Transplant International

ORIGINAL ARTICLE

Diagnostic and therapeutic management algorithm for biliary complications in living liver donors

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SUMMARY

This study aimed to demonstrate the efficacy of our diagnostic and therapeutic management algorithm and catheter-assisted (percutaneous transhepatic biliary tract drainage [PTBD] or transanastomotic feeding tube) hepaticojejunostomy (HJ) procedures in living liver donors (LLDs) with biliary complications. Living donor hepatectomy (LDH) was performed between September 2005 and April 2021 in 2 489 LLDs. Biliary complications developed in 220 LLDs (8.8%), 136 of which were male, and the median age was 29 (interquartile range [IQR]: 12) years. Endoscopic sphincterotomy ± stenting was performed in 132 LLDs, which was unsuccessful in 9 LLDs and required HJ. Overall, 142 LLDs underwent interventional radiologic procedures. Fifteen LLDs with biliary complications underwent HJ (PTBD catheter = 6 and transanastomotic feeding tube = 9) at a median of 44 days (IQR: 82). Following HJ, 14 LLDs did not have any complications throughout the median follow-up period of 1619 days (IQR: 1454). However, percutaneous dilation for HJ anastomotic stricture was performed in one patient. Biliary complications are very common following LDH; therefore, surgeons in the field should have a low threshold to perform HJ for biliary complications that persist after other treatments. Our catheter-assisted HJ techniques demonstrated a high success rate and aided HJ in a hostile abdomen during revisional surgery.

Transplant International 2021; 34: 2226–2237

Key words
biliary complications, hepaticojejunostomy, living donor hepatectomy, living donor liver transplantation, percutaneous transhepatic biliary tract drainage

Received: 19 February 2021; Revision requested: 1 September 2021; Accepted: 5 September 2021; Published online: 29 September 2021

Introduction

The deceased donor pool is insufficient to meet the transplantation demands of many countries; therefore, living donor liver transplantation (LDLT) is the main strategy to expand the liver donor pool [1,2]. The main advantages of LDLT are the availability of liver grafts at all times, the ability to perform planned elective or emergency liver transplantation procedures, and shorter cold ischemia durations, which reduce the risk of

doi:10.1111/tri.14104

primary non-function and other related complications [1,2].

An increase in the number of studies addressing morbidity and mortality in LLDs significantly reduced the interest and motivation in performing LDLTs in the Western countries. Currently, studies report an overall morbidity and mortality of 0%–67% and 0.1%–1%, respectively, following living donor hepatectomy (LDH) [1–3]. Biliary complications are one of the most common complications after LDH. Management of biliary complications varies from a “wait and see” strategy to a complex and technically demanding surgical procedure, such as hepaticojejunostomy (HJ). Percutaneous transhepatic biliary tract drainage (PTBD: external–internal, external), percutaneous perihepatic bilioma drainage (transhepatic or transperitoneal), and endoscopic retrograde cholangiopancreatography (ERCP) are among the minimally invasive treatment options for biliary complications. Furthermore, current proposals for the classification of biliary complications are deduced from resections performed for hepatobiliary and pancreatic malignancies, which may not be suitable for complications following LDH [4,5]. There is a lack of consensus regarding the timing and choice of treatment algorithm and the decision to perform HJ in LLDs with persistent biliary complications. This study aimed to present the findings of our diagnostic and therapeutic algorithm for biliary complications in LLDs and our catheter-assisted HJ techniques in necessary cases.

Material and methods

Study design

Data of 2489 LLDs who underwent LDH at the Inonu University Liver Transplant Institute between September 2005 and April 2021 were retrospectively analyzed. This study was designed to emphasize three major points: first, we delineated a diagnostic and therapeutic management algorithm for biliary complications following LDH; second, we presented our catheter-assisted HJ techniques (PTBD catheter-assisted HJ and transanastomotic feeding tube- assisted HJ) for biliary stricture and bile leaks that could not be treated with endoscopic and interventional radiologic procedures; third, we determined whether there were statistical differences in the demographic, laboratory and surgical characteristics between LLDs with (n = 220) and without (n = 2269) postoperative biliary complications. For this latter purpose, only LLDs with access to demographic and clinical data were compared.

Donor evaluation protocol

Our detailed LLD candidate evaluation scheme and information regarding the aborted LDHs are emphasized in a recent studies from our institute [6–8].

Until the end of 2013, LLD candidates between 18 and 65 years of age were accepted for further investigation [8]. However, we faced some problems with postoperative graft function in the recipients and remnant liver function in the LLDs older than 60 years; therefore, we started to evaluate LLD candidates between 18 and 60 years old [6]. Since 2018, in the majority of LLDs, we have complied with the evaluation criteria, which consisted of donor age, remnant liver volume, and hepatosteatosis, as recommended by Asan Medical Center [9]. Based on these criteria, we included healthy individuals aged between 18 and 55 years with normal renal and liver functions in the LLD evaluation. As stated in our previous published studies, the hepatic regenerative capacity of elderly LLD candidates is limited, creating a risk for LLDs. Furthermore, the poor graft quality could be a problem for the recipient, which may include a high risk of primary non-function and higher biliary complication rates [10-12].

Donor hepatectomy technique

The preferred technique for LDH has been described in previous studies from our institute [13–15]. The procedure starts with cholecystectomy, and we routinely perform intraoperative cholangiography. It is performed as the initial step of the procedure in order to decide whether to proceed with LDH. We also performed intraoperative cholangiography after the completion of LDH to compare with images taken at the begining of the procedure. This is especially important in LLDs with a complicated biliary anatomy.

