The impact of donor's biliary anatomy variations on the procedure of living donor liver transplantation

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Background
Anatomical variation of biliary anatomy is the cornerstone for the procedure of living donor liver transplantation (LDLT).
Aim
The aim was to study the effect of donor's biliary variant anatomy on the procedure of adult LDLT.
Participants and methods
A retrospective study was conducted using the data of all donors and recipients of LDLT (June 2013–December 2017) in HPB Department and Liver Transplant Surgery. A total of 120 potential donors were assessed preoperatively by MRCP to evaluate the biliary anatomy of the liver and classified into four types according to Varotti and colleagues.
Results
Of 120 donors, 13 (10.8%) were excluded from donation before surgery owing to various causes; six (46.1%) of them were excluded owing to donor's biliary anatomical variation. According to the classification of Varotti and colleagues, biliary variations were seen in 27 (25.2%) of 107 donors (five of type 2, 14 of type 3a, and eight of type 3b); type 1 with short stump was seen in 25 (23.1%) cases. Biliary complications (BCs) occurred in 53 (49.5%) of 107 recipients, including bile leak in 40 (37.5%) cases, biliary strictures in 13 (12.1%) cases, and concomitant biliary stricture and leak in 17 (15.9%) cases. There was a statistically significant correlation between the presence of donor's right hepatic duct (RTH) duct (type 1 with short stump) and BCs in their recipients ($P=0.04$). There was a statistically significant between the occurrence of BCs in recipient and hospital stay ($P=0.046$). BCs presented in eight (7.4%) donors, where six (5.6%) of them had bile leak and two (1.8%) had a biliary stricture. Anatomical biliary variations were a risk factor for potential donor exclusion ($P=0.021$).
Conclusions
There was a statistically significant difference between donor's RTH (type 1 with short stump) and BCs in their recipients, and between the occurrence of BCs in recipient and hospital stay. Donor biliary anatomical variations had a statistically significant effect for potential donor's exclusion.

Keywords:
biliary complication, biliary variation, donor, liver transplant, graft-to-recipient weight ratio

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Introduction

Living donor liver transplantation (LDLT) is a lifeline procedure for cirrhotic patients, especially in countries where there is a shortage of deceased organ donors. Biliary complications (BCs) remain one of the most common and the most worrisome problems in liver transplant recipients. Biliary strictures and bile leaks account for most BCs after LDLT, and the outcomes are potentially lethal [1]. Donor operation safety is directly related to the precise recognition of liver anatomy. Anatomic variations of the vascular and biliary system in the liver are common. Biliary tract variations are found in 24–57% of cases [2]. The incidence of type 1 biliary anatomy between 53 and 72% has been reported by different studies. Most right liver (RL) grafts with type 1 biliary anatomy determined by cholangiogram are found after parenchymal transaction to have a single duct to be reconstructed. In the right HD with a short length (<1 cm), an RL graft can turn out to have two ducts [3]. Therefore, it is apparent that thorough knowledge and successful detection and recognition of such anatomic variations can lead to decreased morbidity and mortality rates during LDLT surgery [4]. The combination of preoperative MRCP with

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intraoperative cholangiogram provides a 'biliary map' that facilitates donor dissection with minimal manipulation. Moreover, postresection cholangiogram is performed to exclude an inadvertent biliary injury during donation and provides a baseline study if future interventions are necessary [5]. Therefore, the aim of the study was to assess the effect of the donor's biliary variant anatomy on the procedure of adult living donor liver transplantation.

Participants and methods

This is a retrospective study of the data retrieved from the medical records of all donors and recipients of LDLT in the period from June 2013 to the end of December 2017 (120 donors) in the Department of HPB and Liver Transplant Surgery, National Liver Institute, Menuofia University, Egypt. These data included the following: demographic and preoperative data of the donor, such as age, sex, BMI, and computed tomography imaging studies, including pelviabdominal ultrasound, computed tomography triphasic abdomen and pelvis with vascular reconstruction and volumetric study, and MRCP and liver biopsy. Donor preoperative biliary variables were based on preoperative MRCP according to Varotti and colleagues. MRCP was routinely performed to evaluate the anatomy of the donor biliary anatomy. It was performed by 1.5 T magnets using breath-hold heavily T2-weighted sequences in axial and coronal thin sections, and variable-thickness rotating slabs (Figure 1). Of 120 donors, 13 (10.8%) were excluded from donation before surgery owing to various causes. Changed plane for graft selection intraoperative occurred in three donors from right (RT) lobe graft to left (LT) lobe graft with middle hepatic Vein (MHV).

Demographic and preoperative data of the recipients recorded were as follows: age, sex, body mass index, the indication of LDLT, Child–Pugh score, model of end-stage liver disease (MELD), co-morbidities, and previous abdominal surgery.

