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ORIGINAL ARTICLE

Biliary reconstruction and complications after living-donor liver transplantation

Reza F. Saidi, Nahel Elias, Dicken Sc Ko, Tatsou Kawai, James Markmann, A. Benedict Cosimi & Martin Hertl

Transplantation Unit, Department of Surgery, Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA

Abstract

Background: The technique of biliary reconstruction remains controversial in living-donor liver transplantation (LDLT). The objective of this study was to assess the incidence of biliary complications after LDLT based on the reconstruction technique.

Methods: Between 1997 and 2007, 30 patients underwent LDLT. The type of allograft was the right lobe in 15, left lobe in 4 and left lateral sector in 11 patients. There were 18 adult and 12 paediatric recipients. The mean follow-up was 48 months (range 18–120 months). Biliary complications were defined as leak or stricture requiring intervention.

Results: Biliary reconstruction was achieved with Roux-en-Y choledochojejunostomy (RYCJ) in 17 patients and duct-to-duct (DD) anastomosis in 13 patients. An external biliary stent was placed in all patients (except one) in the RYCJ group and reconstruction over a T-tube was done in 6 out of 13 patients in the DD Group. Twenty-five (83.3%) patients had one biliary anastomosis and the remaining five (16.7%) had multiple anastomoses (one in the RYCJ group and four in the DD group).

The overall incidence of biliary complications was 30%.; 29.4% in the RYCJ group and 38.4% in the DD group ($P = 0.6$). Biliary complications occurred equally in patients with and without an external stent or T-tube stenting (12.5% vs. 18.8%). The incidence of biliary leakage was 23.5% for RYCJ and 15.3% for DD ($P = 0.4$). Although the incidence of biliary stricture was significantly higher in the DD (23.1%) compared with the RYCY group (5.9 %) ($P < 0.01$), all DDCC strictures were successfully managed endoscopically. Need for operative revision of biliary anastomoses was significantly higher in patients with RYCY compared with DD reconstruction; 17.7% vs. 7.7% ($P < 0.01$).

Conclusions: Although there was a higher rate of biliary stricture formation in the DDCC group, we feel that because of physiological bilioenteric continuity, comparable incidence of leakage and easy endoscopic access, DD reconstruction is the preferred approach for biliary drainage in LDLT. After LDLT, the endoscopic approach has been shown to provide effective treatment of most biliary complications.

Keywords

live donor liver transplantation, biliary complications, management

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Correspondence

Martin Hertl, Department of Surgery, Massachusetts General Hospital, 55 Fruit Street, Boston, MA 02114, USA. E-mail: mhertl@partners.org

Introduction

Bile duct reconstruction has been labelled the 'Achilles' heel' of liver transplantation.[1] Despite progress in surgical techniques, organ preservation and immunosuppressive management, biliary complications still frequently occur after liver transplantation (7–29%) and have retained a high risk of significant mortality and morbidity.[2] Anastomotic problems have been the major reason for biliary complications, despite various innovations for biliary reconstruction that have been achieved for whole organ liver transplantation.

Biliary reconstruction in living donor liver transplantation (LDLT) using partial liver grafts is still a matter of debate. In the past, Roux-en-Y choledochojejunostomy (RYCJ) has been the standard technique for biliary reconstruction because the majority of LDLT recipients have been patients with biliary atresia.

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Recent reports on biliary complications still show an incidence of 12% to 28% after RYCJ in LDLT.[3–5] The disadvantages of this technique are a comparatively long operative time, a possibly higher risk of contamination as a result of spillage of enteric contents, the non-physiologic nature of the re-established bilioenteric and the not infrequent inability to access the anastomosis endoscopically in the post-operative period. In contrast, DDCC reconstruction is the technique of choice for biliary anastomosis in whole organ liver transplantation.[1] When the duct-to-duct (DD) technique can be used for LDLT, an extraintestinal anastomosis can be avoided, the continuity is more physiological than that of RYCJ and preservation of the sphincter function of the lower bile duct may reduce the risk of enteric reflux into the biliary tract.

We describe our surgical experience comparing RYCJ and DD biliary reconstruction in LDLT, and focus on biliary complications, management and outcomes.

Univariate analysis was performed by the unpaired *t*-test for continuous variables, the χ^2-test for categorical variables and Fisher's exact test when data were sparse. Categorical data were summarized as proportions and percentages, and continuous data were summarized as means and standard deviations. A *P*-value of <0.05 was considered to be significant.

