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EVIDENCE-BASED MEDICINE

Non-surgical treatment of post-surgical bile duct injury: Clinical implications and outcomes

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Abstract

AIM: To investigate the prognostic factors determining the success rate of non-surgical treatment in the management of post-operative bile duct injuries (BDIs).

METHODS: The study patients were enrolled from the pancreatobiliary units of a tertiary teaching hospital for the treatment of BDIs after hepatobiliary tract surgeries, excluding operations for liver transplantation and malignancies, from January 1999 to August 2010. A total of 5167 patients underwent operations, and 77 patients had BDIs following surgery. The primary end point was the treatment success rate according to different types of BDIs sustained using endoscopic or percutaneous hepatic approaches. The type of BDI was defined using one of the following diagnostic tools: endoscopic retrograde cholangiography, percutaneous transhepatic cholangiography, computed tomography scan, and magnetic resonance cholangiography. Patients with a final diagnosis of BDI underwent endoscopic and/or percutaneous interventions for the treatment of bile leak and/or stricture if clinically indicated. Patient consent was obtained, and study approval was granted by the Institutional Review Board in accordance with the legal regulations of the Human Clinical Research Center at the Seoul National University Hospital in Seoul, South Korea.

RESULTS: A total of 77 patients were enrolled in the study. They were divided into three groups according to type of BDI. Among them, 55 patients (71%) underwent cholecystectomy. Thirty-six patients (47%) had bile leak only (type 1), 31 patients had biliary stricture only (type 2), and 10 patients had both bile leak and biliary stricture (type 3). Their initial treatment modalities were non-surgical. The success rate of non-surgical treatment in each group was as follows: BDI type 1: 94%; type 2: 71%; and type 3: 30%. Clinical parameters such as demographic factors, primary disease, operation method, type of operation, non-surgical treatment modalities, endoscopic procedure steps, type of BDI, time to diagnosis and treatment duration were evaluated to evaluate the prognostic factors affecting the success rate. The type of BDI was a statistically significant prognostic factor in determining the success rate of non-surgical treatment. In addition, a shorter time to diagnosis of BDI after the operation correlated significantly with higher success rates in the treatment of type 1 BDIs.

CONCLUSION: Endoscopic or percutaneous hepatic approaches can be used as an initial treatment in type 1 and 2 BDIs. However, surgical intervention is a treatment of choice in type 3 BDI.

Key words: Endoscopic retrograde cholangiography; Percutaneous transhepatic cholangiography; Percutaneous transhepatic biliary drainage; Bile duct; Biliary stricture

Core tip: It is not unusual to encounter patients with post-operative bile duct injuries (BDIs) in the setting of a specialized biliary clinic at tertiary hospitals. With regard to the patients' best interests, it is important to determine the suitability of non-invasive treatment. We analyzed the clinical outcomes and various prognostic factors that affected the success rates of non-surgical treatments. The BDI type was the single most powerful factor that determined the success rate of non-surgical treatment. In addition, we emphasize that this series of 77 patients with post-operative BDI was one of the largest series of this type to be examined.

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INTRODUCTION

Bile duct injuries (BDIs) such as bile leak or stricture can occur as one of the most serious complications following a variety of hepatobiliary tract surgical procedures, and the associated morbidities have a definite impact on quality of life[1-3]. Previous studies have reported the incidence of post-operative BDI following open and laparoscopic cholecystectomy to be 0.1%-0.3% and 0.11%-1.4%[4-8]. The laparoscopic approach is preferred because it results in less postoperative pain, a shorter hospital stay, and a faster return to normal activity[6]. Laparoscopic cholecystectomy, which has become the first-line surgical treatment for calculous gallbladder disease, has been associated with a higher risk (2- to 4-fold increase) in the incidence of postoperative BDI[9]. Patients with BDI can have multiple different presentations, and they may present with life-threatening complications such as peritonitis, sepsis, cholangitis or external biliary fistulae[10]. Furthermore, they are also at high risk of developing long-term complications such as secondary biliary cirrhosis, and therefore, BDI may have a major impact on patients' quality of life[10-12]. Some studies have indicated that bile leaks from post-operative BDIs can be successfully treated in 78%-100% of patients using endoscopic or radiological interventions[13-15]. However, there is no current consensus regarding gold standard treatment of post-operative BDIs. In addition, there is controversy as to whether such patients should be treated with surgical or non-surgical methods[11,16]. Provided that the treatment outcomes are equivalent, non-surgical approaches are preferred over invasive surgical options.

Therefore, the aims of this study were to analyze the clinical outcomes of non-surgical treatments in patients with BDI following hepatobiliary operations based on BDI type and to determine the appropriate management according to post-operative BDI type.

