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

Fuad Julardžija*, Adnan Šehić, Damir Jaganjac, Esad Voloder, Srećko Mađura, Dunja Vrcić

Clinic for Radiology, Clinical Center University of Sarajevo, Bolnička 25, 71000 Sarajevo, Bosnia and Herzegovina

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

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 pancreatico-
biliary tree and does not require contrast agent ap-
lication (2). It is increasingly being used as a nonin-
vasive 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 con-
trast 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 com-
fortable technique without breath hold that can be
used to compensate various motion types (4). This
technique is applied in MR hepatobiliary and pan-
creatic systems imaging. In addition to this imag-
ing technique, other imaging techniques can be ap-
plied 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 acquisi-
tions, Miyazaki et al. were able to generate projec-
tion MRCP images using very short scanning time:
2 seconds for the single-slice technique and 18 sec-
onds 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 recon-
struction (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 ac-
cepted by clinicians. In spite of its usefulness, MIP
may be misleading without a proper reference to
source images or a guidance of MPR. Opacifica-
tion 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 tech-
niques in magnetic resonance cholangiopancreatog-
raphy.

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, admit-
ted to a scheduled date of hepatobiliary and pancre-
atic 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). Dur-
ding the scanning body matrix coil was used. Every
patient underwent standard breath hold T2 haste
and navigator triggering T2 turbo spin echo se-
quence 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.

For 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 represented 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-
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).

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 stenosis and 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

REFERENCES


