

RAPID COMMUNICATION

Surgical management in biliary restructure after Roux-en-Y hepaticojejunostomy for bile duct injury

Ji-Qi Yan, Cheng-Hong Peng, Jia-Zeng Ding, Wei-Ping Yang, Guang-Wen Zhou, Yong-Jun Chen, Zong-Yuan Tao, Hong-Wei Li

Ji-Qi Yan, Cheng-Hong Peng, Jia-Zeng Ding, Wei-Ping Yang, Guang-Wen Zhou, Yong-Jun Chen, Zong-Yuan Tao, Hong-Wei Li, Department of Surgery, Ruijin Hospital, School of Medicine, Shanghai Jiaotong University, Shanghai 200025, China
Correspondence to: Cheng-Hong Peng, Department of Surgery, Ruijin Hospital, School of Medicine, Shanghai Jiaotong University, 197 Ruijin Road, Shanghai 200025, China. chhpeng@188.com
Telephone: +86-21-64370045 Fax: +86-21-64333548
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Abstract

AIM: To discuss the surgical method and skill of biliary restructure after Roux-en-Y hepaticojejunostomy for bile duct injury.

METHODS: From November 2005 to December 2006, eight patients with biliary restructure after Roux-en-Y hepaticojejunostomy for bile duct injury were admitted to our hospital. Their clinical data were analyzed retrospectively.

RESULTS: Bile duct injury was caused by cholecystectomy in the eight cases, including seven cases with laparoscopic cholecystectomy and one with mini-incision cholecystectomy. According to the classification of Strasberg, type E1 injury was found in one patient, type E2 injury in three, type E3 injury in two and type E4 injury in two patients. Both of the type E4 injury patients also had a vascular lesion of the hepatic artery. Six patients received Roux-en-Y hepaticojejunostomy for the second time, and one of them who had type E4 injury with the right hepatic artery disruption received right hepatectomy afterward. One patient who had type E4 injury with the proper hepatic artery lesion underwent liver transplantation, and the remaining one with type E3 injury received external biliary drainage. All the patients recovered fairly well postoperatively.

CONCLUSION: Roux-en-Y hepaticojejunostomy is still the main approach for such failed surgical cases with bile duct injury. Special attention should be paid to concomitant vascular injury in these cases. The optimal timing and meticulous and excellent skills are essential to the success in this surgery.

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Key words: Bile duct injury; Biliary stricture; Roux-en-Y

INTRODUCTION

Since its introduction in the 1990s by Dubois^[1], laparoscopic cholecystectomy has become the “gold standard” treatment for symptomatic gallbladder stone disease. Limited postoperative discomfort, shorter hospitalization, and rapid postoperative recovery have been proven to be advantageous of the procedure. Concomitantly, it became obvious that the incidence of bile duct injury rose from 0.06% to 0.3%, as known for open cholecystectomy, to 0.5% to 1.4% when performed laparoscopically^[2-6]. Bile duct injury following cholecystectomy is an iatrogenic catastrophe associated with significant perioperative morbidity and mortality^[7,8], reduced long-term survival and quality of life^[9,10], and high rates of subsequent litigation. Apparently, it is a great surgical challenge to handle with biliary restructure after Roux-en-Y hepaticojejunostomy for bile duct injury. The operation can be much more complex and difficult when compared with the first attempt for bile duct injury reparation.

MATERIALS AND METHODS

Methods

From November 2005 to December 2006, eight cases of biliary restructure after Roux-en-Y hepaticojejunostomy, performed at other hospitals for bile duct injury, were admitted to our hospital. The average age of those patients, seven female and one male, was 48.9 ± 7.5 (35-60) years. Bile duct injuries were all caused by cholecystectomy in other hospitals, including seven cases with laparoscopic cholecystectomy and one case with mini-incision cholecystectomy. Although bile duct injury in three patients was initially treated by a T-tube placement within a choledochostomy, Roux-en-Y hepaticojejunostomy was performed afterward (with a range of 4-13 mo) in those patients because of failure

Table 1 Patient basic status of bile duct injury

Patient number	Type of injury (Strasberg)	Combined with vascular injury	Operation type	Postoperative liver function
1	E1	-	Roux-en-Y	Normal
2	E2	-	Roux-en-Y	Normal
3	E2	-	Roux-en-Y	Normal
4	E2	-	Roux-en-Y	Normal
5	E3	-	Roux-en-Y	Normal
6	E3	-	External biliary drainage	TBIL among 100 mmol/L
7	E4	right HA injury	Roux-en-Y, right hepatectomy afterward	Normal
8	E4	Proper HA injury	Liver transplantation	Normal

HA: Hepatic artery; Roux-en-Y: Roux-en-Y hepaticojejunostomy; TBIL: Total bilirubin.

in primary reparation. For the remaining five patients, Roux-en-Y hepaticojejunostomy was performed initially either during the operation of cholecystectomy or within a week after cholecystectomy. Unfortunately, all patients developed biliary restructure during the follow-up period, and were therefore transferred to our hospital.

