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Original Article

Change of hepatic arterial systolic/diastolic ratio predicts ischemic type biliary lesion after orthotropic liver transplantation

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ABSTRACT

Background: We conducted this prospective nested case–control study for the hepatic artery and portal vein hemodynamic changes after orthotopic liver transplantation.
Methods: A total 128 cases of orthotropic liver transplantation were analyzed, including 25 cases of ischemic type biliary lesions (ITBL). The portal vein and hepatic artery flow velocities were detected by ultrasound on days 28, 42, and 84 after liver transplantation. In the GLM analysis of Lg(S/D), the *P* values of Group Effect, Time Effect, and Time × Group were 0.014, 0.376, and 0.008, respectively.
Conclusion: Our results show a relatively reduced hepatic artery S/D in ITBL, especially in extrahepatic ITBL.

Liver transplantation has been widely accepted as the treatment of choice for end-stage liver disease in China. Transplantation in China is characterized by high speed growth, with a peak of almost 4000 liver transplantations performed in 2005. Biliary complications after liver transplantations, especially ischemic type biliary lesions (ITBL), have greatly affected the long-term survival of recipients. ITBL is the main cause of late graft loss. Except for retransplantation, currently, the present treatments of ITBL are mainly interventional therapies for biliary strictures. Although interventional therapies usually have limited efficacy, early treatment is still helpful in preventing bile duct obstruction. Thus, the early diagnosis of ITBL is essential for treatment. Postoperative T-tube cholangiography is a diagnostic method for ITBL. Its complications include peritonitis, chills and fever, abdominal pain, abdominal tenderness and distention, and infection of the abdominal cavity. This examination cannot be performed many times, but high-frequency examination is necessary for early and fast detection of ITBL. Therefore, other noninvasive tests or examinations are also required for diagnosis.

A wide range of risk factors have been reported, involving organ procurement, organ storage, transplantation procedures, cytomegalovirus infection, hepatic artery (HA) and portal vein (PV) complications [1], autoimmune diseases [2], and genetic susceptibility [2,3]. However, they contribute little to revealing the ITBL pathogenesis. High incidence of ITBL was reported after liver transplantation using donation after cardiac death (DCD) donors. The microcirculatory disturbance by ischemia was the most likely reason to explain it.

The blood supply of the liver graft was monitored after operation by ultrasound, which was a routine examination in our center. Whether the hemodynamic change of hepatic vasculature in ITBL patient can be found by ultrasound is not clear. We conducted this prospective nested case–control study for the characteristics of HA and PV hemodynamic changes detected by ultrasound in ITBL and non-ITBL patients. It will be helpful in depicting the hemodynamic changes in ITBL patients. The characteristic detected by ultrasound can also be used in predicting ITBL.

1. Patients and methods

1.1. Patients

We made a prospective nested case–control study of all the consecutive patients who underwent orthotropic liver transplantation (OLT) between September 3, 2013, and August 2, 2014. The following are the

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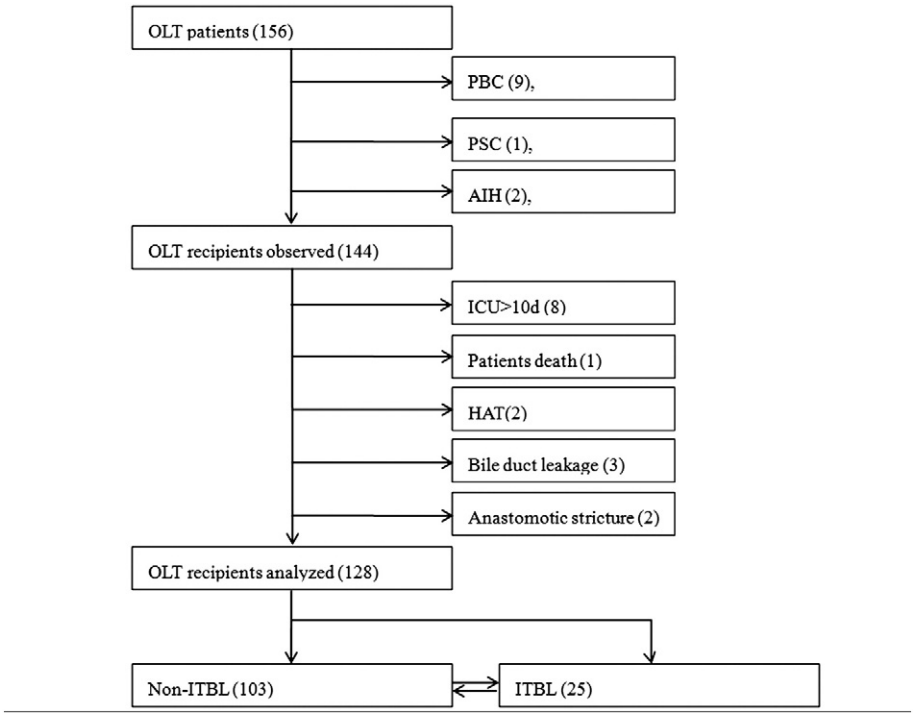

