

Management of bile duct injuries: comparative study between Roux-en-Y hepaticojejunostomy and primary repair with stent placement

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Received 29 July 2013

Accepted 18 September 2013

Journal of the Arab Society for Medical Research 2013, 8:89–95

Background

Bile duct injury (BDI) is a major complication in biliary surgery such as laparoscopic cholecystectomy. The management of major BDI is a surgical challenge even for experienced hepatobiliary surgeons. The aim of this study was to introduce a new surgical technique for reconstruction of the biliary duct by primary repair after stent placement.

Patients and methods

The present study was carried out on a selected group of BDI patients (34 patients), who were referred for management of BDIs. Patients were divided into two equal groups: group A underwent primary repair of the bile duct by placement of a plastic stent (which is used in endoscopic retrograde cholangiopancreatography) and group B underwent Roux-en-Y hepaticojejunostomy.

Results

The study included 34 patients, 10 men (30.9%) and 24 women (69.1%) with a mean age of 40.84 years, whose main presentations were postoperative jaundice (82%) and bile leak (15%). All the patients underwent surgery successfully. There was no intraoperative mortality and bile leakage during the observation period, but primary repair of the bile duct with plastic stent placement was associated with better results as regards operation time, hospital stay, cost, safety, and postoperative complications.

Conclusion

Primary repair of the bile duct with stent placement showed good results, involved minimal morbidity, hospital stay, and cost; and helped avoid the drawbacks of Roux-Y hepaticojejunostomy. It also replaced exploration of the common bile duct with a T-tube, with advantages of function of the Oddis sphincter.

Keywords:

bile duct injury, biliary reconstruction, biliary stent

J Arab Soc Med Res 8:89–95

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1687-4293

Introduction

Bile duct injury (BDI) represents a serious and challenging surgical complication. These complex injuries are most often a consequence of laparoscopic cholecystectomy (LC) [1] and are still a major problem in current surgical practice. BDI is associated with reduced survival, increased morbidity, and poor quality of life [2,3]. It is not clear whether the injury should be repaired immediately or the repair should be delayed [4].

Iatrogenic BDI (IBDI) may occur following several types of abdominal operations, for example, liver surgery, gastrectomy, common bile duct (CBD) exploration, etc., and can be associated with life-threatening complications. However, the majority of IBDIs result from open cholecystectomy or LC [5]. The incidence of BDI at LC has been reported to be between 0.3 and 1.4% [6]. Only 30% of injuries are recognized at the time of operation. Measures to prevent and recognize BDI are outlined in many publications [7–9]. Preoperative management of BDI

ranges from simple drainage and referral to a tertiary center to an end-to-end anastomosis (EEA), with or without T-tube drainage and hepaticojejunostomy [10]. However, EEA is considered to be a relatively simple definitive repair, and it is also an optimal initial drainage procedure before reconstructive surgery in a secondary setting [11].

The classic injury occurs in the CBD, resulting in clipping and division of the common duct, which is then resected with the gallbladder [12]. Opting for laparotomy is not to be considered to be a failure but rather a good surgical decision that ensures the patients' safety [13].

BDIs can occur during difficult reconstructions, even when carried out by experienced surgeons, and are associated with prolonged hospital stay and a high risk of long-term complications. Roux-en-Y hepaticojejunostomy has been the most commonly used approach for biliary reconstruction, especially in cases of duct transaction injury [14]. However, its long-term outcome is still far from satisfactory

because of the high incidence of reflux cholangitis, choledocholithiasis, and anastomotic stenosis [15].

In the recent years, primary duct-to-duct reconstruction has been used in living donor liver transplantation and has gained good effects [16–18]. It preserves the function of the Oddis sphincter, which serves as a barrier to prevent any reflux into the bile duct [19].

The aim of this study was to introduce a new surgical technique for primary repair of BDI by placement of a plastic stent tube [stent used in endoscopic retrograde cholangiopancreatography (ERCP)] in the bile duct, and to compare its results with those of Roux-en-Y hepaticojejunostomy.

