High Hilar Dissection: New Technique to Reduce Biliary Complication in Living Donor Liver Transplantation

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Biliary complications after living donor liver transplantation (LDLT) continue to be problematic. For reducing the biliary complications, the authors applied an intrahepatic Glissonian approach to the recipient hepatectomy. We called this Glissonian dissection technique at the high hilar level *high hilar dissection (HHD)*. In this study, we introduced this HHD technique and evaluated its outcome in 31 recipients of a living donor liver transplant (LDLT). With total occlusion of hepatoduodenal ligament Glissonia pedicles were divided at the intrahepatic level at the third level of pedicles or beyond. After portal vein and hepatic artery were isolated from the hepatoduodenal ligament, unused bile ducts and bleeding were controlled with continuous suture of the hilar plate. Single duct anastomosis was performed in about 21 and dual duct anastomosis in 10 recipients. Bile leakage of the biliary anastomosis did not occur. There were 6 biliary complications in five patients; 2 bile leaks from the cut liver surface and 4 biliary strictures of which one of unknown etiology. In none of the patients with biliary complications, conversion to a hepaticojejunostomy was necessary. This new HHD technique during recipient hepatectomy may contribute to reduce the biliary complications in duct-to-duct anastomosis by allowing a tension free anastomosis and preserving adequate blood supply to the bile duct. Moreover, it facilitates multiple ductal anastomoses without difficult surgical manipulation. (*Liver Transpl 2004;10:1158–1162.*)

Biliary complications after living donor liver transplantation (LDLT) continue to be problematic. They are important causes of morbidity, graft loss, and mortality related to liver transplantation.[1] There is still no consensus among transplant surgeons regarding the type of biliary anastomosis to be used in performing LDLT. Enteric drainage of liver grafts was considered safer in the initial series of LDLT in terms of biliary complications.[2,3] In recent years, as a result of advances in surgical techniques, a direct duct-to-duct biliary anastomosis has become a widely performed procedure in transplant centers. This procedure was accompanied with an acceptable biliary complication rate. Duct-to-duct biliary reconstruction is a physiological and faster method in restoring bilio-enteric continuity. It allows easy access and imaging through endoscopic techniques.[1,3,4] Although the incidence of biliary complications in a deceased donor liver transplantation has decreased 5% to 15% in recent years, a greater incidence of biliary complications has been reported, ranging between 10% and 50% in large clinical series of LDLT.[5–8] Potential risk factors related to posttransplant biliary complications include technical, anatomical, ischemic, and immunological factors, such as arterial thrombosis, cytomegalovirus (CMV) infection, rejection, and preservation injury.[1] Although cold ischemic times are relatively short and bile duct skeletonization are avoided, biliary complications are still the most frequent cause of surgical morbidity after LDLT.[9] To reduce these biliary complications in the recipient, there have been many reports regarding surgical efforts at preservation of blood supply in the donor bile duct, biliary anastomosis techniques, and various types of stents or decompression.[6] For the transplant recipient, a sufficient vascular supply to the duct and a longer bile duct to create a tension-free anastomosis are important factors to reduce biliary complications.[4]

The Glissonian approach has been used for systemic resection of the liver. Compared with the simple Pringle maneuver during hepatectomy, it has some merits, such as the ability to save the blood supply to the remaining liver.[10] We applied this approach to the recipient hepatectomy. We called this Glissonian dissection technique at the high hilar level high hilar dissection (HHD). Conventionally, the hepatic ducts and hepatic artery were dissected, followed by cut and ligation. The portal vein was left for the maintenance of blood flow until removal of the liver. Compared with this conventional method, we were able to obtain longer bile ducts

Abbreviations: LDLT, living donor liver transplantation; HHD, high hilar dissection; CMV, cytomegalovirus.

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and kept a better blood supply to the bile duct using the HHD technique.

In this article, we introduce this HHD technique and evaluate the outcome of the HHD technique.