Operative data obtained were as follows: type of graft, graft weight, graft-to-recipient weight ratio (GRWR), changed plane for graft selection, cold and warm ischemia times, intraoperative cholangiogram, number of the bile duct in the graft, type of biliary reconstruction (duct to duct or hepaticojejunostomy), bleeding, and blood transfusion.

Postoperative data obtained were as follows: BCs (leaks or strictures), morbidity and mortality of the recipient, and their correlation to donor's biliary variant anatomy. The research was conducted ethically by following the World Medical Association Declaration of Helsinki. The patients have given their written informed consent on admission and preoperative to use their prospective database and files for research work. The study protocol was approved by the National Liver Institute Committee and Review Board (NLI: 23745). The work has been approved by the National Liver Institute Ethical Committees, in which the study was performed, and the patients gave informed consent to use their retrospectively collected data from files for study and research work. The editor in chief can access the consent any time when needed.

Recently anatomic variations of the biliary tract were classified into four types (according to Varotti and colleagues):

(1) Type 1: the right anterior and right posterior hepatic ducts (HDs) join together to form the right HD.
(2) Type 2: the right HD is absent, and the right anterior HD and right posterior HD join directly to the confluence with the left HD to form the common HD.
(3) Type 3: the right anterior HD (type 3a) or the right posterior HD (type 3b) opens directly into the left HD.
(4) Type 4: the right anterior HD (type 4a) or the right posterior HD (type 4b) opens directly into the common HD.

Statistical analysis

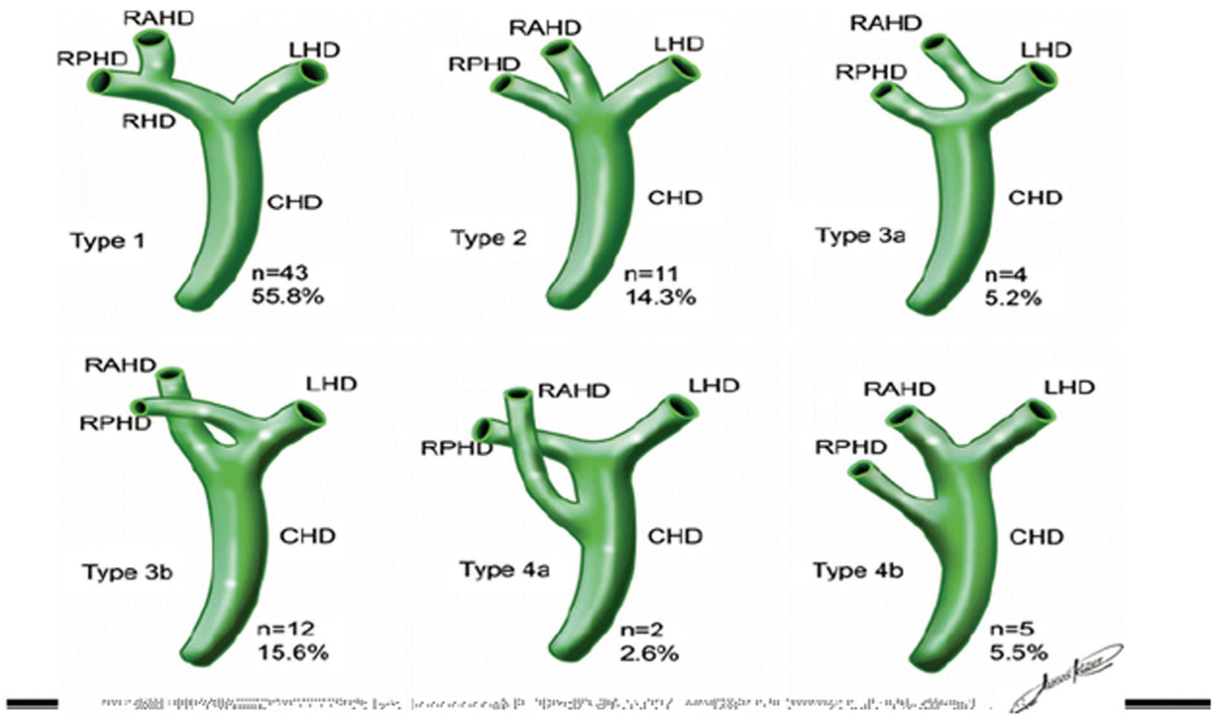
Data were collected, tabulated, and entered into the computer using the Statistical Package for the Social Sciences (SPSS, program version 23.0; SPSS Inc., Chicago, Illinois, USA), for statistical analysis. Descriptive statistics included quantitative data such as mean, SD, and range, and qualitative data such as frequency and percent at 95% confidence interval. Analytical statistics included χ^2-test and Fisher exact test (if expected value <0.05), which were used to measure the association between two sets of qualitative variables.

