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Original Article

Minimizing the postoperative biliary complications in living donor liver transplantation, by utility of preoperative non-enhanced magnetic resonance cholangiopancreatography

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ABSTRACT

Aim of the work: The aim of this study was to assess the utility of non-enhanced MRCP in reduction of biliary complications in LDLT donors and compare the results with IOC.
Patients and methods: A total of 54 potential donors with preoperative MRCP (45 males, 9 females, age range 22–51 years). A total of 50 donors underwent right lobe resection and had IOC for comparison. The MRCP and IOC reports were reviewed.
The MRCP was performed on 1.5 T MR magnets. Specificity, sensitivity and accuracy were analyzed and compared with IOC findings.
Result: A total of 50 donors underwent MRCP and IOC.
The findings were classified according to Yoshida et. al.'s study: 42.6% with type 1, 5.6% with type 2, 25.9% with type 3, 7.4% with type 4, and 18.5% with type 8. In comparison with MRCP findings with the golden standard IOC, the sensitivity, specificity and the diagnostic accuracy of MRCP were calculated:
Sensitivity was of 88.2%), specificity was of 94.2% and accuracy was of 92%.
Conclusion: Biliary complications remain common in LDLT. MRCP has potential in preoperative biliary evaluation for LDLT donors to minimize the postoperative biliary complications.
Conclusion: Further improvements of MRCP in LDLT are required to increase its quality and accuracy.

1. Introduction

Liver transplantation has become widely accepted as a lifesaving alternative treatment for properly selected patients with end stage liver disease, in addition to numerous indications for liver transplantation that ranges from fulminate hepatic failure, advanced chronic liver failure, hepatic malignancy and inherited metabolic liver disease, and the most common indication for LDLT is hepatitis C virus related cirrhosis [1,2].

Preoperative imaging evaluation is essential in guiding the surgeon in deciding when and how to operate safely and effectively.

Despite improvements in surgical techniques, biliary complications e.g. leaks and strictures are observed on average in 5–15% of transplants and are the second most frequent cause of transplant failure after acute rejection, so in transplantation surgery a road map of the biliary and arterial vascularity of the donor and recipient has been advocated [3,4].

Anomalous biliary anatomy is common, as the normal classical branching pattern of the biliary system presents only in about 60% of the normal population. Anomalies result in multiple graft bile duct openings and require more complicated biliary anastomosis in the recipient, so preoperative knowledge of hepatic vascular and biliary anatomical variants is important for planning the optimal surgical strategy [5].

Modern imaging techniques such as Magnetic resonance cholangiopancreatography (MRCP) as a noninvasive imaging technique are very useful in the preoperative evaluation of the biliary system anatomy in living donor liver transplantation.

In this study, we used intraoperative cholangiography (IOC) as the gold standard to evaluate the efficacy of MRCP in depicting the biliary anatomy of liver donors and to reduce the postoperative biliary complications.

2. Patients and methods

This study was performed in our university hospital with cooperation with a specialized hospital. From January 2015 to November 2016, in 54 potential donors with preoperative MRCP

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(45 males, 9 females, age range 22–51 years, mean age 37.2 years) 50 donors underwent conventional MRCP preoperatively and had intraoperative cholangiography (IOC) which acts as a gold standard. Four patients were excluded due to biliary related causes based on MRCP findings (three cases were choledochal cysts and 1 case was multiple biliary hamartomas).

2.1. MRCP protocol

All MRCP studies were performed by 1.5 T magnets (Magnetom Avanto; Siemens Medical Solutions, Erlangen, Germany) and an 8-channel array coil was used. All LDLT donors fasted for at least 6 h before MR imaging.

A multiplanar fast field echo (FFE) starting from the diaphragm to the lower border of both kidneys with slice thickness 9 mm was carried out. Then 2D thin slap axial T2 single shot fast spin echo (SSFSE) respiratory triggered sequence starting from the liver down to the 2nd part of duodenum (TR/TE: 1050/120 ms, slice thickness: 6 mm, FOV: 40 mm, Flip angle: 150, Frequency: 256). This is followed by 3D thin slap coronal oblique with heavy T2 fast saturated fast spin echo (FAT SAT FSE) respiratory triggered sequence (TR/TE: 1860/840 ms, slice thickness: 3 mm, FOV: 32 mm, Flip angle: 180, Frequency: 384). The slaps are arranged parallel to the CBD to visualize both hepatic ducts.