Patients and methods

This was a prospective study of patients with a clinical diagnosis of BDI, referred to the Department of General Surgery, Faculty of Medicine, Al-Azhar University, and the El Harm Hospital over a 5-year period between January 2008 and January 2013.

During the study period, a total of 34 patients with BDI were enrolled. Among them, 10 (30.1%) were male and 24 (69.1%) were female. Their ages ranged from 20 to 70 years, with a mean age of 40.84 years. All patients presented with BDI in the early postoperative stage after surgery (within the first few weeks). The main presentations were jaundice (82%), bile leak (15%), and other symptoms (3%).

Careful history taking, clinical examination, laboratory investigations, and liver function tests to estimate the levels of bilirubin, alanine aminotransferase, and aspartate aminotransferase were carried out. Abdominal ultrasonography, CT scanning of the abdomen, and ERCP or magnetic resonance cholangiography (MRC) were also performed. All patients were admitted to the Surgical Department after failure of endoscopic management.

Surgical procedure

Prognosis of surgical management depends on the timing of recognition of the injury, time of surgery, type of injury, patient's condition and available facilities, and the surgeon's expertise.

Operative procedures and guidelines for the treatment of BDI are presented in Table 1. The 34 patients were divided into two equal groups: group A underwent primary repair of the bile duct with placement of a plastic stent (which is used in ERCP) and group B underwent Roux-en-Y hepaticojejunostomy.

Operative procedure for group A

A 35-year-old woman presented with a history of LC, followed, within a few days, by a formal laparotomy for suspected BDI. Approximately 1 week after laparotomy, she developed a sinus on the anterior abdominal wall that was draining bile. She was then referred to our institution (Bab El-Sheria, Al-Azhar University Hospital) for further management. The earlier surgery was performed after rapid preparation and diagnosis by CT scanning and MRC revealed arrest of the dye at the level of the CBD (Fig. 1). Intraoperatively, massive inflammation around the cystic duct was observed, with multiple sutures and dilatation of the CBD; exploration of the CBD after careful removal of the sutures and cholangiography showed a patent CBD. CBD was reconstructed by EEA by insertion of a plastic stent (7–10 Fr; which is used in ERCP) into the bile duct. Purse-string sutures with 4–0 vicryl were made at both ends of the bile duct. The stent was inserted into both ends of the bile duct. The two ends of the bile duct were slightly closed and the purse-string sutures were tied to fix both ends of the bile duct on the stent to reconstruct the CBD (Fig. 2). Patients were allowed to start oral feeding after 24 h and cholangiography showed a normal biliary tree, without any leakage; the patient had a complete recovery (accidental use of ERCP plastic stent).

Table 1 Guidelines for the treatment of BDI

Guidelines for the treatment of BDI
Exposure of damaged area, avoiding too much dissection
The end of the injured bile duct has to free from burnt areas
Intraoperative cholangiography in every bile leakage
Vascular integrity should be confirmed
The CBD was reconstructed by EEA after stent placement.
Roux-en-Y hepaticojejunostomy is recommended if a part of the bile duct is lost
Opposition of both mucosa with absorbable sutures
Use of magnification (if available)

BDI, bile duct injury.

Figure 1



Complete ligation of the distal common bile duct with no filling of the proximal common bile duct.

Operative procedure for group B

During LC, CBD was misidentified for subverted anatomy caused by inflammation. The CBD was clipped, and the patient presented with jaundice 3 days after the operation. ERCP was performed showing the stop, and MRC was performed showing ligation of the right and left hepatic ducts (Fig. 3). Therefore, reoperation was needed and intraoperatively, showed clipping CBD with burned common hepatic duct, above the level of cystic (class iii Stewart–Way classification), Roux-en-Y hepaticojejunostomy was performed with complete recovery (Fig. 4).