Material and Methods

Thirty patients underwent LDLT from January 1997 to May 2007. The type of allograft was the right lobe in 15, left lobe in 4 and left lateral sector in 11 patients. There were 18 adults and 12 paediatric recipients.

All donors underwent computed tomography (CT) volumetry pre-operatively. The biliary anatomy was evaluated pre-operatively with magnetic resonance cholangiography (MRC). An intra-operative cholangiogram was then routinely performed in every patients before parenchymal transection to confirm the anatomy of the bile ducts and to decide the correct point for bile duct transection. Recently, we have pre-operatively utilized CT cholangiography rather than MRC after we encountered one patient in whom MRC missed a segment IV bile duct which was draining into the right system (Fig. 1). This was only identified during intra-operative cholangiogram at which point the donor right hepatectomy was aborted. The portal vein and hepatic artery were isolated without excessive periductal dissection to minimize ischaemic damage to the bile duct. A final cholangiogram was performed at the conclusion of the procedure to ensure the integrity of the biliary system.

The allografts were flushed and stored in University of Wisconsin solution. The recipient hepatectomy was performed with preservation of the native inferior vena cava (IVC) and revascularization using the 'piggy back' approach. Venovenous bypass was not used. The biliary anastomosis was performed after the vascular anastomoses were completed. Either DD or RYCJ was chosen according to which best allowed reciprocal matching of the size of the graft and number of recipient duct openings. The anastomosis was commenced at the posterior wall with interrupted 6-0 PDS sutures, after which the anterior wall of the anastomosis was completed in an interrupted fashion. T-tube and external stenting (5 Fr paediatric feeding tube) were used selectively.

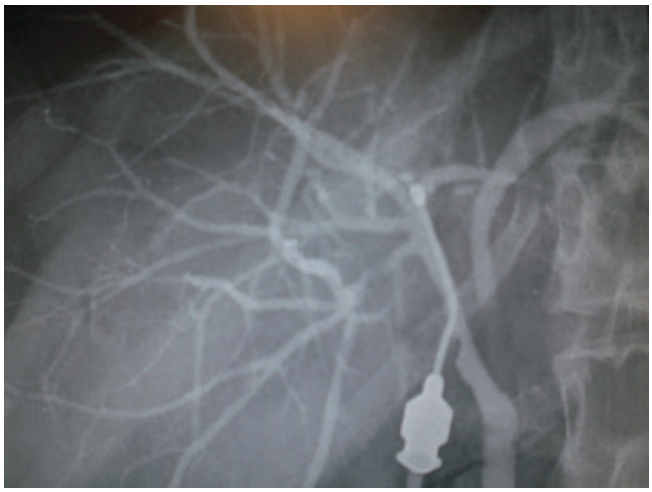

Figure 1 Intra-operative cholangiogram shows the segment IV bile duct (arrow) was draining into the right system (probe is in the right hepatic duct)

Biliary complications were primarily classified as anastomotic leak or anastomotic stenosis requiring intervention. An anastomotic leak was diagnosed on the basis of bile appearing in abdominal drains, extrahepatic biloma on radiological imaging or identification of a leak by external stents or endoscopic retrograde cholangiography (ERC). An anastomotic stenosis was diagnosed on the basis of an overt dilatation of the intrahepatic duct according to CT or ultrasonography, or direct visualization of stenosis during ERC. For the patients furnished with a T-tube, a routine post-operative cholangiogram was performed 5 days after transplantation. ERC was performed first if a DD recipient was suspected of a biliary complication during the early post-operative period. Stenoses were treated using internal stenting repeated every 3 months until complete resolution. The T-tube was removed after 6 months. The mean follow-up was 48 months (range 18–120 months).

Results

The LDLT programme was started at Massachusetts General Hospital in 1997. The demographics of these 30 recipients are summarized in Table 1.

Biliary reconstruction was achieved with RYCJ in 17 patients and DD in 13 patients.

Table 2 shows the biliary reconstruction techniques based on type of allograft. RYCJ was most commonly used for left lateral grafts and DD was more commonly performed in left and right

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lobe grafts. An external biliary stent was placed in all patients (expect one) in the RYCJ Group and reconstruction over a T-tube was done in 6 out of13 patients in the DD Group. Twenty-five (83.3%) patients had one biliary anastomosis and the remaining five (16.7%) had multiple anastomoses (one in the RYCJ Group and four in the DD Group). There was no case of hepatic artery thrombosis.