Materials and Methods

HHD

After dissecting the ligaments around the liver, retrohepatic inferior vena cava (IVC) was dissected from the liver. The right hepatic vein was first encircled by Nylon tape, followed by the middle and left hepatic vein trunk. After this full mobilization of the recipients' liver, the total occlusion of hepatoduodenal ligament was performed with a tourniquet. We did not use portal or systemic bypass during total occlusion time. While holding the hepatoduodenal ligament with the left-hand fingers, a high hilar plate was bluntly dissected with suction tip or scissors. Glissonian pedicles were cut intrahepatically at the third level of pedicles or beyond (Fig. 1). After completing the remaining perihepatic dissection, the right hepatic vein and the middle and left hepatic vein trunk were clamped with vascular clamps. Then, the recipient liver was removed. The portal vein was isolated from the hepatoduodenal ligament and the portal vein and the remaining hilar structures were clamped separately with vascular clamps. The hepatic artery for arterial anastomosis was isolated from the remaining hilar structures and clamped with a microsurgical clip. The left hepatic artery was preferred for arterial anastomosis rather than the right hepatic artery. After the adequate bile duct(s) for duct-to-duct anastomosis was(were) selected, bleeding vessels and unnecessary bile

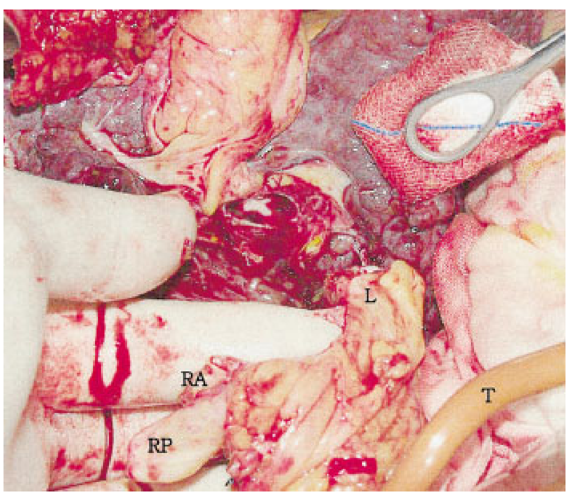
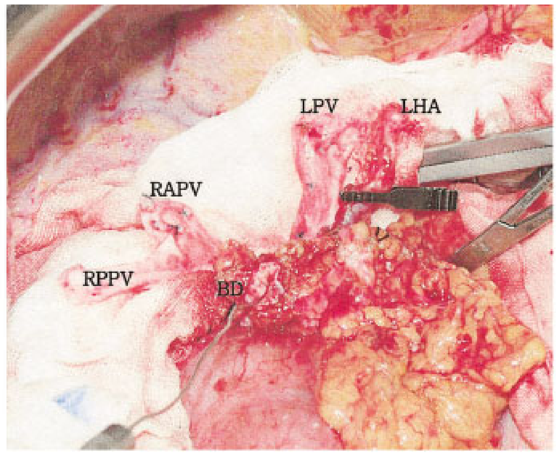
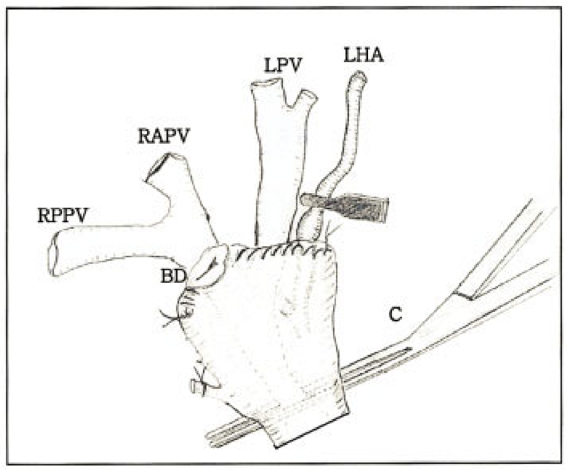


Figure 1. Intrahepatic Glissonian dissection. After the total occlusion of hepatoduodenal ligament with a vascular tourniquet (T), right anterior (RA) and right posterior (RP) sectoral Glissonian pedicles are already cut. Umbilical portion of the left hepatic pedicle (L) is just cut.



(A)



(B)

Figure 2. The manipulation of hepatic hilum for the anastomosis. Portal vein is isolated from hepatic pedicle and clamped separately with vascular clamp (C). Long right anterior sectoral portal vein (RAPV), right posterior sectoral portal vein (RPPV), and left portal vein (LPV) are seen. Left hepatic artery (LHA) is dissected and clipped with a black clamp for the arterial anastomosis. After selection of the proper bile duct (BD) for the duct-to-duct anastomosis, the hilar plate of remaining pedicles was sutured with continuous nonabsorbable suture.

ducts at the end of the hilar plate were sutured continuously with 5-0 Prolene® (Ethicon, Somerville, NJ). Then, the vascular clamp on the remaining hilar structures was removed (Fig. 2).