Data acquisition

Of the 2489 LDHs that were performed between September 2005 and April 2021, 220 (8.8%) LLDs developed biliary complications, and only one of them was determined intraoperatively. The following parameters were used for the three main purposes of the study: age, sex, body mass index (BMI: kg/m^2), type of LDH (right, left, left lateral segmentectomy), remnant liver volume (%), timing of surgery (elective or emergency), preoperative bilirubin levels, number of bile duct orifices on the liver graft, time from LDH to ERCP, time from LDH to interventional radiologic procedures, and time from LDH to relaparatomy or HJ. Biliary complications of 220 LLDs were classified according to the classifications proposed by the Clavien Surgical Morbidity Scale (modified for LLD) [16], International Study Group of Liver Surgery (ISGLS) [4], and Nagano and colleagues [5].

Definition of biliary complications

Physical examination findings, biochemical parameters, and imaging studies including ultrasonography (US), MDCT, MRCP, and ERCP were used to identify and classify biliary complications following LDH. All of the findings defined in detail below were regarded as postoperative biliary complications.

Management algorithm for biliary complications

(I) The majority of LLDs who had a radiologically proven perihepatic bilioma (Fig. 1a), with findings of cholangitis or abscess without acute abdomen, underwent percutaneous transhepatic drainage, and on rare occasions (Fig. 1b), a percutaneous transperitoneal (nonhepatic) drainage was performed. Routine percutaneous needle aspiration was performed in all these cases, and if the aspirate was not bilious, a drainage catheter was not inserted. US follow-up was generally performed in these cases. In rare cases with persistent collection, the procedure was repeated.

LLDs who received a drainage catheter were controlled regularly, and a pouchography was performed 1 or 2 days after the placement of the catheter. In cases without any bile duct connection, the “wait and see” strategy was chosen (Fig. 1c). In majority of these cases, the bilioma was caused by a minor bile duct draining the caudate lobe (Fig. 1d). If the pouchography showed communication with the biliary tree, the treatment was directed according to the anatomic location of the communication (Fig. 2). Biliary communication with the main bile ducts was treated with ERCP + sphincterotomy ± stent placement. If ERCP failed due to technical reasons or bile leaks persisted despite repeated ERCP sessions, an external–internal or external PTBD catheter was inserted. In LLDs with bile leaks from an isolated segmental bile duct located on

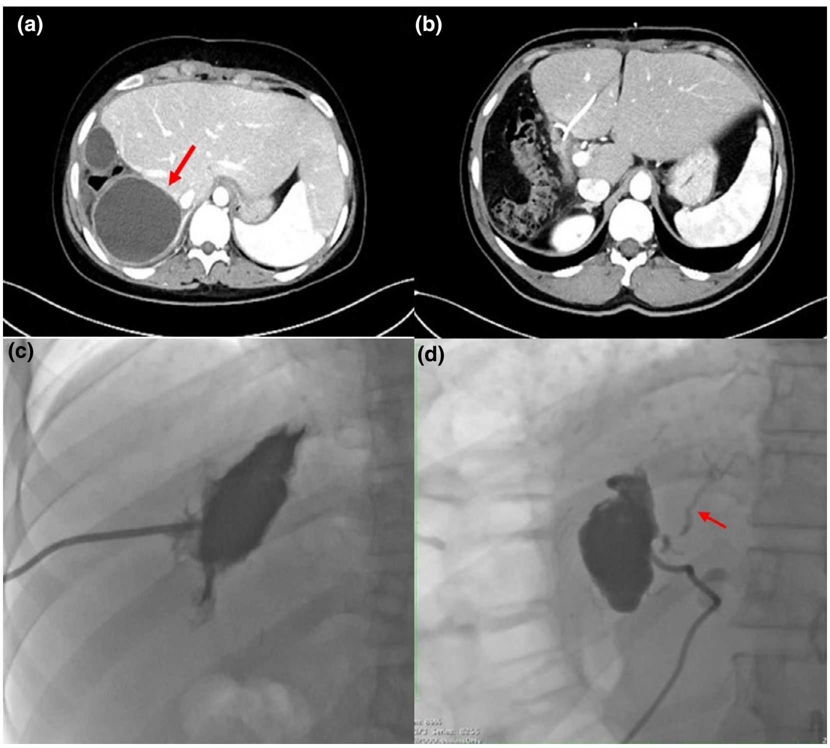


Figure 1 Different contrast-enhanced tomography images of postoperative biliary complications. Extrahepatic bilioma (a), drainage of extrahepatic bilioma via PTBD catheter (b), no communication between the bilioma and the bile ducts (c), and communication between the bilioma and the minor segmental bile duct (d).