Surgical outcome

The patients were assessed preoperatively, intraoperatively, and postoperatively. Conservative charting and clinical evaluation, estimation of the level of bilirubin on liver function tests, ultrasonography of the abdomen, and MRC to detect biliary continuity were carried out. Follow-up examinations were carried out at outpatient clinics (3–12 months).

Statistical analysis

Statistical analysis was carried out using SPSS (SPSS Inc., Chicago, Illinois, USA). Data on patient

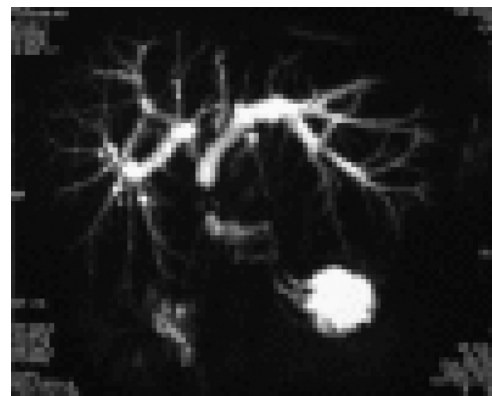
characteristics, management, and outcome are expressed as number of patients and percentages, with a significance level of P less than 0.05.

Results

BDIs are infrequent but potentially devastating complications that have become more common since the introduction of LC. The successful management of these injuries depends on the injury type, the timing of its recognition, the presence of complicating factors, and the condition of the patient. There was neither intraoperative death nor bile leakage detected during the observation period in both groups of our study.

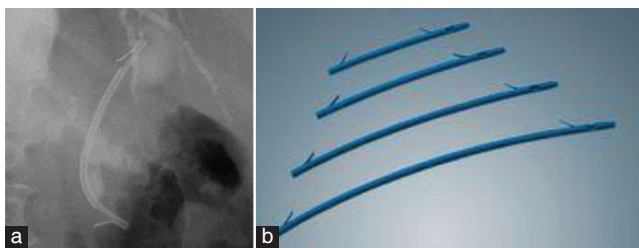
BDIs in these patients were divided on the basis of the mechanism and anatomy of the injury into four classes using the Stewart–Way classification (Fig. 5):

Figure 3



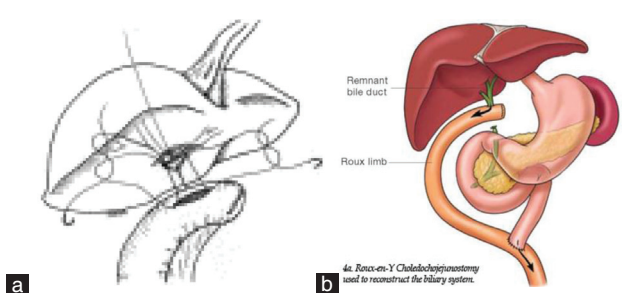
Magnetic resonance cholangiography (MRC) revealed bile duct injury (BDI), with right and left hepatic duct ligation and common bile duct cross-section.

Figure 2



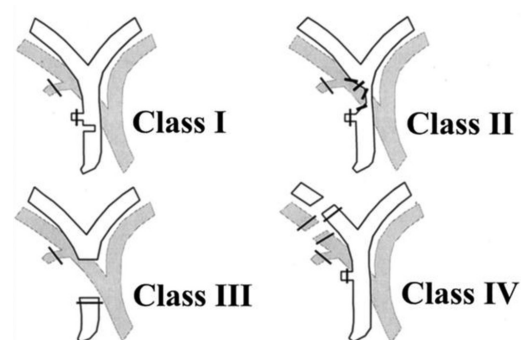
(a) Stent draining bile duct. (b) Polyethylene biliary stents are soft and pliable and conform ideally to the anatomy of the bile duct. The specific design facilitates easy insertion and allows for optimal drainage flow.

Figure 4



(a) Side-to-side hepaticojejunostomy: absorbable 5-0 monofilament interrupted stitches leaving the knots outside the anastomotic lumen. (b) Roux-en-Y hepaticojejunostomy.