Then 2D thin slap coronal T2 single shot fast spin echo (SSFSE) respiratory triggered sequence was taken (TR/TE: 1050/120 ms, slice thickness: 4 mm, FOV: 40 mm, Flip angle: 150, Frequency: 256). This is followed by 2D coronal thick slap heavy T2 breath hold sequence with 15 –20 slap centered on the CBD (TR/TE:3120/1200 ms, slice thickness: 40 mm, FOV: 34 mm, Flip angle: 180, Frequency: 320).

2.1.1. Intraoperative cholangiography

The IOC was performed by the surgeons before the resection of the right lobe in all patients. After cholecystectomy the remaining part of the cystic duct was cannulated and 10–20 ml of iohexol (Omnipaque, GE Healthcare) contrast media was injected manually to opacify the intrahepatic biliary system under fluoroscopic control, and anteroposterior and oblique views are performed using C-arm fluoroscopic (OEC 9800.GE healthcare) system. The MRCP findings preoperatively were compared with those findings of the IOC.

2.2. Image interpretation

Image reconstruction and post processing with GE workstation using 3D half-Fourier RARE(3D FASE)sequence of the MRCP source images were performed using a maximum intensity projection (MIP) and volume rendering (VR) technique.

After 3D VR and MIP images were obtained, the source axial and coronal images were viewed, to allow optimal evaluation of small bile duct branches or any small accessory bile ducts.

The biliary anatomy was classified into 8 types according to Yoshida classification (Fig. 1).

Images are analyzed for both intra and extra hepatic bile ducts, any biliary congenital anomaly, biliary variants and accessory bile ducts are identified.

2.3. Statistical analysis

A total of 50 donors underwent MRCP, and their anatomical findings were compared to the anatomical findings of intra operative cholangiography.

The diagnostic accuracy of MRCP was correlated with the gold standard intra operative cholangiography (IOC) to calculate the sensitivity, specificity and accuracy of MRCP as a single preoperative method for assessment of biliary anatomy of living liver donors. Statistical Package for Social Science (SPSS) version 9.0 was used. The difference between MRCP and IOC was statistically insignificant according to Kappa method = 0.95 with p value < 0.001.

2.4. Ethical consideration

The protocol of the study was discussed and approved by the ethical scientific committee of the institutional review board as written and signed informed consent of each patient or the patient's authorized representative, was obtained prior to performing the procedure.

3. Results

In our study 54 potential liver donors (45 males, 9 females, age range 22–51 years, mean age 37.2 years) were included. All donors were examined by conventional MRCP without contrast materials. Only 50 donors underwent right liver lobe donation and had intra operative cholangiography for comparison. Four patients were excluded due to biliary related causes based on MRCP findings (3 cases were choledochal cysts and 1 case was multiple biliary hamartomas).

According to Youshida et al.'s classification we found 23 (42.6%) candidates consistent with type 1, 3 (5.6%) candidates consistent with type 2, 14 (25.9%) candidates consistent with type 3, 4 (7.4%) candidates consistent with type 4, and 10 (18.5%) candidate consistent with type 8 (Fig. 2).

Comparison of MRCP findings with intra-operative cholangiography findings was done in the 50 donors of our study (Table 1 and Fig. 3).

MRCP correctly predicted variant anatomy in 46 cases of all 50 cases in our study. Four cases were inaccurate by MRCP interpretation, and they were as follows:-

- Two cases of RPSD drainage into LHD (confirmed by IOC) which were reported as a normal bifurcation with drainage of RPSD into RHD.
- One case of RPSD drainage into CHD (confirmed by IOC) which was reported as an aberrant drainage of right posterior duct into left main duct with accessory small right bile duct into CHD.
- One case of biliary trifurcation (confirmed by IOC) which was reported as RPSD drainage into distal RHD with short carina.

IOC displays additional data in 5 cases from these 46 correct cases that were missed by MRCP:

- Two cases with small IHB duct draining into the distal part of right hepatic duct distal to the insertion of the RPSD.
- One case with small IHB duct draining into the distal part of the common hepatic duct.
- One case with small IHB duct draining into the distal part of right hepatic duct
- One case with small IHB duct draining into the distal part of right posterior sectorial duct.

In comparison with MRCP findings in our study with the golden standard intra-operative cholangiography, the sensitivity, specificity and the diagnostic accuracy of MRCP in demonstrating normal biliary anatomy and anatomical variants were calculated as ollowing:

$$\text{Sensitivity} = 88.2\%, \text{Specificity} = 94.2\% \text{ and accuracy} = 92\%.$$

The diagnostic accuracy of MRCP in detecting small sized segmental accessory intra-hepatic biliary ducts in 5 cases from 10 cases was 50%.

In this study MRCP correctly determined the normal anatomy in 15 candidates (100%) and aberrant ductal anatomy