MATERIALS AND METHODS

Patients

The study patients were enrolled from the pancreatobiliary units of a tertiary teaching hospital (Seoul National University Hospital) for the treatment of BDIs after hepatobiliary tract surgeries, excluding operations for liver transplantation and malignancies, from January 1999 to August 2010. A total of 5167 patients underwent hepatobiliary tract surgeries, excluding operations for liver transplantation and malignancies, and 77 patients had BDIs after their operations. Patient consent was obtained, and study approval was granted by the Institutional Review Board in accord with the legal regulations of the Human Clinical Research Center at our hospital in Seoul, South Korea.

Protocol for endoscopic intervention

The patients underwent endoscopic retrograde cholangiography (ERC) using a duodenoscope (TJF240; Olympus, Tokyo) after an overnight fast. The type and anatomical location of the BDIs were confirmed by contrast media injection during ERC. Cannulation of the bile duct and endoscopic sphincterotomy (EST) were performed, and a guide-wire (Jagwire, 0.025 or 0.035-inch; Boston Scientific Inc., MA) was passed proximal to the site of the BDI. Dilatation with a 6-10 mm balloon catheter (Boston Scientific Inc., MA) was performed at the stricture site. Inflation of the balloon catheter was maintained for 45-60 s, and single or multiple plastic stents -as many as possible - were placed at the stricture site (7 Fr or 10 Fr RX Plastic Biliary Stents; Boston Scientific Inc., MA). If there was more than one stricture site, multiple biliary stents were placed simultaneously. In the case of a bile leak, a 10 Fr plastic stent was placed into the proximal section of the affected site. The patients were monitored closely, and an ERC was repeated every 1-2 mo until the bile leak was resolved. Each patient received prophylactic antibiotics, either cefotaxime or ciprofloxacin, immediately before endoscopic intervention. However, antibiotic treatment was continued if the patient showed any signs or symptoms of systemic infection after the procedure. The primary end point was the treatment success rate according to the different types of BDIs sustained during endoscopic or percutaneous hepatic approaches.

Protocol for percutaneous transhepatic intervention

A percutaneous transhepatic biliary drainage (PTBD) track was made to approach the biliary stricture site. A 0.018-inch-diameter guide-wire (Cook, Bloomington, Illinois) was inserted into the bile duct through a Chiba needle. A Terumo guide-wire (0.035-inch) with a 5 Fr yellow sheath was placed using the standard guide-wire technique. Dilatations using balloons 6-10 mm in diameter (Blue Max; Microvasive Boston Scientific Inc., Natick, Massachusetts) were performed along with guide-wire insertion through a percutaneous transhepatic biliary drainage tract. A biliary drainage catheter (8.5 Fr, Cook, Bloomington, IL) was advanced into the bile duct and finally placed at the stricture site. In the same manner, a biliary drainage catheter (8.5 Fr, Cook, Bloomington, IL) was placed beyond the leakage point, which facilitated the healing process at the leakage site. Imaging evidence of resolution of the BDI was confirmed by subsequent percutaneous transhepatic cholangiographys (PTCs), and functional testing of intact bile duct status was confirmed by closing the PTBD track. The catheter was removed when there were no symptoms of biliary obstruction despite closure of the PTBD track.

Terms and definitions

The type of BDI was defined using one of the following diagnostic tools: ERC, PTC, CT scan, and magnetic resonance cholangiography. Patients with a final diagnosis of BDI underwent endoscopic and/or percutaneous interventions for the treatment of a bile leak and/or stricture if clinically indicated. Patient consent was obtained, and study approval was granted by the Institutional Review Board in accord with the legal regulations of the Human Clinical Research Center at the Seoul National University Hospital in Seoul, Korea. The patients with post-operative BDIs were stratified into the following types: type 1: bile leak only; type 2: biliary stricture only and type 3: bile leak and biliary stricture[17]. We also used the Strasberg classification, which is based on stricture location, size and bile leakage, to determine the type of BDI (Figure 1, Table 1). A successful intervention was defined by the fulfillment of all of the following criteria: (1) resolution of symptoms associated with BDI; (2) a cholangiogram showing no evidence of residual biliary stricture or leakage with removal of the stent or biliary catheter; and (3) no subsequent need for additional procedures including surgery during or after the 6 mo following stent or catheter removal. The clinical events were defined as follows: time to diagnosis of post-operative BDI, duration of the treatment, and relapse of post- operative BDI. The duration from the hepatobiliary surgery to the diagnosis of BDI was defined as the time to diagnosis of post- operative BDI. Duration of the treatment was the time interval from the time of endoscopic and/or percutaneous procedures until the removal of biliary stents with a patent bile duct. Relapse of post-operative BDI was defined as a clinical condition requiring intervention due to a recurrence of BDI at least 6 mo after the removal of biliary stents or tubes.