Figure 5



The Stewart–Way classification of laparoscopic bile duct injuries. Class I, incision (incomplete transection) of the common bile duct (CBD); class II, lateral damage to the common hepatic duct (CHD); class III, transection of the CBD or CHD; and class IV, right hepatic duct or right segmental hepatic duct injuries.

class I, incision (incomplete transection) of the CBD [$n = 6$ (17.6%)]; class II, lateral damage to the common hepatic duct [$n = 9$ (26.5%)]; class III, transection of the CBD or common hepatic duct [$n = 15$ (44.1%)]; and class IV, right hepatic duct or right segmental hepatic duct injuries [$n = 4$ (11.8%)].

Patient characteristics

Patient characteristics are presented in Table 2. There were no significant differences in age, sex, or cause of biliary injury among patients.

All patients were treated by primary repair of BDI by biliary stent therapy; a successful outcome was obtained in 15 of 17 patients, with no sign of stenosis or leakage. However, two patients required surgical revision (because of stent migration) using the Roux-en-Y technique. It was also significantly longer for time of operation (2–4 to 3–6 h), hospital stay (5–8 to 10–42 days), Cost-effectiveness and Safety, but postoperative complications include (postoperative sepsis, surgical site infection, and wound dehiscence) and biliary-specific complications is not significant (Table 3).

Discussion

BDI is a major complication of biliary surgery. It can be classified according to the injury site using

Table 2 Patient characteristics

Patient characteristics	
Total patients (n)	34
Age at operation	
Mean (years)	20–70 (40.84)
Sex [n (%)]	
Male/female ratio	10 (30.9)/34 (69.1)
Presentation (%)	
Bile leak	82
Obstructive jaundice	15
Other	3

Table 3 Comparison between group I, which underwent primary repair of BDI, and group II, which underwent Roux-en-Y hepaticojejunostomy

Parameters	Group I	Group II	P -value
Operative time (h)	2–3	4–6	0.002
Postoperative oral feeding (days)	12.15 $\pm$ 3	97.1 $\pm$ 3	0.16
Hospital stay (days)	1.47	57	0.550
Return to work (days)	14.40 $\pm$ 4	70.17	0.017
Postoperative complications			
Bile leak	2 (5.0)	1 (5.0)	0.017
Superficial infection	0 (0.0)	2 (10.0)	0.014
Postoperative cholangitis	3 (16.0)	4 (20.0)	0.012

BDI, bile duct injury, Statistically significant: P -value 0.05.

several classification systems, for example, Bismuth classification [11], Strasberg classification [8], and Stewart–Way classification of laparoscopic BDIs [20].

Maintaining biliary continuity and integrity of function is essential in biliary reconstruction. Roux-en-Y hepaticojejunostomy has been the most commonly used procedure for repairing CBD defects. However, the function of the Oddis sphincter was lost in patients undergoing this procedure, leading to a high incidence of postoperative reflux cholangitis [21]. In this procedure, the stent plays an important role. The stent is connected to two ends of the bile duct to maintain the continuity of the biliary structure, and it is also used as an inner stent to prevent anastomosis restenoses [22,23]. The blood supply for the biliary anastomosis is a major concern in duct-to-duct biliary reconstructions. Obtaining adequate blood supply is fundamental for technical improvements in biliary reconstruction [16].

The risk for increased damage is smaller in an EEA procedure, and with the use a T-tube instant bile drainage is realized. If indicated, reconstructive surgery by elective hepaticojejunostomy can be performed. The present study shows a long-term stricture free survival of 91% in EEA patients after treatment at a tertiary center. The analysis also shows that the majority of complications after primary EEA at a general hospital can successfully be treated by endoscopic and radiological interventions. In only one-third of the patients, a secondary surgical repair is necessary. Surgical reconstruction after EEA was associated with acceptable morbidity and was without mortality [10].

