Clinical Case Report

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Laparoscopic living donor right hemihepatectomy with venous outflow reconstruction using cadaveric common iliac artery allograft

Case report and literature review

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Abstract

Rationale: With the development of laparoscopic technique, the total laparoscopic living donor right hemihepatectomy (LLDRH) procurement surgery has been successfully performed in many liver transplant centers all over the world, and the number of cases is continuing to increase. We report our case of laparoscopic right graft resection with venous outflow reconstruction using cadaveric common iliac artery allograft in our center and review literatures about total LLDRH surgery.

Patient concerns and Diagnoses: A 40-year-old male living donor for right hepatectomy was selected after pretransplant evaluation including laboratory tests, liver volume, anatomy of hepatic vein, artery, portal vein, and bile duct. Living donor liver transplantation surgery was approved by Sichuan Provincial Health Department and the ethics committee of the West China Hospital, Sichuan University.

Interventions: Hepatic parenchyma transection was performed by ultrasonic scalpel and Cavitron Ultrasonic Surgical Aspirator (CUSA). Right branch of portal vein, right hepatic artery, right hepatic duct, and right hepatic vein were meticulously dissected. The right hepatic duct was ligated and transected 2 mm far from the bifurcation of common hepatic duct, right hepatic artery, and portal vein were also ligated and transected, the right hepatic vein was transected by laparoscopic linear cutting stapler. The gap between short hepatic veins and right hepatic vein was bridged and reconstructed by cadaveric common iliac artery allograft.

Outcomes: The operation time was 480 minutes and warm ischemia time was 4 minutes. Blood loss was 300 mL without blood transfusion. The donor was discharged on postoperative day 7 uneventfully without complications. Literatures about laparoscopic living donor right hemihepatectomy are compared and summarized in table.

Lessons: The total laparoscopic living donor right hemihepatectomy is technically feasible and safe in some transplant centers which should have rich open living donor liver transplantation experience and skilled laparoscopic techniques. Venous outflow tract reconstruction is necessary if orifice diameter of short hepatic vein is greater than 0.5 cm on the graft cutting surface.

Abbreviations: CT = computed tomography, CUSA = Cavitron Ultrasonic Surgical Aspirator, HCC = hepatocellular carcinoma, IVC = inferior vena cava, LDLT = living donor liver transplantation, LLDRH = laparoscopic living donor right hemihepatectomy, MELD = model for end-stage liver disease, MRCP = magnetic resonance cholangiopancreatography, PTFE = polytetrafluoroethylene.

Keywords: laparoscopy, living donor liver transplantation, right hemihepatectomy, venous reconstruction

1. Introduction

Living donor liver transplantation (LDLT) is an essential option for patients with end-stage liver diseases in countries with the low cadaveric organ donation rate. Since the first case of pure laparoscopic LDLT was reported in 2013,[1] more and more sporadic cases of laparoscopic right donor hepatectomy were performed in many transplant centers all over the world.[2,3] To date, the total laparoscopic LDLT was considered as a feasible and safe method in certain liver transplant centers which have an advanced laparoscopic technique. Herein we report the case of LLDRH with venous outflow reconstruction and review current literatures about total LLDRH.

2. Case presentation

A 36-year-old man had been suffering from abdominal distension and jaundice for 3 months when he was admitted to hospital. He had no abdominal pain, diarrhea, vomiting, and nausea. He had weight loss of 8 kg over the 6 months prior to diagnosis and had history of Hepatitis B Virus (HBV) infection for more than 20 years. Alpha fetal protein was higher than 1000 ng/mL, Liver function was class B according to Child-Pugh classification, and model for end-stage liver disease (MELD) score was 10.7.

Editor: Muhammed Mubarak.

The authors have no funding and conflicts of interest to disclose.