Table 1 Demographics of the 30 patients who underwent living-donor liver transplantation (LDLT)

Age	1–66 (mean 35.1)
Gender	
Male	17
Female	13
Diagnosis	
Hereditary tyrosinemia1	
Alpha 1 antitrypsin deficiency	1
Maple syrup disease	1
Cystic fibrosis	3
Fulminate liver failure	4
Biliary atresia	5
Hepatitis C	7
Primary sclerosing cholangitis	3
Alcoholic cirrhosis	3
Primary biliary cirrhosis	1
Hepatic sarcoidosis	1
Concurrent HCC[a]	2

[a]Hepatocellular carcinoma.

The overall incidence of biliary complications was 30% (Table 3); 29.4% in the RYCJ Group and 38.4% in the DD Group ($P = 0.6$). The mean time to develop a biliary leak was 10.1 days (6–20 days) and for development of a stricture was 4.25 months (2–8 months).The incidence of biliary leakage was 23.5% in the RYCJ group and 15.3% in the DD group ($P = 0.4$). However, the incidence of biliary stricture was significantly higher in the DD group (23.1%) compared with 5.9% in the RYCJ group ($P < 0.01$). There were three strictures in the DDCC group and one in the RYCJ group which were all successfully managed by ERC and stenting (Table 4). There were four leaks in the RYCJ group, three of which (75%) needed revision and one (25%) was managed by endoscopy. All patients required access to multiple (mean 4.2, range 2–7) endoscopy sessions. On the other hand, two patients developed biliary leak after DD, one of which needed conversion to RYCJ and one was managed by endoscopy. Overall, need for operative revision of biliary anastomoses was significantly higher in RYCJ compared with DD reconstruction; 17.7% vs. 7.7% ($P < 0.01$). Overall, endoscopic approach was successful in management of biliary complication in 80% (4/5) of the DD group compared with 40% (2/5) in the RYCJ group ($P < 0.01$).

Interestingly, the incidence of biliary complications did not change with the learning curve (33.3% in the first 15 patients compared with 26.6% in the second 15 patients, $P = 0.72$). DD was performed in 60% of the right lobe grafts.

The use of a T-tube or external stent had no impact on biliary complications. The rate of biliary complications were 12.5% in the patients who had a T-tube or stent compared with 18.8% in patients who did not ($P = 0.3$).

Table 2 Technique of biliary anastomosis based on the graft type

Graft type	Biliary reconstruction	Note
Left later sector ($n = 11$)	RYCJ (90.9%, $n = 10$)	nine with exteral stent
	DD (9.1%, $n = 1$)	with T-tube
Left lobe ($n = 4$)	RYCJ (25%, $n = 1$)	
	DD (75%, $n = 3$)	two with T-tube
Right lobe ($n = 15$)	DD (60%, $n = 9$)	four (44.4%) more than one duct
		four (44.4%) with T-tube
	RYCJ (40%, $n = 6$)	

RYCJ, Roux-en-Y choledochojejunostomy, DD, duct-to-duct.

Table 3 Comparison of biliary complications in two groups

Biliary anastomosis	Biliary stent/T-tube	Biliary complications	Biliary leak	Biliary stricture	Need of anastomotic revision
Roux-en-Y choledocho-jejunostomy ($n = 17$)	94.1% ($n = 16$)	29.4% ($n = 5$)	23.5% ($n = 4$)	5.9% ($n = 1$)	17.7%* ($n = 3$)
duct-to-duct anastomosis ($n = 13$)	46.2% ($n = 7$)	38.4% ($n = 5$)	15.3% ($n = 2$)	23.1%* ($n = 3$)	7.7% ($n = 1$)

*$P < 0.01$.

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Table 4 Characteristics and management of biliary complications

Graft	Biliary Complication	Reconstruction	Management
Left lateral sector (*n* = 12)	leak (*n* = 1)	RYCJ	revision
	leak (*n* = 1)	RYCJ	ERC+stent
	leak (*n* = 1)	DD	RYCJ
	stricture (*n* = 1)	RYCJ	ERC+stent
Left lobe (*n* = 4)	leak (*n* = 1)	RYCJ	revision
	stricture (*n* = 1)	DD	ERC+stent
Right lobe (*n* = 14)	leak (*n* = 1)	RYCJ	revision
	stricture (*n* = 2)	DD	ECR+stent
	leak (*n* = 1)	DD	ERC+stent

ERC, endoscopic retrograde cholangiography; RYCJ, Roux-en-Y choledochojejunostomy, DD, duct-to-duct.