Fig. 1. Process of patients' selection.

inclusion criteria: (a) patients had to be more than 18 years old and (b) they were required to have received full liver grafts. The exclusion criteria are the following: (a) cases of retransplantation and (b) patients with diagnosis of primary biliary cirrhosis (PBC), primary sclerosing cholangitis (PSC), autoimmune hepatitis (AIH), or other autoimmune liver diseases (Fig. 1). The withdrawal criteria are as follows: (a) any reason that led to a prolonged intensive care unit (ICU) stay (>10 days); (b) recipients that died within 3 months after operation; (c) HA or PV complications, such as thrombosis or stricture, were diagnosed; (d) bile duct leakage or anastomotic stricture was found; and (e) acute cellular rejection was diagnosed.

1.2. Managements

All the liver grafts were procured after the donor's heart beat had stopped. They were preserved in 4°C UW solution following a static cold storage procedure. End-to-end anastomosis with T-tube drainage was conducted for biliary reconstruction. The immunosuppressive regimen consisted of tacrolimus, mycophenolate mofetil, steroid, and basiliximab. The recipient age, donor age, MELD score, and AST level were obtained from the medical records. The time interval of PV and HA reperfusion (arterialization time), warm ischemia time (WIT), and cold ischemia time (CIT) were monitored by an independent observer. These data were used for baseline comparison.

An enhanced computed tomography scan was performed in the second week after OLT. PV and HA patency were confirmed in this way. Routine T-tube retrograde cholangiographies were performed on days 14 and 90 after liver transplantation. Every result was assessed by a senior surgeon and an experienced radiologist.

All patients underwent routine color Doppler flow imaging (CDFI) by a Siemens Acuson Sequoia 512 Ultrasound System (Fig. 2). All the CDFI were performed between 8 and 10 am, after patients fasted for 8–10 h. The reports of CDFI, including PV and HA velocities, were given by two experienced sonographers. PV and HA velocities on day 28 (4 w), day 42 (6 w), and day 84 (12 w) were involved in statistical analysis. These time points were selected according to the time of discharge and follow-up. Patients were usually discharged on day 28, and they came back for follow-up 2 weeks later. On day 84, patients underwent the last CDFI before the second cholangiography. The reason for choosing these time points is explained in the forthcoming discussion section of this paper.

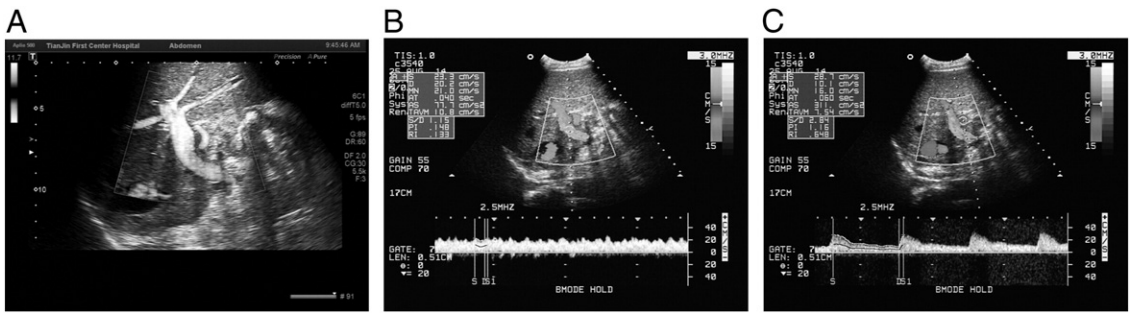

Fig. 2. Doppler imaging of HA and PV. (A) HA (right) and PV (left) showed in Doppler imaging; (B) PV velocity detected by Doppler imaging; (C) HA peak systolic velocity and end diastolic velocity detected by Doppler imaging.