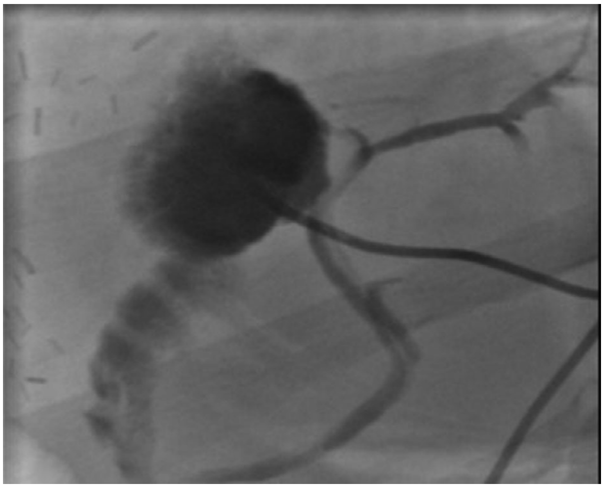


Figure 2 Pouchography showed that the contrast medium passes both to the left hepatic duct and to the common bile duct.

the cut surface of the remnant liver that had no communication with a major bile duct, the treatment method was chosen according to the daily output of biliary drainage. If the biliary drainage was less than 50 ml/day, which is mostly related to the minor segmental bile duct, close follow-up without any invasive intervention was preferred. However, fibrin glue plugs were rarely applied to the bile duct through percutaneous catheter placement in bile leaks with prolonged low-volume drainage. LLDs with prolonged biliary drainage ≥ 50 ml/days could be related to the major segmental bile duct, which required a PTBD catheter. If bile leaks are communicated with the major segmental bile duct, PTBD-assisted HJ can be considered. Even if the external–internal PTBD catheter is inserted, the most appropriate approach is PTBD-assisted HJ in cases with persistent bile leaks from the site of bile duct stumps. This is a reasonable approach because, in these patients, there are ischemic defects in the bile duct stump that are often not suitable for primary repair.

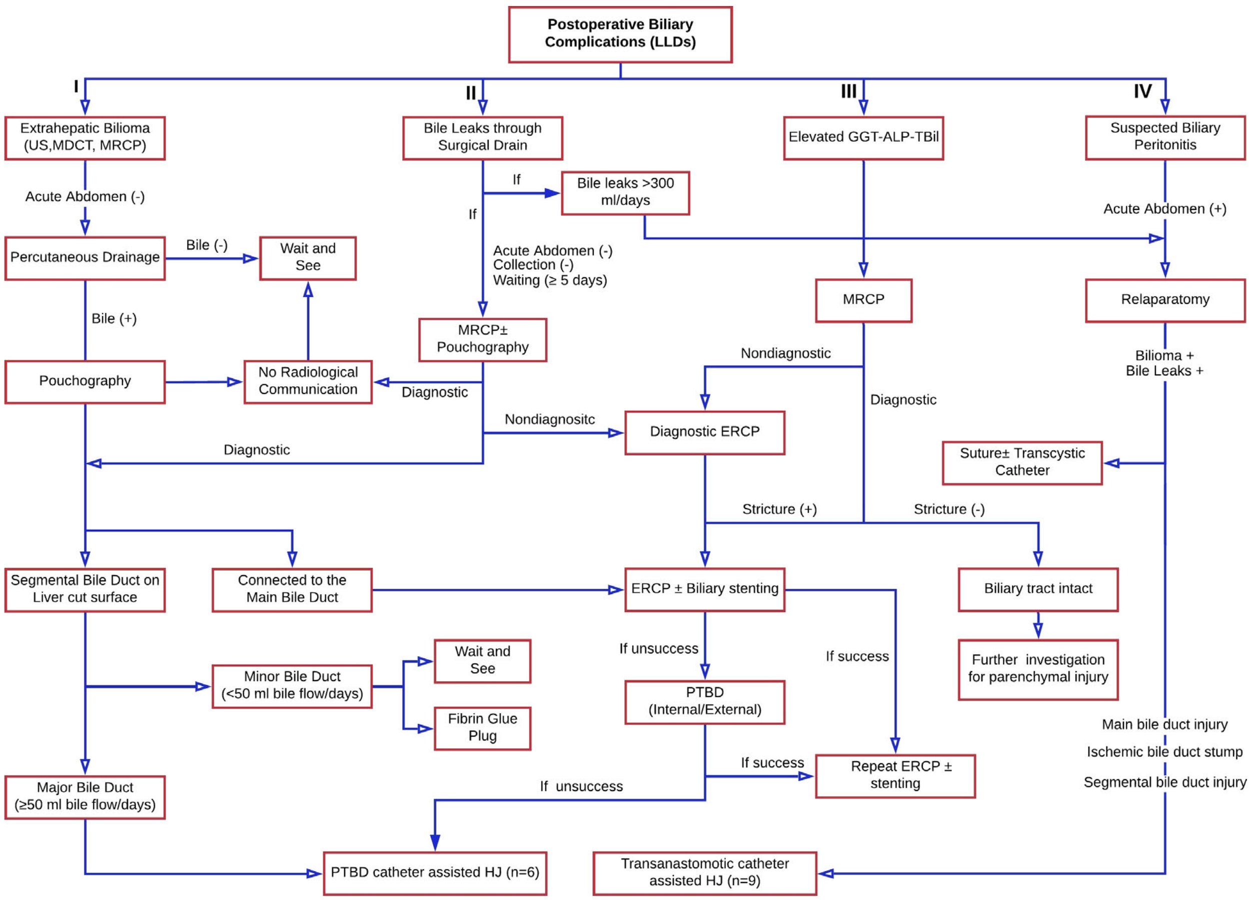
(II) In LLDs with biliary drainage from the perihepatic surgical drain and those who do not have signs and symptoms of acute abdomen, we usually preferred the "wait and see" strategy for the first postoperative 5 days. Early relaparatomy is beneficial in cases with pure biliary drainage that has an output of more than 300 ml/day within the first 2 postoperative days. In LLDs with persistent biliary drainage (≥5 days), we usually preferred to evaluate with MRCP and/or occasionally with fluoroscopy enhanced with contrast media delivered from the surgical drain. In patients whose MRCP was unsuccessful in showing the remnant biliary tract, diagnostic ERCP was considered, and a stent was inserted in necessary cases.

