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Donor ductal anomaly is not a contraindication to right liver lobe donation ☆

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ABSTRACT

Background: Data of living-donor liver transplantation (LDLT) suggested that donor ductal anomaly may contribute to postoperative biliary complications in recipients and in donors. This retrospective study aimed to determine if the occurrence of postoperative biliary stricture in donors or recipients in right-lobe LDLT (RLDLT) is related to donor biliary anatomy type.

Methods: We analyzed our RLDLT recipients' clinical data and those of their graft donors. The recipients were divided into 2 groups: with and without postoperative biliary stricture. The 2 groups were compared. The primary endpoints were donor biliary anatomy type and postoperative biliary complication incidence; the secondary endpoints were 1-, 3- and 5-year graft and patient survival rates.

Results: Totally 127 patients were included in the study; 25 (19.7%) of them developed biliary anastomotic stricture. In these 25 patients, 16 had type A biliary anatomy, 3 had type B, 2 had type C, 3 had type D, and 1 had type E. In the 127 donors, 96 (75.6%) had type A biliary anatomy, 13 (10.2%) had type B, 6 (4.7%) had type C, 10 (7.9%) had type D, and 2 (1.6%) had type E. Biliary stricture was seen in 2 donors, who had type A biliary anatomy. None of the recipients or donors developed bile leakage. No association between the occurrence of postoperative biliary stricture and donor biliary anatomy type was found ($P=0.527$).

Conclusions: The incidence of biliary stricture in donors or recipients after RLDLT was not related to donor biliary anatomy type. As postoperative complications were similar in whatever type of donor bile duct anatomy, donor ductal anomaly should not be considered a contraindication to donation of right liver lobe.

Introduction

Biliary complication is the Achilles' heel in living donor liver transplantation (LDLT). Its incidence is higher in recipients of right-lobe grafts than in recipients of left-lobe grafts, as up to one third of right liver lobes have more than one hepatic duct [1]. The vascularity, number and size of bile ducts are risk factors for biliary complication [2–9]. Jeon et al. [8] suggested that the anatomy of the donor right posterior bile duct might be an important factor contributing to biliary complication in recipients. However, it would be impractical to reject a live liver donor because of a biliary anatomical variation since usually a second donor would not be available. On the other hand, if transplant outcomes would be severely jeopardized by a donor biliary anatomical variation, the transplantation would not be justified. This retrospective study aimed to determine if there is a correlation between donor biliary anatomy type and postoperative biliary stricture in recipients and in donors and if donor ductal anomaly is thus a contraindication to liver donation in the context of right-lobe LDLT (RLDLT).

Methods

This study analyzed our adult RLDLT recipients' clinical data as well as the data of their graft donors from January 2011 to December 2014. Re-transplantations were not excluded from the

