Total hepatectomy during living donor liver transplantation at 108 Military Central Hospital

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Summary

Objective: To evaluate the results and summarizing the experiences of total hepatectomy in living donor liver transplantation. *Subject and method*: A cross-sectional, descriptive study, over 165 cases of living donor liver transplantation at 108 Military Central Hospital from January 2019 to April 2023. *Result:* The average age of patients was 51.57 ± 13.19 years old, HBV infection rate was 70.9%. Indications for liver transplantation include acute liver failure (2.4%), acute on chronic liver failure (34%), decompensated cirrhosis (24.8%), hepatocellular carcinoma (37%), intrahepatic cholangiocarcinoma (1.2%), liver metastases from colon cancer (0.6%). High hilum dissection of the hepatic artery in continuity with the bile duct rate was 95.2%, individual dissection in 3% and total occlusion in 1.8% of cases. The left and middle hepatic veins trunk was divided before segment 1 dissection in 95.8% of patients. Average time of total hepatectomy was 148.12 ± 38.9 minutes, average blood loss during total hepatectomy was 867 ± 442ml. *Conclusion:* High hilum dissection of the hepatic artery in continuity with the bile duct combined with left and middle hepatic veins trunk divided before dissecting of the segment 1 is safe and feasible for total hepatectomy during living donor liver transplantation.

Keywords: Total hepatectomy, living donor liver transplant, high hilum dissection.

1. Background

Until now, liver transplantation has been the only curative treatment for end-stage liver diseases. In Asian countries, including Vietnam, the rate of brain-dead organ donation is still very low. Therefore, liver transplantation from living donors is considered an effective effort to expand the source of liver transplants, creating an opportunity to save more patients on the transplant waiting list [1]. However, living-donor liver transplantation (LDLT) is still a big challenge, especially in surgical techniques. In addition to the graft harvest surgery, it is necessary to ensure absolute safety for the liver donor-a healthy person. The technique of total hepatectomy in the recipient is to remove the diseased liver as well as prepare vascular and biliary stumps for reconstruction, which plays an important role. In LDLT, the biliary tract and vessels of the graft are smaller and shorter than in a whole liver transplant from a brain-dead person. Therefore, total liver resection, especially liver hilum dissection, must ensure that the vascular and biliary stumps are long enough and not damaged.

The high hilar dissection technique is considered effective in reducing postoperative complications, especially biliary anastomotic complications (the Achilles heel of liver transplantation). Dissecting high into the hepatic hilum helps ensure the biliary stump is long enough while preserving maximum blood vessels feeding the biliary tract. This is considered a prerequisite to help nourish the anastomosis and reduce anastomotic complications. In addition to the hilar dissection technique, total liver resection is also a challenge when operating in patients with severe cirrhosis, multiple collateral circulations, or liver failure patients with coagulation disorders [1], [2], [3].

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In Vietnam, liver transplantation is still a new concern and has many challenges. More research is needed to evaluate and improve to continuously improve surgical techniques, reduce complications, and improve treatment results of patients with end-stage liver diseases. The study was conducted to summarize some experiences in total hepatectomy in LDLT at 108 Military Central Hospital.

2. Subject and method

2.1. Patient

Includes patients receiving LDLT at the Department of Hepatobiliary-Pancreatic Surgery (B3B), from January 2019 to April 2023, at 108 Military Central Hospital.

2.2. Method

Retrospective, cross-sectional, non-controlled study. Sample size: Convenience sample.

2.3. Research's protocol

2.3.1. Indications for liver transplantation include [4]

Acute liver failure (ALF) due to viruses, acetaminophen poisoning, other drugs/chemicals.

Acute on chronic liver failure (ACLF): Hepatitis B and C viruses, alcohol.

Cirrhosis (CH) and complications: Ascites, hepatic encephalopathy, portal hypertension, hepatopulmonary syndrome.

Malignant diseases of the liver: Hepatocellular carcinoma (HCC), hepatoblastoma, cholangiocarcinoma, liver metastasis.

Liver diseases related to metabolism: a1-antitrypsin deficiency, Wilson's disease, amyloidosis, urea cycle disorders, tyrosemia...