Bile duct injury was classified according to Strasberg^[11] when the medical files from the referring hospital were reviewed. After admission, those patients received abdominal CT and MRCP examination. Type E1 injury was found in one patient, type E2 injury in three, type E3 injury in two and type E4 injury in two patients (Table 1 and Figure 1). Both of the patients with type E4 injury also had a vascular lesion of the hepatic artery, with disruption of either the right hepatic artery or the proper hepatic artery. The average period between the primary Roux-en-Y hepaticojejunostomy and the operation in our hospital was 41.3 ± 46.5 (5-148) mo. Six of the eight patients received Roux-en-Y hepaticojejunostomy for the second time without stent implantation, and one of the six patients who had type E4 injury with the right hepatic artery disruption underwent right hepatectomy afterward. One patient who had type E4 injury with the proper hepatic artery lesion received liver transplantation, and the remaining one patient with type E3 injury received external biliary drainage.

RESULTS

All patients recovered uneventfully, and no significant complications occurred postoperatively. Three patients received additional or alternative surgical procedures. In one patient who had type E4 injury with the right hepatic artery disruption, the primary bile-enteric anastomosis of the left hepatic duct was fairly good, however the scarred biliary stricture occurred in the primary biliary-enteric anastomosis of the right hepatic duct, and multiple small abscesses were located in the right lobe of the liver. Considering the possibility of liver failure caused by insufficient remnant liver volume, we did not perform right hemihepatectomy at that time. Carefully removing those

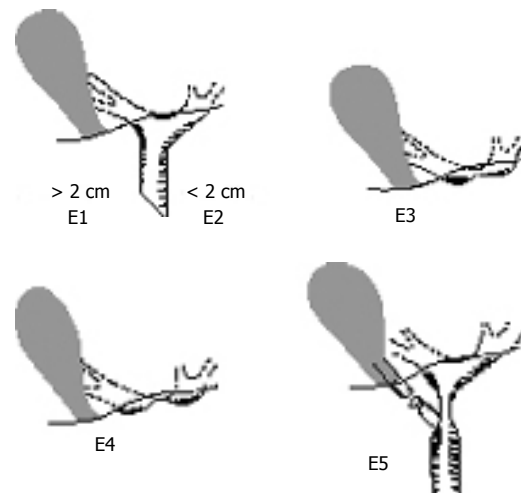


Figure 1 Strasberg classification of bile duct injury. E1: Transected main bile duct with a stricture more than 2 cm from the hilus; E2: Transected main bile duct with a stricture less than 2 cm from the hilus; E3: Stricture of the hilus with right and left ducts in communication; E4: Stricture of the hilus with separation of right and left ducts; E5: Stricture of the main bile duct and the right posterior sectoral duct.



Figure 2 Computed Tomography angiography (CTA) of one type E4 injury patient displayed the lesion of the proper hepatic artery (arrow), although some compensatory collateral arterial blood supply from the left gastric artery could be identified. This patient received liver transplantation.

inflammatory scar tissues, we identified the openings of the right anterior hepatic duct and the right posterior hepatic duct. We connected these two bile duct openings into one by plastic reconstruction and performed biliary-enteric reanastomosis. Six weeks later, the abscess was found in the right hepatic lobe of this patient on CT with clinical symptoms. However, the left hepatic lobe compensatory enlarged and liver function improved, and thus the right hemihepatectomy was performed safely afterward. The other patient with type E4 injury had proper hepatic artery disruption, although compensatory collateral arterial blood supply from the left gastric artery could be identified by CT (Figure 2). The patient presenting secondary biliary cirrhosis combined with portal hypertension at admission received liver transplantation. The remaining patient with type E3 injury suffered from severe biliary infection, and the general condition was extremely poor. Although several stones were removed in the biliary-enteric anastomosis of the left duct during the operation, we could not expose

the main opening of the right hepatic duct even when painstakingly dissecting hepatic hilar tissue about 3 cm in depth. As a result, external biliary drainage had to be carried out.