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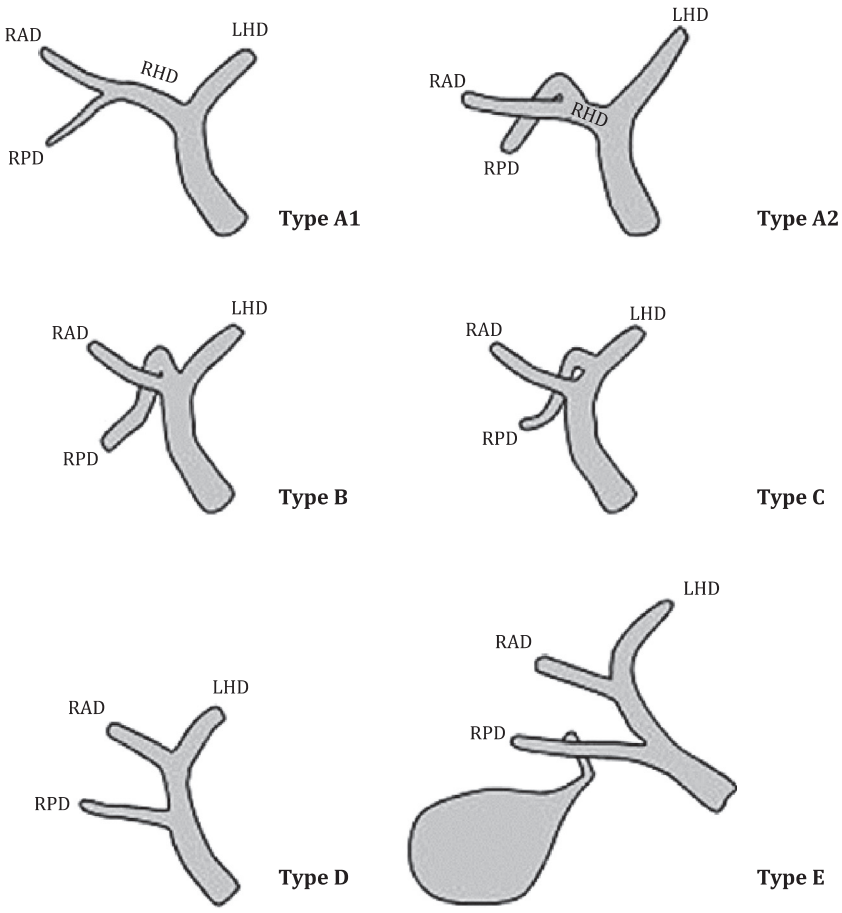

Fig. 1. Huang's classification of biliary anatomy (Courtesy of Transplantation Proceedings, 1996; 28: 1669–1670.). RAD: right anterior duct; RPD: right posterior duct; RHD: right hepatic duct; LHD: left hepatic duct.

study. Huang's classification of biliary anatomy was employed [10] (Fig. 1). The first author reviewed all cholangiograms in the study.

Written consent to transplantation was acquired from recipients (if mentally fit) and donors and their families, with them informed that donors had a 0.5% risk of mortality (in right lobe donation) and a 20% chance of morbidity, and recipients had a 10% risk of mortality and a 30% chance of morbidity, and that the recipient 5-year overall survival rate would be >80%. Written consent to the use of their clinical data for studies was also acquired.

Donor workup was done stepwise [11]. To be qualified for liver donation, the donors must be physically fit and have compatible blood group. Moreover, they had to be assessed by a clinical psychologist for psychological readiness for liver donation. A 2.5 mm-cut computed tomography was performed to determine the liver volume, which was calculated along the proposed transection line [12]. Preoperative biliary imaging was not performed. Donor hepatectomy and graft implantation were performed as reported previously [11]. Histidine-tryptophan-ketoglutarate solution was used as the preservation solution. The bile duct was left untouched at all times and was flushed with the preservation solution. For biliary reconstruction, duct-to-duct anastomosis and hepaticojejunostomy were the two methods employed. When two duct openings were more than 5 mm apart, a duct-to-duct anastomosis and a hepaticojejunostomy or two hepaticojejunostomies were performed. Otherwise, ductoplasty or anastomosis to the hilar plate was performed. We did not use any internal or external stent. Polydioxanone suture (6/0) was used for anastomosis. Posterior layer continuous and anterior interrupted suturing was done under surgical loupes (2x magnification). After transplantation, all patients visited our outpatient clinic every week for follow-up in the first 3 months. Thereafter, follow-up visit took place every 1–3 months, depending on the patients' clinical conditions.

The primary study endpoints were type of donor biliary anatomy and incidence of postoperative biliary complication, and the secondary study endpoints were 1-, 3- and 5-year graft and patient survival rates.

Statistical analysis

All statistical analyses were performed by the computer software SPSS, version 18.0 (SPSS Inc., Chicago, IL, USA). Pearson's Chi-squared test or Fisher's exact test where appropriate was used to compare categorical variables. The Mann–Whitney *U* test was used to compare continuous variables, which were presented as medians with ranges. The Kaplan–Meier method was used to estimate survival and the log-rank test was used to compare survival between patient groups. Statistical significance was denoted by $P < 0.05$. All *P* values were two-tailed.