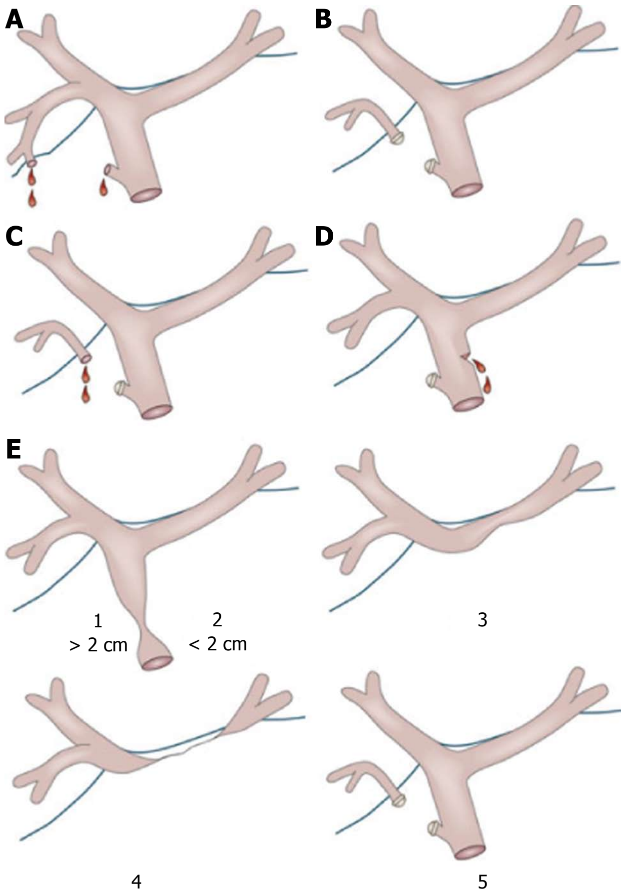

Figure 1 Strasberg classification of biliary injury.

Table 1 Strasberg classification of biliary injury

Class	Description
A	Injury to small ducts in continuity with biliary system, with cystic duct leak
B	Injury to sectoral duct with consequent obstruction
C	Injury to sectoral duct with consequent bile leak from a duct not in continuity with biliary system
D	Injury lateral to extrahepatic ducts
E1	Stricture located > 2 cm from bile duct confluence
E2	Stricture located < 2 cm from bile duct confluence
E3	Stricture located at bile duct confluence
E4	Stricture involving right and left bile ducts
E5	Complete occlusion of all bile ducts

Complications

Procedure-related complications included the following: cholangitis, acute pancreatitis, perforation and significant bleeding. Cholangitis was defined as the new onset of fever (> 38.3 ℃) and/or leukocytosis (WBC > 10000/mm^3) with abdominal pain around the right upper quadrant. Acute pancreatitis was diagnosed when serum amylase levels reached three times the upper limit of normal (180 U/L) with persistent abdominal pain for at least 24 h after the treatment procedure. Significant bleeding was defined

Table 2 Study patients *n* (%)

Variables	Total (*n* = 77)
Age (yr, range)	49.94 (20-81)
Sex	
Male	46 (60)
Disease	
GB stones with/without CBD stones	52 (68)
IHD stones	11 (14)
Others1	14 (18)
Operation	
Laparoscopic surgery	49 (64)
Open laparotomy	28 (36)
Bile duct exploration	43 (56)
Time to diagnosis [median, d (IQR)]	13 (5-90)
Follow up period [median, d (IQR)]	339 (200-817)

[1]Others: Gallbladder polyp and *etc*. CBD: Common bile duct; IHD: Intrahepatic duct; BDI: Bile duct injury; IQR: Interquartile range; GB: Gallbladder.

as progressive anemia requiring transfusions of more than 2 units or hemostasis after the treatment procedure.

Statistical analysis

Statistical analysis was performed using SPSS 15.0 (Fisher's exact test Pearson's χ^2 test and Kruskall-Wallis test were used, when appropriate, to determine the statistical significance of different demographic and clinical variables). Multivariate logistic regression analysis was performed to determine the significance of variables with respect to the treatment results in patients with biliary stricture. A P value < 0.05 was considered statistically significant.

RESULTS

Study patients

The total of 5167 patients underwent hepatobiliary tract surgeries, excluding operations for liver transplantation and malignancies, and 77 patients had BDIs after the surgical procedures. Seventy-seven patients who developed BDI after the hepatobiliary operations were enrolled in this study. Among them, 55 patients (71%) underwent cholecystectomy and 22 patients underwent partial hepatectomy with bile duct exploration due to intrahepatic duct stones. The initial treatment modalities were non-surgical. The characteristics of study patients are listed in Table 2. The mean age and male-to-female ratio were 50 years and 1.5, respectively. The preoperative diagnosis in 52 (68%) patients was symptomatic GB stone, and a total of 64% patients underwent laparoscopic surgery. Bile duct exploration was performed in 56% of the patients (Table 2).

