Original Article

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Bile duct injuries after laparoscopic cholecystectomy: 11-year experience in a tertiary center

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Summary **Incidence of bile duct injuries (BDI) is low but remains a dramatic complication after laparoscopic cholecystectomy (LC). This study aimed to assess BDI incidence and management strategies. All patients treated in our institution for BDI after LC between 2000 and 2011 were retrospectively analyzed. Patients referred from others centers were excluded. Strasberg classification was used to determine the type of lesion. Thirteen patients presented iatrogenic BDI among 2,840 consecutive cholecystectomies performed (0.46%). Four cases were classified Strasberg type A, 4 type D, and 5 type E. Injury was recognized intraoperatively in 6 cases (46%). Three of these 6 required conversions to open surgery and all but one were primary sutured on a drain; the remaining patient required immediate biliodigestive anastomosis. In 7 patients, the injury was discovered postoperatively (54%). Among them, one was treated by direct closure of a cystic leak through immediate re-laparoscopy. Six underwent initially main bile duct stenting, but 4 required delayed secondary surgery (mean time 115 days), 2 to improve bile duct drainage and 2 for biliodigestive derivation. BDI incidence remains low but management depends on the time of diagnosis. BDI are complex and require tailored treatment usually in a tertiary center for a multidisciplinary approach.**

Keywords: Complications, primary suture, biliodigestive anastomosis

1. Introduction

From historical perspective, Langenbuch performed the first open cholecystectomy 1882, Kehr the first intraoperative biliary repair 1899, and Hepp and Couinaud the first biliodigestive anastomosis with detachment of the hilar plate 1956 (*1-3*). The first laparoscopic cholecystectomy (LC) was performed by Mühe in Germany 1985, followed by Mouret in France 1987 (*4*). Despite the absence of randomized controlled trials showing significant benefit of laparoscopic approach, it has now become the gold standard for more than 3 decades in the treatment of symptomatic cholelithiasis. Increased incidence of iatrogenic bile duct injuries (BDI) was reported, about 0.3% against 0.2% in laparotomy (*5,6*). The study aim was to analyze incidence and management strategies of these lesions in a single teaching center.

2. Materials and Methods

Single-center retrospective study of patients managed for BDI after LC between 2000 and 2011. Patients referred from others centers were excluded. Medical records were examined individually to extract data on demographics, LC indication, time of diagnosis, conversion to laparotomy, use of intraoperative cholangiography (IOC), length of stay and treatments. Strasberg classification was used to determine the type of lesion (*6*). Of note, cholecystectomies were performed using a standardized 3-trocars technique and IOC was used systematically until 2006 and then selectively only since 2007. Calot's triangle dissection was done using monopolar hook, followed by the application of two metal clips on the cystic duct with section between clips. In case of a wide cystic duct (> 5 mm diameter), Hem-O-Lok® was

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applied based on anatomy and surgeon's evaluation. The same technique was used for cystic artery. At the end of the procedure, no drain was placed. The institutional review board approved the study.

3. Results

Thirteen patients presented BDI among 2,840 consecutive cholecystectomies (0.46%), including 9 major wounds of the common bile duct (0.32%) and 4 minor wounds (0.14%). These injuries were observed in 6 men and 7 women, with a mean age of 67 years. Patient demographics are summarized in Figures 1-3. The distribution of body mass index (BMI) varied, with a predominance of 25-30 kg/m^2 category. The American Society of Anesthesiologists score II prevailed, and more than three quarters of patients were older than 60 years. The lesions were classified according to Strasberg in Table 1 (*6*).

Indication for surgery was acute cholecystitis in 9 cases, symptomatic cholecystolithiasis in 3, and choledocholithiasis with preoperative endoscopic retrograde cholangiopancreatography (ERCP) and sphincterotomy in 1 case. The procedure was performed urgently in 3 cases and electively in 10 cases.

The main cause of BDI was anatomical misinterpretation (n = 5). This includes confusion of the common bile duct (CBD) with the cystic duct at the time of section (n = 2) or during IOC (n = 3). Other causes include postoperative cicatricial stenosis on a misplaced clip in 1 case, cystic stump dehiscence in 4 cases, direct injury to the CBD during dissection in 1 case and unknown mechanism in 2 cases.

On all 8 IOC performed, 3 identified directly a D type lesion, 3 confirmed a suspected lesion (2xE1 and D lesions), and 2 showed no abnormality at the time of interpretation (A and E1 lesions). Diagnostic methods were various: 6 injuries were recognized immediately in the operative field, 3 thanks to bile leak identification and 3 by IOC, while 2 were recognized postoperatively during secondary exploratory laparoscopy, and 5 detected by non-surgical methods – computed tomography (CT), ERCP, and magnetic resonance imaging (MRI).

