Technical Feasibility and Clinical Outcomes of Interventional Endovascular Treatment for Hepatic Artery Thrombosis After Living-donor Liver Transplantation

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ABSTRACT

Objectives. Hepatic artery thrombosis (HAT) is a serious complication after living-donor liver transplantation (LDLT) leading to patient death in the absence of revascularization. With the recent advances in interventional radiology, interventional endovascular techniques have been used as alternative therapeutic options for HAT. This study evaluates the feasibility and clinical outcomes of endovascular treatment for HAT after LDLT.

Methods. The medical records of 120 patients who underwent adult-to-adult LDLT between February 2002 and February 2015 in our hospital were retrospectively reviewed to evaluate the frequency of HAT and outcomes of endovascular treatment.

Results. A total of nine patients (7.5%) developed HAT after LDLT, and the all patients underwent endovascular treatment. Overall technical success with endovascular treatment was achieved in 77.8% (7 of 9) of the patients. Intra-arterial thrombolysis was successful in one patient. Further intervention after intra-arterial thrombolysis was performed in the form of percutaneous transluminal angioplasty in six patients, and percutaneous transluminal angioplasty with stenting in two patients. Two patients with failure of revascularization by endovascular treatment were treated conservatively and developed hepatic arterial collaterals, and the both patients could avoid the graft failure. The overall survival rates did not differ significantly between the patients without HAT (n = 111) and those with HAT (n = 9) (1-, 3-, and 5-year overall survival rates of the patients without HAT vs. with HAT: 78.1%, 67.8%, and 65.3% vs. 66.7%, 66.7%, and 66.7%, respectively; $P = .77$).

Conclusion. Interventional endovascular treatment of HAT in LDLT is a feasible and reliable procedure in avoiding early graft failure with acceptable long-term patient outcome.

HEPATIC ARTERY THROMBOSIS (HAT) is a serious complication that reportedly complicates 1.7% to 6.7% after living-donor transplantation (LDLT) [1–5], and remains one cause of early graft failure and patient death in the absence of early diagnosis and treatment.

The most effective treatment strategy for HAT remains controversial. Traditionally, arterial complications after liver transplantation have been treated by surgical re-anastomosis, retransplantation, or conservative therapy [6]. Surgical re-anastomosis is an effective treatment for graft salvage and patient rescue, but it is a technically complicated and potentially invasive procedure, especially for

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patients who are not in stable condition in the early postoperative period after LDLT. With the recent advances in interventional radiology, the interventional endovascular techniques have been used as less invasive therapeutic options for HAT. Many cases of successful endovascular treatment have been reported [3,4,7–10] and support this procedure as an effective modality for the treatment of HAT. However, the efficacy of endovascular treatment for HAT remains controversial, and long-term outcome after endovascular treatment for HAT has not been fully elucidated.

The purpose of this study was to evaluate feasibility and long-term outcome of endovascular treatment for HAT after LDLT.

MATERIAL AND METHODS

Written informed consent was obtained from each patient for every diagnostic and interventional radiology procedure performed after a full explanation of the purpose and risks of the procedures was provided. The internal Institutional Research Review Board and Ethical Committee reviewed and approved this retrospective study.

Medical records of 120 consecutive patients who underwent adult-to-adult LDLT at Mie University Hospital from February 2005 to February 2015 were retrospectively reviewed. The median age of recipients was 55 years (range: 20 to 70 years). The patients consisted of 67 men and 53 women. The underlying liver diseases for recipients were hepatocellular carcinoma in 51, hepatitis C virus– or hepatitis B virus–associated liver cirrhosis or alcoholic liver cirrhosis in 27, primary biliary cirrhosis or primary sclerosing cholangitis in 20, fulminant hepatic failure in 12, cryptogenic liver cirrhosis in 7, and other liver diseases in 3 cases. The median Model for End-stage Liver Disease scores and Child-Pugh classification scores were 15 (range: 6–45) and 10 (range: 5–15), respectively. Graft types were comprised of 53 right lobes without the middle hepatic vein, 18 right lobes with the middle hepatic vein, 46 left lobes, and 3 posterior segments. The median follow-up period was 38.4 months (range: 1 month to 121 months).

