



Postoperative Doppler Ultrasonography in Liver Transplantation

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ABSTRACT

Background. Doppler ultrasonography plays an important role in the postoperative management of liver transplantation. We present our initial experiences evaluating liver transplants with the use of postoperative Doppler sonography.

Methods. In our hospital, we performed 20 liver transplantations from July 2014 to October 2016. Among 20 patients, we performed 15 deceased-donor liver transplantations (DDLTs) and 5 living-donor liver transplantations (LDLTs). For deceased donors, inferior vena cava anastomoses were performed with the use of the piggyback technique, and for living donors, modified right grafts were used with middle hepatic vein reconstruction by Dacron graft. In the intensive care unit, we performed Doppler ultrasound at least once a day and at every clinical need. We checked hepatic blood flow by means of Doppler ultrasound.

Results. Eighteen patients underwent Doppler ultrasonography once a day up to postoperative day 6. Of the patients who received LDLT, 2 patients underwent Doppler ultrasonography twice a day because the operator was concerned about the hepatic artery anastomosis. Findings on Doppler ultrasound showed no abnormal wave form in hepatic artery, portal vein and hepatic veins. No patient had abnormal findings on angiographic computerized tomography. There was 1 graft failure in 20 recipients. The graft failure was primary nonfunction, and retransplantation was done. During the hospitalizations, there were no vascular complications.

Conclusions. Doppler ultrasonography can be used to evaluate postoperative vascular complications in liver transplant patients. When the operator checks postoperative Doppler ultrasonography, it is possible to differentiate between patients, and it may help to detect the vascular complications earlier.

IN THE PAST decade, liver transplantation (LT) has gained acceptance as a definitive treatment for end-stage liver disease (ESLD) [1]. Vascular complications (VCs) remain the most serious complications and a common cause for graft failure after LT [2]. The reported incidence of VCs after LT in adults varies widely among transplantation centers, ranging from 8% to 15%. However, this rate can be higher, especially in cases such as split LT or living-donor liver transplantation (LDLT) [3–6].

Doppler ultrasonography (DU) plays an important role in the postoperative recipient surveillance of LT. DU is the initial post-transplantation imaging modality for detection and follow-up of early and delayed graft complications. It is widely accessible, cost-effective, and radiation free and can be performed at the bedside. Knowledge of the immediate

and early physiologic graft hemodynamics after graft perfusion and early identification of VCs are essential for improving graft and patient survival [7]. Therefore, we had DU performed after LT by a radiologist at our center.

Generally, operators are well informed about anatomic knowledge and have a clear understanding of the surgical findings. Therefore, if the operator is proficient in ultrasound

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Table 1. Demographic Data and Surgical Data of 20 Patients

Age, y	50 ± 9.7
Male	14 (70%)
MELD score	22.8 ± 12.9
Etiology of end-stage liver disease	
Hepatitis B	12 (60%)
Alcoholic liver disease	6 (30%)
Primary biliary cirrhosis	1 (5%)
Autoimmune hepatitis	1 (5%)
Donor age, y	39.8 ± 12.5
Graft volume/recipient weight ratio in LDLT, %	1.6 ± 0.7
Operation time, min	514.4 ± 84.5
Cold ischemia time, min	221.1 ± 122.9
Blood loss, mL	2260 ± 1320

Abbreviations: LDLT, living-donor liver transplantation; MELD, Model for End-Stage Liver Disease.

examination, it may be beneficial to follow-up DU after LT. Here, we present our initial experiences evaluating liver transplants with the use of postoperative Doppler sonography.

METHODS

Patients and Surgical Techniques

In our hospital, we performed 20 LTs from July 2014 to October 2016. Among 20 patients, we performed 15 deceased-donor liver transplantations (DDLTs) and 5 LDLTs. All of the 20 patients underwent post-transplantation DU. We reviewed their post-operative DU results and liver transplant outcomes. The Institutional Review Board of our center approved the study design.