At a median follow-up of 10 (range 4-17) mo, the six patients who received Roux-en-Y hepaticojejunostomy for the second time and one undergoing liver transplantation was clinically and biochemically stable without any pathologic findings. The symptoms of biliary infection of the patient receiving external biliary drainage were controlled, the liver function was ameliorated, and total bilirubin dropped from the preoperative level of 318 $\mu\text{mol/L}$ to a level of around 100 $\mu\text{mol/L}$. This patient was waiting for liver transplantation.

DISCUSSION

In the United States and Canada, 34%-49% of surgeons have experienced a major bile duct injury, in one or two cases^[5,12]. Increasing evidence has suggested that such injury should be managed by an experienced hepatobiliary surgeon^[13] and the early recognition of injury directly affects the outcome^[7]. Patients treated by the injuring surgeons have an increased death risk of 11% at nine years^[14], yet in North America 58%-75% of injuries are still repaired by the injuring surgeons^[9,12]. Similarly, such situation also occur in China. Undoubtedly, it is a surgical challenge to handle the failed cases of Roux-en-Y hepaticojejunostomy for bile duct injury.

Preoperative preparation

Initial treatment should focus on resuscitation of the patient, drainage of any collections to create a controlled enterocutaneous fistula and treatment of sepsis. Any unuseful intra-abdominal drains may be withdrawn subsequently from the hilum, reducing the inflammation caused by such a foreign body, thereby allowing the tissue to mature. Nutritional supports should be maintained during the whole perioperative period^[15], since bile duct injury may even result in a systemic inflammatory response, with subsequent development of multiorgan failure. A low serum level of albumin at the time of surgery is often associated with a poor outcome^[16]. Thus, it is important to address any nutritional deficit with enteral feeding, as long periods of biliary-enteric discontinuity will impair the function of the intestinal barrier and increase the risk of endotoxaemia and fat soluble vitamin deficiency^[17].

Choice of operative method

If the biliary confluence is intact and there is no associated vascular injury, a hepaticojejunostomy onto the extrahepatic bile duct gives the best result^[15,18-20]. Based on our preliminary experience, the number and diameter of bile duct openings at the hilum is not the limiting factor of the surgery. Murr *et al*^[20] reported a 91% success rate and an 88% 5-year stricture-free survival. In liver transplantation surgery, biliary complications are almost universal following hepatic artery thrombosis. Vascular injuries contribute significantly to postoperative morbidity and mortality, particularly in cases of delayed diagnosis^[21]. It has been shown that ductal ischemia due to concomitant

hepatic arterial damage may be a cause of failed primary hepatojejunostomal reconstruction or late peripheral bile duct stenosis^[22,23]. Occlusion of the right hepatic artery can lead to necrosis of the right hepatic lobe; therefore, it may be appropriate to consider a right hemihepatectomy^[21]. In the case of poor general condition and uncontrollable biliary system infection, external biliary drainage might be the unique choice at the time of emergency. Patients who have developed secondary biliary cirrhosis should be considered to be the candidates for liver transplantation rather than further reconstruction, especially if there is significant portal hypertension^[15]. Bile duct injury associated with complex vascular lesions might even necessitate liver transplantation^[24].

Exposure of proximal bile duct

It is extremely important to create the biliary-enteric anastomosis to a healthy, non-inflamed, non-scarred duct. After the failure of the first attempt of Roux-en-Y hepaticojejunostomy, such dissection would become particularly difficult, for the level of scarred biliary stricture could be much higher than that of the primary bile duct injury. Once all adhesions of the right upper quadrant are sectioned, dissection of the jejunal limb is performed because misplacement and erroneous construction of Roux-en-Y are found in some patients^[25]. For a correct hilar dissection, it is necessary to avoid the interruption of arterial branches as much as possible. No effort is given to completely dissect the arterial supply to the liver^[26]. The hepatic artery itself and the previous surgical suture could be a useful anatomical mark in searching the bile duct at the hepatic hilum. The hilar plate is sectioned and the hilus is retracted caudally. If bile leak is observed during dissection, fine bile dilators are carefully inserted to identify the main ducts. Once the bile duct is explored, the scarred duct has to be removed up to a level at which a healthy duct is found. If the bifurcation is lost, with the isolated left and right hepatic duct, or the confluence is high and deep in the liver, dissection of the proximal bile ducts is not easily obtained. In such cases, partial liver resection of the segment IV and V is done to allow adequate exposure of the left and right ducts, as described by Strasberg^[27].