Other end-stage liver diseases: Autoimmune hepatitis, Caroli disease, primary biliary cirrhosis, Budd-Chiari syndrome, other hepatic vascular diseases: Portal vein atrophy, portal vein thrombosis...

2.3.2. The total hepatectomy technique is performed uniformly through steps

Open the abdomen and evaluate the condition of the abdomen and liver disease.

Cut the ligaments to release the liver.

Cholecystectomy, liver pedicle dissection with high dissection technique into the liver hilum.

Dissect each component of the hepatic pedicle: The hepatic artery, portal vein, and biliary tract were dissected separately (Figure 1A).

Enbloc dissection of the hepatic artery and biliary tract: The portal vein is exposed and isolated. The hepatic artery and biliary tract are tourniqueted into one block at the distal end, the proximal ends are cut together as deep as possible into the liver hilum (Figure 1B).

Enbloc dissection of the entire hepatic pedicle: The entire liver pedicle is tourniqueted at the distal end, the proximal end is cut into a block deep into the liver hilum (Figure 1C)

Cut the left and middle hepatic veins to make releasing segment 1 from the vena cava easier.

Release segment 1 from the vena cava.

Removal of diseased liver (starting anhepatic phase)

To optimize portal vein flow, it is possible to measure portal vein pressure and ligation of collateral anastomoses when these anastomoses are dilated.

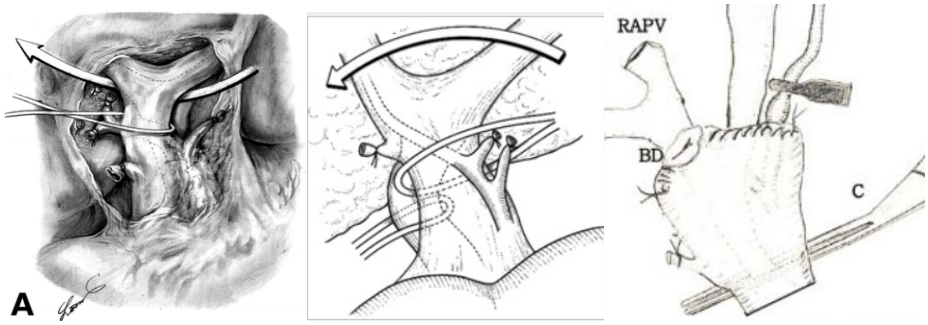

Figure 1. Technique of liver pedicle dissection

A-Dissect each component of the hepatic pedicle, B-Enbloc dissection of the hepatic artery and biliary tract C-Enbloc dissection of the entire hepatic pedicle

During the liver pedicle dissection, the Pringle procedure was performed, using a Foley catheter to block the entire liver pedicle to reduce hemorrhage.

2.4. Research's parameter

Age, gender, cause, alcohol abuse, body mass index (BMI), HBV, HCV, MELD score scale.

Total hepatectomy time was counted from the time of skin incision to the end of dissection of the entire liver from the vena cava and placement hanging on the right hepatic vein and portal vein (minutes). The length of the anhepatic phase was estimated from when the portal vein was cut in the recipient until the liver graft was reperfused (ml). Blood loss during surgery was measured from the beginning to the end of total liver resection (ml).

2.5. Statistical analysis

All statistical analyses were performed using SPSS (version 26.0; SPSS Inc., Chicago, Ill., USA). A $p<0.05$ was considered statistically significant.

3. Result

3.1. General characteristics

Table 1. Patients' characteristics

Patients' characteristics		Results (n = 165)
Mean age (year)		51.57 ± 13.19 (8-80)
Male / Female		139/26 (5.36/1)
BMI		23.08 ± 2.91
HBV infection		117 (70.9%)
HVC infection		9 (5.5%)
Alcohol abuse		25 (15.2%)
MELD score	< 15	39 (23.6%)
	15 -< 25	52 (31.5%)
	25 -< 35	33 (20.1%)
	≥ 35	41 (24.8%)

Comment: The mean age was 51.57 years old, the male/female ratio was over 5/1, and the HBV infection rate was 70.9%. Patients with MELD scores range 15-25 accounted for the highest proportion (31.5%), and patients with MELD scores >35 accounted for 24.8%.

