J Nepal Health Res Counc 2013 May;11(24):187-93

Bile Duct Injuries during Open and Laparoscopic Cholecystectomy: Management and Outcome

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ABSTRACT

Background: The widespread application of laparosopic cholecystectomy has led to a rise in the numbers of major bile duct injuries (BDI). Perioperative management of these injuries is complex and challenging. There are few published reports locally regarding the perioperative management of BDI. Purpose of this review was to analyze our experience in diagnosis, management and prevention of BDI.

Methods: This study was conducted in department of surgery at B. P. Koirala Institute of Health Sciences. From January 2001 to September 2010, a observational study of all patients with a BDI following cholecystectomy was maintained. Patients' charts were retrospectively reviewed to analyze incidence, type of injury, presentation, and perioperative management of BDI.

Results: A total of 92 patients had BDI which occurred during cholecystectomy, were analysed retrospectively. There were 60/92 (65.5%) patients with BDI resulting from the wrong identification of the anatomy of the Calot's triangle during cholecystectomy. Abdominal ultrasonography was diagnostic for BDI in 71/90 (78.8%). Magnetic resonance cholangiography could reveal the site of injury, the length of injured bile duct and variation of bile duct tree with a diagnostic rate 22/23 (95.6%). The most common injury was Strasberg's E2 in 65/92 (70.7%). A transection or stricture of the bile duct was repaired by hepaticojejunostomy (83 cases in this series). Seventy-five (81.5%) patients were followed up. The mean follow-up time was 2.6 years (range 0.16-6). Good results were achieved in 62/75 (82.6%) of the patients.

Conclusions: The high success rate of bile duct repair in the present study can be attributed to the appropriate timing, meticulous technique and the tertiary care experience.

Keywords: Bile duct injury; cholecystectomy; hepaticojejunostomy.

INTRODUCTION

On an average 1,200 cholecystectomies are performed annually at B. P. Koirala Institute of Health Sciences, making gallstone disease one of the most common digestive health problems.[1] By the early 1990s, laparoscopic cholecystectomy (LC) had supplanted open cholecystectomy (OC) in the operative management of gallbladder stone disease. During the surgical learning curve of this technique there was an initial spurt in the reports of bile duct injuries (BDI) mainly due to inexperience and misinterpretation of the anatomy.[2] It has been suggested that half of all general surgeons may encounter bile duct injuries.[3] The widespread application of LC has led to a concurrent rise in the incidence of major BDI to 0.4% to 0.6% from 0.1% to 0.2% of OC era. [4,5]

The diagnosis, management and prevention of BDI still remain a challenge. The published literature have few reports regarding the early operative management of BDI.[6] The aim of this study was to review the clinical data of patients with BDI, analyze the causes and

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perioperative management at our institute. We aim to further discuss the prevention of BDI based on these analyses.

METHODS

This study was conducted in Department of Surgery at B. P. Koirala Institute of Health Sciences, Nepal from January 2001 to September 2010, a prospective database of all patients with a BDI following cholecystectomy was maintained. This was a retrospective study, patients' charts were retrospectively reviewed to analyze current incidence, mechanism, presentation, and perioperative management of BDI occurring during cholecystectomy in general surgical practice. This study was approved by the Institute's Ethical review board.

The total cholecystectomy performed in the study period was 11345. Among them 75% of the patients underwent LC and 25% patients underwent OC. Eighty-three LC patients (0.9%) were converted to open procedure. The elective cholecystectomy was performed in 9371 patients (82.6%), while 1974 patients (17.4%) underwent emergency cholecystectomy for acute presentation. Total BDI at our institution was 77 (0.68%); 12 (0.41%) during OC and 65 (0.77%) in LC. Seventy-three percent of the BDI occured during elective cholecystectomy, while 27% during emergency. Fifteen patients of BDI were referred from outside, all of which occurred during elective cholecystectomy. Among them, 11 (73.3%) occurred during OC and 4 (26.7%) during LC (Table 1).

