

ORIGINAL RESEARCH

Role of MR Imaging in Evaluation of Post Laparoscopic Cholecystectomy Biliary Duct Injuries: A Prospective Study from North India

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ABSTRACT

Background

Cholecystectomy can be performed as an open procedure via laparotomy, using a conventional (open) incision (OC) or a mini-incision (MC) or using a laparoscopic procedure (LC). MR is excellent for visualisation of the biliary tract including abnormalities as common bile duct stones, postoperative fluid collections and bilomas, but also other pathological conditions in the abdomen such as abscesses. The aim of this study was to use magnetic resonance cholangiopancreatography (MRCP) as a non-invasive alternative to identify Post Laparoscopic Cholecystectomy Biliary Duct Injuries and compare it with ERCP and post operative findings.

Methods

After receiving ethical approval, the current prospective study was conducted for two years in the Department of Internal Medicine among patients with clinical findings suggestive of postoperative bile duct injury who visited the OPD or were admitted to the wards and underwent MRCP followed by ERCP. Clinical history was gathered during OPD hours or after admission, and patient-specific and pertinent information was acquired through interviews in a structured data collection schedule. All tests were done at a 5% level of significance; an association was considered significant if the p value was < 0.05.

Results

In present study, the mean age of patients was 42.3 22.7 years. 82% of patients were females. Among 70% of patients' persistent right upper quadrant pain was the clinical symptom followed by jaundice (48%). Type II (36%) and Type III (38%) were the common observed Bismuth Injury on MRCP. While comparing the bismuth injury on MRCP findings with intraoperative findings, it was observed that Type II and Type II injuries were accurately diagnosed by MRCP and matches with the intraoperative findings. Strictures with associated dilated IHBR were more accurately diagnosed by MRCP (50% of patients) when compared with ERCP (36% of patients).

Conclusion

Our preliminary results support that MRCP is a useful diagnostic test in patients suspected to have bile duct injury after surgery. MRCP depicts the signs of stricture and excision injury accurately and displays the anatomy completely and accurately.

Keywords: MRI, MRCP, Post laparoscopic cholecystectomy, Bile duct injuries, Ultrasonography

INTRODUCTION

Cholecystectomy can be performed as an open procedure via laparotomy, using a conventional (open) incision (OC) or a mini-incision (MC) or using a laparoscopic procedure (LC) [1,2]. In Scandinavia the median cholecystectomy rate from 1989 to 1995 was 104 per 100,000 inhabitants and year (17). The large number of cholecystectomies performed result in a variety of complications, most of them minor [3,4]. Complications traditionally related to cholecystectomy include wound complications, bile duct injury, bile leakage, haemorrhage, retained common bile duct stones, hepatic artery injury, fluid collections and acute pancreatitis. Ultrasonography (US) is usually the initial imaging method for confirming complications after cholecystectomy [5,6]. CT may provide additional information regarding the peritoneal cavity and pelvis. When a bile duct injury or retained biliary stones are suspected, endoscopic retrograde cholangiography (ERC) is diagnostic and offers therapeutic possibilities. The value of MR imaging after cholecystectomy has not yet been fully evaluated and only few reports using small series have been published [7,8,9]. MR is excellent for visualisation of the biliary tract including abnormalities as common bile duct stones, postoperative fluid collections and bilomas, but also other pathological conditions in the abdomen, e.g. abscesses [10]. The aim of this study was to use magnetic resonance cholangiopancreatography (MRCP) as a non-invasive alternative to identify Post Laparoscopic Cholecystectomy Biliary Duct Injuries and compare it with ERC and post operative findings.

MATERIALS and METHODS

Study setting and Design

After receiving ethical approval from the Institutional Ethics Committee (IEC/IRB No. /04/023; Ethics Committee, Varanasi), the current prospective study was conducted for two years (May 2020 to April 2022) in the Department of Internal Medicine of a Heritage hospital in Varanasi, Uttar Pradesh, India.

Study subjects and sample size

Patients (18 years or older) with clinical findings suggestive of postoperative bile duct injury (persistent right upper quadrant pain, epigastric pain, jaundice, and fever) who visited the OPD or were admitted to the wards were included in the study and underwent MRCP followed by ERC. Prior to enrolling subjects in the study, written informed consent was obtained from either the patient or relatives after a detailed explanation of the study's purpose, and a consecutive sampling method was used to enrol the study subjects, resulting in a total of 50 patients being enrolled in the study over the course of the study's defined duration.