Table 2. Indications for liver transplant

Indications for liver transplant	n = 165	%
Acute liver failure (ALF)	4	2.4
Acute-on-chronic liver failure (ACLF)	56	34
Decompensated cirrhosis	41	24.8
Hepatocellular carcinoma (HCC)	61	37
Intrahepatic cholangiocarcinoma (ICC)	2	1.2
Liver metastasis from colon cancer	1	0.6

Comment: Primary liver cancer had the highest rate (37%), acute-on-chronic liver failure had a rate of 34%, and one case received a liver transplant to treat liver metastases from colon cancer (0.6%).

3.2. Intraoperative results

Table 3. Intraoperative results

Intraoperative results		Results (n = 165)
Liver pedicle dissection	Dissect each component of the hepatic pedicle	5 (3%)
	Enbloc dissection of the hepatic artery and biliary tract	157 (95.2%)
	Enbloc dissection of the entire hepatic pedicle	3 (1.8%)
Cut the left and middle hepatic veins prior	Yes	158 (95.8%)
	No	7 (4.2%)
Portal vein thrombectomy		6 (3.6%)
Measure portal vein pressure		12 (7.3%)
Ligation of portocaval anastomoses		5 (3%)
Total hepatectomy time (minutes)		148.12 ± 38.9
Length of the anhepatic phase (minutes)		61.16 ± 22.7
Mean intraoperative blood loss (ml)		867 ± 442
Intraoperative complications	Inferior vena cava injuries	1 (0.6%)
	Right adrenal injuries	5 (3%)

Comment: The majority of patients underwent high hepatic hilum dissection with en-bloc dissection of the hepatic artery and biliary tract techniques (95.2%), and anterior left and middle hepatic vein resection (95.8%). Portal vein thrombectomy in 6 patients (3.6%). Intraoperative complications included damage to the inferior vena cava (0.6%) and the right adrenal gland (3%).

Figure 2. Distribution of total hepatectomy time according to transplant order

Comment: Total hepatectomy time tended to decrease with the number of surgeries.

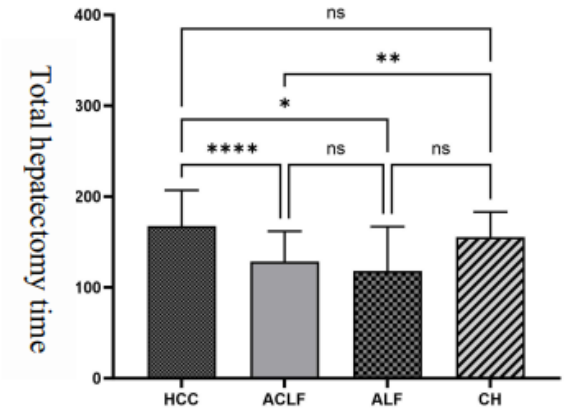

Figure 3. Comparison of mean total hepatectomy time time in disease groups: liver cancer, ALF, ACLF and cirrhosis

Comment: Total hepatectomy time in ACLF patients was shorter than in liver cancer and cirrhosis patients ($p<0.05$).

4. Discussion

4.1. General characteristics

Patients in the study had a mean age of 51.57 years old; the youngest case was 8 years old, and the oldest patient recorded was 80 years old. Although

older age is not a contraindication to liver transplantation, elderly patients often suffer from many comorbidities, such as cardiovascular, metabolic, and respiratory diseases, and their tolerance to complications and side effects is limited. According to Durand et al. (2019), recent statistics in the US show that over 25% of liver transplant patients in the US are over the age of 65. The author also recommends that the dose of anti-rejection drugs in elderly patients should also be less than in young patients, only need to use one drug instead of 2-3 anti-rejection drugs, besides needing an exercise regimen and vitamin D supplementation to help reduce the risk of osteoporosis and bone fractures [5].

Our study's male/female ratio was 5.36, so most liver transplant patients were men. This is also seen in many reports, especially reports in Asian countries. The study by Lee et al. (2004) at Seoul National University Hospital had a male/female ratio of 25/6; this ratio in the study by Ahmed et al. (2020) was 2/1. This can be explained by the higher incidence of end-stage liver disease in men due to heavy alcohol consumption, and at the same time, men are considered the breadwinners in the family, so they receive more treatment attention. Liver transplant patients in the study had an average body mass index (BMI) of 23.08 ± 2.91. Although obesity is not a contraindication for transplantation, this is a factor that makes surgery more complex, as well as postoperative rehabilitation [2], [6].