Major BDI included all transections or partial lacerations of the common hepatic duct, common bile duct, or major segmental ducts at the portahepatis. Minor leaks from the cystic duct or gallbladder bed were excluded. This report includes injuries and strictures incurred in association with cholecystectomy, irrespective of whether the operation was OC, LC or LC converted to an open procedure. Patients with bile duct strictures from trauma or benign inflammatory processes, as well as strictures from malignant causes, were excluded. Strassburg classification was used to categorize the type of BDI.

Resolution of jaundice and/ or cholangitis was defined as good results. Statistical analysis was performed using Stata 7.0 software (Stata Corp, College Station, Tex), with data expressed as means and ranges.

RESULTS

In 9 years and 9 months, 92 patients were treated at our institute for major BDI. There were 28 males and 64 females, the age ranging from 23 to 68 years (mean 46.5 years). The causes of BDI were identified in 79 (85.8%) patients. The most frequent cause was misperception (by mistaking the common bile duct CBD for the cystic duct), and difficult calot's triangle (grade III-V) in 52 (65.9%) patients, followed by anatomical anomalies in 10 (12.7%) patients, unspecified technical mistake in 9 (11.4%) patients, control of intraoperative hemorrhage in 7 (8.8%) patients, and retrograde cholecystectomy for safety in 1 (1.2%) patient.

Table 1. Bile duct injuries during open and laparoscopic cholecystectomy.

Total cholecystectomy (at our institute) in the study period 11345			
LC N (%)	OC N (%)	Elective cholecystectomy N (%)	Emergency/ Acute cholecystectomy N (%)
8424 (75)	2921 (25)	9371 (82.6)	1974 (17.4)
Total BDI (at our institute) N (%)	77 (0.68)		
BDI during OC N (%)	BDI during LC N (%)	BDI at our institute during elective cholecystectomy N (%)	BDI at our institute during emergency/ acute cholecystectomy N (%)
12 (0.41)	65 (0.77)	56 (73)	21 (27)
Total BDI (referred from outside) N	15		
BDI during OC N (%)	BDI during LC N (%)		
11 (73.3)	4 (26.7)		

BDI were classified according to the Strasberg's classification (Table 2).[7]

Table 2. Classification of bile duct injuries proposed by Strasberg.[7]

Type	Characteristics
A	Leak from subvesical duct
B	Clipped and divided right segmental duct
C	Divided right segmental duct
D	Lateral injury common hepatic duct
E1	Common hepatic duct division more than 2cm from bifurcation
E2	Common hepatic duct division less than 2cm from bifurcation
E3	Common duct division at bifurcation
E4	Separate left and right hepatic duct strictures
E5	Combined injury to main duct at bifurcation and right segmental bile duct

The type of and factors leading to BDI found in our cases are tabulated in the (Table 3).

Table 3. Classification of bile duct injuries (n = 92).

Type	N (%)	Factors	N (%)
B	2 (2.1)	Misapplied clips	4 (4.3)
C	4 (4.3)	Scissors	71 (77.3)
D	3 (3.3)	Ligature	3 (3.3)
E1	2 (2.1)	Diathermy	12 (13)
E2	65 (70.7)	Unidentified	2 (2.1)
E3	9 (9.8)		
E4	2 (2.1)		
E5	5 (5.6)		

N- Number of patients

Diagnosis

Clinical manifestation: Of the 92 BDI patients, 27 (29.3%) patients were diagnosed during cholecystectomy by the presence of bile leaking in the operative field and a double biliary stump. The remaining 65 (70.7%) patients were diagnosed postoperatively. Among these 65 patients, 44 (47.8%) patients were recognized in the early stage (within 3 months after BDI). Most of them 38/4 (86.4%) patients were recognized during same hospital admission. The main clinical manifestations in these patients were abdominal pain in 88.6%, bilious drainage from an intra-operatively placed drain or abdominal incision site in 68.2%, peritonitis in 56.8% and jaundice in 27.2%. Bile was found during diagnostic abdominal aspiration in 47.7% of patients in early postoperative period. The remaining 21/92 (22.9%) patients were recognized in the late postoperatively period (after 3 months of BDI). The main clinical manifestations in these patients were recurrent chills, fever, jaundice and abnormal liver function tests.