There were three types of BDI (type 1: bile leak only; type 2: stricture only; and type 3: both bile leak and stricture), and the prevalence of each type was as follows: type 1, 47%; type 2, 40%; and type 3, 13%. The patients with BDIs were categorized in more detail according to the Strasberg classification (Table 3)[18,19]. The patients' bile leaks had a median size of 3.2 mm, ranging from 2.3-3.7 mm, and were treated non-surgically, *i.e.*, ERBD

Table 3 Characteristics of study patients according to types of bile duct injurys *n* (%)

Variables	Total (*n* = 77)
BDI type	
Type 1 (leak only)	36 (47)
Type 2 (stricture only)	31 (40)
Type 3 (combined)	10 (13)
BDI type (Strassberg classification)	
Type A	36 (47)
Type B	10 (13)
Type C	31 (40)
Type D	0 (0)
Length of stricture, mm (median)	3.2 (2.3-3.7)
Size of bile leak, mm (median)	6 (2-12)

BDI: Bile duct injury.

with 7-10 Fr plastic stents with sphincterotomy. The patients' bile duct strictures had a median length of 6 mm, with a range of 2-12 mm. Patients with BDIs underwent endoscopic treatment first, unless it was technically impossible to access the ampulla of Vater *via* endoscopic approaches or endoscopic interventions had failed.

Clinical outcomes of non-surgical treatment

The median duration of follow up was 11.3 (range 6.7-27.2) mo after the treatment. The overall success rate of non-surgical treatment was 77% (59/77). We evaluated the following factors that potentially affected the success rate of non-surgical treatment: age, sex, bile duct exploration, type of surgery (laparoscopic *vs* open), operation type (cholecystectomy or not), method of initial treatment (endoscopic *vs* percutaneous) endoscopic sphincterotomy, BDI type, time to diagnosis, and treatment duration (Table 4). Among these clinical parameters, BDI type was the only statistically significant factor in determining clinical outcomes of non-surgical treatment (P < 0.001) (Table 4). The success rate for BDI type 1 was significantly higher than the other two types (94% *vs* 61%, P < 0.01), whereas the success rate for BDI in type 3 patients was significantly lower than the other types (30% *vs* 84%, P < 0.01). Furthermore, there was no significant difference in the overall success rate according to the initial treatment approach (endoscopic *vs* percutaneous, P = 0.547). As shown in Table 4, BDI type 1 was associated with the shortest time to diagnosis compared to the other BDIs (median time to diagnosis, 6 d *vs* 216 and 11 for types 2 and 3, respectively). Of note, the time to diagnosis of BDI type 1 was significantly shorter in the success group than in the failure group (9 d *vs* 129 d, P = 0.037), whereas the time to diagnosis was not statistically significant between the groups (success *vs* failure group) for BDI type 2 and 3 (data not shown). We also analyzed baseline characteristics to determine whether there were any significant differences among the BDI types with respect to age, gender, bile duct exploration, laparoscopic surgery, cholecystectomy, and status of EST (Table 5) but detected no significant clinical difference among the groups (Table 5). We observed

Table 4 Treatment success rate according to clinical characteristics *n* (%)

	Success rate	*P* value
Overall	59/77 (77)	
Age (yr)		0.467
≤ 50	32/40 (80)	
> 50	27/37 (73)	
Sex		0.101
Female	27/31 (69)	
Male	32/46 (77)	
Bile duct exploration		0.291
Yes	31/43 (72)	
No	28/34 (82)	
Operation method		0.387
Laparoscopic	36/49 (74)	
Open	23/28 (82)	
Operation name		0.247
Cholecystectomy	40/55 (72)	
Other operations	19/22 (86)	
Initial procedure		0.547
Endoscopic	28/38 (74)	
Percutaneous	31/39 (80)	
EST		0.310
Yes	28/39 (72)	
No	31/38 (82)	
BDI		0.000
Type 1	34/36 (94)	
Type 2	22/31 (71)	
Type 3	3/10 (30)	
Time to diagnosis (d)		0.325
≤ 15	34/42 (81)	
> 15	25/35 (71)	
Treatment duration (d)		0.950
≤ 30	30/39 (77)	
> 30	29/38 (76)	

EST: Endoscopic sphincterotomy; BDI: Bile duct injury.

the lowest treatment success rate in BDI type 3, and the detailed clinical characteristics and treatment outcome for each patient with BDI type 3 is described in Table 6. Despite multiple interventions, the treatment success rate in BDI type 3 was only 30%. Overall, treatment-related complications occurred in 15 out of 77 patients (20%). Cholangitis was the most common complication (14/15, 93%), and these patients were treated successfully with medical therapy. One patient had duodenal perforation related to an EST (endoscopic sphincterotomy) procedure, and intervention for a biliary stricture could not be performed due to the incident. The patient was managed non-surgically; however, his clinical signs and symptoms deteriorated, and hepaticojejunostomy was performed to resolve perforation and biliary stricture. We observed that patients with BDI type 2 or 3 appeared to have more intervention-related complications than patients with BDI type 1 (34% *vs* 13%, respectively, P = 0.117). Two of the 23 patients with BDI type 2 who were successfully treated initially relapsed during the long-term follow-up period and could be treated medically. No relapses occurred in patients with BDI type 1 or type 3 during the follow-up period.