Lesions were recognized intraoperatively in 6 patients and in 3 cases a conversion to laparotomy was performed. Injuries and their treatment are summarized in Table 2. Overall, 5 of 6 lesions were treated by primary suture on a drain. One biliodigestive anastomosis was performed immediately because of large substance loss. All lesions recognized intraoperatively underwent immediate reparation. As institutional policy, the surgeon involved never tried to repair the BDI himself, and HPB surgeon presence was required systematically.

Lesions identified postoperatively are described in Table 3. Six were treated initially by main bile duct stenting, and 4 underwent subsequent biliary surgery. One single lesion was treated by laparoscopy. For

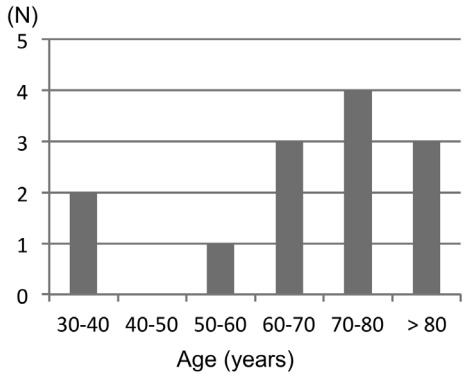

Figure 1. Patient's demographics: age distribution.

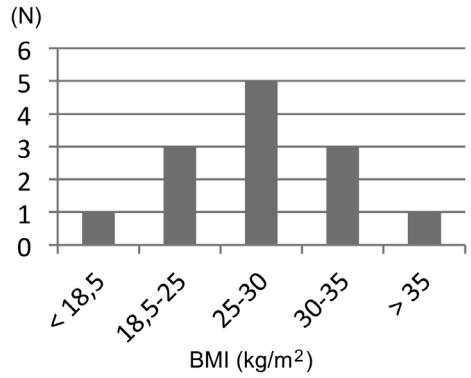

Figure 2. Patient's demographics: body mass index (BMI) distribution.

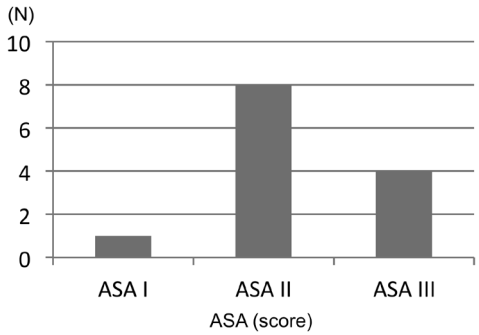

Figure 3. Patient's demographics: American Society of Anesthesiologists (ASA) score distribution.

all lesions discovered postoperatively, the average time between LC and definitive treatment was 115 days (range 1-480 days). Neither liver resection nor transplantation due to the BDI were necessary, and there were no operation-related deaths. One patient developed secondary biliary cirrhosis 2 years after a biliodigestive anastomosis repair (E1 lesion).

Pathological examination of the surgical specimen showed chronic cholecystitis in 10 cases, acute cholecystitis in 2 cases, and well-differentiated adenocarcinoma of the gallbladder in one case.

4. Discussion

Bile duct injury incidence remains low but precise

Table 1. Distribution of injuries according to the Strasberg classification

Type of injuries	*n* =13 (%)
A. Cystic duct leaks or leaks from small ducts in the liver bed	4 (31%)
B. Occlusion of part of the biliary tree, almost invariably the aberrant right hepatic ducts	-
C. Transection without ligation of the aberrant right hepatic duct	-
D. Lateral injuries to major bile duct	4 (31%)
E1. Low common hepatic duct (CHD) stricture, with the length of the CHD stump of > 2 cm	3 (23%)
E2. Proximal CHD stricture - hepatic duct stump < 2 cm	-
E3. Hilar stricture, no residual CHD, but the hepatic ductal confluence is preserved	-
E4. Hilar stricture, with involvement of confluence and loss of communication between right and left hepatic duct	-
E5. Involvement of aberrant right sectorial hepatic duct alone or with concomitant stricture of the CHD	2 (15%)

Table 2. Details of injuries and repairs in case of intraoperative diagnosis

Strasberg Lesion	Repair / surgical approach	Secondary treatment
E1	Primary suture on a drain / laparotomy	- None
D	Primary suture on a drain and surgical site drainage / laparoscopy	- None
D	Primary suture on a drain / laparotomy	- None
D	Primary suture on drain / laparotomy	- None
D	Primary suture on a drain and surgical site drainage / laparoscopy	- Percutaneous drainage of a bilioma
E1	Biliodigestive anastomosis / laparotomy	- Two laparotomies for resection and preparation of a new biliodigestive anastomosis