Duct-to-Duct Anastomosis

After reperfusion of the graft and hepatic arterial anastomosis, the duct-to-duct anastomosis was made using 6-0 PDS®

Table 1. Patient Characteristics

Gender (male : female)	25 : 6
Age (yr; mean range)	49.1 (25–68)
Diagnosis	
HBV related cirrhosis (HCC*)	25 (12)
HCV related cirrhosis (HCC*)	2 (2)
Fulminant liver failure	4
MELD† score	21.4 ± 11.5
GRWR‡	1.0 ± 0.37
Hospital mortality	1
Follow-up duration (months)	10.5 ± 3.6

Abbreviations: HBV, hepatitis B virus; HCV, hepatitis C virus; HCC, hepatocellular carcinoma; MELD, model for end-stage liver disease; GRWR, graft to recipient body weight ratio.
Numbers are expressed as mean ± standard deviation.

(Ethicon, NJ). We usually sutured the posterior wall continuously and anterior wall using an interrupted fashion. We did not routinely use any kind of stent. We used an internal silastic stent in selective cases in which the duct size was very small or at potential sites of internal obstruction in early branching ducts during duct-to-duct anastomosis.

Patients

We began using the HHD technique in August 2002. From August 2002 to July 2003, 48 patients underwent living donor liver transplantation using right hemiliver graft. A total of 43 patients among them received duct-to-duct anastomosis. Thirty-one patients who received the HHD during recipient hepatectomy were included in this study. Inflow occlusion time from the occlusion of the hepatoduedenal ligament until recirculation was 137 minutes (range: 62 to 252 minutes). Duration of implantation of the graft was 114 minutes (range: 49 to 240 minutes), which included warm ischemic time and pedicale dissection time.

Statistical Analysis

A statistical analysis was performed on an IBM compatible computer using SPSS 11.0 (SPSS, Chicago, IL).

Results

Patient Characteristics

The patients' characteristics are listed in Table 1. The majority of the patients were male and hepatitis B virus carriers. There were 14 cases of hepatocellular carcinoma and 4 cases of fulminant hepatic failure. Mean model for end stage liver disease score was 21.4 and graft-to-body weight ratio was 1.0. We had 1 case of mortality due to nonbiliary–related sepsis. Mean follow-up duration was 10.5 months.

Operative Features

Operative features are shown in Table 2. Total operative time from skin opening to closure lasted 600 minutes. Inflow occlusion time from the occlusion of the hepatoduodenal ligament until recirculation was 137 minutes (range: 62 to 252 minutes). Duration of implantation of the graft was 114 minutes (range: 49 to 240 minutes), which included warm ischemic time and pedicle dissection time. In most cases, cold ischemic time was less than 1 hour.

Biliary-Related Features

Fourteen (45.2%) of the grafts had dual bile ducts. As in 4 of these grafts ductoplasty was performed to create only one ductal opening, a dual anastomosis was necessary in 10 cases (32%). In the other 21 cases a single duct anastomosis could be performed. Overall, 8 (25.8%) cases underwent ductoplasty to make either one ductal opening or long common cuff. Internal stents were used in 12 cases 38.7%.

There were 6 biliary related events in 5 patients. One patient experienced biliary stricture as well as nonanastomotic leakage. There was no biliary anastomotic–related leakage. There were 2 events of nonanastomotic leakage due to cut surface on the liver parenchyma and the other from the gall bladder bed. Three patients were complicated by biliary strictures, which was detected at an average postoperative 4.5 months. There was one additional case of common bile duct stricture of unknown etiology.

Most of the biliary complications were managed with conservative therapy. One patient with leakage from gall bladder bed was managed surgically. All 3 cases of strictures were managed with percutaneous transhepatic biliary drainage and balloon dilatation. There was no case of conversion to a hepaticojejunostomy.

Table 2. Operative Features

Total operation time (minutes)*	600 ± 96
Inflow occlusion time (minutes)†	137 ± 51
Implantation time (minutes)‡	114 ± 45
Cold ischemic time (minutes)	49 ± 26
Warm ischemic time (minutes)	33 ± 13

*From incision to closure.
†From the occlusion of the hepatoduodenal ligament to recirculation of the graft.
‡From the recipient hepatectomy to recirculation.

Discussion

Glisson's capsule extends into the liver as tissue sheaths around the hepatic ducts, hepatic arteries, and portal tributaries.[10] Therefore, within the hepatic substances, it is difficult to dissect structures individually. For the conventional recipient hepatectomy, the bile duct and hepatic artery are isolated and ligated individually from hepatic pedicles at the extrahepatic level. Generally, this procedure takes longer and it is relatively bloody. Even with this conventional extrahepatic approach, only first order bile ducts and portal veins can be obtained. In some cases, the recipients' first order bile ducts are insufficient to perform a tension-free anastomosis. To obtain more length from the common bile duct, some have performed a more proximal dissection. However, this has a potential risk of injury to the blood supply to the bile duct.