Risk factors for liver cancer and cirrhosis include hepatitis B and C viruses and alcohol abuse. Vietnam is located in an area with a high incidence of hepatitis B and slow economic development, so preventive and treatment measures in the past have not been taken seriously. Patients in the study had a hepatitis B virus (HBV) infection rate of 70.9% and a hepatitis C virus (HCV) infection rate of 5.5%. This is also mentioned in liver transplant reports in Korea, with HBV infection rates up to 80%. Alcohol abuse is also a risk factor for cirrhosis. In patients with alcoholic cirrhosis, not only is the patient's body deteriorated by alcohol causing nutritional disorders, but the reuse of alcoholic beverages is a problem we must pay attention to. In the study, 15.2% of liver transplant patients were alcohol abusers.

The MELD score is a scale used to evaluate the prognosis of end-stage disease based on the patient's liver failure, kidney failure, and electrolyte disorders. Patients with higher MELD scores indicate a worse prognosis, so they are given priority on the transplant waiting list. Cirrhotic patients with a MELD score ≥ 15 will be placed on the transplant waiting list. Liver transplantation is also indicated for patients with a MELD score < 15 but with cirrhosis complications such as refractory ascites, gastrointestinal bleeding due to esophageal vein rupture, or liver cancer. In 2013, the US Organ Transplant Coordination Organization stipulated that patients with MELD scores above 35 should be given top priority on the waiting list and will receive a liver transplant as soon as a donor is available. Patients with a MELD score above 25 need to have their score updated every 7 days and will be updated more frequently if their condition worsens [4].

The study results showed that 23.6% of patients had a MELD score < 15; these were liver cancer or cirrhosis cases with complications of refractory ascites and bleeding due to ruptured esophageal varices. Patients with MELD score ≥ 35 are found at a rate of 24.8%; these are severe patients who often require emergency liver transplantation. There are also studies showing that MELD score is also one of the factors predicting post-transplant outcomes. According to Ikegam et al. (2011), MELD score ≥ 20 is a risk factor for postoperative biliary complications [7].

4.2. Indications for liver transplantation

Indications for liver transplantation can be divided into two groups: emergency and scheduled transplantation. Emergency liver transplantation is indicated for patients with ALF or ACLF. Unlike in European countries, where liver transplants are common due to acute liver failure, the most common is paracetamol poisoning. In Vietnam and some countries with high rates of HBV infection,

emergency liver transplantation is often indicated for ACLF caused by HBV. In these patients, due to chronic disease, the liver's ability to compensate is weaker after acute injury. Hence, the possibility of recovery is very low without a liver transplant, even though the progression is less drastic than in ALF. Scheduled transplant groups include decompensated cirrhosis, primary liver cancer, and metabolic diseases [4].

In the study, indications for emergency liver transplantation occurred at a rate of 36.4%, which is quite a unique point when advising patients and families on liver transplantation in the study. Typically, for decompensated cirrhosis patients with long-term illness, it is difficult to advise on transplantation for families and patients because economic conditions have been greatly affected, and family members are unwilling to donate their livers to patients in severe conditions. In patients with ALF and ACLF, the disease progresses rapidly in a short period, and the family and patient are always ready to donate their liver and mobilize financial resources for liver transplantation. In developed countries, when health insurance covers the cost of liver transplants, more patients can access liver transplants, so the rate of emergency liver transplants will decrease. Research by Lee et al. (2004) found emergency liver transplantation for acute liver failure at a rate of 1.3% [2].