Imaging: Included abdominal ultrasonography (USG), computed tomography (CT), endoscopic retrograde cholangiopancreatography (ERCP), percutaneous transhepatic cholangiography (PTC), magnetic resonance cholangiography (MRC) (Figure 1), T- tube cholangiography, (Table 4). USG could reveal subhepatic fluid collection, proximal biliary tree dilatation and disruption of continuity of the bile duct. CT scan could display the dilated proximal biliary tree, the level and length of BDI. ERCP could show small distal common bile duct (CBD) or disruption of the CBD but lacked visualization of the proximal biliary tree. PTC showed intrahepatic bile duct dilatation, disruption or stenosis of the bile duct. T tube cholangiography showed disruption or real stenosis of the bile duct. MRC could reveal proximal bile duct dilatation of BDI, the level and length of BDI and variation of bile duct tree anatomy. In early stage (within 3months after BDI), where the biliary leak and peritonitis was the common presentation, most of the patients underwent USG and CT scan. Patients who were referred from outside with drainage tube in biliary duct underwent T-tube cholangiography. Earlier half period of study, we don't have investigation facility like ERCP and MRCP. In the late stage (over 3 months after BDI), where the common presentation was cholangitis and suspicions were near complete/ complete stricture, mostly underwent CT scan and MRCP.

The USG was the most popular way for diagnosing BDI in this group with a diagnostic rate of 78.8%. MRC had a diagnostic rate of 95.6%.

Table 4. Imaging examination in diagnosis of BDI (n = 92).

IMAGING	N	DIAGNOSTIC ACCURACY N (%)
USG	90	71 (78.8)
CT	58	51 (87.9)
ERCP	18	13 (72.2)
PTC	7	4 (57.2)
MRC	23	22 (95.6)
T-tube cholangiography	11	3 (27.2)

ERCP: Endoscopic Retrograde Cholangio-Pancreatography; PTC: Percutaneous Transhepatic Cholangiography; MRC: Magnetic Resonance Cholangiography.

Table 5. Repair of iatrogenic bile duct injuries (n = 92).

Type of repair	Diagnosed during Operation (n = 27)	Recognized in early stage [within 3 months] (n=44)	Recognized in late Stage [after 3 months] (n = 21)
RHD injury repair + T tube drainage	2	4	
Roux-en-Y hepaticojejunostomy	22	40	21
End-to-end anastomosis + T tube drainage	3		

RHD: Right Hepatic Duct; LHD: Left Hepatic Duct.

Repair: Fifteen patients (16.3%) of BDI were referred from outside and 77 (83.7%) were from our institution. Before the patients were referred to our hospital, they had right and/or left hepatic duct drainage and abdominal drainage. Most of the BDI, which were referred from outside occurred during OC. All were detected during intraoperative period. They underwent drainage procedure of extra hepatic biliary radicle with small diameter (5-7 Fr) tubes and one abdominal drain in

hepatorenal pouch. At our hospital, BDI were managed according to their type (Table 5).

When all the adhesions to the right upper quadrant were sectioned, the jejunal limb was dissected. Hepatobiliary duct-jejunum single layer anastomosis was performed with interrupted 4/0 absorbable polyglactin (Vicryl) sutures. Liver resection of segment IV base was done when the liver was overhanging the upper ducts, allowing adequate exposure of the left duct. To obtain a complete view of the confluence and/or the isolated right and left hepatic ducts and to allow free placement of the jejunal limb, liver parenchyma could be removed. When the retractors were released, there was no external compression over the jejunum. Partial injuries to the side wall of the bile duct were repaired primarily with T tube placement through a separate choledochotomy when there was no evidence of ductal devascularisation and when the margins of the defect could be approximated without tension. Injuries to isolated sectoral or segmental ducts were repaired or drained into a Roux-en-Y limb of jejunum. Depending on the level of injury and biliary ductal involvement, a median of 2 biliary stents was placed intraoperatively. The Postoperative transcatheter cholangiography was performed routinely (Figure 2). To prevent postoperative biliomas or intra-abdominal collections, a median of 2 drains was placed intraoperatively at the anastomosis.