Data collection and MR Imaging Technique

Clinical history was gathered during OPD hours or after admission, and patient-specific and pertinent information was acquired through interviews in a structured data collection schedule. MRCP was performed on a 1.5-T scanner (Picker Eclipse; Marconi, Cleveland, OH) using VIA 2.0 software (Marconi), an image quality—enhancing program. A body coil was used on all patients. Breath-hold T2-weighted half-Fourier acquisition single-shot turbo spin-echo (HASTE) fat-suppressed imaging was performed using the following parameters: TR/effective TE, 18,000/80; matrix, 256 × 256; acquisitions, 1; scanning time, 18 sec. HASTE is a rapid spin-echo sequence and a single-shot acquisition technique that collects all the data in one TR period in a single 18-sec breath-hold and uses half-Fourier acquisition. Axial images were acquired first with 8-mm slice thickness, no gap. Four 30- to 50-mm-thick sections were then acquired in oblique coronal planes in the course of the bile duct (as seen in the axial images) using a field of view of 35 cm. The scanning time for each thick section was less than 8 sec. Next, 5-mm-thick no-gap coronal images were obtained. Three-dimensional images were generated from the coronal source images using maximum-intensity-projection algorithms and multiplanar reformatting techniques. The total scanning time in all patients was between 10 and 15 min. MRCP was performed from 1 to 30 days after the initial surgery. The images were considered to be of diagnostic quality in all patients and no examination had to be cancelled because of lack of patient compliance.

All examinations were interpreted clinically at the time of patient presentation by two experienced abdominal imaging radiologists without knowledge of any other radiologic investigations whose final decisions were reached by consensus. MR imaging was evaluated in all patients for bile duct discontinuity, stricture, biliary dilatation and proximal anatomy filling defects, free fluid, collections, and other associated findings. Biliary excision injury was defined as complete lack of visualization of a bile duct segment on MR cholangiopancreatographic images as well as on the source images.

When biliary excision or stricture was seen, an attempt was made to classify the finding according to the Bismuth classification. Bismuth type I injury is a traumatic injury of the main bile duct occurring more than 2 cm distal from the biliary confluence. A type II injury is located less than 2 cm from the biliary bifurcation. A type III injury completely destroys the common hepatic duct stump but leaves the confluence intact. A type IV injury completely or partially involves the biliary confluence. A type V injury involves the right variant segmental branch, with or without involvement of the main duct.

ERCP was performed all patients. The radiologists interpreting contrast-enhanced cholangiograms were unaware of the results of MRCP. The MR imaging findings were then compared with ERCP.

Statistical analysis

The data was entered into an MS Excel spreadsheet and analysed with the Statistical Package for Social Sciences (SPSS) version 26 software. For each group of research patients, their baseline demographic, clinical, and laboratory information were used to analyse the results. Continuous variables were reported as mean SD, whereas categorical variables were presented as numbers and percentages (%). The Kolmogorov-Smirnov test was used to determine whether the data was normal. The non-parametric test was employed if normality was refused. All tests were done at a 5% level of significance; an association was considered significant if the p value was < 0.05.

RESULTS

In present study, the mean age of patients was 42.3 22.7 years. 82% of patients were females. Among 70% of patients' persistent right upper quadrant pain was the clinical symptom followed by jaundice (48%). In 42% patients the MRCP was performed after 3 weeks duration since OPD visit or admission (Table 1).

Table 1. Baseline characteristics of patients (N=50).

| Characteristics | Number/Mean | %/SD |
|--------------------------------------|-------------|------|
| Age | 42.3 | 22.7 |
| Gender | | |
| Male | 9 | 18 |
| Female | 41 | 82 |
| Clinical symptoms* | | |
| Persistent right upper quadrant pain | 35 | 70 |
| Epigastric pain | 5 | 10 |
| Jaundice | 24 | 48 |
| Fever | 19 | 38 |
| MRCP performed | | |
| At <1 week | 3 | 6 |
| At 1-2 weeks | 17 | 34 |
| At 2-3 weeks | 9 | 18 |
| At >3 weeks | 21 | 42 |

*Multiple responses

In present study, the most common bile duct injury observed on MRCP among patients was Strictures with associated dilated IHBR (50%) followed by Transection with associated bilioma and free fluid (42%). Type II (36%) and Type III (38%) were the common observed Bismuth Injury on MRCP. Type E2 (34%) and Type E3 (42%) were the common observed Strasberg Injury on MRCP. Type C (42%) and Type D (44%) were the common observed Bergman Injury on MRCP (Table 2).