Results

Demographic data of donors and recipients

Among the donors, 71 (66.4%) were males and 36 (33.6%) were females, with a mean age of 28.7 years. Regarding ABO compatibility between donors and recipients, 75 (70.1%) were identical, and 32 (29.9%) were compatible. The recipients comprised 97

Figure 1



Varotti and colleagues, classification of biliary variants.

Table 1 Demographic data of the donors and recipients

Donor data	Frequency (%) and mean±SD	Recipient data	Range (mean±SD)
Age (years)	28.77±6.68	Age (years)	22–63 (46.168±8.0394)
Sex		Sex	
Male	71 66.4)	Male	97 (90.7)
Female	36 (33.6)	Female	10 (9.3)
BMI	25.29±3.16	MELD score	7–34 (15.673±4.2665)
Identical	75 (70.1)		
Compatible	32 (29.9)		

MELD, model of end-stage liver disease.

(90.7%) males and 10 (9.3%) females. The mean age was 46.168±8.0394 years, with a range from 22 to 63, and their mean MELD score was 15.673±4.266, with a range from 7 to 34 (Table 1).

Indication of transplantation

The primary liver disease indicated for LT, as scheduled in Table 4, showed that liver disease secondary to hepatitis C virus was seen in the majority (46.7%) (Table 2).

Characteristics of the graft and operative data

RT lobe without MHV 96 (89.7%) was the commonest donation followed by LT lobe+MHV seven (6.5%) and then RT lobe with MHV four (3.7%). The mean±SD of graft weight was 805.477±196.2398, and ranged from 350 to 1250, whereas GRWR mean±SD was 1.0189±0.21469 and ranged from 0.57 to 1.70 (Table 3).

Table 2 Primary liver disease of the transplanted cases

Indication	*n* (%)	Indication	*n* (%)
HCV	50 (46.7)	HCV+PVT	8 (7.5)
HBV	3 (2.8)	Primary biliary cirrhosis	2 (1.9)
HBV+HCC	1 (0.9)	Primary sclerosing cholangitis	3 (2.8)
Wilson's disease	1 (0.9)	HCC+HCV+PVT	3 (2.8)
HCC+HBV +HCV	1 (0.9)	HCV+HBV+PVT	1 (0.9)
HCC+HCV	33 (30.8)	Cryptogenic liver cirrhosis	1 (0.9)

HBV, hepatitis B virus; HCC, hepatocellular carcinoma; HCV, hepatitis C virus; PVT, portal vein thrombosis.

Biliary variables in donors based on preoperative MRCP according to Varotti and colleagues

Type 1 was found in 80 (74.7%) of the donors, of which with a short stump (the length of RHD

Table 3 Operative data and graft characteristics

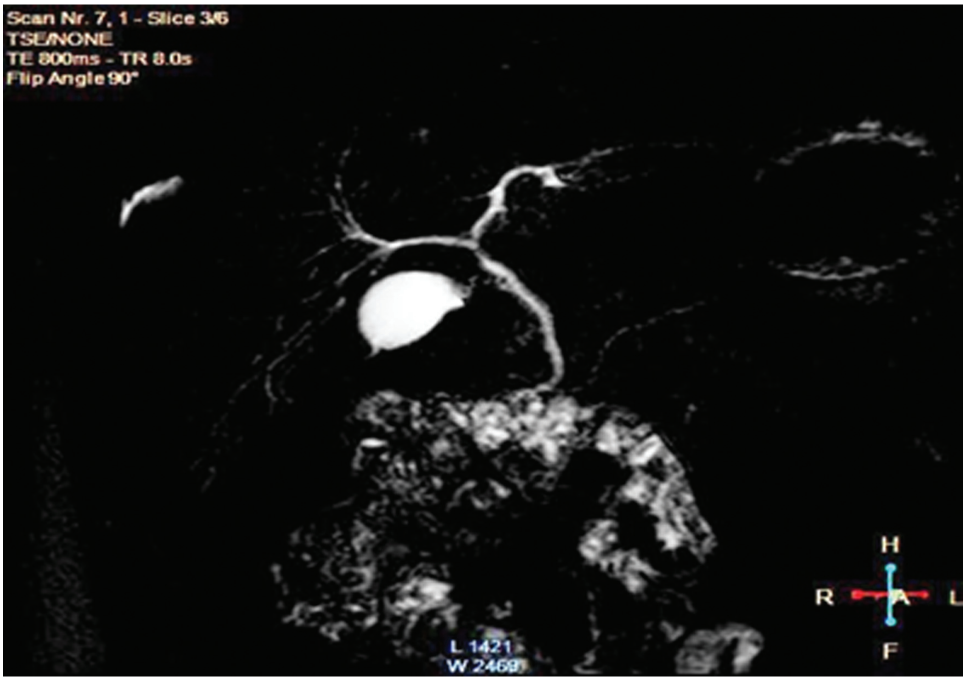
	Mean±SD	Range	*n* (%)
Graft weight (g)	805.477±196.2398	350–1250	
GRWR	1.0189±0.21469	0.57–1.70	
RT lobe−MHV			96 (89.7)
RT lobe+MHV			4 (3.7)
LT lobe+MHV			7 (6.5)
CIT (min)	62.963±27.8794	20–105	
WIT (min)	47.243±14.6215	25–95	
Operative time (h)	11.7061±2.35122	7–17.5	
Blood transfusion (unit)	3.757±3.8506	0–19	