(III) In LLDs with isolated enzyme elevation and without any clinical or ultrasonographic findings, MRCP was utilized to evaluate the biliary tract. LLDs without any biliary stricture in MRCP required further investigation for a possible parenchymal disease. LLDs with biliary stricture detected by MRCP underwent ERCP ± sphincterotomy, and a stent was inserted for the treatment of the stricture. In LLDs with a failed ERCP attempt, PTBD was performed, external–internal PTBD catheter was inserted, and during the follow-up period, and stent renewal was performed with ERCP. If the external–internal PTBD procedure failed to pass through the stricture, an external PTBD catheter was inserted and re-evaluated a few days later. If the repeated attempts failed, PTBD catheter-assisted HJ was performed.

(IV) Relaparatomy was performed for LLDs with an acute abdomen or abundant biliary drainage. Cholangiography was performed via a catheter inserted into the cystic duct. If bile leaks from major bile ducts were detected, the catheter was sent through the cystic duct to the remnant liver bile ducts. After this procedure, the bile leaks points were repaired with polypropylene suture materials. Postoperative cholangiography was performed 4–6 weeks later, and the catheter was withdrawn if no bile leaks were observed. Detailed information is presented in Graphic 1.

Details of the hepaticojejunostomy procedure

The procedure was performed through a previous Makuuchi incision. If possible, a cholangiography was performed following catheterization of the cystic duct stump. However, in LLDs with an external PTBD catheter, the radiologist placed a guide wire through the catheter. The PTBD catheter was withdrawn with care, and the rigid guidewire was pushed forward slowly under fluoroscopic observation (Fig. 3a). A bile duct orifice wide enough to perform an anastomosis was dissected and prepared using a Cavitron Ultrasonic Surgical Aspirator to dissect the periductal liver parenchyma. Following retraction of the guidewire, a PTBD catheter was inserted, and HJ anastomosis was performed over the catheter (Fig. 3b). HJ anastomoses were performed



Graphic 1. Diagnostic and therapeutic algorithm for postoperative biliary complications in living liver donors.

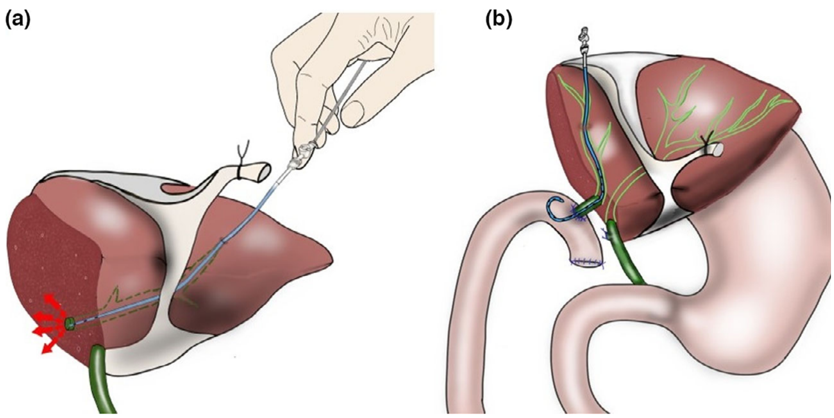


Figure 3 Demonstration of the search of obstructed or ligated bile duct via interventional radiological instruments (a). Following this, HJ was performed over the PTBD catheter (b).

with interrupted sutures using 6/0 monofilament polydioxanone sutures. The same steps were applied in cases undergoing transanastomotic feeding tube-assisted HJ procedure. In these cases, end of feeding tube was pulled out from the stump of the Roux limb (Fig. 4). All catheters were withdrawn in LLDs without bile leaks on cholangiography performed between 4 and 6 weeks postoperatively.

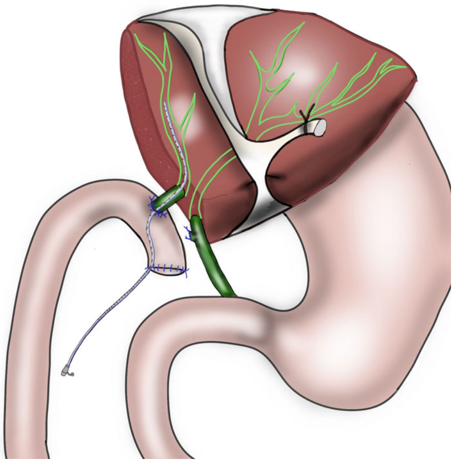


Figure 4 Demonstration of intraoperative iatrogenic segment IV bile duct injury. HJ was performed over the transanastomotic biliary drainage catheter.

Statistical analysis

Statistical analyses were performed using the IBM SPSS Statistics 25.0 (Statistical Package for the Social Sciences, Inc., Chicago, IL, USA). The Chi-square test was used to compare categorical variables, and the Mann–Whitney U test was used to compare continuous variables median and interquartile range (IQR). Differences were considered statistically significant at P values < 0.05. Ethical approval was obtained from the Inonu University Institutional Review Board for non-interventional studies (approval no: 2019/10-23).