Galperin and Karagiulian[11] introduced the technique of selective exposure of the hepatic pedicles and rapid selective ligation without significant normothermal ischemia of the retained parts of the liver. They reported that this selective ligation technique, using the intrahepatic Glissonian approach, could reduce the blood loss and duration of general liver ischemia during hepatectomy. Many surgeons have used a similar technique during partial hepatectomy.[10,12] We applied this intrahepatic Glissonian technique to the recipient hepatectomy. Through this technique, we were able to obtain longer bile ducts, hepatic arteries, and portal veins in a bloodless field, enabling a tension-free anastomosis. Moreover, it was feasible to obtain bile ducts of various sizes and locations. It allowed multiple anastomosis without issues, such as size discrepancy and variable distance between ducts. As a result, this enabled us to perform duct-to-duct anastomosis. Otherwise, a hepaticojejunostomy or a combination procedure would have been necessary. After using the HHD technique, we have not experienced any complications due to anastomotic leakage, which contributed to a smoother postoperative course.

During the initial period of performing the HHD, we had some difficulties in the closure of numerous unused bile ducts and bleeding around the bile ducts. We overcame these difficulties by using a continuous suture. After selecting the proper bile duct(s) for the anastomosis, continuous suture with Prolene was used in the hilar plate, on the far end from the selected bile duct, and then returning to the starting point near the selected duct. This continuous suturing method allowed for easy closure of multiple bile ducts, and knot-free control of bleeding around the selected bile duct. The blood supply could be entirely saved in most cases.

The hilar plexus is a set of collateral vessels that bridge the left and right hepatic arteries and is found on the inferior aspect of the hilar plate. The blood supply to the right hepatic duct and the right sectoral ducts arises from both the right hepatic artery and the hilar plexus. The left hepatic duct is supplied from a plexus that is continuous with the plexus at the confluence of the right hepatic duct and the common bile duct.[4] The right hepatic artery is more important for keeping the blood supply to the hilar plate than the left hepatic artery. Most of the biliary anastomosis was performed at the right hepatic duct or right sectoral ducts. Therefore, we did not attempt to separate the right hepatic artery from the right hepatic duct to keep a sufficient blood supply to the bile duct; we preferred using the left hepatic artery for the arterial anastomosis. The left hepatic artery usually goes along the lymphatic channels located in the left side of the hepatic hilum. Therefore, it is easier to isolate the left hepatic artery than the right hepatic artery. In 74% of the cases, we used the left hepatic artery for arterial anastomosis. In some cases, the insufficient quality of the left hepatic artery forced us to use the right hepatic artery instead.

The HHD gave us not only longer bile ducts, but also a longer portal vein. In the case that the graft has separate anterior and posterior portal veins, the longer left and right portal veins enabled us to use a Y-graft. Besides the usual Y-graft using the recipient portal vein, we sometimes resolved this problem by using direct dual anastomoses. The longer portal vein could prevent angulation problems of the portal vein.

In case of hepatic malignancy, and especially when this was located near the hepatic hilum, the HHD technique had some limitations. Because intrahepatic dissection could spread tumor cells to the operation field, we should be cautious during the HHD in that case. For better safety in case of hepatic malignancy, it might be much better to suture or ligate the intrahepatic end. In most cases that are not hindered by hepatic malignancy, the intrahepatic end could be left open without problem.

The recipient hepatectomy using HHD may have a longer anhepatic time, as compared with that of using the conventional extrahepatic approach. Our inflow occlusion time up to recirculation took about two hours. However, this was not a significant a problem in most of cases because of the advantage of dissecting the hepatic pedicles in a bloodless field. The implantation of the graft took 114 minutes, with the fastest being 49 to 57 minutes. Considering the warm ischemic time, which was the duration of the anastomoses of the hilar structures, therefore, operation time during hepatic hilum dissection was less than one hour in most of cases.

In conclusion, the use this new HHD technique during recipient hepatectomy may help to reduce the biliary complication for duct-to-duct anastomosis by allowing a tension-free anastomosis and keeping a sufficient blood supply to the end of the bile duct. Moreover, it allows to perform multiple anastomoses without difficult surgical manipulation.

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