Original Research Article

Appraisal of Bile Duct Injuries with Magnetic Resonance Imaging

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Abstract

Background: Bile duct injury is a major and potentially life threatening complication of cholecystectomy. Open and laparoscopic cholecystectomy is main therapeutic options for patients with gall stones.
Aim: To ascertain the role of Magnetic Resonance Imaging in the evaluation of bile duct injuries.
Materials and Methods: This prospective study was conducted in department of Radiodiagnosis and Imaging in SKIMS, Soura over a period of 2 year. Twenty-five patients with suspected bile duct injury as a consequence of open and laparoscopic cholecystectomy underwent MR Cholangiography. MR images were evaluated for bile duct strictures, transection injury, leaks, dilated IHBR, free fluid and bilioma formation. Bile duct injuries were classified according to Bismuth, Strasberg and Bergmans classification. Final diagnosis was made on the basis of findings at surgery and on Endoscopic Retrograde Cholangiopancreatography (ERCP).
Results: The location of bile duct injury was accurately predicted in 23 cases. The most common type of Bismuth injury was type III seen in 40% cases, followed by type II seen in 36% cases, type IV seen in 12% cases and type I in 1% case. None of the patients showed type V injury. Intact biliary tree was seen in 2 cases, one showed cystic duct leak and another one CBD leak on ERCP.
Conclusion: MRCP is an important diagnostic tool for evaluation of bile duct injury after surgery enabling the radiologist to classify the type of injury and helps to govern the treatment, whether endoscopic, percutaneous, or surgical.

Key words

BDI-Bile Duct Injury, CBD-Common Bile Duct, CHD-Common Hepatic Duct, ERCP-Endoscopic Retrograde Cholangiopancreatography, IHBR-Intrahepatic Biliary Radicles, MRCP-Magnetic Resonance Cholangiopancreatography, PTC- Percutaneous Trans hepatic cholangiography, USG-Ultrasonography.

Introduction

Bile duct injury is a major and potentially life threatening complication of cholecystectomy [1-3]. Open and laparoscopic cholecystectomy are main therapeutic options for patients with gall stones [4]. latter being associated with less morbidity, shorter hospital stay, earlier return to normal activity and less postoperative pain as compared to former [5]. The incidence of bile duct injury has increased from 0.1 to 0.2% for open cholecystectomy and from 0.4% to 0.6% for laparoscopic cholecystectomy [6-7]. Bile duct injuries are classified as leak, stricture, complete transection and excision of a segment of duct and ligation of a major bile duct [8-14]. Bile duct injuries can be caused by erroneous cutting of bile ducts, accidentally misplaced clips, laceration, occlusion or peri ductal leakage due to thermal injury by electrocautery leading to fibrosis [1-3, 8-12].

The Bismuth classification is based on the localisation of biliary strictures according to the distance from the biliary confluence [15]:

Bismuth classification of IBDI

Type	Criteria
I	Common bile duct and low common hepatic duct (CHD) > 2 cm from hepatic duct confluence;
II	Proximal CHD < 2 cm from the confluence
III	Hilar injury with no residual CHD-confluence intact
IV	Destruction of confluence: right and left hepatic ducts separated
V	Involvement of aberrant right sectoral hepatic duct alone or with concomitant injury of CHD

However, Bismuth classification does not include the entire spectrum of bile duct injury. Consequently, Strasberg, et al. [16] made the Bismuth classification much more comprehensive by including other types of laparoscopic extra-hepatic bile duct injuries, and is described hereunder:

Type	Criteria
A	Leak from cystic duct or bile duct of Luschka.
B	Occlusion of aberrant right hepatic duct.
C	Transection without ligation of aberrant right hepatic duct.
D	Lateral injury to major bile duct.
E	Subdivided as per the bismuth classification into E1-E5.

Bergman, et al. [17] has also divised classification system that divides post laparoscopic cholecystectomy biliary tract injuries into four types:

Type A → Cystic duct leak or lakage from aberrant or peripheral hepatic radicles.

Type B → Major bile duct leaks with or without concomitant biliary strictures.

Type C → Bile duct strictures without bile leakage.

Type D → Complete transection of the duct with or without excision of some portion of biliary tree.

The initial treatment of these patients depends on the type of injury and the time of its recognition. Therefore, it is essential to determine the morphological details of the injury and define the anatomy of proximal biliary tree; this would determine strategy for biliary reconstruction and significantly affect the long term prognosis [9, 18-19]. Radiological imaging is extremely useful and is the preferred way to evaluate for the

presence of bile duct injury. The initial radiological imaging technique is abdominal ultrasound. However, cholangiography remains the gold standard for evaluating bile duct injuries. Various modalities used in the diagnosis of bile duct injuries are Percutaneous Transhepatic Cholangiography (PTC), Endoscopic Retrograde Cholangiopancreatography (ERCP), direct cholangiography, and Magnetic Resonance Cholangiopancreatography (MRCP). Of all these MRCP being safe, non-invasive and rapid, allows exploration above and below the level of obstruction, a resource provided by neither ERCP nor PTC and allows the accurate classification of injuries. Therefore, this study was undertaken to perform a critical appraisal of MRI/MRCP in the evaluation of bile duct injuries.