Surgical technique

In the present study, all patients received surgical repairs at their primary hospitals, and some even experienced numerous attempts. All those failed biliary-enteric anastomoses were placed at a too low level and exhibited technical faults such as the use of non-absorbable silk suture materials or a two-layer anastomotic technique. Attention to the anatomical placement of the anastomosis is of great importance^[19,28,29], as failure after hepaticojejunostomy is usually caused by an anastomotic stricture, which is often ischemic in nature^[28]. The healthy soft opening of the bile duct is crucial to the success of biliary-enteric reconstruction, however, the number and diameter of bile duct openings are comparatively of less importance. If bile duct openings at the hilum are nearby, plastic reconstruction could merge them into one or two openings (Figures 3 and 4). Although it is still controversial whether interrupted suturing or continuous

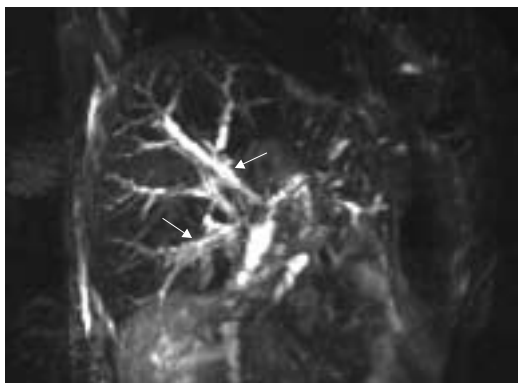


Figure 3 MRCP appearance of one type E3 injury patient showing dilation of intrahepatic bile ducts (arrows).



Figure 4 Plastic reconstruction in one type E3 patient merging several bile duct openings into one at the hilum after removal of the scarred ducts (the same patient in Figure 3).

running suturing is better for biliary-enteric anastomosis, we prefer the latter even in those extremely difficult cases with a single bile duct opening less than 3 mm in diameter. Actually, the distribution of tension in a continuous running suture would be more equal than an interrupted suture. Moreover, without the disturbance of multiple stitches as in interrupted suture, a continuous running suture would provide surgeons an easier way to focus their attentions to performing the anastomosis. The assistant surgeon should never pull the suture too tight during the entire procedure as we do expect to leave a 'growth factor' in every stitch. To improve the quality of biliary-enteric anastomosis is beyond the quarrel of the interrupted suture or continuous running suture. Based on our experience, traditional silk suturing should be abandoned in biliary-enteric anastomosis, since it might cause 'silk suture reactive stones,' looking like a necklace around the anastomosis area in some cases. Compared to most of the reported literature using absorbable PDS® suture for the anastomosis, we routinely use the non-absorbable Prolene® suture. Having observed a few cases of anastomotic edema of bile duct reconstruction using PDS® suture in previous liver transplanted patients, we consider that such absorbable suturing might be responsible for the foreign body reaction. However, this requires further investigations to draw a conclusion as to whether the absorbable PDS® suture or the non-absorbable Prolene® suture is advantageous in biliary-enteric anastomosis.

Attention to concomitant hepatic artery injury

It was reported that concomitant vascular injury was present in 71% of patients with Bismuth level IV lesions and in 63% of those with Bismuth level III bile duct injury^[23]. In our group, both of the type E4 injury patients had a hepatic artery lesion. Special attention should be paid to concomitant vascular injury in those complicated cases. The prognostic impact of vascular damage was underlined by Buell *et al.*, who reported a 38% mortality rate in the presence of arterial lesions as against 3% in patients with injuries limited solely to the bile duct^[30]. When vascular injury is recognized during the original operation, we would recommend immediate arterial reconstruction if the surgeon is capable or transfer the patient to a tertiary specialty department/clinic for definitive surgical

repair. Delayed diagnosed vascular lesions are mostly not accessible for revascularization and can be followed by hepatic necrosis or persistent cholangitis resulting in end-stage liver cirrhosis. Based on our limited experience on one patient receiving liver transplantation and data reported by others, patients with bile duct injury associated with severe vascular lesion might be considered for liver transplantation.