Results

A total of 127 patients (87 males and 40 females) were included in the study. After transplantation, 25 (19.7%) patients developed biliary anastomotic stricture whereas no biliary stricture was found in the remaining 102 patients. The median age was 55 years in both groups of patients ($P = 0.875$). The median Model for End-stage Liver Disease score was 28 in patients with biliary stricture and 18 in patients without biliary stricture ($P = 0.162$). Preoperative data in the two groups are shown in Table 1 and operative data are shown in Table 2. The groups were all comparable.

Table 1
Demographic characteristics and preoperative data of the patients.

Characteristics	No biliary stricture ($n=102$)	With biliary stricture ($n=25$)	*P* value
Age (yr, median, range)	55 (11–73)	55 (35–72)	0.875
Male/Female	67/35	20/5	0.167
Diagnosis			
Cirrhosis	56 (54.9%)	12 (48.0%)	
Chronic active hepatitis	2 (2.0%)	0	
Fulminant hepatic failure	3 (2.9%)	2 (8.0%)	
Biliary atresia	3 (2.9%)	0	
Primary biliary cholangitis	4 (3.9%)	2 (8.0%)	
Cirrhosis with acute deterioration	18 (17.6%)	4 (16.0%)	
Chronic active hepatitis acute flare	10 (9.8%)	4 (16.0%)	
Hereditary hemorrhagic telangiectasia	1 (1.0%)	0	
Caroli disease	1 (1.0%)	0	
Graft failure	3 (2.9%)	1 (4.0%)	
Concurrent hepatocellular carcinoma	39 (38.2%)	10 (40.0%)	0.871
MELD score (median, range)	18 (6–47)	28 (6–46)	0.162

MELD: Model for End-stage Liver Disease.

Table 2
Operative data in the two groups of patients.

Variables	No biliary stricture ($n=102$)	With biliary stricture ($n=25$)	*P* value
Ratio of GW to ESLV	49.1% (29.5%–74.7%)	47.5% (33.5%–66.4%)	1.000
Cold ischemic time (min)	102 (62–243)	98 (64–159)	0.142
Warm ischemic time (min)	49.5 (25–100)	42 (24–89)	0.178
Operative time (min)	743 (417–1061)	710 (549–1203)	0.658
Number of bile duct			0.080
One	82 (80.4%)	16 (64.0%)	
More than one	20 (19.6%)	9 (36.0%)	
Method of biliary reconstruction			0.420
Duct-to-duct anastomosis	69 (67.6%)	16 (64.0%)	
Hepaticojejunostomy	28 (27.5%)	6 (24.0%)	
Both techniques	5 (4.9%)	3 (12.0%)	

Data were expressed as median (range) or number (percentage). GW: graft weight; ESLV: estimated standard liver volume of recipient.

After transplantation, no patient had bile leakage. In the patients who had biliary anastomotic stricture, 1 (4.0%) developed graft rejection and 12 (48.0%) had cytomegalovirus antigenemia. In patients without biliary anastomotic stricture, 5 (4.9%) developed graft rejection ($P=1.000$) and 32 (31.4%) had cytomegalovirus antigenemia ($P=0.117$).

In the 25 patients who developed biliary anastomotic stricture, 16 had type A biliary anatomy, 3 had type B, 2 had type C, 3 had type D, and 1 had type E. In the 127 donors, 96 (75.6%) had type A biliary anatomy, 13 (10.2%) had type B, 6 (4.7%) had type C, 10 (7.9%) had type D, and 2 (1.6%) had type E. Postoperative biliary stricture occurred in 2 donors (both type A). No donor had bile leakage. No association between donor biliary anatomy type and postoperative biliary stricture incidence in recipients was found ($P=0.527$) (Table 3).

Graft and patient survival rates at 1, 3 and 5 years can be viewed in Fig. 2. By log-rank test, patients with and without biliary stricture were comparable in terms of graft survival ($P=0.755$) as well as patient survival ($P=0.628$) (Fig. 2). No donor or patient died during the hospital stay for transplantation.