Table 5 Clinical Characteristics according to bile duct injury type

BDI type	1	2	3	*P* value
Patients (*n*)	36	31	10	
Age (mean, yr)	50	52	44	0.321
Male	56%	65%	60%	0.756
Bile duct exploration	44%	65%	70%	0.161
Laparoscopic surgery	72%	48%	80%	0.067
Cholecystectomy	64%	74%	90%	0.246
Endoscopic sphincterotomy	31%	54%	78%	0.059
Complication rate	11%	36%	20%	0.056
Time to diagnosis (median, d)	6	216	11	0.000

BDI: Bile duct injury.

Clinical outcomes in a subgroup of patients who underwent cholecystectomy

We also analyzed 55 patients with BDIs who underwent cholecystectomy due to gallstones or gallbladder polyps (Table 7). The type of BDI was the only significant factor affecting the success rate of non-surgical treatments, and that result was consistent with the results observed in all patients with BDI. Patients with bile duct exploration experienced more frequent biliary stricture (BDI type 2 or 3) compared with patients without bile duct exploration [20/25 (80%) *vs* 12/30 (40%), respectively, P = 0.006].

DISCUSSION

Post-operative BDI is one of the most serious complications after hepatobiliary surgery despite tremendous improvement in surgical techniques and experiences[20]. Furthermore, non-surgical treatments such as endoscopic or percutaneous procedures have played an important role in the treatment of BDIs with excellent long-term success rates, except in cases of complete bile duct transection[16,21]. Therefore, the aim of this study was to report our experiences with a series of 77 patients with post-operative BDIs, specifically including the homogenous group of 55 patients who developed BDI after cholecystectomy. The study data set examined here is one of the largest series that has been examined. As noted in the methods section, the BDIs were initially managed non-surgically, and the success rate was approximately 80%. Our success rate was lower than those of previous studies, which reported a 78%-100% success rate[8-10]. A possible explanation for this difference may be that we defined the point of successful treatment very strictly, as successful treatment without relapse for at least 6 mo after initial management. We observed that only 3% (2 out of 59) of patients relapsed during a median follow-up of 11.3 (6.7-27.2) mo.

To identify the important variables affecting clinical outcomes of non-surgical treatment in patients with BDI, we investigated all possible clinical factors. Among the possible contributing factors, BDI type was the only factor that significantly affected treatment outcomes. Non-

Table 6 Clinical characteristics and treatment outcomes of patients with bile duct injury type 3

Sex/age	Result	Operation	Time to diagnosis (d)	Number of procedures			Treatment duration (d)	Leak location	Stricture location
				ERC	PTC	PCD			
F/37	Success	Cholecystectomy	10	2	7	2	180	Multiple	Anastomosis
M/40	Failure	Cholecystectomy	5	1	1	0	5	IHD	IHD/
F/26	Success	Cholecystectomy	59	2	0	1	94	CBD/CHD	CBD/CHD
M/22	Failure	Cholecystectomy	21	0	3	0	69	CBD/CHD	CBD/CHD
F/50	Failure	Cholecystectomy	5	1	2	0	13	Duct stump	IHD
M/45	Failure	Cholecystectomy	0	1	0	0	45	CBD/CHD	CBD/CHD
M/25	Failure	Cholecystectomy	13	1	1	0	7	CBD/CHD	CBD/CHD
M/45	Failure	Rt. hepatectomy	12	0	1	1	45	IHD	IHD
F/65	Success	Cholecystectomy	60	5	0	0	364	CBD/CHD	CBD/CHD
M/81	Failure	Cholecystectomy	8	1	5	4	482	Duct stump	IHD

IHD: Intrahepatic duct; CBD: Common bile duct; CHD: Common hepatic duct; ERC: Endoscopic retrograde cholangiography; PTC: Percutaneous transhepatic cholangiography; PCD: Percutaneous drainage; M: Male; F: Female.

Table 7 Subgroup analyses of 55 patients who underwent cholecystectomy *n* (%)

	Success rate	*P* value
Overall	40/55 (73)	
Age (yr)		0.428
≤ 50	14/21 (67)	
> 50	26/34 (775)	
Sex		0.359
Female	17/21 (81)	
Male	23/34 (68)	
Bile duct exploration		0.185
Yes	16/25 (64)	
No	24/30 (80)	
Operation method		1.000
Laparoscopic	29/40 (73)	
Open	11/15 (73)	
EST		0.537
Yes	25/36 (69)	
No	15/19 (79)	
BDI		0.001
Type 1	22/23 (96)	
Type 2	15/23 (65)	
Type 3	3/9 (33)	
Time to diagnosis (d)		0.322
≤ 15	22/28 (79)	
> 15	18/27 (68)	
Treatment duration (d)		1.000
≤ 30	17/24 (71)	
> 30	23/31 (74)	

EST: Endoscopic sphincterotomy; BDI: Bile duct injury.

surgical treatment failed in two-thirds of the patients with BDI type 3, and these patients may be considered better candidates for surgery. Three patients with BDI type 3 were successfully treated by multiple interventions (3, 5, and 11 interventions each) and they experienced longer durations to completion of non-surgical treatment (mean, 213 d) (Table 5). Based on our study, initial surgical management might be judiciously applied in patients with BDI type 3, considering the low success rate of non-surgical treatments, extended treatment duration and the need for multiple interventions.