Table 2. Type of bile duct injury observed on MRCP among patients (N=50).

| Bile duct injury | Number | % |
|--|---------------|----------|
| Injury types | | |
| Strictures with associated dilated IHBR | 25 | 50 |
| Transection with associated bilioma and free fluid | 21 | 42 |
| Normal CBD* | 4 | 8 |
| Type of Bismuth Injury on MRCP | | |
| Normal | 4 | 8 |
| Type I | 2 | 4 |
| Type II | 18 | 36 |
| Type III | 19 | 38 |
| Type IV | 7 | 14 |
| Type V | 0 | 0 |
| Type of Strasberg Injury on MRCP | | |
| Normal | 4 | 8 |
| Type A | 0 | 0 |
| Type B | 0 | 0 |
| Type C | 0 | 0 |
| Type D | 0 | 0 |
| Type E1 | 3 | 6 |
| Type E2 | 17 | 34 |
| Type E3 | 21 | 42 |
| Type E4 | 5 | 10 |
| Type E5 | 0 | 0 |
| Type of Bergman Injury on MRCP | | |
| Normal | 4 | 8 |
| Type A | 0 | 0 |
| Type B | 3 | 6 |
| Type C | 21 | 42 |
| Type D | 22 | 44 |

* With a small collection in sub hepatic region with mild free fluid

While comparing the bismuth injury on MRCP findings with intraoperative findings, it was observed that Type II and Type II injuries were accurately diagnosed by MRCP and matches with the intraoperative findings. Strictures with associated dilated IHBR were more accurately diagnosed by MRCP (50% of patients) when compared with ERCP (36% of patients) (Table 3).

Table 3. Comparison of MRCP, ERCP and intra-operative findings among patients (N=50).

| Injury type | Number | % | Number | % |
|--|---------------|-------------|--------------------------------|-------------|
| Bismuth Injury | | MRCP | | |
| Normal | 4 | 8 | Intraoperative findings | |
| Type I | 2 | 4 | 4 | 8 |
| Type II | 18 | 36 | 3 | 6 |
| Type III | 19 | 38 | 17 | 34 |
| Type IV | 7 | 14 | 19 | 38 |
| Type V | 0 | 0 | 7 | 24 |
| | | | 0 | 0 |
| Type of injuries | | MRCP | | ERCP |
| Strictures with associated dilated IHBR | 25 | 50 | 19 | 36 |
| Transection with associated bilioma and free fluid | 21 | 42 | 21 | 42 |
| Normal CBD* | 4 | 8 | 0 | 0 |
| Cystic duct leak or CBD leak | 0 | 0 | 4 | 8 |
| Non suggestive | 0 | 0 | 6 | 12 |

* With a small collection in sub hepatic region with mild free fluid

DISCUSSION

The results of this study showed that MR cholangiography is an accurate diagnostic technique in the identification of postoperative bile duct injuries. These iatrogenic injuries can be devastating, increasing the morbidity and medical cost, while decreasing the patients' quality of life [11]. These bile duct injuries may be recognized intra-operatively, can present in the immediate postoperative period or may manifest later. Intraoperative detection and proper management give the best results. In the present study, MRCP was seen to be highly effective in diagnosing these patients, since it was able to visualize the supra and infrastenotic zones as well as the stenotic area. Indeed, the technique diagnosed the postoperative biliary tract lesions in all 46 patients and correctly visualized the anatomy of the biliary tract. The diagnostic efficacy of ERCP was comparatively inferior in these patients, with the exception of a biliary leak where MRCP showed diagnostic uncertainty. In this context, since MRCP uses no contrast, it is less precise in visualizing fistulous orifices or leakage. Our data was consistent with other studies Yeh et al., [12] and Khalid et al., [13] that have evaluated the role of MRCP in patients with suspected of iatrogenic bile duct injuries. The studies conducted by Roslyn et al., [14] and Adamsen et al., [15] showed that the incidence of bile duct injury was more with laparoscopic cholecystectomy as compared with open cholecystectomy.