Follow-up and outcome: Of the 92 patients with BDI who underwent biliary reconstruction, three (3.3%) died in the postoperative period due to sepsis and multiple organ failure. Longer-term outcome was assessed by clinical symptoms and liver function tests in outpatient visit. The follow-up protocol for these patients included clinical assessment and liver function test (LFT) every 6 months.

Seventy five patients were followed up. The mean time of follow-up was 2.6 years (range 0.16-6). Good results resolution of jaundice and/ or cholangitis was obtained in (62/75) 82.6%. Three patients developed symptoms suggestive of cholangitis within 24 months and imaging demonstrated re-stricture. They underwent revision Roux-en-Y hepaticojejunostomy.

DISCUSSION

BDI is a serious complication of cholecystectomy with a long-term morbidity, reduced survival and impaired quality of life.[8-12] Although the reported incidence is less than 0.7%, the true incidence is unknown. Some injuries remain unrecognized for many years, occasionally coming to light only when the patient develops secondary biliary cirrhosis.[13] Even though cholecystectomy is a common operation, it is full of dangers.[14]

Main cause of BDI during cholecystectomy in this series was removal of gallbladder without identifying the anatomy of the Calot's triangle, before transecting cystic duct. Three-step principle of "identifying-cutting-identifying" should be followed during cholecystectomy, namely, identifying CBD and common hepatic duct CHD before cutting the cystic duct and identifying the integrity of CBD and CHD again after removal of the gall bladder. Immediate recognition and correct repair of BDI have long been believed to be associated with the best long term results. In this series, BDI in 27 patients was recognized during cholecystectomy and managed correctly.

Several classifications of BDI have been proposed.[15-17] An ideal classification should not only consider the level of BDI, but also take into account the length and diameter of BDI as well as instruments leading to BDI and vascular injury. Such classifications are useful for standardization of outcome and prediction of prognosis. More important is such classifications not only differentiate the extent of BDI, but also guide the surgical management of BDI. Bismuth classification was used to stratify biliary injuries in the era of open cholecystectomy,[18] but it has become less useful as the pattern of injury has altered due to laparoscopic cholecystectomy. In 1995, Strasberg introduced a classification that retained the essence of the Bismuth classification for major injuries, but broadened the classification to separately itemize the injuries seen with increased frequency during laparoscopic cholecystectomy and this classification has found considerable acceptance.[7] A minor (type A or C) injury needs drainage only, sometimes with ligation of the subvesical/ segmental duct, and a lateral injury (type D) can be repaired over a T-tube or by postoperative endoscopic sphincterotomy and stenting. A major BDI (type E) detected during cholecystectomy can be repaired with a Roux-en-Y hepaticojejunostomy if the expertise is available — "the best time to fix it is that time".[6] BDI caused by electrocoagulation or electrotome, usually presents as scorched eschar in the operation region, and is difficult to do end-to-end anastomosis. With respect to the Strasberg's classification, the most common type was type E injuries (90.2%), followed by type C injuries (4.3%) in our series. Attention should be paid to type B injuries (2.1%) as they are associated with aberrant right hepatic duct.