CIT, cold ischemia time; GRWR, graft-to-recipient weight ratio; LT, left; MHV, middle hepatic Vein; RT, right; WIT, worm ischemia time.

Table 4 Biliary variable and reconstruction data

MRCP according to Varotti	*n* (%)	Variables	*n* (%)
Type 1	80 (74.7)	Number of graft bile duct openings	
Short stump	25 (23.3)	1	50 (46.7)
		2	52 (48.6)
		3	4 (3.7)
		4	1 (0.9)
Type 2	5 (4.7)	Number of biliary anastomoses	66 (61.7)
Type 3a	14 (13.1)	2	39 (36.4)
		3	1 (0.9)
Type 3b	8 (7.5)	4	1 (0.9)
Type of anastomosis			
Duct to duct	102 (95.3)		
Hepaticojejunostomy	5 (4.7)		

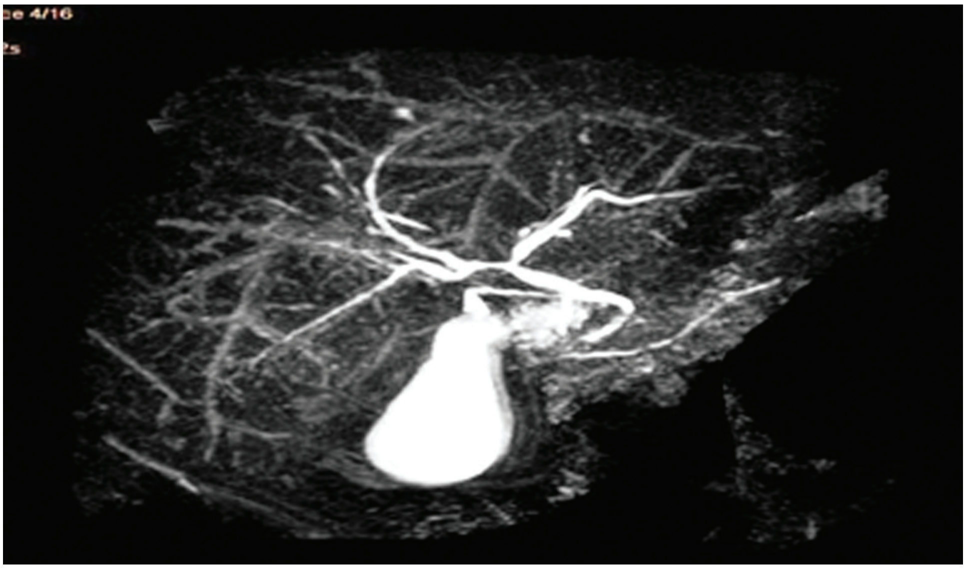
Figure 2



Normal biliary anatomy.

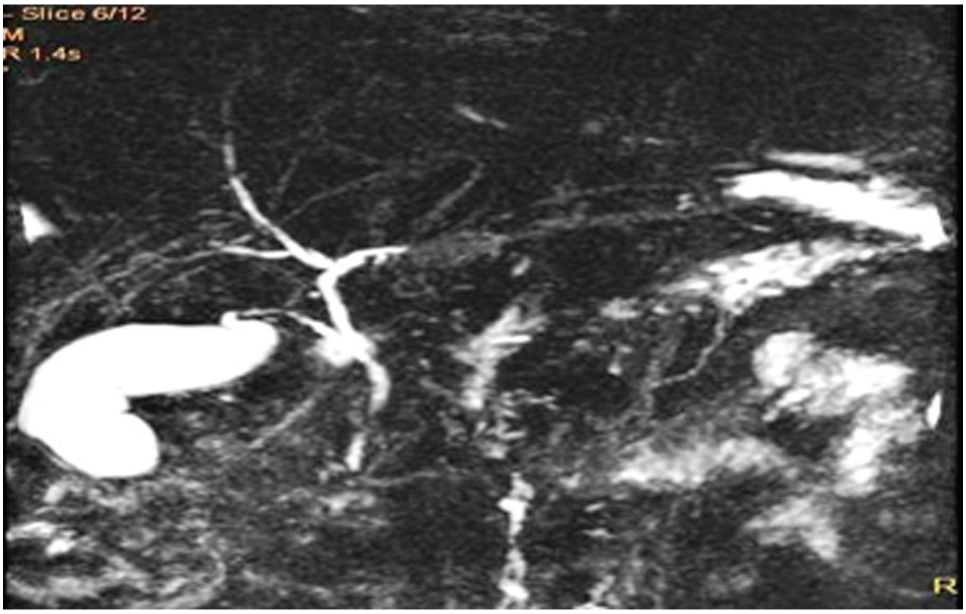
<1 cm) in 25 (23.3%); type 2 in five (4.7%); and types 3a and 3b in 14 (13.1%) and eight (7.5%), respectively (Figs 2–5). So according to the classification of Varotti and colleagues, there were 27 (25.2%) donors with biliary anatomy variant (Table 4).