We also analyzed the success rate according to the various initial non-surgical treatments (endoscopic *vs* percutaneous), and there were no significant differences in success rate between the two groups. However, we cannot rely entirely on this result when choosing either of the non-surgical treatment options (endoscopic or percutaneous) as an initial treatment modality when managing patients with BDIs. Post-operative BDI is a very complex condition that requires a multidisciplinary approach[22]. This study demonstrated that BDI type 1 can be more successfully treated by non-surgical methods than BDI type 2 or type 3 (94% *vs* 71% *vs* 33%, respectively). It has recently been reported that endoscopic approaches were used successfully to treat 12 out of 13 patients with BDI type 1; however, treatment failed in 1 out of 3 patients with BDI type 3[23]. The studies above clearly indicate that BDI type 1 can easily be treated by non-surgical therapies and that these therapies may be widely accepted. Some investigators have suggested that initial non-surgical treatment might not be suitable for the management of post-operative bile duct stricture because most cases of post-operative bile duct stricture ultimately require surgical treatment, even in patients with isolated bile duct stricture[17,24]. On the contrary, recently published accounts have indicated that endoscopic and/or percutaneous intervention should be regarded as an initial treatment choice in patients with post-operative BDI, including stricture[25,26]. In our series, isolated bile duct stricture like BDI type 1, 2 were also managed successfully compared to patients with BDI type 3. Therefore, it can be suggested that BDI types 1 and 2 can initially be treated non-surgically. On the other hand, 7 patients who had BDI type 3 underwent surgical reconstruction, and they recovered without post-operative complications. Although we had a low success rate of 30% among BDI type 3 patients, this result might also be interpreted to mean that one third of patients with BDI type 3 did not require invasive surgery. Therefore, we stress the importance of a multidisciplinary approach to decision making in the management of BDI type 3.

Another important factor in the management of BDIs was the time-to-diagnosis interval. Delayed detection of BDI may lead to increased morbidity, increased severity of the injury, treatment failure and even death[22].

In this study, time to diagnosis of BDI type 1 was significantly shorter than that of BDI type 2, as might be expected, because a bile leak can immediately cause bile peritonitis and induce severe abdominal pain[27]. Early diagnosis resulted in a better outcome in patients with BDI type 1 but was not significant in BDI type 2 patients. It may be suggested that early detection ensures the success rate of treatment in BDI type 1.

We also wish to discuss operative approaches with regard to the development of BDIs. As we mentioned in Table 2, 43 out of 77 patients (56%) underwent bile duct exploration, and the transcystic technique was used in 33 patients (77%). Subgroup analysis of 55 patients with cholecystectomies revealed that patients who underwent bile duct exploration during cholecystectomy had a tendency to develop BDI type 2 more often than patients who did not undergo bile duct exploration. Some studies have also suggested the potential for BDIs such as bile leak or stricture after intraoperative bile duct exploration[28-30]. Interestingly, the results of both this and other indicated that there was no significant difference in the clinical outcomes of BDI treatment according to whether patients had undergone bile duct exploration[30].

Here, we report that the most important prognostic parameter in determining the success rate of treatment of post-operative BDI is the type of BDI, regardless of other clinical factors. BDI type 1 (bile leak only) and type 2 (biliary stricture only) after hepatobiliary operations can be managed by endoscopic intervention with a promising success rate that is associated with a better quality of life for patients with BDI after surgery. Surgical treatment could be considered as a first treatment of choice in BDI type 3 (bile leak and biliary stricture) considering low success rate of non-surgical treatment. Further investigation with larger groups of patients and randomized clinical trials would provide a better understanding of appropriate treatments in patients with BDIs after hepatobiliary surgery.

COMMENTS

Background

Bile duct injuries (BDIs) such as bile leak or stricture are some of the most serious complications that can occur after various heptobiliary tract surgeries, and these morbidities can affect the patient's quality of life.

Research frontiers

There is no current consensus regarding the gold standard for treatment of post-operative BDIs.

Innovations and breakthroughs

Non-surgical approaches are superior to invasive surgical approaches as long as the treatment outcomes are favorable. Therefore, the aim of this study was to analyze the clinical outcomes of non-surgical treatments in patients with BDI following hepatobiliary operations according to BDI type, as well as to determine the appropriate approach for the various post- operative BDI types.