Recognition of BDI at the time of cholecystectomy allows an opportunity for the surgeon to assess its severity and the presence of any vascular injury. If bile or a double biliary stump is seen in the operative field during cholecystectomy, BDI should be considered. A total of 27 BDIs were diagnosed during cholecystectomy in our series. As many as 65 (70.7%) cases of BDI were

not diagnosed during surgery in this series, which is comparable to incidence reported in other series.[7] BDI should be considered when the following manifestations occur after cholecystectomy: presence of jaundice in the early postoperative period, peritonitis or bile on abdominal aspiration, patients with gradual distention of their abdomen, imaging examination revealing intrahepatic duct dilatation and unclear extrahepatic duct.

Patients already on broad-spectrum antibiotics may have delayed signs of biliary peritonitis and only show abdominal distention. There were seven such cases (15.9%) in our series and abdominal aspiration was diagnostic.

The main clinical manifestations were recurrent chills, fever, jaundice and abnormal liver function tests. Late presentations included recurrent cholangitis. Ultrasonography was the most common examination. Ninety patients in our series had undergone this examination, revealing any collection, check the integrity of CBD and for any evidence of distal obstruction. CT scan displayed dilated proximal biliary tree, level and length of BDI. If ultrasonography and CT scan results are equivocal in a symptomatic patient, magnetic resonance cholangiography could be performed as its sensitivity is higher than ultrasonography and CT scan (95.6% vs 78.8% and 87.9%). MRCP is also better and more specific investigation modalities in delineating the biliary tree.

The repair time of BDI often remains controversial.[19-22] To determine the time of re-operation, the following criteria should be met according to our experience. Firstly, the proximal bile duct should be dilated with its diameter exceeding 5mm. Secondly, abscess presented around the injured bile duct is a contraindication of operation. In our series, for patients with complete CBD 'cut-off' on MRC/ERC and gross peritoneal contamination, exploratory laparotomy was performed to drain the peritoneal cavity and create a controlled external biliary fistula. At laparotomy, the proximal leaking stump was identified. Gentle effort was made to look for the distal divided end of the CBD by removing any ligature or clip in the hepatoduodenal ligament distally. If both ends could be identified, biliary continuity was established by inserting a T-tube of appropriate size into both the stumps (Figure 2). Otherwise, the proximal stump was drained by an infant feeding tube of adequate size (tube hepaticostomy). A large bore tube drain was placed in the subhepatic space to drain out the leaking bile. Very sick patients were managed in the intensive care unit. They were initially administered broad spectrum and later culture specific antibiotics. In patients with tube hepaticostomy or T-tube, the subhepatic drain was removed once it stopped draining. The T-tube was clamped if cholangiogram showed free flow of dye into duodenum. The patients were discharged home either with the tube hepaticostomy or the clamped T-tube. They were kept on regular follow-up and a definitive repair, i.e. hepaticojejunostomy was performed at least after 3 months.

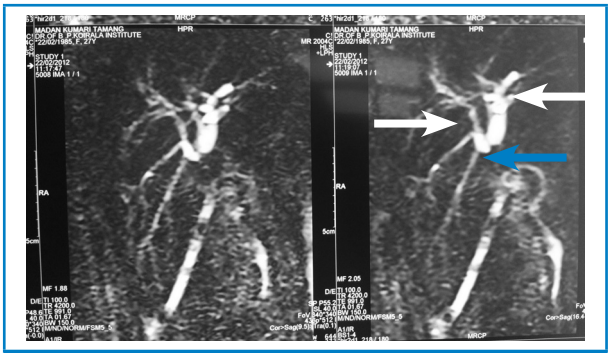

Figure 1. Magnetic resonance cholangio-pancreatography: in a patient with common hepatic duct stricture (Strasberg grade E3) following laparoscopic cholecystectomy.

Right hepatic duct – white arrow, Left hepatic duct- blue arrow, Stricture at hilum- black arrow

Figure 2. Postoperative transcatheter cholangiography in the same patient after a Roux-en-Y hepaticojejunostomy (white arrow) anastomosis.