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Medicine (2017) 96:7(e6167)

Received: 13 September 2016 / Received in final form: 24 January 2017 / Accepted: 27 January 2017

http://dx.doi.org/10.1097/MD.0000000000006167

Ultrasonography showed a 9.5 × 9×9 cm hypoechoic mass with clear margin in the right posterior lobe of liver, computed tomography (CT) scan demonstrated an enhanced 9 cm in diameter mass in the right liver in the arterial phase, chest x-ray and bone scan was normal. Primary diagnosis was liver cancer. Our protocol for transplantation is based on Shanghai Fudan Criteria: Hepatocellular carcinoma (HCC) patients with solitary lesions ≤9 cm in diameter, or no more than 3 lesions, the largest ≤5 cm, with a total tumor diameter ≤9 cm.[4]

For donor, 40 years old man, liver volume of 3D reconstruction showed that the right graft without middle hepatic vein was 615 mL and the graft to recipient weight ratio (GRWR) was 0.85%, the anatomy of portal vein, hepatic artery, hepatic vein, and hepatic duct was normal.

LDLT surgery was approved by Sichuan Provincial Health Department and the ethics committee of the West China Hospital, Sichuan University. Informed consents were obtained from the donor, recipient, and their relatives after full explanation of the potential risks including laparoscopic hepatectomy and LDLT surgery.

2.1. Patient position and port placement

The patient was placed supine in the 30-degree left position; laparoscopy was performed under CO_2 pneumoperitoneum with insufflation pressure of 12 mm Hg. The operating surgeon stood by the patient's right side, and the assistant and cameraman stood by the patient's left side. Two monitors were placed on both side. Three 12-mm and two 5-mm trocars (Ethicon Endo-Surgery, Cincinnati, OH) were inserted. The port positions are illustrated in Fig. 1.

2.2. Laparoscopic hepatectomy

Bulldog was used to clamp the right portal vein transiently for ischemic line, and the transection line was marked by electric cautery along the ischemic line. Hepatic parenchyma transection was performed by ultrasonic scalpel and CUSA (Valleylab, CO); bipolar was used to stop bleeding of the cutting surface. Right branch of portal vein, right hepatic artery, right hepatic duct, and right hepatic vein were meticulously dissected and marked by color ropes. No variation of the biliary tract was found in preoperative magnetic resonance cholangiopancreatography (MRCP), and intraoperative dissection showed that the length of right hepatic duct was 1.1 cm with clear anatomical relationship to common hepatic duct and left hepatic duct; thus, we ligated and transected the right hepatic duct 2 mm far from the bifurcation of common hepatic duct without intraoperative cholangiography, right portal vein, and right hepatic artery were also ligated and transected, and laparoscopic linear cutting stapler was used to transect the right hepatic vein (Fig. 2). The right liver graft was placed in a retrieval bag and took out from suprapubic incision.

2.3. Reconstruction of the venous outflow tract

Two large short hepatic veins with 0.5 cm and 0.6 cm in diameter, respectively, drained to inferior vena cava; therefore, we planned to reconstruct the outflow of short hepatic vein. Reconstruction was completed by using cadaveric common iliac artery allograft on back table. Ostia of 2 short hepatic veins were reconstructed to 1 common stump by 5-0 polypropylene sutures. A preserved common iliac artery allograft from deceased donor was used to bridge the gap between short hepatic veins and right hepatic vein by 5-0 polypropylene sutures. The bridging graft was longitudinal opened and anastomosed with inferior vena cava (IVC) of recipient (Fig. 3).

The right liver graft procurement operation time was 480 minutes and warm ischemia time was 4 minutes. Blood loss was 300 mL without blood transfusion. The drainage tube was removed on postoperative day 5, the donor was discharged on postoperative day 7 uneventfully, and no complication was found. The graft functioned well in the recipient without any graft related complications and discharged on postoperative day 20. During follow-up of 3 months, there was no biliary tract complication and liver function was normal.