LDLT was performed with the use of a standard technique; we used modified right lobe with middle hepatic vein reconstruction. In hepatic artery (HA) reconstruction, the graft right hepatic artery (RHA) was connected to the recipient's RHA, left hepatic artery (LHA), or proper HA according to the diameter, length, and status of the intima. End-to-end anastomosis was performed with interrupted sutures with the use of nylon #9-0 under a microscope ($\times 10$). For deceased donors, inferior vena cava anastomosis was performed by means of piggyback technique.

Postoperative Care and Follow-up

Liver transplant patients were observed in the intensive care unit (ICU) through postoperative day (POD) 6. DU was routinely performed once a day until POD 6. Abdominal computerized tomographic (CT) scans were performed on the 7th and 20th days after operation. The immunosuppressive regimen consisted of conventional triple regimen (tacrolimus, mycophenolate mofetil [MMF], and steroid). The serum level of tacrolimus was kept at 6-10 ng/mL for the 1st month after operation and 4-6 ng/mL thereafter. The steroid was tapered generally at the 1st month after operation, and MMF was withdrawn by 6 months after operation. An interleukin-2 receptor blocker was used on the day before the surgery and on the 4th day after surgery. The principle of using immunosuppressants between LDLT and DDLT was the same.

RESULTS

During the 3-year period, 20 patients underwent LT, age range 27-65 years, mean age 50 years. Indications for LT were primarily hepatitis B ($n = 12$), alcoholic liver disease ($n = 6$), primary biliary cirrhosis ($n = 1$), and autoimmune hepatitis

($n = 1$). At the time of transplantation, mean Model of End-Stage Liver Disease score of the 20 patients was 22.8 ± 1.29 . The mean follow-up time was 16.8 ± 9.0 months. The mean age of donors was 39.8 ± 12.5 years. Mean graft volume/recipient weight ratio (GRWR) in LDLT was $1.6 \pm 0.7\%$. The mean operation time was 514.4 ± 84.5 min. The mean cold ischemia time was 221.1 ± 122.9 min. The mean intra-operative blood loss was $2,260 \pm 1,320$ mL (Table 1).

Eighteen patients underwent Doppler ultrasound once a day up to POD 6. Two patients who received LDLT underwent DU twice a day because we were worried about the hepatic artery anastomosis. We first checked for liver parenchymal echogenicity and abnormal fluid collection by means of grayscale ultrasonography. Then hepatic vein, portal vein, and HA flow were confirmed with the use of color DU. Findings on DU showed no abnormal wave-form in the HA, portal vein, and hepatic veins (Fig 1). All patients were translated to a general ward on POD 7, and we checked angiographic CT on postoperative day 7. Normal vasculature of the graft was identified on angiographic CT in all 20 patients without abnormal findings on DU.

In this series, the 90-day mortality (operative mortality) was 0%. There was 1 graft failure in 20 recipients. Because graft vasculature was normal in angiographic CT as well as in DU, the cause of graft failure was diagnosed as primary nonfunction. She underwent retransplantation and was then discharged without any problems. There were 3 mortality cases in the follow-up period. The causes of mortality were cardiac arrest, hepatocellular carcinoma recurrence, and cholangiocarcinoma recurrence 4, 14, and 7 months after operation, respectively. There was no vascular complication during the postoperative period. Acute cellular rejection (ACR) occurred in 2 patients, and they all recovered from ACR with the use of steroid pulse therapy (Table 2).

DISCUSSION

The blood flow of the grafted liver plays a vital role after LT. DU is the primary imaging modality and the most important diagnostic tool for the evaluation of the graft vascular perfusion in LT after surgery [8]. DU can evaluate postoperative vascular complications in liver transplant patients. Generally, ultrasonography is a highly operator- and patient-dependent procedure. Therefore, DU was performed by a radiologist after LT in our center. However, after getting used to abdominal ultrasound, there was no difficulty in checking DU after LT.

In our protocol, we routinely performed DU once a day until POD 6. Previous studies regarding the frequency and duration of DU screening after LT have suggested that routine DU should be performed daily in the 1st 2 weeks [9,10]. Other suggested DU screening protocols include screening on the 1st day and every 3 days in the early postoperative phase [11]. However, there has been no study or guidelines suggesting a DU screening protocol after adult LT that accounts for recent technical advances and improved postoperative care.

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