Discussion

LDLT is an alternative to deceased donor liver transplantation for patients with end-stage liver disease, especially in places with severe scarcity of deceased-donor liver grafts. In order to justify the use of LDLT, the safety of donor operation must be ensured. At the same time, reasonably good transplant outcomes in recipients are a prerequisite for wide application of LDLT.

The right posterior sectoral anatomy has been found to be the most important predictive factor for postoperative biliary complication in recipients [8]. This might be due to inadvertent damage to the bile duct during donor hepatectomy. Another large adult-to-adult living donor liver transplantation (A2ALL) study showed that the number of graft bile duct was not related to postoperative biliary complications in recipients [13]. Nonetheless, this study should be taken with caution as the overall biliary complication rate was as high as 56% at 1 year, reflecting the heterogeneity of case volume in different centers.

As a live liver donor is not easy to come by, it is necessary to find out if donor biliary anatomy type has any effect on the occurrence of postoperative biliary complication, which can also be related to transection technique. It is important that intending donors and recipients are fully informed of the chance of potential complications before giving their consent to receiving any operation.

In the present study, the most common biliary anatomy type in the donors was type A. Two donors, who both had type-A anatomy, developed biliary stricture after donation. The strictures were successfully managed with endoscopic dilatation. On the other hand, 19.7% of the recipients developed biliary anastomotic stricture. No bile leakage occurred in any donor or recipient. Pearson's chi-squared test showed no correlation between donor biliary anatomy type and the occurrence of biliary stricture. Although all the donor hepatectomies were performed by experienced hepatobiliary surgeons, it is postulated that biliary transection technique rather than biliary anatomy was the main source of problem.

At our center, donor hepatectomy is conducted only by surgeons with ample experience in hepatobiliary operations, and

Table 3
Biliary stricture in recipients in relation to biliary reconstruction method and donor biliary anatomy type.

Groups		No biliary stricture ($n=102$)	With biliary stricture ($n=25$)	P value
Biliary reconstruction method				0.420
DDA		69 (67.6%)	16 (64%)	
HJ		28 (27.5%)	6 (24%)	
DDA + HJ		5 (4.9%)	3 (12%)	
Donor biliary anatomy type				0.527
Type A		80 (78.4%)	16 (64.0%)	
Type B		10 (9.8%)	3 (12.0%)	
Type C		4 (3.9%)	2 (8.0%)	
Type D		7 (6.9%)	3 (12.0%)	
Type E		1 (1.0%)	1 (4.0%)	
Donor biliary anatomy type	Biliary reconstruction method			
Type A	DDA	59 (57.8%)	12 (48.0%)	0.904
	HJ	20 (19.6%)	4 (16.0%)	
	DDA + HJ	1 (1.0%)	0	
Type B	DDA	6 (5.9%)	2 (8.0%)	1.000
	HJ	4 (3.9%)	1 (4.0%)	
	DDA + HJ	0	0	
Type C	DDA	2 (2.0%)	1 (4.0%)	0.687
	HJ	1 (1.0%)	0	
	DDA + HJ	1 (1.0%)	1 (4.0%)	
Type D	DDA	2 (2.0%)	1 (4.0%)	0.961
	HJ	3 (2.9%)	1 (4.0%)	
	DDA + HJ	2 (2.0%)	1 (4.0%)	
Type E	DDA	0	0	
	HJ	0	0	
	DDA + HJ	1 (1.0%)	1 (4.0%)	

DDA: duct-to-duct anastomosis; HJ: hepaticojenunostomy.