3. Literature review

Literature review was conducted via databases of Medline and PubMed searching the key words "laparoscopy," "laparoscopic," and "living donor liver transplantation"; only 6 articles about LLDRH were found for this review. The first case was reported by Soubrane et al[1] in 2013; there were totally 9 cases summarized in Table 1 until September 2016. All cases were successful except 2 cases with biliary fistulae in Takahara

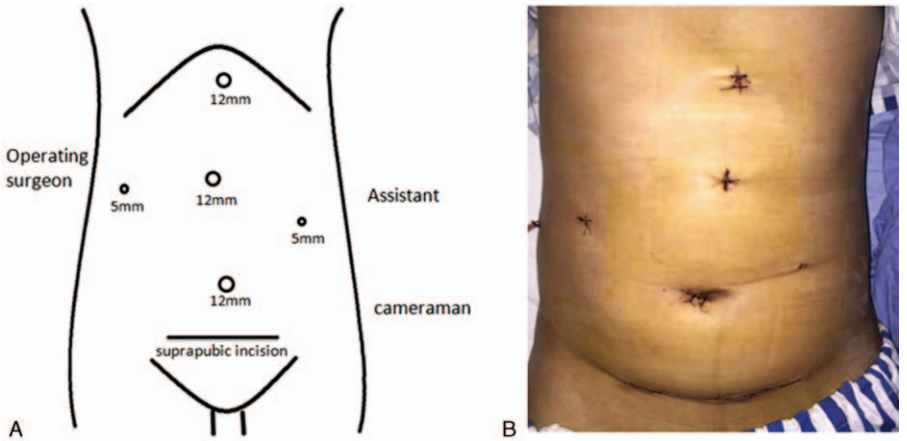

Figure 1. (A) Port position; (B) postoperative incision.

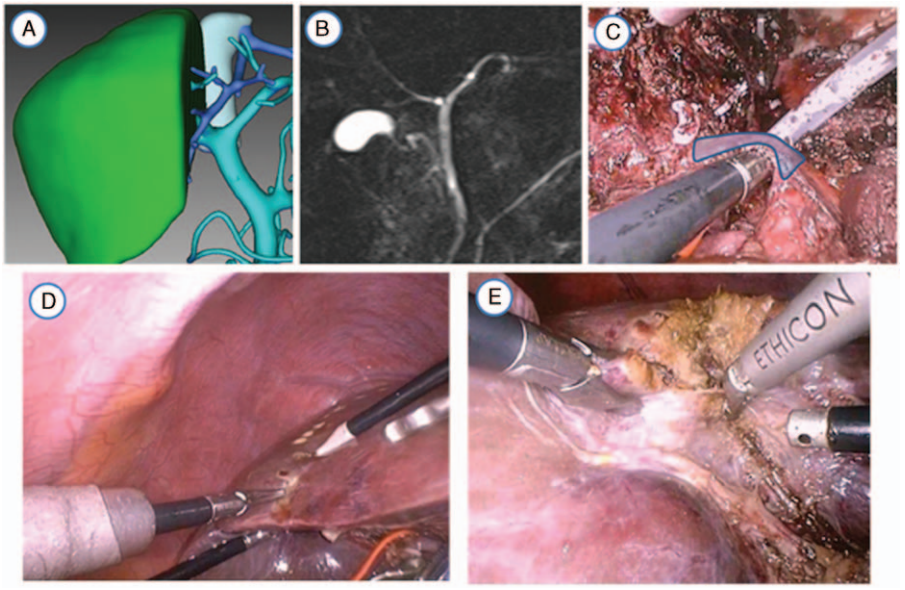

Figure 2. (A) Computer-assisted calculation of total liver volume is 1022 mL, and right liver graft is 615 mL; (B) MRCP showing the biliary tract of donor; (C) dissecting right hepatic duct (gray area demonstrating right hepatic duct); (D) transient clamp the right portal vein, the transection line was marked by electric cautery; (E) parenchyma was transected by harmonic scalpel. MRCP = magnetic resonance cholangiopancreatography.

et al[5]'s report and 1 case with subcutaneous hematoma in the Pfannenstiel incision in Chen et al[6]'s report. The operative time ranged from 406 to 540 minutes (mean 480 min), intraoperative blood loss ranged from 69 to 350mL (mean 129 mL), and the length of hospital stay was 4 to 12 days (mean 7.6 days).

This technique should be obtained in a stepwise manner going from open living donor hemihepatectomy to laparoscopy assisted, and to total LLDRH. The learning curve was essential for performing laparoscopic living donor hepatectomy safely and efficiently.

