diagnostic imaging. The data for patients were obtained from their medical records (medical history, clinician finding sand referral form).

All the patients underwent the examination on the Trio 3T Siemens system (Siemens, Germany). During the scanning body matrix coil was used. Every patient underwent standard breath hold T2 haste and navigator triggering T2 turbo spin echo sequence for MRCP. For T2 haste multibreath hold sequence the parameters were: Slices 38, Dist. factor 30 %, FoV read 400 mm, FoV phase 60 %, Slice thickness 5.0 mm, TR 1700 ms, TE 90 ms, TA:1.26 min. Basic resolution 320.

For T2 tse triggering sequence the parameters were: Slices 86, Dist. factor 30 %, FoV read 380 mm, FoV phase 100 %, Slice thickness 1.2 mm, TR 1800 ms, TE 441 ms, TA:4.27 min. Basic resolution 320. After the completed scanning, MIP reconstruction of hepatic and pancreatic ducts was conducted, where the hepatobiliary tract ducts and main pancreatic duct demonstration analysis was done.

Statistical analysis

Descriptive statistics, T-test, Spearman's rank correlation coefficient and ROC curve were used for data analysis. 3D MIP reconstruction was compared with 2D T2 haste images in pancreatic duct demonstration resulting in the following.

RESULTS

There were 51 patients, of which 45.1% (n= 23) male and 54.9% (n=28) female. Patients' mean age was 53 years and ranged from 17 to 81 years. All the patients stood the examination well and there were no unwanted effects.

According to admitting diagnosis the patients were generally diagnosed with cholecystectomy 11.7 % (n= 6) while in 8 patients other diseases were repre-sented by single admitting diagnosis each (Figure 1).

In the conclusion of the final radiological report MR findings were generally with no abnormalities detected 43.2 % (n=22), and the minimum of findings were with choledochal duct dilatation 1.9% (n=1) and choledochal diverticulosis 1.9% (n=1). The emphasis on pancreatic duct was in 3.9% (n=2) patients with pancreatic duct dilatation finding, no abnormalities were found in other radiological findings. In 5.8% (n=3) cases image analysis was impossible due to respiratory motion artifacts presence (Figure 2).

In 64% patients 2D T2 haste sequence showed higher sensibility for the respiratory artifacts presence, that is in this sequence more respiratory artifacts appeared compared to 3D MIP reconstruction with standard error (0.09), result significance indi-
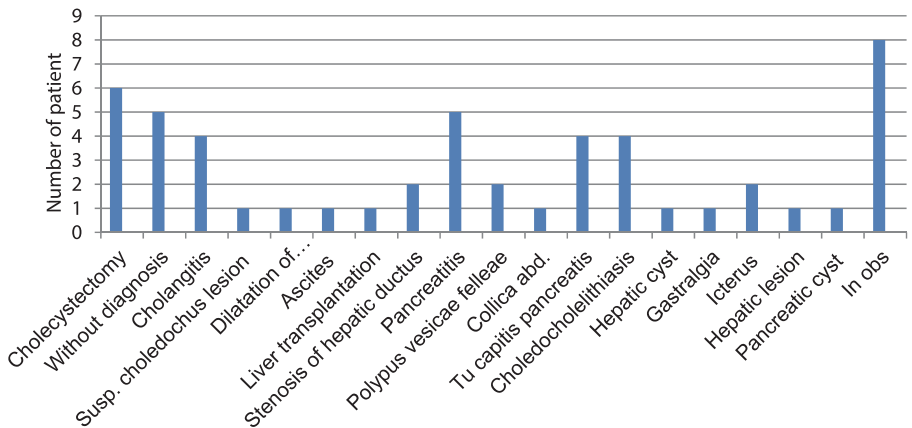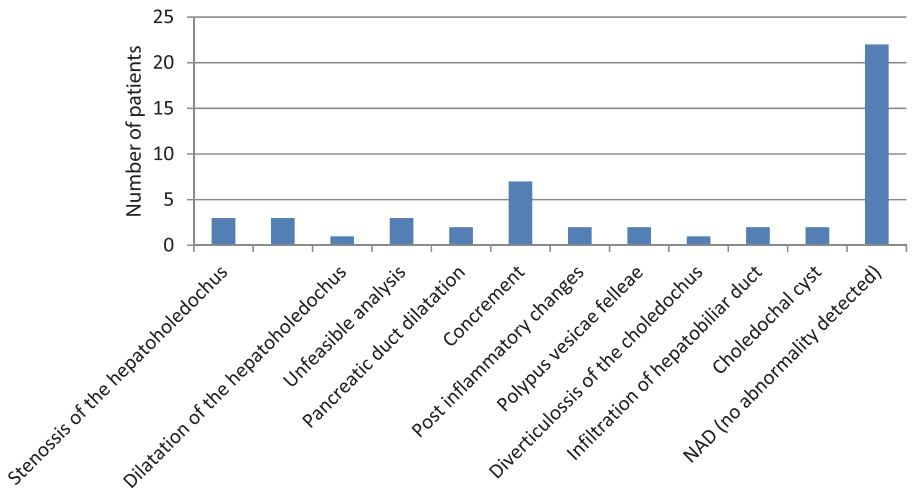