Right hepatic duct – white arrow, Left hepatic duct- blue arrow, Stricture at hilum- black arrow

Operative technique focuses on the site of proximal BDI and takes corresponding operation procedure according to the type of BDI. Hepaticojejunostomy is preferred to either choledocho-choledochotomy or choledocho-duodenostomy, for a tension-free anastomosis. Choledocho-choledochotomy has the additional disadvantage of poor blood supply. Patients with BDI are not suitable for Roux-en-Y hepaticojejunostomy when

the diameter of proximal bile duct is less than 5 mm. A transection or stricture of the bile duct is repaired by hepaticojejunostomy (83 cases in this series) to the biliary confluence with extension into the left and/or right hepatic duct, onto a 60 cm Roux-en-Y limb of proximal jejunum. Fine absorbable sutures polyglactin (Vicryl 4-0 round body needle) are used to construct the anastomosis. We use the anastomotic stent of siliastic tube of 5-7 Fr, when very small ducts have been anastomosed, which was inserted through the jejunum. Stents are left through the anastomosis for several days in order to perform postoperative cholangiogram.

When hepaticojejunostomy is performed, the following manoeuvres may be helpful according to our experience. (1) The hepatic hilus great triangle should be ascertained to downsize the area for seeking the injured bile duct. (2) Cordlike tissue near hepatic hilus usually gives clues for the site of bile duct. (3) Ligamentum teres approach can identify the left duct, and gallbladder bed approach can identify the right duct. Resecting liver parenchyma of segments IV and V helps to expose hepatic hilus bile duct. (4) To achieve a wide hepatobiliary basin (1-3 cm), the extrahepatic portion of the left hepatic duct could be lowered by dividing the hepatic plate, (first step in all E type repairs which are not fresh), and an anterior longitudinal opening is created in the bile duct and a long side-to-side anastomosis is performed. This is technically easier, less hazardous, causes less devascularizing and creates wide anastomosis. (5) In high repairs, exposure could be facilitated by dividing the bridge of tissue between segments III and IV, by fully opening the gallbladder fossa. Resecting part of segment IVb resection is an invaluable adjunct in the very difficult case. (6) Tension-free anastomosis can be achieved by obtaining an adequate free limb by preparing the mesentery, with preservation of the vascular arcades. The jejunal limb should be in-phase with duodenum but not with climb across duodenum. (7) Factors associated with an improved outcome include the use of absorbable sutures, tension free, single-layer, nonischemic mucosa to mucosa, adequate caliber anastomosis with good blood supply and debridement.

CONCLUSIONS

Over the last 10 years, we have developed an institutional methodology for management of patients with major BDI following OC and LC. Our experience represents the largest experience with patients with major BDI reported by a single institution. The high success rate of bile duct repair in the present study can be attributed to the appropriate timing, meticulous technique and the tertiary care experience, a fact that has been highlighted by several authors.

The experiences gained from open cholecystectomy and the advantages of LC in terms of visualization and magnification will help in reducing the incidence of such catastrophes. Principles of management include anatomic definition of injury, control of sepsis, staged approach involving interventional radiology and refined operative technique.