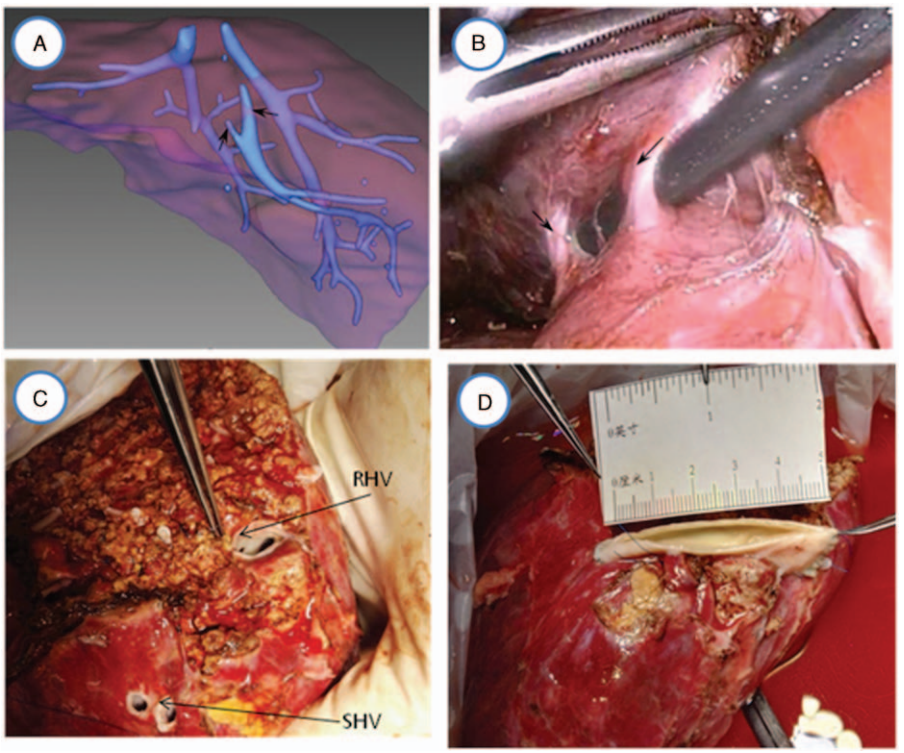

Figure 3. (A) 3D reconstruction demonstrating short hepatic veins (black arrow); (B) short hepatic veins under laparoscope; (C) cutting surface of graft with opening of short hepatic veins (SHV) and right hepatic vein (RHV); (D) longitudinal opening of bridging graft. RHV = right hepatic vein, SHV = short hepatic veins.

Table 1

Summary of previous reports about laparoscopic living donor right hemihepatectomy.

	Graft type	Case no.	OT (min)	WIT (min)	Blood loss (mL)	Transfusion (mL)	LOS (day)	Postoperative complications
Soubrane et al	RL	1	480	7	100	No	7	No
Rotellar et al	RL	1	480	3	<100	No	4	No
Takahara et al	RL,LL	3,3	482 (406–605)	N/A	69.5 (30–184)	0	8.5 (8–12)	Biliary fistulae in 2 cases
Han et al	RL	2	N/A	N/A	N/A	N/A	9 (8–10)	No
Chen et al	RL	1	415	6	150	No	6	Subcutaneous hematoma in the Pfannenstielincision
Li et al[17]	RL	1	540	4	350	200	8	No

LL = left liver, LOS = length of stay, N/A = not applicable, OT = operation time, RL = right liver, WIT = warm ischemia time.

The limitations of the study about LLDRH were that the number of donor was very small and those studies were not randomized. Thus, the randomized controlled trial including a large number of donor cases of LLDRH are needed to be done in the future.