FIGURE 1. Admitting diagnoses of the patients

FIGURE 2. Radiological findings in the study group
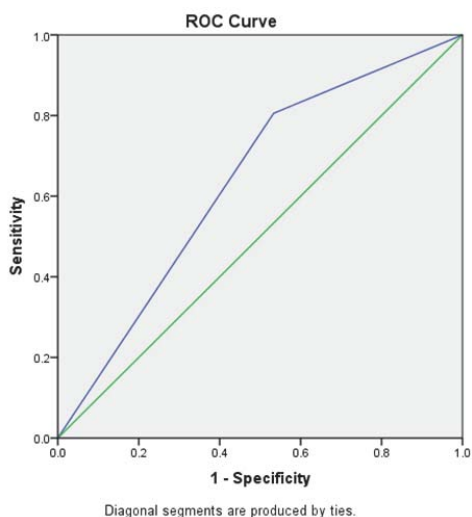
FIGURE 3. ROC curve for sensibility demonstration of 2D T2 haste sequence for respiratory artifacts presence.

cation (p=0.129) and confidence interval (0.46 to 0.81) (Figure 3).

In 73% patients 2D T2 haste sequence had higher sensibility for the pancreatic duct demonstration compared to 3D MIP reconstruction with standard error (0.07), result significance indication (p=0.01) and confidence interval (0.59 to 0.87) (Figure 4).
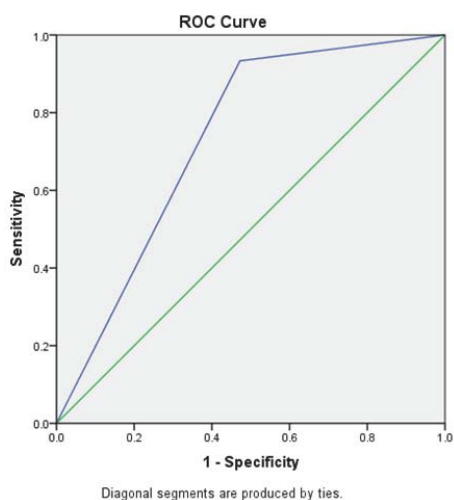

FIGURE 4. ROC curve for sensibility demonstration of 2D T2 haste sequence in pancreatic duct examination.

Based on acquired results it can be concluded that in pancreatic duct demonstration statistically significant difference exists between 3D MIP reconstruction and 2D T2 haste sequence, on the statistical significance level pancreatic duct was better demonstrated in 2D T2 haste sequence (p<0.01) compared to 3D MIP reconstruction, respectively.

DISCUSSION

MRCP is a modern diagnostic radiology method that offers many possibilities. It is not harmful for the patients and does not require special preparation, as in case of ERCP. Its advantages are that MRCP is noninvasive, cheaper, uses no ionizing radiation, requires no anesthesia, it is less operator dependent, better demonstrates ducts proximal to an obstruction or tight stenosisand when combined with conventional T1- and T2-weighted sequences, allows anatomic imaging of extraductal disease (8).

Apart from its possibilities, there are certain limitations that sometimes can present some sort of pitfalls in radiological finding interpretation. These pitfalls or diagnostic errors may have a variety of causes and may simulate or mask various diseases of the pancreatobiliary tract (9).

For the MR imaging, cooperation of patients and medical radiology engineer performing the imaging procedure is very important because of required breath hold in some sequences. Respiratory motion artifact scan present a problem in 3D MIP reconstruction when the patient does not hold the breath long enough to complete one imaging session. In our research 2D T2 haste sequence was more sensitive to the respiratory artifacts presence in 64% patients.

MIP reconstructed images completely obscure small filling defects due to the partial volume effect (10). In pancreatic duct demonstration in 3D MIP reconstruction and 2D T2 haste sequence there is statistically significant difference on the statistical significance level (p<0.01)meaning that 2D T2 haste sequence is more superior than 3D MIP reconstruction in the pancreatic duct examination. Because of this difference, image analysis acquired by MRCP needs to include both 3D MIP reconstruction and 2D T2 haste sequence. MRCP can accurately demonstrate the normal pancreatic duct as well as vari-

ous pancreatic duct abnormalities, including congenital anomalies of the biliary tree and pancreatic duct (11).

During the imaging when the patient does not perform an adequate breath hold for the period required for image acquisition, respiratory artifacts that degrade 3D MIP reconstruction appearance can emerge, resulting that choledochal duct and pancreatic duct may appear stenotic, dilated, or duplicated.

MRCP with a half-Fourier single-shot turbo spin-echo sequence depicts not only static fluid in the pancreatobiliary tree but also slow-flow vascular structures (e.g. portal vein, hepatic vein) (12) due to a relatively short echo time. In addition to these structures 2D T2 haste sequence allows clear morphological demonstration of hepatic and pancreatic parenchyma, and adjacent structures.

CONCLUSION

In demonstration of pancreatic duct 2D T2 haste sequence had a better result compared to 3D MIP reconstruction. For MR demonstration and analysis of hepatobiliary and pancreatic system, it is essential to use both 2D T2 haste sequence and 3D MIP reconstruction with source images as they supplement each other.

COMPETING INTERESTS

The authors declare no conflict of interest

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