Technique of Hepatic Artery Anastomosis and Postoperative Management

Our technique of hepatic artery reconstruction involves performing an end-to-end anastomosis between the graft right or left hepatic artery and the recipient right or left hepatic artery, common hepatic artery, and other available arteries. We choose the recipient artery nearest in size to the graft artery to minimize the size mismatch. The length must be adequate to allow a tension-free anastomosis, but if it is too long, it must be trimmed to avoid kinks and rotations.

Anastomosis of hepatic artery was microscopically performed with interrupted stitches with Seidenberg or Back wall method using the monofilament nonabsorbable nylon 8–0. A double clamp was used. After anastomosis, flow of hepatic artery was confirmed intraoperatively by using Doppler ultrasonography (DUS) or indocyanine fluorescence angiography. Serial DUS scans were performed for all recipients twice a day during 2 weeks after LDLT and once daily until hospital discharge. The immunosuppression protocol consisted of tacrolimus and low-dose steroid.

Diagnosis and Treatment Strategy of HAT

We suspected HAT in the presence of weakness or loss of hepatic arterial signal by DUS and an increase of serum liver enzymes. When DUS showed low pulsatility index (PI) (PI = [Vmax − Vmin]/Vmean < 0.6) of hepatic artery and prolonged systolic acceleration time [5,11], multidetector contrast-enhanced computed tomography (MDCT) was always performed to confirm the diagnosis of HAT. If occlusion of hepatic artery was confirmed on MDCT, hepatic arterial angiography was immediately performed. HAT was defined as thrombotic complete occlusion of the hepatic artery on hepatic arterial angiography.

Interventional endovascular treatment is our first-choice treatment strategy for HAT. The patients who were diagnosed with HAT by hepatic arterial angiography were subsequently treated with interventional endovascular treatment.

Technique of Interventional Endovascular Treatment

Diagnostic arteriography was performed with standard catheter techniques using the right femoral artery access with selective catheterization of the celiac trunk. If HAT was confirmed, a microcatheter was manipulated into the thrombus, and intra-arterial thrombolysis (IAT) was performed [4]. Briefly, after heparin (Mochida, Tokyo, Japan) at a dose of 5000 IU was injected in a 1-shot manner, and urokinase (Mochida, Tokyo, Japan) at a dose of 60,000 to 240,000 IU was injected into the thrombosed hepatic artery through a 3-Fr catheter.

If the angiogram after recanalization revealed an underlying anastomotic stenosis, percutaneous transluminal angioplasty (PTA) or stent-graft placement was performed [4]. Briefly, a 0.014-inch microguidewire was passed through the stenosis, and transluminal angioplasty was performed using a balloon with a diameter of from 2 mm to 5 mm and a length of 20 mm. As for stent-graft placement, a polytetrafluoroethylene-coated stent-graft with a diameter of 3 mm to 4 mm and a length of 19 mm to 23 mm was placed at the anastomotic site through a 6-Fr guiding catheter. After endovascular treatment, anticoagulant therapy was instituted using heparin at a dosage of 10,000 IU/d to maintain the target level of activated partial thromboplastin time ranged from 45 seconds to 60 seconds for approximately 3 days to 5 days, followed by aspirin at a dosage of 100 mg/d in case of graft-stent placement.

Successful IAT was defined as complete or partial resolution of the thrombus with delineation of the intrahepatic branches. Definite treatment was defined as complete resolution of the thrombus without underlying anastomotic stenosis by endovascular recanalization. After recanalization, intensive follow-up included daily DUS and laboratory examinations every day for 1 week after endovascular treatment, and then every 2 days to 3 days during the hospital stay.

Outcomes and Statistical Analysis

Overall incidence of HAT after adult-to-adult LDLT was analyzed. Characteristics of patients complicated with HAT were examined. The outcomes of interventional endovascular treatment for HAT were evaluated for initial success rate and complications during the procedure. The technical success of interventional endovascular treatment was defined as recanalization of the thrombosed hepatic artery. Because HAT causes ischemic bile duct injury leading to biliary complications such as cholangitis, bile leak, and biliary strictures [12], overall incidence of delayed biliary complications were also analyzed. Overall survival (OS) rates after LDLT were determined using the Kaplan-Meier method and compared using the log-rank test. All statistical analyses were performed with JMP Pro 9.0.2 (SAS Institute Inc., Cary, North Carolina, United States). *P* values less than .05 were considered statistically significant.