REFERENCES

1. Yadav RP, Adhikary S, Agrawal CS, Bhattarai B, Gupta RK, Ghimire A. A comparative study of early vs. delayed laparoscopic cholecystectomy in acute cholecystitis. Kathmandu Univ Med J. 2009 Jan- Mar;7(25):16-20.
2. Huang ZQ, Huang XQ. Changing patterns of traumatic bile duct injuries: A review of 40 years experience. World J Gastroenterol. 2002 Feb;8(1):5-12.
3. Francoeur JR, Wiseman K, Buczkowski AK, Chung SW, Scudamore CH. Surgeons' anonymous response after bile duct injury during cholecystectomy. Am J Surg. 2003 May;185(5):468-75.
4. Roslyn JJ, Binns GS, Hughes EF, et al. Open cholecystectomy: a contemporary analysis of 42,474 patients. Ann Surg. 1993 Aug;218(2):129-37.
5. Deziel DJ, Millikan KW, Economou SG et al. Complications of laparoscopic cholecystectomy: a national survey of 4,292 hospitals and an analysis of 77,604 cases. Am J Surg. 1993 Jan;165(1):9-14.
6. Lillemoe KD, Melton GB, Cameron JL, Pitt HA, Campbell KA, Talamini MA et al. Postoperative bile duct strictures: management and outcome in the 1990s. Ann Surg. 2000 Sep;232(3):430-41.
7. Strasberg SM, Hertl M, Soper NJ. An analysis of the problem of biliary injury during laparoscpic cholecystectomy. J Am Coll Surg. 1995 Jan;180(1):101-25.
8. Mirza DF, Narsimhan KL, Ferraz Neto BH, Mayer AD, McMaster P, Buckels JA. Bile duct injury following laparoscopic cholecystectomy: referral pattern and management. Br J Surg. 1997 Jun;84(6):786-90.
9. Zen Y, Harada K, Sasaki M, Tsuneyama K, Matsui K, Haratake J et al. Are bile duct lesions of primary biliary cirrhosis distinguishable from those of autoimmune hepatitis and chronic viral hepatitis? Interobserver histological agreement on trimmed bile ducts. J Gastroenterol. 2005 Feb;40(2):164-70.
10. Flum DR, Cheadle A, Prela C, Dellinger EP, Chan L. Bile duct injury during cholecystectomy and survival in medicare beneficiaries. JAMA. 2003 Oct 22; 290(16):2168-73.
11. Moore DE, Feurer ID, Holzman MD, Wudel LJ, Strickland C, Gorden DL et al. Long-term detrimental effect of bile duct injury on health-related quality of life. Arch Surg. 2004 May;139(5):476-81.
12. Melton GB, Lillemoe KD, Cameron JL, Sauter PA, Coleman J, Yeo CJ. Major bile duct injuries associated with laparoscopic cholecystectomy: effect of surgical repair on quality of life. Ann Surg. 2002 Jun;235(6):888-95..

13. Schmidt SC, Langrehr JM, Hintze RE, Neuhaus P. Long-term results and risk factors influencing outcome of major bile duct injuries following cholecystectomy. Br J Surg. 2005 Jan;92(1):76-82.

14. Yang JM. Cholecystectomy and bile duct injury. Zhongguo Shiyong Waike Zazhi. 1999;19:454-56.

15. Stewart L, Robinson TN, Lee CM, Liu K, Whang K, Way LW. Right hepatic artery injury associated with laparoscopic bile duct injury: incidence, mechanism, and consequences. J Gastrointest Surg. 2004 Jul-Aug;8(5):523-30.

16. Schmidt SC, Settmacher U, Langrehr JM, Neuhaus P. Management and outcome of patients with combined bile duct and hepatic arterial injuries after laparoscopic cholecystectomy. Surgery. 2004 Jun;135(6):613-8.

17. Csendes A, Navarrete C, Burdiles P, Yarmuch J. Treatment of common bile duct injuries during laparoscopic cholecystectomy: endoscopic and surgical management. World J Surg. 2001 Oct;25(10):1346-51.

18. Bismuth H. Postoperative strictures of the bile duct. In: The Biliary Tract. Blumgart LH (ed). Edinburgh: Churchill Livingstone, 1982:209–18.

19. Moraca RJ, Lee FT, Ryan JA Jr, Traverso LW. Long-term biliary function after reconstruction of major bile duct injuries with hepaticoduodenostomy or hepaticojejunostomy. Arch Surg. 2002 Aug; 137(8):889-93.

20. Connor S, Garden OJ. Bile duct injury in the era of laparoscopic cholecystectomy. Br J Surg. 2006 Feb;93(2):158-68.

21. Chaudhary A, Chandra A, Negi SS, Sachdev A. Reoperative surgery for postcholecystectomy bile duct injuries. Dig Surg. 2002;19:22-27.

22. Kapoor V K. Bile duct injury repair: when? What? Who? J Hepatobiliary Pancreat Surg. 2007;14(5):476-9.