Figure 3



Variant anomaly (short right stump).

Figure 4



Type II (Triforcate).

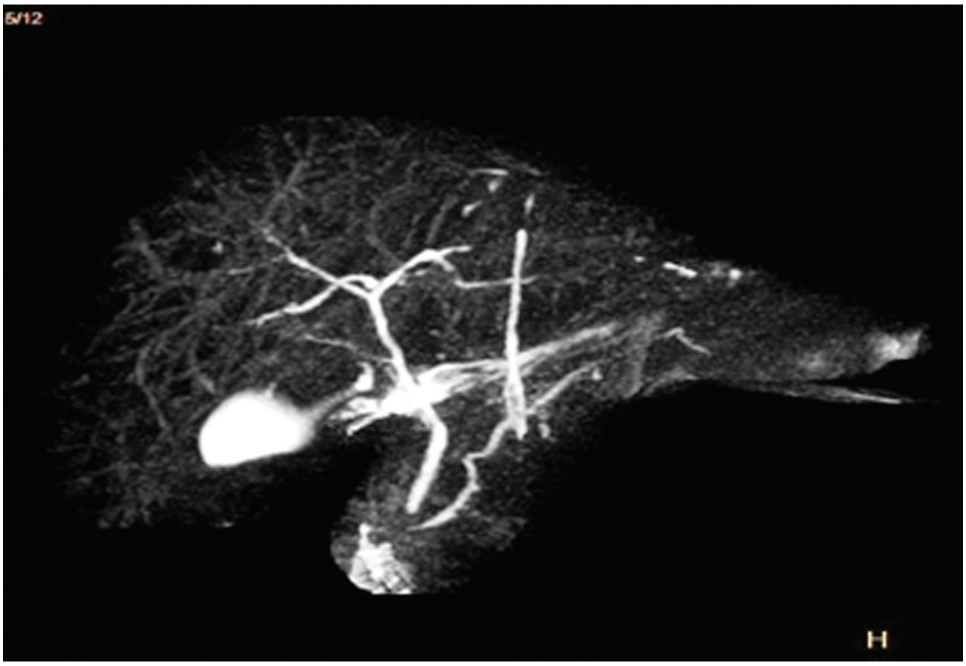
Biliary reconstruction data

One bile duct opening was presented in 50 (46.7%) graft cases, and two bile duct opening was in 52 (48.6%) graft cases (Table 4). Regarding biliary reconstruction, duct-to-duct anastomosis using 6/0 proline interrupted suture (anterior and posterior) was the standard in 102 (95.3%) patients. In addition, some grafts were presented with two bile ducts opening (the distance between them <1 cm) and underwent ductoplasty for one opening, so that one opening anastomosis was done in 66 (61.7%) cases, whereas the two duct anastomoses using recipient's common hepatic duct (CHD) and cystic duct was done in 39 (36.4%), and hepaticojejunostomy was done in five (4.7%) cases.

Incidence of biliary complications

They occurred in 53 (49.5%) of 107 recipients included: isolated bile leak in 23 (21.5%) recipients, isolated biliary stricture in 13 (12.1%) recipients, and both biliary stricture and bile leak in 17 (15.9%) recipients. Regarding the correlation between biliary anatomical variants in donors and BCs in recipients, there was no statistically significant difference between the biliary anatomical variations of the donor and BC

Figure 5



Type III B (right postduct arising from left duct).

of the recipient, as *P* value was 0.182, whereas on the comparison of each biliary variant to BCs revealed that type 1 was the most common pattern, and subdividing it into type 1 with short stump and nonshort stump, it showed that the type 1 with the short stump was statistically significant, as *P* value 0.042. However, type 2 and 3a and b did not reach a statistically significant value (Table 5).

The type and number of biliary-enteric anastomosis, numbers of the graft bile duct, and ABO blood group compatibility were statistically insignificant as a potential risk factor for BCs.