Major bile duct injury during cholecystectomy is a disaster not only for the patient, but also for the surgeon. Although it would be extremely difficult to manage the patients with biliary restructure after Roux-en-Y hepaticojejunostomy for bile duct injury, good results could be achieved in the form of Roux-en-Y hepaticojejunostomy for the second time in those complicated cases. Undoubtedly, a better general preoperative condition, careful selection of the operation method, excellent surgical skills and meticulous postoperative management would account for a favourable outcome in bile duct injury cases.

COMMENTS

Background

Laparoscopic cholecystectomy has become the first choice of management for symptomatic cholecystolithiasis. While it is associated with decreased postoperative morbidity and mortality, bile duct injuries are reported more severe and more common when compared with open cholecystectomy.

Research frontiers

Bile duct injury would be aggravated by delayed recognition or a failed initial repair. It is a great challenge for surgeons to handle the biliary restructure after Roux-en-Y hepaticojejunostomy for bile duct injury. In most cases, if the biliary confluence is intact and there is no associated vascular injury, a secondary hepaticojejunostomy on the extrahepatic bile duct gives the best result.

Innovations and breakthroughs

It is extremely important to create the biliary-enteric anastomosis to a healthy, noninflamed, nonscarred duct, although the level of scarred biliary stricture could be much higher than that of the primary bile duct injury. Based on our preliminary experience, the number and diameter of bile duct openings at the hilum are not the limiting factors of the surgery. We prefer continuous running suture for biliary-enteric anastomosis.

Applications

Although it would be of great difficulty to manage the patients with biliary restructure

after Roux-en-Y hepaticojejunostomy for bile duct injury, good results could be achieved in a secondary Roux-en-Y hepaticojejunostomy in those complicated cases.

Terminology

Hepaticojejunostomy: anastomosis of hepatic duct and jejunum.

Peer review

The paper by Yan *et al* describes their surgical experience on biliary stricture after Roux-en-Y hepaticojejunostomy for bile duct injury in a Chinese university hospital. The results of the surgery seem to be impressive.