Applications

This study provides useful information for determining treatment choices for patients with post-operative BDIs (not including liver transplantation patients). Furthermore, the results will aid clinicians who are considering not only the success rate of treatment outcomes but also how to improve patient quality of life in the management of BDIs.

Terminology

Post-operative BDI: Iatrogenic complications associated with significant perioperative morbidity and mortality, reduced long-term survival and quality of life.

Peer review

This paperis clear and innovative and provides useful information in determining treatment choices for patients with post-surgical BDIs. Data are well organized, results provide sufficient experimental evidence.

REFERENCES

1 **Zhou LK**, Prasoon P. Mechanical and preventable factors of bile duct injuries during laparoscopic cholecystectomy. *Hepatogastroenterology* 2012; **59**: 51-53 [PMID: 22251523 DOI: 10.5754/hge10249]

2 **Parmeggiani D**, Cimmino G, Cerbone D, Avenia N, Ruggero R, Gubitosi A, Docimo G, Mordente S, Misso C, Parmeggiani U. Biliary tract injuries during laparoscopic cholecystectomy: three case reports and literature review. *G Chir* 2010; **31**: 16-19 [PMID: 20298660]

3 **Shah JN**. Endoscopic treatment of bile leaks: current standards and recent innovations. *Gastrointest Endosc* 2007; **65**: 1069-1072 [PMID: 17531644 DOI: 10.1016/j.gie.2007.02.022]

4 **Li LB**, Cai XJ, Mou YP, Wei Q, Wang XF. Factors influencing the results of treatment of bile duct injuries during laparoscopic cholecystectomy. *Hepatobiliary Pancreat Dis Int* 2005; **4**: 113-116 [PMID: 15730933]

5 **Adamsen S**, Hansen OH, Funch-Jensen P, Schulze S, Stage JG, Wara P. Bile duct injury during laparoscopic cholecystectomy: a prospective nationwide series. *J Am Coll Surg* 1997; **184**: 571-578 [PMID: 9179112]

6 **McMahon AJ**, Russell IT, Baxter JN, Ross S, Anderson JR, Morran CG, Sunderland G, Galloway D, Ramsay G, O'Dwyer PJ. Laparoscopic versus minilaparotomy cholecystectomy: a randomised trial. *Lancet* 1994; **343**: 135-138 [PMID: 7904002]

7 **MacFadyen BV**, Vecchio R, Ricardo AE, Mathis CR. Bile duct injury after laparoscopic cholecystectomy. The United States experience. *Surg Endosc* 1998; **12**: 315-321 [PMID: 9543520]

8 **Frilling A**, Li J, Weber F, Frühauf NR, Engel J, Beckebaum S, Paul A, Zöpf T, Malago M, Broelsch CE. Major bile duct injuries after laparoscopic cholecystectomy: a tertiary center experience. *J Gastrointest Surg* 2004; **8**: 679-685 [PMID: 15358328 DOI: 10.1016/j.gassur.2004.04.005]

9 **Pawa S**, Al-Kawas FH. ERCP in the management of biliary complications after cholecystectomy. *Curr Gastroenterol Rep* 2009; **11**: 160-166 [PMID: 19281705]

10 **Vitale GC**, Davis BR. Evaluation and treatment of biliary leaks after gastrointestinal surgery. *J Gastrointest Surg* 2011; **15**: 1323-1324 [PMID: 21562917 DOI: 10.1007/s11605-011-1513-y]

11 **Dolan JP**, Diggs BS, Sheppard BC, Hunter JG. Ten-year trend in the national volume of bile duct injuries requiring operative repair. *Surg Endosc* 2005; **19**: 967-973 [PMID: 15920680 DOI: 10.1007/s00464-004-8942-6]

12 **Boerma D**, Rauws EA, Keulemans YC, Bergman JJ, Obertop H, Huibregtse K, Gouma DJ. Impaired quality of life 5 years after bile duct injury during laparoscopic cholecystectomy: a prospective analysis. *Ann Surg* 2001; **234**: 750-757 [PMID: 11729381]

13 **Fatima J**, Barton JG, Grotz TE, Geng Z, Harmsen WS, Huebner M, Baron TH, Kendrick ML, Donohue JH, Que FG, Nagorney DM, Farnell MB. Is there a role for endoscopic therapy as a definitive treatment for post-laparoscopic bile duct injuries? *J Am Coll Surg* 2010; **211**: 495-502 [PMID: 20801692 DOI: 10.1016/j.jamcollsurg.2010.06.013]

14 **Fukasawa M**, Maguchi H, Takahashi K, Katanuma A, Osanai M, Kurita A, Ichiya T, Tsuchiya T, Kin T. Clinical features

and natural history of serous cystic neoplasm of the pancreas. *Pancreatology* 2010; **10**: 695-701 [PMID: 21242709 DOI: 10.1159/000320694]