In a situation in which preoperative bile leakage is due to (extensive) tissue loss, particularly in patients with more proximal lesions at the bifurcation or intrahepatically, no primary repair should be performed. In this situation, adequate drainage of the upper right abdomen is strongly advised and the patient should be referred for elective reconstruction, which has a positive effect on outcome [3].

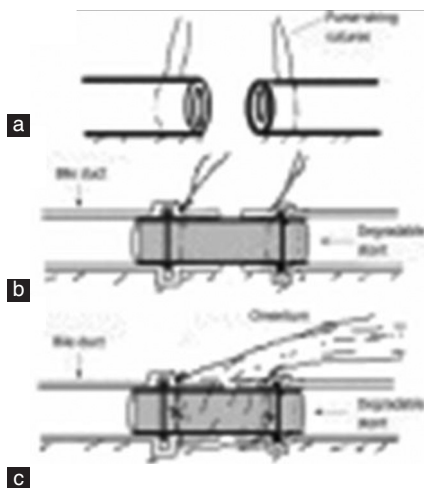
Patients with postoperative biliary leaks fare much better than those with complete cutoff or strictures, as 93% of patients with postoperative biliary leaks were managed successfully. Magnetic resonance cholangiopancreatography should be performed in all patients before surgery, and in the case of continuity with the proximal system, repeat ERCP should be performed. Further, re-exploration should be deferred until all other noninvasive modalities have been tried out. Of the 41 patients, five (12.2%) with bile leak developed biliary strictures on subsequent ERCP. Nine of the 15 patients (60%) with complete cutoff on initial

endoscopy were successfully treated on subsequent ERCP after demonstration of biliary continuity on magnetic resonance cholangiopancreatography. Six (40%) patients were referred for surgery [23]. Endoscopic therapy is safe and effective in the management of postoperative bile duct leak. For postoperative bile duct strictures, ERCP is a less favorable option [24].

Liang *et al.* [25] created a novel method for CBD reconstruction, namely duct-to-duct anastomosis (Fig. 6). This technique was effective in repairing the defect, with a good short-term effect without postoperative bile duct stricture, proving its feasibility and safety. The management of BDI has become a hot topic in clinical studies. With the development of tissue engineering, several studies on biodegradable materials for the bile duct have been conducted.

EEA is reported to be associated with a high incidence of recurrent jaundice due to stricture formation in the anastomotic area [26]. Therefore, some authors report that EEA is almost never appropriate if the bile duct has been completely transected [27]. Stent therapy for iatrogenic bile duct strictures has changed during the last decade, and therefore the long-term outcome after stenting has improved [28]. The only severe complication that occurred in the present series, due to stent migration, was not reported in previous series [29]. Determining the optimal procedure for biliary construction is an important surgical issue. Scatton and colleagues reported a lower incidence of overall biliary complication in the T-tube group. However, the most frequent complication was leakage after T-tube removal, whereas the incidence of anastomotic stricture was greater in the group without a T-tube [30].

Figure 6



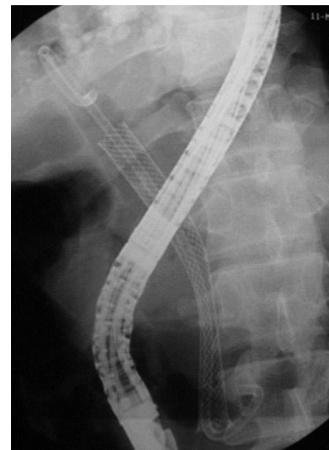
Schematic diagram of repairing a bile duct with a degradable stent and omentum. (a) Purse-string sutures with 4-0 vicryl were made at both ends of the bile duct. (b) The stent was inserted into both ends of the bile duct. (c) A vascularized greater omentum.

Short-term and long-term results of reconstructive methods and quality of life of patients treated for IBIs with Roux-en-Y hepaticojejunostomy or EEA were compared. Complications occurred earlier after hepaticojejunostomy [31]. Plastic biliary end prostheses have not changed much since their introduction more than three decades ago. Although their use has been challenged by the introduction of metal stents, plastic stents still remain commonly used. Much work has been carried out to improve the problem of stent obstruction, but without substantial clinical success. In this review, the authors discuss the history of plastic biliary stent development and the current use of plastic stents for malignant biliary diseases [32].