Potential risk factors for biliary complications

Age, MELD score of the recipient, graft weight, GRWR, cold ischemia time (CIT), worm ischemia time (WIT), time of arterial anastomosis, operative time, and intraoperative blood transfusion were statistically insignificant as a potential risk factor for BCs. Regarding BCs and hospital stay, there was a statistically significant difference between the occurrence of BCs in the recipient and early hospital staying until discharge, with *P* value 0.046 (Table 6).

Recipient's biliary complications

Biliary leak

It occurred in 40 (37.38%) of 107 recipients and represented 75% of 53 recipients with BCs. It was diagnosed with the presence of bilious discharge from the intra-abdominal drain or after aspiration of intra-abdominal localized collection. Management of bile leak was conservative treatment in 13 (32.5%), pigtail insertion in 22 (55%), and ERCP with stent was done for 15 (37.5%). Surgery was done in seven (17.5%) recipients (peritoneal lavage and drains or external biliary diversion). The outcome of management of bile leak was 25 (62.5%) survival and 15 (37.5%) mortality.

Biliary stricture

It occurred in 30 (28.04%) of 107 recipients and represented 56.6% of the 53 recipients with BCs. A total of 17 cases were preceded by the biliary leak. Biliary stricture occurred within the first 3 months following transplant in three (10%) cases, whereas it appeared after 3 months following transplant in the rest of cases. It was diagnosed by abdominal ultrasound, MRCP, and ERCP with the elevation of direct bilirubin. The treatment of biliary stricture was ERCP and stent in 28 (93.3%) cases and two (6.5%) cases underwent surgery in the form of hepaticojejunostomy.

Mortality and survival

The total number of recipient's mortality was 43 (40%) of 107. Mortality occurred in 13 (48.1%) patients of 27 whose donors had biliary variant anatomy, yet this was not statistically significant. BCs contributed to the death of 11 (10.28%) recipients of 107 and 25.58% of the total number of mortalities and were statistically insignificant. The cause of death was related to

Table 5 Incidence of biliary complications in recipients and its correlation with donor's anatomy, type of biliary anastomosis, and number of graft bile duct

Type of biliary complications			*n* (%)	
Bile leak			23 (21.5)	
Biliary stricture			13 (12.1)	
Biliary stricture and biliary leak			17 (15.9)	
Biliary variant anatomy	BC *n* (%)	No BC *n* (%)	χ^2 (*d.f.*)	*P* value
Yes	10	17		
No	43	37	2.277 (1)	0.0.182
Type 1 with short stump	17	8	4.527(1)	0.042
Non-type 1 with short stump	36	46		
Type 2	2	3		
Non-type 2	51	51	0.192 (1)	1.000
Type 3a	5	11		
Non-type 3a	48	43	2.571 (1)	0.174
Type 3b	3	5		
Non-type 3b	50	49	0.506 (1)	0.716
Number of anastomosed graft bile ducts				
1	28	36	4.967 (3)	0.174
2	24	17		
3	0	1		
4	1	0		
Number of graft bile ducts				
1	22	24	2.582 (3)	0.461
2	29	27		
3	1	3		
4	1	0		
ABO blood group compatibility				
Identical	37	38	1.423 (2)	0.491
Compatible	16	15		
Nonidentical	0	1		

Table 6 Statistical analysis of potential risk factors for biliary complications in recipients using Student's *t*-test

	BC Mean±SD	No BC Mean±SD	*t* (*d.f.*)	*P* value
Age	46.208±8.7	46.130±7.3921	0.05 (101.61)	1.56
MELD score of the recipient	15.302±3.861	16.037±4.637	−0.89 (105)	0.375
Graft weight	834.585±177.877	795.407±183.109	1.22 (105)	0.264
Graft-to-recipient weight ratio	1.044±0.209	0.994±0.2189	1.227 (105)	0.222
Cold ischemia time (min)	64.094±32.519	61.852±22.681	0.413 (92.76)	0.681
Warm ischemia time (min)	49.623±15.059	44.907±13.92	1.68 (104.02)	0.096
Time of arterial anastomosis (min)	71.132±28.908	71.204± 23.9	−0.014 (105)	0.989
Operative time (h)	11.952 ±2.281	11.391±2.333	1.258 (104.9)	0.211
Blood transfusion (packed RBCs)	3.717±3.94	3.796±3.794	−0.106 (104.6)	0.916
Early hospitalization (days)	32±26.82	23.037±18.122	2.022 (91.091)	0.046
Variant anatomy	Mortality *n* (%)	Survival *n* (%)	χ^2 (*d.f.*)	*P* value
Yes	13	14	0.942 (1)	0.369
No	30	50		

BC, biliary complication; MELD, model of end-stage liver disease; RBC, red blood cells.

systemic sepsis and multiorgan failure secondary to BCs (basically biliary leak) and infection (Table 6).