15 **Singh P**, Erickson RA, Mukhopadhyay P, Gopal S, Kiss A, Khan A, Ulf Westblom T. EUS for detection of the hepatocellular carcinoma: results of a prospective study. *Gastrointest Endosc* 2007; **66**: 265-273 [PMID: 17543307 DOI: 10.1016/j.gie.2006.10.053]

16 **Davids PH**, Tanka AK, Rauws EA, van Gulik TM, van Leeuwen DJ, de Wit LT, Verbeek PC, Huibregtse K, van der Heyde MN, Tytgat GN. Benign biliary strictures. Surgery or endoscopy? *Ann Surg* 1993; **217**: 237-243 [PMID: 8452402]

17 **Do IN**, Kim JC, Park SH, Lee JY, Jung SW, Cha JM, Han JM, Choi EK, Lee SS, Seo DW, Lee SK, Kim MH. [The outcome of endoscopic treatment in bile duct injury after cholecystectomy]. *Korean J Gastroenterol* 2005; **46**: 463-470 [PMID: 16371721]

18 **Soper NJ**. Prevention of biliary leaks. *J Gastrointest Surg* 2011; **15**: 1005-1006 [PMID: 21484487 DOI: 10.1007/s11605-011-1512-z]

19 **Strasberg SM**, Callery MP, Soper NJ. Laparoscopic surgery of the bile ducts. *Gastrointest Endosc Clin N Am* 1996; **6**: 81-105 [PMID: 8903564]

20 **Khan K**. High-resolution EUS to differentiate hypertrophic pyloric stenosis. *Gastrointest Endosc* 2008; **67**: 375-376 [PMID: 18028921 DOI: 10.1016/j.gie.2007.05.049]

21 **Tocchi A**, Mazzoni G, Liotta G, Costa G, Lepre L, Miccini M, De Masi E, Lamazza MA, Fiori E. Management of benign biliary strictures: biliary enteric anastomosis vs endoscopic stenting. *Arch Surg* 2000; **135**: 153-157 [PMID: 10668872]

22 **Gouma DJ**, Rauws EA, Laméris JS. [Bile duct injury after cholecystectomy: risk of mortality substantially higher]. *Ned Tijdschr Geneeskd* 2004; **148**: 1020-1024 [PMID: 15185435]

23 **Khan MH**, Howard TJ, Fogel EL, Sherman S, McHenry L, Watkins JL, Canal DF, Lehman GA. Frequency of biliary complications after laparoscopic cholecystectomy detected by ERCP: experience at a large tertiary referral center. *Gastrointest Endosc* 2007; **65**: 247-252 [PMID: 17258983 DOI: 10.1016/j.gie.2005.12.037]

24 **Bergman JJ**, van den Brink GR, Rauws EA, de Wit L, Obertop H, Huibregtse K, Tytgat GN, Gouma DJ. Treatment of bile duct lesions after laparoscopic cholecystectomy. *Gut* 1996; **38**: 141-147 [PMID: 8566842]

25 **de Reuver PR**, Rauws EA, Vermeulen M, Dijkgraaf MG, Gouma DJ, Bruno MJ. Endoscopic treatment of post-surgical bile duct injuries: long term outcome and predictors of success. *Gut* 2007; **56**: 1599-1605 [PMID: 17595232 DOI: 10.1136/gut.2007.123596]

26 **Misra S**, Melton GB, Geschwind JF, Venbrux AC, Cameron JL, Lillemoe KD. Percutaneous management of bile duct strictures and injuries associated with laparoscopic cholecystectomy: a decade of experience. *J Am Coll Surg* 2004; **198**: 218-226 [PMID: 14759778 DOI: 10.1016/j.jamcollsurg.2003.09.020]

27 **Melcher ML**, Freise CE, Ascher NL, Roberts JP. Outcomes of surgical repair of bile leaks and strictures after adult-to-adult living donor liver transplant. *Clin Transplant* 2010; **24**: E230-E235 [PMID: 20529098 DOI: 10.1111/j.1399-0012.2010.01289.x]

28 **Moreaux J**. Traditional surgical management of common bile duct stones: a prospective study during a 20-year experience. *Am J Surg* 1995; **169**: 220-226 [PMID: 7840384 DOI: 10.1016/S0002-9610(99)80141-X]

29 **Sheridan WG**, Williams HO, Lewis MH. Morbidity and mortality of common bile duct exploration. *Br J Surg* 1987; **74**: 1095-1099 [PMID: 3427352 DOI: 10.1002/bjs.1800741208]

30 **Ryu M**, Uematsu S, Watanabe Y, Furukawa T, Kikuchi T, Ozaki M, Sato H. [Ultrasonically guided percutaneous pancreatography (author's transl)]. *Rinsho Hoshasen* 1981; **26**: 1075-1079 [PMID: 7311057]

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