We performed a retrospective case review of patients who were referred for ERCP after traumatic BDI secondary to blunt (motor vehicle accident) or penetrating (gunshot) trauma for management of bile leaks. Fourteen patients underwent ERCP for the management of a traumatic bile leak over a 5-year period. All patients were treated by biliary stent placement, and the outcome was successful in all patients (100%). The mean duration of follow-up was 85.6 days (range 54–175 days). There were no ERCP-related complications. On the basis of our study results, ERCP should be considered as first-line therapy in the management of traumatic bile leaks [33].

Pauswasadi *et al.* [34] reported that full cover self-expandable metal stents may be a reasonably good alternative treatment option for difficult benign biliary strictures and bile leaks. The current data, however, do not demonstrate the superiority of full cover self-expandable metal stent placement over plastic stent placement (Fig. 7). Randomized controlled studies

Figure 7



Method to prevent fully covered stent migration. A double pigtail plastic stent was inserted as a stent-in-stent to lock movement of the fully covered metal stent (FCMS).

assessing stent efficacy, complications, and cost-effectiveness are needed before the routine use of this modality in benign biliary strictures and bile leaks can be recommended.

Among 10 123 LCs performed during the study period, BDI was sustained during the procedure in 19 cases. Intraoperative cholangiography was routinely performed. BDI was diagnosed intraoperatively in 17 patients (89.4%). The mean age was 56.4 years (range 18–81 years), and 15 patients were women (88%). According to the Strasberg classification of BDI, there were three type C lesions, 12 type D lesions, and two type E2 lesions. There were no associated vascular injuries. Twelve cases (71%) were converted to open surgery. The repairs included 10 primary biliary closures, four Roux-en-Y hepaticojejunostomies, end-to-end anastomosis, and one laparoscopic transpapillary drainage. Postoperative complications occurred in five patients (29.4%). During the follow-up period, early biliary strictures developed in two patients (11.7%) and were treated by percutaneous dilation and Roux-en-Y hepaticojejunostomy with satisfactory long-term results [35].

Surgery remains the choice in CBD transection, ligation, and combined injuries of stones, strictures, and leakage in 60% of cases. Bilioenteric anastomosis was the procedure of choice. The learning curve seems influential in both endoscopy and surgery. Cumulative experience increased the success of endoscopy from 60 to 95%. In addition, surgery improved, with decreased morbidity and mortality. In conclusion, endoscopy is comparable to surgery during the initial treatment of simple problems, but for major leaks, ligation, transection, and complex problems, surgery is the main treatment option because of its invasiveness [36].

In view of the high rate of success and low incidence of complications in the CBD, it became the gold standard in the treatment of BDI. However, once again, it should be stressed that good results can be obtained only by careful selection of patients in association with surgical experts from among those in whom ERCP, which is considered as first-line therapy in the management of BDI, failed.

Conclusion

Surgical treatment of BDI by primary repair of the bile duct by stent placement shows good results, involving minimal morbidity, operative time, hospital stay, and cost; avoiding the drawbacks of Roux-en-Y hepaticojejunostomy, including high risk of contamination due to construction of the Roux-en-Y limb, and allowing nonphysiological re-establishment of bilioenteric continuity. It also replaced

exploration of CBD using a T-tube, with more advantages of using a plastic tube. It is also of importance to preserve the function of the Oddis sphincter, which may reduce the risk of enteric reflux into the biliary tract. The stent played an important role in maintaining continuity of the biliary structure and preventing anastomosis restenoses.