Causes of donor exclusion

Thirteen potential donors (10.9%) were excluded. The causes of donors exclusions were as follows: 6 donors (46.1%) had variant biliary anatomy (≥3 branches of RT HD (types 2 and 3a and b) and excluded owing to the expected BCs in both donors and recipient especially after experience from these type of variation before), three (23.1%) donors had remaining liver volume less than 30%, two (15.3%)

Table 7 Causes of donor exclusion

Variables	Donors done (*n*=107) [*n* (%)]	Donors excluded (*n*=13) [*n* (%)]	*P* value
Biliary variations	27 (25.2)	6 (46.1)	0.021
Remaining liver volume <30%	0	3 (23.07)	
Drug abuse	0	2 (15.3)	
Homozygous factors V	0	1 (7.6)	
Refused surgery	0	1 (7.6)	

donors had drug abuse, one (7.6%) donor had factor V Leiden homozygous mutation, and one (7.6%) donor refused surgery in the last minute. Twenty-seven (25.2%) donors of already donors have done had variant biliary anatomy in comparison to donor exclusions due to variant biliary anatomy (46.1%), anatomical biliary variations were statically significant risk factor for potential donors exclusion (*P*=0.021). Changed plane for graft selection intraoperatively occurred in three (2.8%) donors from RT lobe graft without MHV to LT lobe graft with MHV due to multiple branching (≥three) of RT HD and single LHD with GRWR of the LT lobe was applied to recipient weight (GRWR=0.77) and the portal flow modulation through splenectomy was done to avoid the small for size graft with no complications occurred. Regarding biliary donor complications, eight (7.4%) donors of 107 experienced BC after operation in the form of biliary leak in six (5.6%) donors: four cases from the cut surface and were treated conservatively, whereas two cases from the biliary stump, and underwent ERCP with stent in one donor and just precut of sphincter in one case. Two donors developed biliary stricture (1.8%) 6 months postoperatively and were treated by ERCP and stent with frequent dilatation every 4 months (Table 7).

Discussion

Preoperative assessment of the branching pattern of the bile duct at the hepatic hilum is important for surgeons to select appropriate donors and plan the surgical approach. There are a variety of anomalous branching patterns that can affect the surgical approach and biliary anastomotic technique and may even preclude liver donation [6]. Biliary reconstruction in liver transplant recipients has been considered, for years, as the Achilles heel of liver transplant procedures [7]. Although the incidence of BCs has declined in deceased-donor liver transplant, it has remained high in LDLT, ranging from 24 to 60% [8–15].

With rapid strides being made in imaging techniques, preoperative road mapping of the biliary anatomy has come to play a significant part in surgical planning. This is all the more relevant in evaluation of donors for live donor liver transplantation [16,17]. Different series have reported the incidence of type 1 between 53 and 72%. Most RL grafts with type 1 biliary anatomy determined by cholangiogram are found after parenchymal transaction to have a single duct to be reconstructed. In the right HD with a short length (<1 cm), an RL graft can turn out to have two ducts [3]. This agreed with our study in which type 1 was found in 80 (74.7%) of the donors, of which type 1 with short stump (the length of RHD <1 cm) was 25 (23.3%), making the RT lobe graft with more than one duct.

A major drawback with previous studies is that the classification of anatomical variants was done using a single classification scheme [18–22]. This drawback was presented in the current study; according to the classification of Varotti and colleagues, there were 27 (25.2%) donors with biliary anatomy variant, whereas on Hakki classification, 52 (48.5%) donors were with biliary variant if considered type 1 RT HD with short stump 25 (23.3%) included in it (type K2a; the RPHD opens into the RAHD in a distance 1 cm or less from the confluence of the RAHD and the LHD) [23]. In the study reported by Hassaan and Hosny, in the 50 donors, MRCP shows only 12 (24%) had type K1 (classical branching patterns of the biliary system). The remaining 38 subjects had anatomical variants: 17 (34%) had type K2a, three (6%) had type K2b, 10 (20%) had type K3a, four (8%) had type K3b, two (4%) had type K4, and two (4%) had classified pattern (type K6) [24]. In the current study and according to the classification of Varotti and colleagues, there had been 27 (25.2%) donors with biliary anatomy variant in the form of type 1 found in 80 (74.7%) of the donors, of which with short stump (the length of RHD <1 cm) were 25 (23.3%); type 2 in five (4.7%); type 3a and 3b in 14 (13.1%) and eight (7.5%), respectively; and type 4 (the right anterior HD (type 4a) or the right posterior HD (type 4b) open directly into the common HD) did not show in this study.