The rate of DD anastomosis increased from 13.3% (2/15) in our initial 15 paients to 66.6% (10/15) in the most recent patients. In our initial 15 patients, all biliary anastomoses using right lobe grafts were done using RYCJ techniques. This rate of DD reconstruction has been increased to 80% in our recent experience with right lobe allografts.

Discussion

The incidence of biliary complications in deceased donor liver transplantation has now fallen below 10%,[1,2] but the incidence of such complications in LDLT has been reported to range from 15% to 40%.[3–5] Thus, biliary reconstruction remains a technical challenge in LDLT. Biliary complications are associated with increased hospital stay and cost, decreased quality of life and often repeated therapeutic interventions. In our series, patients with biliary complications needed an average of 4.2 endoscopic sessions.

The Adult-to-Adult Living Donor Liver Transplantation Cohort Study (A2ALL) examined recipient complications after 384 LDLT and 216 deceased donor liver transplantations (DDLT). Biliary complications occurred at a significantly higher rate in LDLT recipients compared with DDLT (41.9% vs. 24.5%).[6,7] The A2ALL consortium reported a significantly decreased incidence of bile leaks in the first 90 days from 38% to 24% when centres performed more than 21 LDLT.[6] We were unable to demonstrate a significant 'learning curve' in bile duct strictures after LDLT despite changes in our operative technique and practice over time as the incidence of biliary complications was 33.3% in the first 15 patients compared with 26.6% in the second 15 patients ($P = 0.72$).

There is still no consensus in the transplant community with regard to the preferred type of biliary reconstruction in LDLT. Recently, the use of duct-to-duct reconstruction has been increasingly reported in LDLT.[8–14] Biliary reconstructions with RYCJ have traditionally been considered to be better than DD and more durable because of more reliable blood supply to the anastomosis and the ability to consistently obtain a tension-free anastomosis. Some reports suggest an RYCJ reconstruction is associated with a lower stricture rate in LDLT.[3] The DD biliary reconstruction is a quicker and preferred method in adult cadaveric liver transplantation when using the whole liver. However, this method has not always been feasible in the LDLT setting because of the type of recipient disease (e.g. primary sclerosing cholangitis) or the uncertainty of the vascular integrity of the biliary blood supply. There are several key points in performing DD in LDLT: (i) the size of donor and native bile duct should match, (ii) both ducts should be of good quality and well perfused, and (iii) tension frees anastomosis can be performed safely. DD should not be used in primary sclerosing cholangitis because of risk of malignancy in the native bile duct.

Biliary strictures were encountered in 23.1% of the patients with DD reconstruction in this series, which was significantly higher than the RYCJ group (5.9%). Although strictures seemed to develop more frequently in the DDCC group, all were managed by endoscopy. The requirement for surgical revision for biliary complications were lower (7.7%) in the DD group compared with 17.7% in the RYCY group ($P < 0.01$).

Several principles should be followed to increase the likelihood of obtaining a healthy well-vascularized bile duct(s). First, dissection of the hilar plate should be minimized to avoid disruption of the microcirculation around the hepatic duct and artery. Second, the duct should be divided sharply and perpendicular to its long-axis to minimize the risk of 'skeletonizing' the ducts.

Stenting of the anastomosis or use of a T-tube is another controversial topic for discussion in LDLT. The rationale of stent is the maintenance of biliary flow despite swelling of the anastomotic site and easy access for cholangiography suspected leakage or stricture. The external stent tends to reduce biliary complication in the Roux-en-Y reconstruction. Scatton *et al.*, however, reported that employment of a T-tube increased the incidence of biliary complications and recommended the use of duct-to-duct without a T-tube in deceased donor liver transplantation.[15] The most frequent complication was leakage after T-tube removal. Placement of external stent or T-tubes did not appear to be beneficial; however, a bias likely exists as stents were only placed in patients when a difficult anatomical situation was encountered.

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This study has several limitations. First, this is retrospective analysis of a prospective database with a limited number of patients. Second, the patient population is heterogeneous from paediatric patients with biliary atresia to adults with alcoholic cirrhosis. However, our findings show that DD anastomosis is an attractive alternative to RYCJ after LDLT and provides access for future endoscopic therapy for leak or stricture. The rate of biliary strictures was significantly higher in the DDCC group. However, while biliary strictures after LDLT using DD reconstruction are common, in most recipients they can usually be managed nonoperatively and do not affect short-term graft survival. Because of preserved physiological bilioenteric continuity, and less need for operative revision because of easy endoscopic access, duct-to-duct reconstruction represents a feasible technique in LDLT and should be considered the primary choice for reconstruction in living donor transplantation.

Conflicts of interest

None declared.

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