Acknowledgements

Conflicts of interest

None

References

- McPartland KJ, Pomposelli JJ. Iatrogenic biliary injuries: classification, identification, and management. *Surg Clin North Am* 2008; 88:1329–1343.
- Boerma D, Rauws EAJ, Keulemans YCA, Bergman JJGHM, 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.
- Flum DR, Cheadle A, Prael C, Dellinger EP, Chan L. Bile duct injury during cholecystectomy and survival in Medicare beneficiaries. *J Am Med Assoc* 2003; 290:2168–2173.
- Balzarotti R, Cimbanassi S, Chiara O, Zabbialini G, Smadja C. Isolated extrahepatic bile duct rupture: a rare consequence of blunt abdominal trauma. Case report and review of the literature. *World J Emerg Surg* 2012; 7:16.
- Isla AM, Griniatsos J, Wan A. A technique for safe placement of a biliary endoprosthesis after laparoscopic choledochotomy. *J Laparoendosc Adv Surg Tech A* 2002; 12:207–211.
- Calvete J, Sabater L, Camps B, Verdú A, Gomez-Portilla A, Martín J, *et al.* Bile duct injury during laparoscopic cholecystectomy: Myth or reality of the learning curve? *Surg Endosc* 2000; 14:608–611.
- Lillemo 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; 232:430–441.
- Strasberg SM. Avoidance of biliary injury during laparoscopic cholecystectomy. *J Hepatobiliary Pancreat Surg* 2002; 9:543–547.
- Chapman WC, Abecassis M, Jarnagin W, Mulvihill S, Strasberg SM. Bile duct injuries 12 years after the introduction of laparoscopic cholecystectomy. *J Gastrointest Surg* 2003; 7:412–416.
- De Reuver PR, Busch ORC, Rauws EA, Lameris JS, Van Gulik, ThM Gouma, DJ. Long-term results of a primary end-to-end anastomosis in peroperative detected bile duct injury. *J Gastrointest Surg* 2007; 11:296–302.
- Bismuth H, Majno PE. Biliary strictures: classification based on the principles of surgical treatment. *World J Surg* 2001; 25:1241–1244.
- Massarweh NN, Devlin A, Elrod JAB, Symons RG, Flum DR. Surgeon knowledge, behavior, and opinions regarding intraoperative cholangiography. *J Am Coll Surg* 2008; 207:821–830.
- Parmeggiani D, Cimmino G, Cerbone D, Avenia N, Ruggero R, Gubitosi A, *et al.* Biliary tract injuries during laparoscopic cholecystectomy: three case reports and literature review. *G Chir* 2010; 31:16–19.
- Mercado MA, Domínguez I. Classification and management of bile duct injuries. *World J Gastrointest Surg* 2011; 3:43–48.
- Al-Ghnam R, Benjamin IS. Long-term outcome of hepaticojejunostomy with routine access loop formation following iatrogenic bile duct injury. *Br J Surg* 2002; 89:1118–1124.
- Ishiko T, Egawa H, Kasahara M, Nakamura T, Oike F, Kaihara S, *et al.* Duct-to-duct biliary reconstruction in living donor liver transplantation utilizing right lobe graft. *Ann Surg* 2002; 236:235–240.
- Yamamoto S, Sato Y, Oya H, Nakatsuka H, Kobayashi T, Hara, Y, *et al.* Risk factors and prevention of biliary anastomotic complications in adult living donor liver transplantation. *World J Gastroenterol* 2007; 13:4236–4241.
- Kasahara M, Egawa H, Takada Y, Oike F, Sakamoto S, Kiuchi T, *et al.* Biliary reconstruction in right lobe living-donor liver transplantation: comparison of different techniques in 321 recipients. *Ann Surg* 2006; 243:559–566.