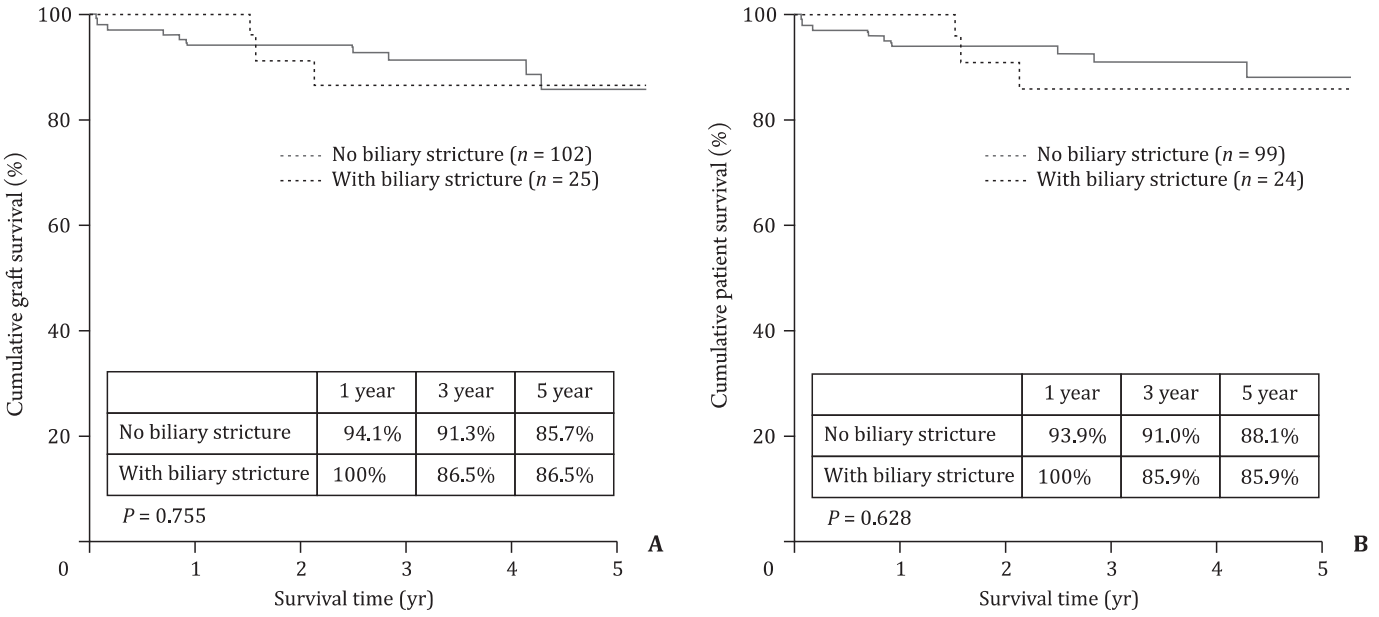

Fig. 2. Graft survival (**A**) and patient survival (**B**) in the study (the 4 retransplants were not included in patient survival analysis).

operative cholangiography is performed to check for any obscure ductal anomaly. The technique for obtaining good-quality operative cholangiograms has been detailed previously [14,15]. The first cholangiography is to get a "true" anterior-posterior view of the biliary system. With another cholangiography the site of division of the right hepatic duct is determined, and the patency of the left ductal system is confirmed with a last cholangiography.

There are some points to note about the present study. As a retrospective cohort study, it could not be free of selection bias. Moreover, the small sample size entailed a considerable risk of type 2 error. Subgroup analysis was not performed as it would be meaningless because of the small sample size. Furthermore, our center's considerable experience in RLDLT definitely had contributed to the favorable outcomes. However, the study can be used as reference when potential live liver donors with ductal anomalies (e.g. double bile duct openings) are encountered.

In conclusion, post-RLDLT incidence of biliary complication in recipients or donors was not related to donor biliary anatomy type. As postoperative complications were similar in whatever type of donor bile duct anatomy, donor ductal anomaly should

not be considered a contraindication to donation of right liver lobe.

Contributors

CKSH designed the study, analyzed the data and wrote the article. FJYY, DWC, SSL, MKW, CACY, CTT and LCM collected the data and provided expertise. All authors approved the submitted version. CKSH is the guarantor.

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Ethical approval

Not needed.

Competing interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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