Results

General characteristics of the study population

A total of 220 LLDs developed biliary complications. There were no statistically significant differences between the LLDs with (n = 220) and without (n = 2062) biliary complications in terms of sex (P = 0.391), age (P = 0.336), BMI (P = 0.960), remnant liver volume (P = 0.369), preoperative total bilirubin (P = 0.444), direct bilirubin (P = 0.401), indirect bilirubin (P = 0.517), timing of surgery (P = 0.549), type of donor hepatectomy (P = 0.506), and the number of bile duct orifices on the liver graft, which also indicates the number of biliary orifices on the remnant bile duct (P = 0.893; Table 1).

Table 1. Comparison of LLDs with and without postoperative biliary complications.

Donor characteristics	Biliary compl (−) (n = 2062)	Biliary compl (+) (n = 220)	P
Gender			
Male	1213 (58.8)	136 (61.8)	0.391
Female	849 (41.2)	84 (38.2)	
Age			
Median (IQR)	29 (13)	29 (12)	0.336
Min–Max	18–66	18–62	
BMI			
Median (IQR)	24 (4)	24 (4)	0.960
Min–Max	16–38	16–32	
Remnant liver volume (%)			
Median (IQR)	33 (5)	33 (36)	0.369
Min–Max	28–85	29–84	
Total bil (Preop)			
Median (IQR)	0.57 (0.4)	0.60 (0.4)	0.444
Min–Max	0.1–3.8	0.15–2.3	
Direct bil (Preop)			
Median (IQR)	0.22 (0.13)	0.24 (0.14)	0.401
Min–Max	0.01–0.80	0.10–0.73	
Indirect bil (Preop)			
Median (IQR)	0.33 (0.27)	0.36 (0.29)	0.517
Min–Max	0.02–3.15	0.04–1.60	
Surgery timing			
Elective	1868 (90.6)	196 (90.4)	0.549
Emergency	194 (9.4)	24 (90.6)	
Graft type			
Right hepatectomy	1626	166	0.506
Left hepatectomy	145	18	
Left lateral segmentectomy	291	36	
Liver graft with bile duct orfice			
One orifice	856	105	0.893
Two orifice	644	77	
Three orifice	88	9	
Four orifice	3	0	

Assessment of the ERCP results

One to ten sessions of ERCP were performed in 132 LLDs in a median of 24 days (IQR: 32 days) following LDH. Among these patients, seven underwent PTBD ± stenting because of unsuccessful ERCP or persistent biliary leak. A total of 15 LLDs received HJ. Nine of 15 LLDs who underwent HJ had a history of failed ERCP attempts. One ERCP session resulted in duodenal perforation, and our treatment strategy for this patient was previously published [17]. Six LLDs with biliary complications had mild-to-moderate pancreatitis following ERCP.

Assessment of the percutaneous procedures results

Overall, 142 LLDs with biliary complications underwent one to four sessions of interventional radiology-assisted

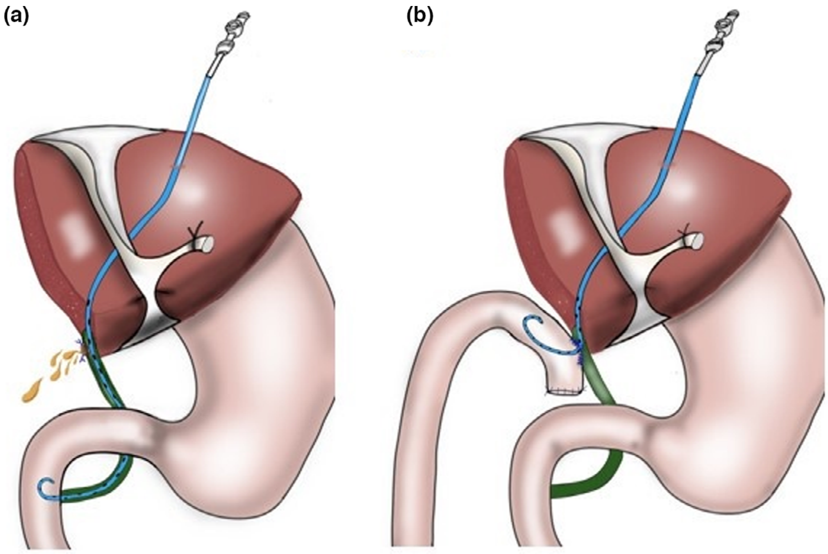


Figure 5 Demonstration of the persistent bile leaks from stump despite PTBD catheter placement (a). Following this, side-to-side HJ was performed over the PTBD catheter (b). Thus, the common bile duct was preserved.

percutaneous procedures. Thirty LLDs received an external or external–internal PTBD catheter. The remaining 112 patients underwent transhepatic or transperitoneal perihepatic bilioma drainage, and drainage catheters were not placed in 25 of these patients because the aspirated fluid was serous/purulent rather than bilious. The median time from LDH to interventional radiology procedure was 19 days (IQR: 18 days). Among 30 LLDs that had an external or external–internal PTBD catheter inserted, six underwent PTBD catheter-assisted HJ.

Assessment of the hepaticojejunostomy results

The HJ procedure was performed in 15 LLDs who had postoperative (n = 14) or intraoperative (n = 1) biliary complications. (i) Intraoperative biliary complications consisted of iatrogenic segment IV bile duct injury. In this LLD, HJ anastomosis was performed on the bile duct draining segment 4, and the common bile duct was left intact (Fig. 4). (ii) Isolated major segmental duct obstruction was present in four LLDs, and there was no problem in the main bile duct. In these LLDs, these isolated bile ducts were probably unnoticed in the first operation and were ligated accidentally. (iii) Two LLDs had obstruction in the main bile duct that could not be resolved by percutaneous interventional procedures, and the treatment required HJ. Single-orifice HJ was performed in the above-mentioned seven LLDs. (iv) In three LLDs, a large ischemic defective area was found on the ductal stump area, which was caused by an obstruction in the main biliary tract. Side-to-side HJ was performed (Fig. 5). (v) Two LLDs had both a major biliary tract and isolated segmental major biliary tract obstruction. These patients underwent double-orifice HJ (Fig. 6). (v) HJ was performed in three LLDs due to persistent bile leaks and extrahepatic bile duct obstruction.