Materials and methods

Patients

In a period of two years, a total of 25 patients with suspected postoperative bile duct injury were subjected to a prospective study with MRCP. There were 4 men and 21 women, the average age was 38.96 years, range (18-70 years). The highest number of cases (60%) occurred in 31- 40 years of age. Women were more affected (84%). Patients most commonly presented with icterus (n=15), pain abdomen (n=13) and fever (n=12).

Technique

MR cholangiography studies were performed on a 1.5-T scanner (MAGNETOM Avanto, Siemens). A body coil was used in all patients. Breath-hold axial fast spin-echo T2-weighted images were obtained using the following parameters: TR/effective TE18,000/84; matrix 256×256; scanning time 18 sec; and slice thickness 5 mm. Four 30- to 50-mm-thick sections were then acquired in oblique coronal planes along the course of the bile duct using a field of view of 35–38 cm. The scanning time for each section was less than 8 sec. Subsequently, 5-mm thick no-gap breath-hold fat-suppressed coronal images (scanning time 16 sec) were obtained. Two dimensional and 3D images were finally generated from the coronal source images using maximum-intensity-projection algorithm and multi-planar reformatting techniques. The total scanning time in all patients ranged between 20 and 25 min. MR images were considered of good diagnostic quality in all patients and no examination was cancelled. MR images were evaluated for bile duct discontinuity, presence or absence of biliary dilation, stricture, transection injury, free fluid, and collections. Stricture was defined as sudden cut –off in calibre of CBD with associated dilated IHBR and patient presented late after surgery while as transection was defined as sudden cut –off in calibre of CBD with associated subhepatic or gall bladder fossa collection and patient presented in early post cholecystectomy period. Biliary injuries were classified according to the Bismuth, Strasberg and Bergmans classification. MR cholangiography was performed after 21 days of post cholecystectomy in 11 cases (44%), after 16-21 days in 5 cases (20%), 7-15 days in 8 cases (32%) and within 1 week in 1 case.

Results

In our study, out of 25 patients; 12 patients (48%) shows strictures with associated dilated IHBR, 11 patients (44%) show transection with associated bilioma and free fluid; and CBD was normal in 2 patients (8%) with a small collection in sub hepatic region with mild free fluid. Cystic duct leak or CBD leak was not detected by MRCP. One patient shows features of both transection with dilated IHBR, bilioma and free fluid which was diagnosed as ligature injury with leak at surgery. According to Bismuth classification, the most common type of bile duct injury was type III (40%) (**Figure - 1A, 1B**), followed by type II (36%) (**Figure - 2**), type IV (12%) (**Figure - 3**) and type I (4%) (**Figure - 4**). MRCP was normal in 2 patients (8%) and none of the patient shows type V injury. **Table - 1** shows distribution of patients according to type of Bismuth injury on MRCP.

Figure - 1A: MR Cholangiogram showing Bismuth type I injury.

Figure - 1B: Corresponding ERCP image depicts no flow of contrast across the stricture.

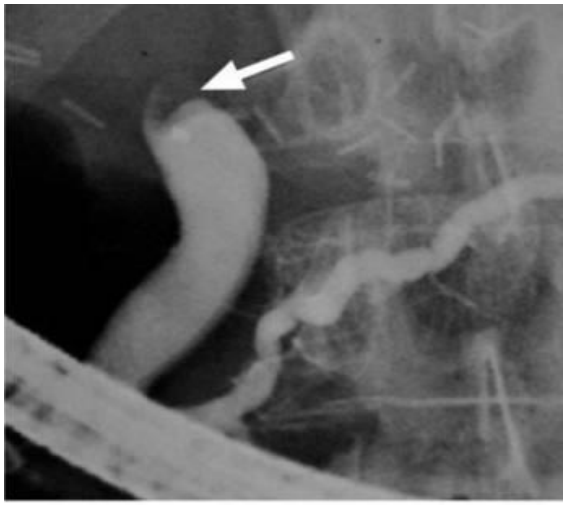

Figure - 2: MR Cholangiogram showing Bismuth type II injury.

Figure - 3: MR Cholangiogram showing Bismuth type III injury at the level of common hepatic duct, leaving biliary confluence intact.

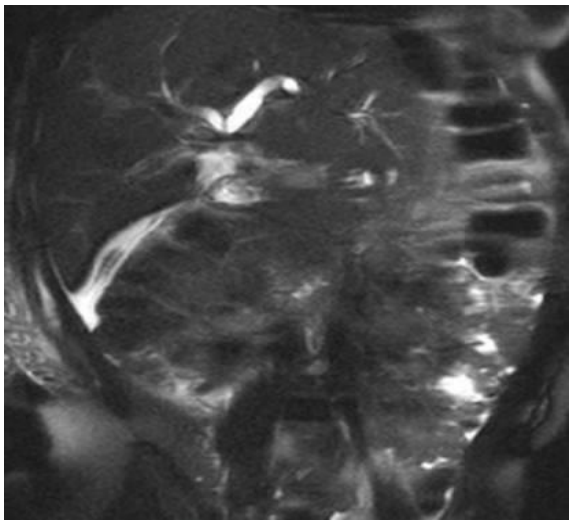

Figure - 4: MR Cholangiogram showing Bismuth type IV injury at the level of common hepatic duct with extension and partial destruction of biliary confluence. Patient was treated with hepaticojejunostomy.