ERCP showed stricture in 19 cases (38%), Transection with associated bilioma and free fluid in 21 cases (42%), cystic duct leak or CBD leak in 4 case (8%). No information was given by ERCP in 6 cases (12%) due to failed duodenal intubation. Moreover, evaluation by ERCP in case of complete cut-off was limited by the fact that it showed only the lower end of obstruction and fails to delineate the proximal biliary tract and it is the proximal element of stricture which is important for the type of surgical management. It has been stated that it is difficult to distinguish between biliary stricture and transection on MRCP [16]. CBD was normal in 4 cases (8%) with a small sub hepatic collection and mild free fluid on MRCP.

As MRCP is not a functional study, it does not show bile duct leak directly. To demonstrate leakage IV administration of hepatobiliary contrast agent is needed. In these four cases, ERCP was done which showed cystic duct leak or CBD leak. These four cases does not undergo surgery and were treated by sphincterotomy and stent was placed to temporarily divert the bile flow from the injured segment and permit healing. These patients remain asymptomatic on clinical follow up. The location of bile duct injury was accurately predicted in 46 cases by applying the Bismuth classification to findings on MRCP. The results of our study were comparable with the study done by Alfonso et al., [17]. In their study, injury of bile duct was observed in 16 cases. Of these, two patients had Bismuth type I injuries seen on MR cholangiography as a stricture at the level of the common bile duct more than 2 cm from the biliary confluence; one patient had Bismuth type II injury, and 11 patients had Bismuth type III injuries, showing destruction of the common hepatic duct, leaving the biliary confluence intact with associated presence of intrahepatic bile duct dilation. One patient had Bismuth type IV injury and one patient had a Bismuth type V injury with involvement of the right variant segmental branch and the common hepatic duct. In three patients, MR cholangiography showed an intact biliary tree with small collections adjacent to the cystic duct remnant and evidence of free fluid. The advantages of MRCP over ERCP include a complete anatomical map being obtained of the biliary tract. The technique is also able to detect perihepatic biliomas, degree of stenosis and even allow exact measurements of the supra and infrastenotic tract for the planning of reparatory surgery.

We believe that MRCP play an important role in these postoperative lesions, providing diagnostic data and contributing to decide the best therapeutic approach (conservative, endoscopic-radiologic or reparative surgery). MRCP would thus make it possible to avoid exclusively diagnostic ERCP. The latter technique would in turn play a fundamental role in the type of pathology where some therapeutic intervention is contemplated in the course of the exploration. Our study gave more elaborate account of ductal injury on MRCP than does the results of Yeh et al., [12], Khalid et al., [13] and Alfonso et al., [17]. A limitation in MRCP was that it tends to result in overestimation of the length of strictures because the duct immediately distal to the stricture may be collapsed. Careful analysis of the source images, however, reduces such overestimation. In our small sample, MRCP accurately predicted an intact biliary tree, visualized transection injuries as different from focal stricture, and predicted the presence of bile leaks. Validation from studies with larger sample sizes is needed to establish the accuracy of this imaging procedure. Furthermore, while it is important to recognize this potential limitation of MRCP because surgical reconstruction is the treatment of choice

for bile duct stricture, only the site of the most proximal element of the stricture is relevant, and it is typically the distal extent that is overestimated at MRCP. Our results and that of others suggest that it is unlikely that a stricture will be missed on MRCP [13,16,18,19,20]. Further MRCP has sensitivity of 100% in localizing the site of injury in biliary stricture and transection. This was in accordance with the study conducted by Janice Ward et al.,[21].

CONCLUSION

Our preliminary results support that MRCP is a useful diagnostic test in patients suspected to have bile duct injury after surgery. MRCP depicts the signs of stricture and excision injury accurately and displays the anatomy completely and accurately. The information derived from MRCP enables the radiologist to classify the type of injury and helps to determine treatment, whether endoscopic, percutaneous, or surgical.

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