Table 3. Details of injuries and repairs in case of postoperative diagnosis

Strasberg lesion	Initial treatment	Secondary treatment
E1[†]	ERCP and stent	- 3 ERCP and stents, biliodigestive anastomosis
A[*]	ERCP failed	- Transcystic drainage by laparoscopy
A[*]	Percutaneous drainage	- 4 ERCP and stents
E5[*]	Percutaneous drainage	- 3 ERCP and stents, transcystic drainage by laparotomy, and new ERCP and stent
E5[†]	2 ERCP failed	- Biliodigestive anastomosis
A[*]	Ligation of cystic leak and surgical site drainage by laparoscopy	- None
A[*]	Percutaneous drainage	- ERCP and stent

ERCP, endoscopic retrograde cholangiopancreatography; [*] < 6 weeks, [†] ≥ 6 weeks

management depends on the time of diagnosis. The role of IOC is still controversial. In this series, IOC was used systematically until 2006, and then selectively only since 2007. IOC does not eliminate the risk for injuries, but rather helps to identify them earlier provided an adequate interpretation is done. In fact IOC is misinterpreted in up to 50% of cases, making the effectiveness of implementing it systematically questionable (*7*). A recently published systematic review displayed neither evidence in favor nor against the use of IOC (*8*).

There seems to be a relationship between the time when the injury is recognized, and the type of injury. Lesions recognized intraoperatively were related to confusion between cystic and CBD with partial or full section. Hugh demonstrated that up to 75% BDI were caused by such a misinterpretation (*9*). Another important cause of BDI is desperate attempts to control bleeding in the Calot's triangle with several clips or broad electrocautery (*10*). In cases of postoperative recognition, minor lesions due to cystic stump leakage are more likely. However, complex wounds can also be observed postoperatively; early in case of complete or partial transection, or later in case of cicatricial stenosis.

In case of intraoperative diagnosis, before immediate repair, complete assessment of biliary tract anatomy with IOC is mandatory, either by an open or by laparoscopic approach (*5*). A conversion to laparotomy is required if the operator's experience is limited, or if the anatomy is unclear. An HPB surgeon should be involved in the management and repair as outcomes are significantly better (*5,11,12*). For minor A lesion, applying a clip or a ligature combined with a transcystic drainage is recommended. In case of type D lesions, primary suture on a drain is the technique of choice. In case of complete CBD transection or aberrant duct (B, C and E types) and great substance loss, immediate biliodigestive anastomosis is recommended (*5*). If the defect is limited or absent, an end-to-end biliary anastomosis on a drain may be performed. DeReuver reported 91% stricture free results at 7 years follow up in 56 patients after end-to-end anastomosis (*13*). If the surgeon is not comfortable with the injury, drainage of the hepatic pedicle and sub-hepatic region should be performed, and patient transferred to a tertiary center (*14,15*). Mismanagement can result in extension of the lesions, and need for additional complex therapeutic procedures.