4. Discussion

Since the first successful LDLT was performed in 1989, this life-saving procedure has been applied to many patients. [7] Right liver graft in adult-to-adult LDLT has become a feasible option for patients with liver cancer or end-stage liver failure. LDLT reduces the waiting list mortality and provides better graft survival in comparison to cadaveric liver transplantation.[8,9]

Donor safety is always the first concern in LDLT procurement surgery, and donor death is rarely happened in experienced liver transplant centers. However, wound complications and abdominal incision scar may make some living donors hesitate to undergo donor hepatectomy. Although minimally invasive liver surgery like laparoscopic living donor hepatectomy has obvious advantages such as smaller wound and faster recovery than conventional open surgery, we believe that those benefits will increase the willingness of being potential donors in LDLT.[10,11]

Conversion from laparoscopic to open is basically dependent on intraoperative situations, blood loss greater than 800 mL, intraoperative transfusion and the need for biliary reconstruction were associated with a significantly higher risk of conversion from laparoscopic to open, conversion represents a prudent surgical practice rather than failure, and laparoscopic practice and learning curve improvement may help prevent this unnecessary and avoidable situation.

Biliary transection is the most important step in LDLT, and it may bring serious complications such as biliary stricture to the donor or recipient if not handled well[12,13]; therefore, intraoperative cholangiography is usually needed before biliary transection for making decision of the cutting line, especially for cases with bile duct variation. However, we did not perform cholangiography during surgery, because the preoperative MRCP examination for donor found no variation of hepatic duct bifurcation and long right hepatic duct more than 1 cm, intraoperative meticulous dissection of common hepatic duct, right and left hepatic duct were performed, Hem-O-Lock was used to clamp right hepatic duct followed by transection, and there were no bile leakage, bile duct stricture, and other biliary complications both for donor and recipient postoperatively. We believed that the intraoperative cholangiography step was not necessary if the preoperative evaluation of biliary tract without variation combined with clear anatomical relationship of common, left and right hepatic duct; on the contrary, intraoperative cholangiography was needed when there was variation in the bile duct or hepatic duct without clear anatomical relationships.

Laparoscopic left lateral hepatectomy is considered to be standard operation for mass located at the left lateral hepatic lobe; however, there was only a few reports of laparoscopic donor liver procurement in LDLT surgery, because it is high technique demanding of both skilled laparoscopic technique and LDLT experience.[14] More than 100 cases of LDLT were carried out in our center since 2002, and 13 cases of laparoscopy assisted adult LDLT were performed from 2011 to 2013. Currently, we were able to complete laparoscopic right hepatectomy, left hepatectomy, caudatectomy, and any other complicated surgeries; thus, we have rich experience in LDLT and laparoscopic technique for the total LLDRH surgery.

The most controversial issue in LDLT is whether to keep the middle hepatic vein.[15] Graft with middle hepatic vein means to retain drainage from segment V and VIII segments and has a better postoperative graft function. However, venous outflow reconstruction is needed if the graft is lack of middle hepatic vein in order to prevent congestion of liver segments of V and VIII. The commonly used graft materials for venous outflow tract reconstruction include frozen iliac artery, iliac vein, and polytetrafluoroethylene (PTFE) artificial vessel.[16] Laparoscopic linear cutting stapler was used to cut and close right hepatic vein, resulting in a loss of about 3 to 4 mm length close to graft right hepatic vein stump, increasing the difficulty of anastomosis with inferior vena cava. Therefore, we utilized cryopreserved cadaveric common iliac artery as a bypass to reconstruct venous outflow tract and achieved good results.

5. Conclusions

Overall, our center accumulated some experience through carrying out total laparoscopic LDLT surgery as follows:

1. To carry out a total laparoscopic LDLT requires extensive open LDLT experience and skilled laparoscopic techniques, gradual learning process from open surgery to laparoscopy assisted surgery, and finally to total laparoscopic surgery are absolutely necessary.
2. Intraoperative cholangiography is not a necessary step in some conditions including no variation in preoperative evaluation of the biliary tract, intraoperative meticulous dissection with clear anatomical relationship of common hepatic duct, right and left hepatic duct, right hepatic duct length greater than 1 cm; if the above conditions can't be met, cholangiography is a required procedure.
3. If there are short hepatic veins with orifice diameter greater than 0.5 cm on the graft cutting surface, venous outflow tract reconstruction is necessary, reconstruction materials including iliac vein, artery and PTFE artificial vessel.

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