In our study, there were 2 cases of liver transplant for intrahepatic cholangiocarcinoma and 1 case for liver metastasis from colon cancer. These are relatively new and challenging issues in liver transplantation. Previously, the above two diseases were not listed as indications for liver transplantation due to the risk of cancer progression after taking anti-rejection drugs. Recent statistics show that a certain percentage of cholangiocarcinoma detected after liver transplantation (indicated for primary liver cancer) shows relatively positive results. Furthermore, in LDLT, when financial resources and organs are transplanted from the patient's relatives, indications for liver transplantation can be expanded to provide more opportunities for the patient. Liver transplantation to treat inoperable colorectal cancer with liver metastases is also mentioned. A Norwegian study compared two groups of patients with liver metastases from inoperable colorectal cancer. One group received a liver transplant, and the other group received chemotherapy and systemic treatment. The results showed that the one-year survival rate was significantly higher in patients who received a liver transplant compared to the group receiving chemotherapy (56% vs. 9%; $P<0.001$) despite similar disease-free survival (10 months vs. 8 months) [8], [9]

4.3. Intraoperative results

High dissection into the hepatic hilum is recommended in total hepatectomy in preparation for liver transplantation. This technique helps preserve the vascular and biliary tracts stump long enough to perform anastomosis. This is especially important in LDLT, when the size of the graft, as well as the vascular processes and biliary tract, are much shorter than in whole liver grafts. In addition to keeping the vascular processes long enough, preserving the blood vessels that feed the biliary tract in biliary-biliary anastomosis plays an essential role in helping to limit biliary complications after transplantation. High dissection technique into the liver hilum can be performed in 1 of 3 forms: dissect each component of the hepatic pedicle, en-bloc dissection of the hepatic artery and biliary tract, and en-bloc dissection of the entire hepatic pedicle. In particular, en-bloc dissection of the entire hepatic pedicle helps preserve the blood vessels feeding the biliary tract. However, it has the disadvantage of causing blood stasis in the intestine. Dissecting each component helps reveal the vascular pedicles but has the risk of damaging the feeding vessels of the biliary tract [2], [7]. In the study, most patients underwent en-bloc dissection of the hepatic artery and biliary tract technique (95.2%). This technique overcomes the disadvantages of the two above methods because it helps maintain portal vein circulation without damaging the biliary artery. This is

also mentioned in the research of Abu-Gazala (2016) and Soejima (2008); they stated that using this technique helps reduce biliary complications after liver transplantation from living donors [3], [10].

In cirrhotic patients, surgically releasing the entire liver, especially segment 1, from the portal vein is sometimes quite tricky due to hypertrophy of segment 1 and dense liver parenchyma. In our study, the middle and left hepatic veins were transected before releasing segment 1 to optimize portal vein flow; combined surgical techniques include portal vein thrombectomy (3.6%), measuring portal pressure (7.3%), and ligation of portosystemic anastomoses (3%).

The mean total hepatectomy time in the study was 148.12 ± 38.9 minutes, with a mean length of anhepatic phase of 61.16 ± 22.7 minutes. Figure 1 shows that total liver resection time tends to decrease over time, although many cases still have prolonged surgery time. This can be explained by the fact that later on, we performed transplantation for more complex diseases, which will have a longer time for total hepatectomy. Figure 2 compares the mean total liver resection time in disease groups indicated for liver transplantation. The results showed that liver cancer and cirrhosis patients had a longer total hepatectomy time than other groups; the difference was statistically significant ($p<0.05$). The mean blood loss during total hepatectomy was 867 ± 442ml.

Intraoperative complications recorded in the study included damage to the inferior vena cava and damage to the adrenal gland. In total hepatectomy, the subsegment must be dissected away from the inferior vena cava. In cases of cirrhosis, this is quite difficult due to subsegment 1 hypertrophy, fibrosis, and difficulty in exposing and ligating hepatic venous branches that drain directly into the inferior vena cava. That is why bleeding from these branches is quite common; luckily, controlling the hemorrhage is not very difficult. There was one case where part of the inferior vena cava was damaged, causing narrowing of the vessel lumen, requiring a partial reconstruction of the vena cava wall with a saphenous vein graft. Accidental damage to the adrenal gland is more common; however, this accident is not difficult to manage by stitching to control adrenal bleeding. Experience with adrenal gland hemostasis is to use 5.0 prolene suture up the gland capsule to compress the parenchyma. Because the adrenal parenchyma is quite friable and has many blood vessels, if you try to sew it into the parenchyma, the tissue will break without achieving effective hemostasis.

5. Conclusion

Total hepatectomy with dissecting the hepatic hilum by en-bloc dissection of the hepatic artery and biliary tract technique combined with the resection of the left and middle hepatic vein is a safe and feasible method in LDLT. Surgery time will gradually improve with the surgeon's experience.

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