Six LLDs underwent PTBD catheter-assisted HJ. In one patient who underwent an emergency laparotomy

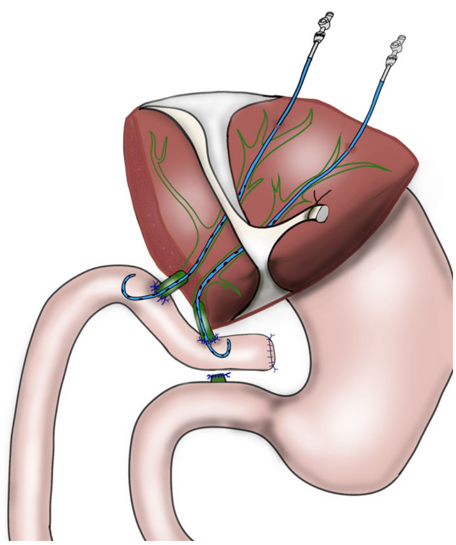


Figure 6 Demonstration of two separate HJ anastomosis on the same Roux limb.

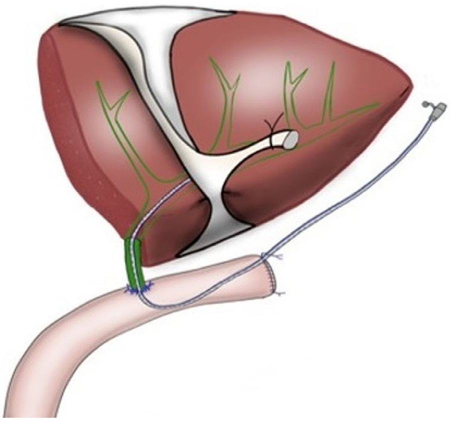


Figure 7 Demonstration of end-to-side HJ between roux limb and common bile duct. HJ was performed over the transanastomotic biliary drainage catheter.

in the early postoperative period and did not have a PTBD catheter, a transanastomotic catheter was inserted, and the distal tip of the catheter was advanced into the intrahepatic bile ducts (Fig. 7).

Fifteen LLDs with biliary complications underwent HJ at a median of 44 days (IQR: 82 days) after the LDH procedure (right lobe, 10; left lobe, 3; left lateral segment, 2). There was no statistically significant difference between LLDs, who had biliary complications, with (*n* = 15) and without (*n* = 205) HJ procedures in terms of sex, age, graft type, BMI, and bile duct anatomy. LLDs with biliary complications were followed up for a median of 1270 days (IQR: 1454). Following HJ, 14 LLDs did not have any complications along the median of 1619 days of follow-up. For a patient who suffered from HJ anastomosis stricture on long-term follow-up, an internal biliary drainage catheter was inserted, and the catheter was withdrawn following three sessions of balloon dilation.

Classification of biliary complication according to the three proposed systems

The distribution of LLD biliary complications according to the Clavien Surgical Morbidity Scale was as follows: grade IIIa (*n* = 85) and grade IIIb (*n* = 135). The distribution of LLD biliary complications according to ISGLS was as follows: grade B (*n* = 175; ERCP alone, ERCP+ percutaneous intervention combined, percutaneous intervention alone) and grade C (*n* = 45). According to Nagano and colleagues, the distribution of LLD biliary complications was as follows: type A (*n* = 146), type B (*n* = 70), and type C (*n* = 4).

Classification of biliary complications according to institutional experience

The most frequent biliary complication type that we encountered was type A (*n* = 146), which was bile leaks from the cut surface of the remnant liver. The second most frequent type of complication was type B (*n* = 70), which was bile leak from the stump of the closed bile ducts. Less frequently, we have seen iatrogenic biliary tract injuries that were classified as Type C. We further divided the Type C bile duct injuries into two subcategories: type C1 (*n* = 2) and type C2 (*n* = 2). Type C1 consisted of iatrogenic transection of the major bile ducts, such as the right anterior, posterior, segment II, or segment III bile ducts. These injuries were identified during relaparatomy by recognizing the biliary orifice on the cut surface of the liver. Because the bile duct was had been ligated. Type C2 injuries were defined as iatrogenic injury of the major bile ducts, which were recognized by intraoperatively or postoperative radiologic diagnostic modalities. Mostly there was a bile leak due to open bile duct. Type C injuries are almost always treated with HJ. Type D (*n* = 0) injuries were iatrogenic, complete, or nearly complete transection of the common hepatic duct. This classification is demonstrated in Fig. 8(a-c).