- 19 Tocchi A, Mazzoni G, Liotta G, Lepre L, Cassini D, Miccini M. Late development of bile duct cancer in patients who had biliary-enteric drainage for benign disease: a follow-up study of more than 1000 patients. *Ann Surg* 2001; 234:210–214.
- 20 Way LW, Stewart L, Gantert W, Liu K, Lee CM, Whang K, Hunter JG. Causes and prevention of laparoscopic bile duct injuries: analysis of 252 cases from a human factors and cognitive psychology perspective. *Ann Surg* 2003; 237:460–469.
- 21 Miyazawa M, Torii T, Toshimitsu Y, Okada K, Koyama I, Ikada Y. A tissue-engineered artificial bile duct grown to resemble the native bile duct. *Am J Transplant* 2005; 5:1541–1547.
- 22 Wu JS, Soper NJ. Comparison of laparoscopic choledochotomy closure techniques. *Surg Endosc* 2002; 16:1309–1313.
- 23 Ghazanfar S, Qureshi S, Leghari A, Taj MA, Niaz SK, Quraishy MS. Endoscopic management of post operative bile duct injuries. *J Pak Med Assoc* 2012; 62:257–262.
- 24 Abdel-Raouf A, Hamdy E, El-Hanafy E, El-Ebidy G. Endoscopic management of postoperative bile duct injuries: a single center experience. *Saudi J Gastroenterol* 2010; 16:19–24.
- 25 Liang Y-L, Yu Y-C, Liu K, Wang W-J, Ying J-B, Wang Y-F, Cai X-J. Repair of bile duct defect with degradable stent and autologous tissue in a porcine model. *World J Gastroenterol* 2012; 18:5205–5210.
- 26 Stewart L, Way LW, Meyers WC. Bile duct injuries during laparoscopic cholecystectomy: factors that influence the results of treatment. *Arch Surg* 1995; 130:1123–1129.
- 27 Wudel Jr, LJ, Wright, JK, Pinson, CW, Herline, A, Debelak, J, Seidel, S, *et al.* Bile duct injury following laparoscopic cholecystectomy: a cause for continued concern. *Am Surg* 2001; 67:557–563. Discussion 563
- 28 Costamagna G, Pandolfi M, Mutignani M, Spada C, Perri V. Long-term results of endoscopic management of postoperative bile duct strictures with increasing numbers of stents. *Gastrointest Endosc* 2001; 54:162–168.
- 29 Bergman JJ, Burgemeister L, Bruno MJ, Rauws EA, Gouma DJ, Tytgat GN, Huibregtse K. Long-term follow-up after biliary stent placement for postoperative bile duct stenosis. *Gastrointest Endosc* 2001; 54:154–161.
- 30 Scatton O, Meunier B, Cherqui D, Boillot O, Sauvanet A, Boudjema K, *et al.* Randomized trial of choledochcholedochostomy with or without a T tube in orthotopic liver transplantation. *Ann Surg* 2001; 233:432–437.
- 31 Jabłońska B, Lampe P, Olakowski M, Górka Z, Lekstan A, Gruszka T. Hepaticojejunostomy vs. end-to-end biliary reconstructions in the treatment of iatrogenic bile duct injuries. *J Gastrointest Surg* 2009; 13:1084–1093.
- 32 Huibregtse I, Fockens P. Plastic biliary stents for malignant biliary diseases. *Gastrointest Endosc Clin N Am* 2011; 21:435–445.
- 33 Spinn MP, Patel MK, Cotton BA, Lukens FJ. Successful endoscopic therapy of traumatic bile leaks. *Case Rep Gastroenterol* 2013; 7:56–62.
- 34 Pausawasadi N, Soontornmanokul T, Rerknimitr R. Role of fully covered self-expandable metal stent for treatment of benign biliary strictures and bile leaks. *Korean J Radiol* 2012; 13(Suppl 1):S67–S73.
- 35 Pekolj J, Alvarez FA, Palavecino M, Sánchez Clariá R, Mazza O, De Santibañes E. Intraoperative management and repair of bile duct injuries sustained during 10 123 laparoscopic cholecystectomies in a high-volume referral center. *J Am Coll Surg* 2013; 216:894–901.
- 36 Redwan AA. Complex post-cholecystectomy biliary injuries: management with 10 years' experience in a major referral center. *J Laparoendosc Adv Surg Tech A* 2012; 22:539–549.