REFERENCES

- Dubois F, Icard P, Berthelot G, Levard H. Coelioscopic cholecystectomy. Preliminary report of 36 cases. *Ann Surg* 1990; **211**: 60-62
- de Reuver PR, Rauws EA, Bruno MJ, Lameris JS, Busch OR, van Gulik TM, Gouma DJ. Survival in bile duct injury patients after laparoscopic cholecystectomy: a multidisciplinary approach of gastroenterologists, radiologists, and surgeons. *Surgery* 2007; **142**: 1-9
- McMahon AJ, Fullarton G, Baxter JN, O'Dwyer PJ. Bile duct injury and bile leakage in laparoscopic cholecystectomy. *Br J Surg* 1995; **82**: 307-313
- Deziel DJ, Millikan KW, Economou SG, Doolas A, Ko ST, Airan MC. Complications of laparoscopic cholecystectomy: a national survey of 4,292 hospitals and an analysis of 77,604 cases. *Am J Surg* 1993; **165**: 9-14
- Archer SB, Brown DW, Smith CD, Branum GD, Hunter JG. Bile duct injury during laparoscopic cholecystectomy: results of a national survey. *Ann Surg* 2001; **234**: 549-58; discussion 558-9
- MacFadyen BV Jr, Vecchio R, Ricardo AE, Mathis CR. Bile duct injury after laparoscopic cholecystectomy. The United States experience. *Surg Endosc* 1998; **12**: 315-321
- Savader SJ, Lillemoe KD, Prescott CA, Winick AB, Venbrux AC, Lund GB, Mitchell SE, Cameron JL, Osterman FA Jr. Laparoscopic cholecystectomy-related bile duct injuries: a health and financial disaster. *Ann Surg* 1997; **225**: 268-273
- Moossa AR, Mayer AD, Stabile B. Iatrogenic injury to the bile duct. Who, how, where? *Arch Surg* 1990; **125**: 1028-130; discussion 1028-130
- Flum DR, Cheadle A, Prela C, Dellinger EP, Chan L. Bile duct injury during cholecystectomy and survival in medicare beneficiaries. *JAMA* 2003; **290**: 2168-2173
- Moore DE, Feurer ID, Holzman MD, Wudel LJ, Strickland C, Gorden DL, Chari R, Wright JK, Pinson CW. Long-term detrimental effect of bile duct injury on health-related quality of life. *Arch Surg* 2004; **139**: 476-81; discussion 481-2
- Strasberg SM, Hertl M, Soper NJ. An analysis of the problem of biliary injury during laparoscopic cholecystectomy. *J Am Coll Surg* 1995; **180**: 101-125
- Francoeur JR, Wiseman K, Buczkowski AK, Chung SW, Scudamore CH. Surgeons' anonymous response after bile duct injury during cholecystectomy. *Am J Surg* 2003; **185**: 468-475
- Stewart L, Way LW. Bile duct injuries during laparoscopic cholecystectomy. Factors that influence the results of treatment. *Arch Surg* 1995; **130**: 1123-1128; discussion 1129
- Hugh TB. New strategies to prevent laparoscopic bile duct injury-surgeons can learn from pilots. *Surgery* 2002; **132**: 826-835
- Connor S, Garden OJ. Bile duct injury in the era of laparoscopic cholecystectomy. *Br J Surg* 2006; **93**: 158-168
- Blumgart LH, Kelley CJ, Benjamin IS. Benign bile duct stricture following cholecystectomy: critical factors in management. *Br J Surg* 1984; **71**: 836-843
- Kamiya S, Nagino M, Kanazawa H, Komatsu S, Mayumi T, Takagi K, Asahara T, Nomoto K, Tanaka R, Nimura Y. The value of bile replacement during external biliary drainage: an analysis of intestinal permeability, integrity, and microflora. *Ann Surg* 2004; **239**: 510-517
- Chaudhary A, Chandra A, Negi SS, Sachdev A. Reoperative surgery for postcholecystectomy bile duct injuries. *Dig Surg* 2002; **19**: 22-27
- Sutherland F, Launois B, Stanescu M, Campion JP, Spiliopoulos Y, Stasik C. A refined approach to the repair of postcholecystectomy bile duct strictures. *Arch Surg* 1999; **134**: 299-302
- Murr MM, Gigot JF, Nagorney DM, Harmsen WS, Ilstrup DM, Farnell MB. Long-term results of biliary reconstruction after laparoscopic bile duct injuries. *Arch Surg* 1999; **134**: 604-69; discussion 604-69
- 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
- Mathisen O, Søreide O, Bergan A. Laparoscopic cholecystectomy: bile duct and vascular injuries: management and outcome. *Scand J Gastroenterol* 2002; **37**: 476-481
- Koffron A, Ferrario M, Parsons W, Nemcek A, Saker M, Abecassis M. Failed primary management of iatrogenic biliary injury: incidence and significance of concomitant hepatic arterial disruption. *Surgery* 2001; **130**: 722-78; discussion 722-78
- Nordin A, Halme L, Mäkisalo H, Isoniemi H, Höckerstedt K. Management and outcome of major bile duct injuries after laparoscopic cholecystectomy: from therapeutic endoscopy to liver transplantation. *Liver Transpl* 2002; **8**: 1036-1043
- Mercado MA, Chan C, Orozco H, Podgaetz E, Estuardo Porras-Aguilar D, Rodrigo Lozano R, Davila-Cervantes A. Iatrogenic intestinal injury concomitant to iatrogenic bile duct injury: the second component. *Curr Surg* 2004; **61**: 380-385
- Mercado MA, Chan C, Orozco H, Villalta JM, Barajas-Olivas A, Eraña J, Domínguez I. Long-term evaluation of biliary reconstruction after partial resection of segments IV and V in iatrogenic injuries. *J Gastrointest Surg* 2006; **10**: 77-82
- Strasberg SM, Picus DD, Drebin JA. Results of a new strategy for reconstruction of biliary injuries having an isolated right-sided component. *J Gastrointest Surg* 2001; **5**: 266-274
- Terblanche J, Worthley CS, Spence RA, Krige JE. High or low hepaticojejunostomy for bile duct strictures? *Surgery* 1990; **108**: 828-834
- Pereira-Lima L. Biliary reconstruction in benign postoperative stricture with transhepatic tubes. *Am J Surg* 1992; **164**: 124-128
- Buell JF, Cronin DC, Funaki B, Koffron A, Yoshida A, Lo A, Leef J, Millis JM. Devastating and fatal complications associated with combined vascular and bile duct injuries during cholecystectomy. *Arch Surg* 2002; **137**: 703-78; discussion 703-78

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