Discussion

Biliary complications following LDH are common, the incidence rate of which has been reported to be 0%–38.6% [18]. Ghobrial et al. [19] reported a retrospective study conducted by the A2ALL study group; this multicentric study including nine centers that performed LDLT reported that biliary complications are the second most common complication encountered in LLDs in the postoperative period, with an incidence of 9.2%. Wide variations of the incidence of biliary complications in LLDs reported in various studies may be due to the lack of a uniform definition of these complications. The centers who report low postoperative biliary complications can be so due to the low rate of abdominal drain use, negligence of the subclinical bile leaks, and early discharges because of problems in reimbursements in these centers [20–22]. In the present study, the overall postoperative biliary complication rate following LDH was 8.8%. Yuan et al. [18] have stated that total biliary complication rates in LLDs have been shown to be higher in right lobe harvesting (6.6% versus 2.9%). Biliary anatomic variations of the right lobe of the liver are more frequently encountered, which may explain

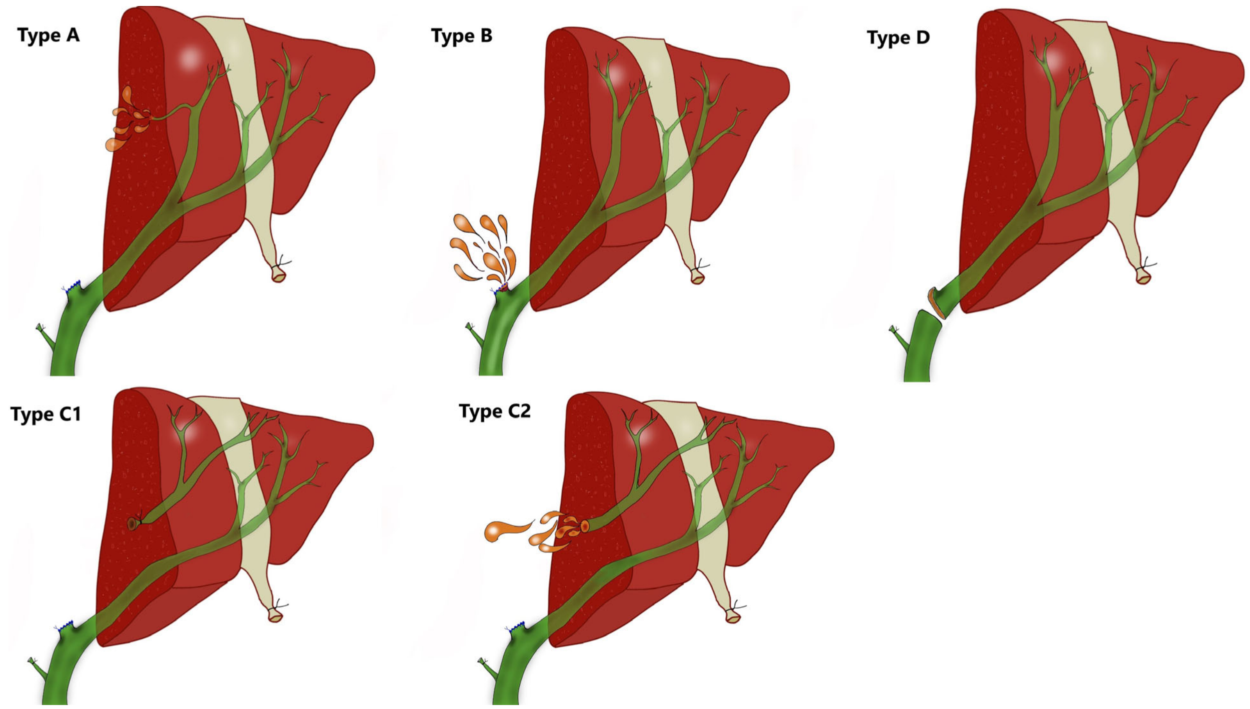


Figure 8 Classification of postoperative bile leaks into the following four groups: type A, bile leaks from the cut surface of the remnant liver; type B, bile leaks from the bile duct stump that is insufficiently closed; type C1, iatrogenic transection and closure of the transected injured bile duct; type C2, iatrogenic transection of the bile duct; type D, iatrogenic complete or nearly complete transection of the common hepatic duct.

the high complication rates observed in the present study. In our study, there were no statistically significant differences between right and left lobe donors in terms of biliary complications, which may be due to the advanced experience of the center.

Management of biliary complications in LLD should be preemptive, and surgeons in the field should have a low threshold to perform HJ whenever feasible. Therefore, the management algorithm is significantly more important than the classification of the problem. Furthermore, most current classification systems are deduced from hepatic resections for hepatobiliary and pancreatic malignancies [4,5]. It is noteworthy that LLDs were not patients and were completely normal; therefore, complications that develop after LDH should be actively treated. Furthermore, the definitions applied in other scenarios may not be representative of LDH. We propose that endoscopic and interventional radiologic procedures should be actively performed if bile leaks are related to the main biliary ducts. If these methods do not treat the biliary leak, the surgeon should have a low threshold to perform catheter-assisted HJ. On the other hand, if the bile leaks originate from a minor bile duct, then the decision should be made according to the drainage volume of the leak.

The algorithm for the management of postoperative biliary complications presented in our study is the result of our extensive experience. In some studies, flowchart-like diagrams were presented for the diagnosis and treatment of biliary complications; however, in these studies, the development of an algorithm was attempted based on results obtained from a limited number of cases [2,23]. Our algorithm provides discrete information for low-output bile leaks that stem from isolated minor bile ducts and also for high-output bile leaks that are the result of major bile duct injury. It is noteworthy that 30 years have passed since the first LDLT procedure, and little has been published to guide physicians regarding the management of biliary complications following LDH. We believe that the present study will provide a useful algorithm for the management of postoperative living donor biliary complications in centers performing LDLT.