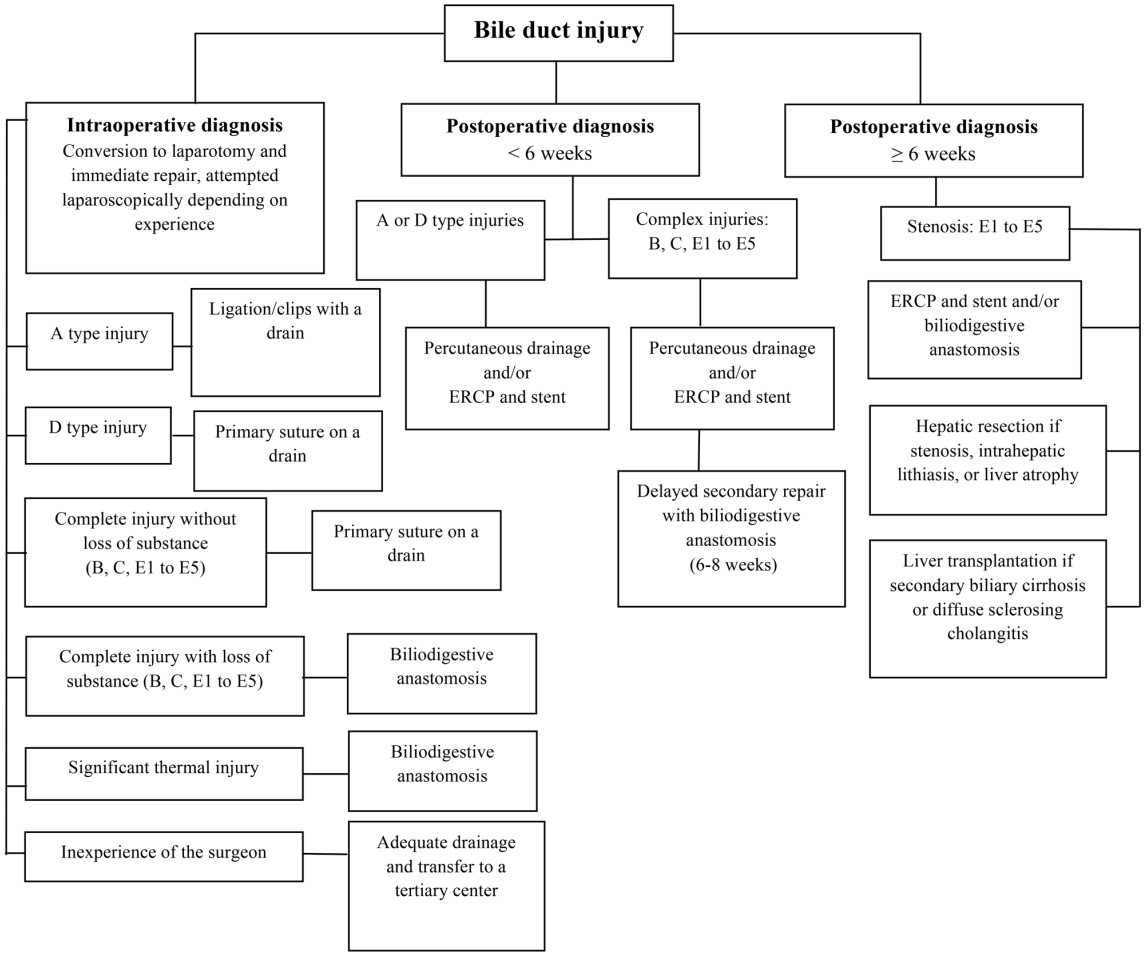

Figure 4. Treatment algorithm in case of bile duct injury according to Strasberg classification.

In case of postoperative diagnosis, the timing of bile duct repair is still a matter of debate. A full assessment of the lesion is essential before choosing an appropriate treatment. The choice of an interval of 6 weeks to define early and late diagnosis was based on the hypothesis that this time interval may differentiate sections from ischemic stenoses (*16*). If type A or D lesions are discovered early (< 6 weeks) by abscess, bilioma or cholangitis, immediate percutaneous drainage or ERCP with application of stent to calibrate the leak is recommended. If it fails, a surgical approach by laparoscopy or laparotomy becomes necessary. In case of complex lesion (B, C or E) and early diagnosis (< 6 weeks), immediate repair is not recommended, because of considerable risk of long-term complications (30% stricture rate) and mortality (*17*). Percutaneous drainage or ERCP to improve local conditions should be used, and then a biliodigestive repair performed 6-8 weeks later so that the inflammation process did regress. This approach is supported by data from several expert centers, and by the fact that the lesion may progresses to its final stage before final repair (*18,19*). In case of late postoperative diagnosis (≥ 6 weeks), injuries are mainly ischemic stenosis related to devascularization. Treatment remains controversial. ERCP with dilatation and stenting if the anatomical location allows it should be tried first, and biliodigestive anastomosis performed eventually in second line if stenting was not possible or the result insufficient. In the present series, neither resection nor liver transplantation were necessary.

Each case should be analyzed individually during multidisciplinary conference including interventional radiology, endoscopy, and HPB surgery. Stewart demonstrated that treating BDI in expert centers offered significantly better outcomes than if performed in the center where the injury was performed (94% *vs*. 17%) (*12*). On the other hand, there is less data on the results of HPB surgeons in high volume centers repairing their own injuries. Evaluation of the outcome of biliary tract repair is a difficult task. In our department, patients were examined by HPB surgeon 4 to 6 weeks after discharge, and then followed by their general practitioner with clinical and biological assessment every year. Long-term follow-up is mandatory because biliary stricture can be observed up to 10 to 20 years after initial repair (*19*). Moreover, it has been reported that such lesions may have significant impact on physical and psychological quality of life (*20*).

Based on BDI repair techniques analysis of our center, and based on data from several expert centers,

a treatment algorithm was developed and is presented in Figure 4. This algorithm however, needs further evaluation and validation.

The main limitation of the present study is its retrospective nature and a relatively small number of patients, thus limiting associations and comparisons with the literature.

In conclusion, BDI incidence remains low but their management depends on the time of diagnosis. These injuries are complex, and treatment needs to be individualized based on patient, anatomy and nature of the injury. Multidisciplinary management in tertiary centers should be recommended.

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