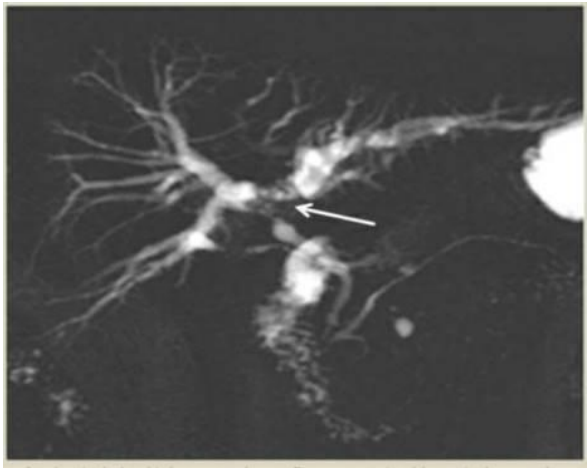

Table – 1: Distribution of patients according to type of Bismuth injury on MRCP.

Type of Bismuth Injury on MRCP	No. of patients (n=25)	%
Normal	2	8
Type I	1	4
Type II	9	36
Type III	10	40
Type IV	3	12
Type V	0	0

Similarly, according to type of Strasberg injury on MRCP. Out of 25 patients; the most common type of bile duct injury was type E3 (40%), followed by type E2 (36%), type E4 (12%) and type E1(4%). MRCP was normal in 2 patients (8%) and none of the patient shows type A, type B, type C, type D and type E5. **Table - 2** shows distribution of patients according to type of Strasberg injury on MRCP.

Table – 2: Distribution of patients according to type of Strasberg injury on MRCP.

Type of Strasberg Injury on MRCP	No. of patients (n=25)	%
Normal	2	8
Type A	0	0
Type B	0	0
Type C	0	0
Type D	0	0
Type E1	1	4
Type E2	9	36
Type E3	10	40
Type E4	3	12
Type E5	0	0

According to type of Bergman injury on MRCP. Out of 25 patients; type C and type D constitute 11 patients (44%) each, 1 patient (4%) shows type B injury, 2 patients (8%) show normal MRCP and none of the patients show type A Bergman injury. **Table - 3** shows distribution of patients according to type of Bergman injury on MRCP.

Table – 3: Distribution of patients according to type of Bergman injury on MRCP.

Type of Bergman Injury on MRCP	No. of patients (n=25)	%
Normal	2	8
Type A	0	0
Type B	1	4
Type C	11	44
Type D	11	44

When compared with intraoperative findings, all 10 cases of type III bismuth injury on MRCP were confirmed on surgery. Out of 9 cases of type II Bismuth injury on MRCP, only 8 cases came out as type II Bismuth injury on surgery. 1 case actually had CBD ligation injury with associated leaks on surgery. 3 cases of type IV Bismuth injury were accurately depicted on surgery. 1 case showing type I Bismuth injury on MRCP reveal same findings on surgery. None of the patients show type V Bismuth injury on surgery as same was revealed by MRCP. All these 23 cases undergo Roux-en-Y hepaticojejunostomy. The two cases who were diagnosed as biliary leaks on ERCP does not undergo surgery, as these patients remain asymptomatic on clinical follow up.

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 [20]. 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 23 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 TS [9] and Khalid TR [18] that have evaluated the role of MRCP in patients with suspected of iatrogenic bile duct injuries. In our study the incidence of bile duct injury was more with open cholecystectomy as compared with laparoscopic cholecystectomy which was not in accordance with the study conducted by Roslyn

JJ [6] and Adamsen S [7]. This was due to the fact that most of the cases (n= 19) underwent open cholecystectomy and only 6 cases underwent laparoscopic cholecystectomy. Moreover, all cases of open cholecystectomy were done in rural areas where operative skills for cholecystectomy are less as compared to urban area. ERCP showed stricture in 9 cases (36%), complete cut –off of bile duct in 7 cases (28%), partial cut –off in 4 cases (16%), cystic duct leak in 1 case (4%) and CBD leak in 1 case (12%). No information was given by ERCP in 3 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 [21]. CBD was normal in 2 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 two cases, ERCP was done which showed cystic duct leak in 1 case and CBD leak in another case. These two 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 23 cases by applying the Bismuth classification to findings on MRCP. The results of our study were comparable with the study done by Alfonso [22]. 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 TS [9], Khalid TR [18] and Alfonso [22]. 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. 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 [8, 18, 19, 21, 23]. 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 [24].

Conclusion

MRCP is a non-invasive, high resolution imaging technique which provides excellent delineation of the biliary anatomy proximal and distal to the level of injury. So it is considered the imaging of choice for characterizing the injury and planning management procedures.

Limitations of the study

Low proportion of patients is a limitation of our study.

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