However, Icoz *et al.* [25] and García-Valdecasas *et al.* [26] stated that LDLT is a challenging surgical procedure, and donor safety has to be of utmost importance. The most important postoperative complications encountered after LDLT are BCs presenting in up to 30–50% of patients. Moreover, this finding parallels our study, where the overall BCs occurred in 53 (49.5%) of the recipients, isolated bile leak in 23 (21.5%) recipients, isolated biliary stricture in 13 (12.1%), and both biliary stricture and bile leak in 17 (15.9%) recipients. Hisatsune *et al*. [27] reported biliary anastomotic complications occurred in 18.2% of 391 living donor recipients, with a 9% incidence of anastomotic strictures. Moreover, in the study of Patkowski *et al*. [28] external bile leakage accounts for 8.1–31.6% of complications among liver transplant recipients.

In our study, there were no significant differences between patients with or without BCs in terms of donor age, GRWR, and cold or warm ischemic time and intraoperative blood loss, indicated by blood transfusions. These results were in correspondence with Sultan *et al*. [30] and Hisami *et al*. [30].

In our study, we found that donor's biliary variant anatomy according to Varotti and colleagues had significant effect on BC, in which the short stump right duct was 25, of which 22 cases had more than one duct, which raises attention to care about the transection line in these cases, especially that they have a significant influence on BCs in recipients, with a *P* value of 0.042.

Varotti *et al*. [3] reported in their study in the right HD with a short length (<1 cm) an RL graft can turn out to have two ducts. Sultan *et al*. [29] stated that in a multivariate analysis of factors predicting the development of postoperative BCs, only the transection method proved to be significant. Moreover, Takatsuki *et al*. [31] described a technique of encircling the hilar plate with a radiopaque marker obtained from surgical gauze. Fluoroscopy was then used to confirm that the marker was in the proper plane; they reported a significant reduction in the incidence of multiple ducts, with no occurrence of biliary strictures.

Palanisamy *et al*. [32], in their study reported that patients developing BCs had significantly increased overall in-hospital costs, guided by a wide range of individual service groups, including staying and accommodations, diagnostics, laboratories, operation costs, and pharmacy services. Similarly, in the current study, there was a statistically significant difference between the occurrence of BCs in the recipient and early hospital stay until discharge.Palanisamy *et al*. [32] demonstrated that BCs significantly influence patient survival, which is in contrast with other previous studies. Qian *et al*. [15] studied LT in 230 patients performed over for 11 years and demonstrated that BCs had no significant effect on patient survival. This goes in parallel with the current study, in which the donor's biliary variant anatomy and BCs had no statistically significant effect on the recipient's survival.

Shoreem *et al*. [33] reported in their study that small-for-size graft is the independent and main factor for occurrence of SFSS after LDLT leading to poor outcome. However, the prevention is the main line of management of this catastrophe through selecting graft with proper size, splenectomy to decrease portal venous inflow, and improving hepatic vein outflow by reconstructing large draining veins of the graft. In the current study, the modulation of the portal flow through splenectomy to prevent small for size graft was done in three LT lobe grafts with single HD (2.8%) with GRWR: 0.77, to avoid RL graft with multiple branching (≥3) of RT HD.

Shoreem *et al*. [34] in their study demonstrated that only 7.8% were donated out 15% potential donors who were evaluated and accepted for donation. Exclusion reasons included psychological instability in four donors, family pressure to withdraw consent in one donor, substance abuse in two donors, early pregnancy was in one donor, one donor was discovered to be incompatible ABO, and Factor V Leiden homozygous mutation was in two donors. Selzner *et al*. [35] reported the aim to provide recipients with a graft that has (GRWR) greater than or equal to 0.8 and leave donors with a residual liver volume of greater than or equal to 30%. However, we have successfully used the right lobe grafts with GRWR of 0.6. Sapisochin and colleagues [36] reported in their study to avoid right lobe donors with greater than or equal to 3 right HDs and those with segment IV ducts that enter the right anterior or posterior HDs above the main right and left duct confluence.

In our study, thirteen potential donors (10.9%) were excluded. The causes of donors exclusions were as follows: six (46.1%) donors had variant biliary anatomy (in the form multiples branches of RT HD), three (23.1%) donors had remaining liver volume less than 30%, two (15.3%) donors had drug abuse, one (7.6%) donor had Factor V Leiden homozygous mutation, and one (7.6%) donor refused surgery in the last minute.

Conclusion

The anatomy of the donor is one of the cornerstone in LDLT procedure. There was a statistically significant

RT HD (type 1 with short stump) and BCs in their recipients. Donor biliary anatomical variations were a statically significant risk factors for potential donor's exclusion. Our results may be the first to highlight the effect of short stump right duct on BCs in LDLT recipients in literature. More research studies are needed to clarify our results. Our study provides robust evidence to support the good selection of the RL graft with a single duct or LT Lobe graft with modulation of the portal flow aimed at minimizing the incidence and severity of BCs and to optimize care.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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