Patients who have biliary complications that cannot be treated by interventional radiology or ERCP need to be treated with HJ; this is a reality that transplant surgeons cannot avoid. Studies from centers that perform LDLT have major shortcomings regarding the extent of LLDs that require HJ following biliary complications. For example, it is not clear whether “the surgical

Table 2. Literature summary about living liver donors who underwent Roux-en-Y HJ or Choledochojejunostomy due to major biliary complications following living donor hepatectomy.

Authors	Year	Country	Center	Period	Total LDH	Biliary complications	Right LDH	Left LDH	HJ	Conclusion
Gorgen	2018	Canada	University Health Network	2000–2017	587	10 (1.7)	10	0	3	Roux-en-Y HJ
Aziz	2016	Egypt	Menoufia University	2003–2013	204	30 (14.7)	24	6	1	Roux-en-Y HJ
Kim	2016	S. Korea	National Cancer Center	2005–2014	500	10 (2.0)	10	0	1	Roux-en-Y HJ
Dayangac	2011	Turkey	Florance Nightingale Hospit	2004–2009	150	6 (4.0)	NS	NS	3	Roux-en-Y HJ
Taketomi	2010	Japan	Kyushu University	1996–2009	343	14 (4.1)	NS	NS	1	Choledochojejunostomy
Iida	2010	Japan	Kyoto University	1990–2007	1262	99 (7.8)	61	38	3	Roux-en-Y HJ
Azzam	2010	Japan	Kyoto University	1998–2003	311	37 (12)	311	0	1	Roux-en-Y HJ
Shio	2008	Japan	Kyoto University	1999–2006	731	55 (7.5)	434	297	5	Roux-en-Y HJ
Kiuchi	2003	Japan	Kyoto University	1998–2002	250	NS	250	0	1	Roux-en-Y HJ
Grewal	1998	USA	Chicago University	1989–1996	100	7 (7.0)	0	100	1	Choledochojejunostomy

repair" and "repeat biliary reconstruction" referred to in these studies are actually HJ or not [23,24]. We do not see much emphasis on this issue in the literature. To date, we have tried to identify cases of HJ reported in LLDs. A total of 15 HJs were reported in nine published studies (Table 2) [6,13,14,22,25–32].

HJ is a major operation performed for the management of biliary complications following LDH. This has emotional consequences for surgeons who perform LDH. Nevertheless, it is important to state that HJ is a life-saving procedure in the management of biliary complications because biliary complications may have devastating consequences for the donor, resulting in death [2,33]. Of course, all non-surgical methods should be used to treat biliary complications, especially in LLDs. However, unnecessary waiting for cases that do not recover will only result in a disaster. In bile leaks that are not resolved with percutaneous interventions, HJ should be kept in mind as a last resort for management.

Furthermore, if HJ is chosen to treat a biliary complication in LLDs, it should be performed as a one-step procedure during reoperation. In the present study, additional procedures were needed in one LLD who underwent surgery for biliary complications, and HJ was performed. HJ was performed in a sufficiently wide bile duct. Intraoperative cholangiography was performed through a PTBD catheter that had been inserted prior to the operation, and bile ducts were visualized and the operation ended. In fact, the visualized bile ducts belong to segments II and IV. The segment III hepatic duct remained obstructed and was not visualized. Unfortunately, we did not compare the final intraoperative cholangiography images with donor MRCP or intraoperative cholangiography images obtained at the beginning of the LDH procedure. Therefore, this patient required relaparatomy for a second HJ anastomosis.

The main goal of the study was to demonstrate the efficacy of our management algorithm and the results of our catheter-assisted HJ procedure. On the other hand, we would also like to draw attention from surgeons in the field of LT to two factors. LDH is performed on healthy individuals. The main question that should be answered by transplant societies is the timing of transition from healthy individuals to patients. In other words, when are LLDs considered as patients? We believe that, once the LLD candidates enter the operating theater and induction of anesthesia starts, the individual becomes a patient. The second point that should be emphasized is that any complication that develops in LLD requires a different reflex from complications that develop in any other hepatic resection for hepatobiliary diseases. In our opinion, physicians should react quickly to treat complications in LLDs.

The results of this study show that postoperative biliary complications are still a major problem following LDH. Donor safety during LDLT is imperative; however, if this concern leads to improper transection of the graft during LDH, the results may be devastating for the recipient. Therefore, a good balance should be obtained during LDH. Necessary precautions should be taken to avoid damage to the donor bile ducts, but sufficient bile ducts should be provided for safe anastomosis in the recipient. However, this balance can occasionally be disrupted, leading to unfavorable donor outcomes. In countries with insufficient cadaveric organ supply, LDLT continues to be the major source of organ supply, and biliary complications will be encountered in LLDs. In centers performing LDLT, early and accurate management protocols for postoperative donor biliary complications should be prioritized. Surgeons should not hesitate to perform HJ once other measures have failed.

Authorship

Development of the project: Akbulut S, Sahin TT, Yilmaz S, Karabulut E, and Ozsay O; data collection: Sarici KB, Baskiran A, Gonultas F, Ozdemir F and Ersan V; writing: Akbulut S, Isik B and Yilmaz S; drawing of figures: SU; radiological interventions: Kutlu R; endoscopic interventions: Harputluoglu M; editing; Akbulut S, Isik B, Sahin TT and Yilmaz S.

Funding

The authors declare no funding.

Conflict of interest

The authors have no conflict of interest to declare in relation to the content of the submitted paper. This research did not receive any specific grant from funding from any official or corporate funding.

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