CLINICAL STUDY

Interventional Treatment for Hepatic Artery Thrombosis after Liver Transplantation

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ABSTRACT

Purpose: To evaluate short-term and long-term effectiveness of interventional treatment for hepatic artery thrombosis (HAT).

Materials and Methods: From March 2003 to October 2015, 34 patients (32 male and 2 female; mean age, 45 y; range 7–64 y) with HAT were identified 0–21d (mean 6.5 d ± 6.0) after liver transplantation and underwent interventional treatments. Technical success, clinical success, complications, hepatic artery patency, and survival time were assessed.

Results: All 34 patients underwent urokinase thrombolytic treatment. The mean dosage of urokinase was 1,250,000 U ± 1,000,000 (range, 350,000–9,000,000 U). Thrombolysis treatment required 5–120 h (mean 50 h ± 31) for completion. In 21 patients, stents were also implanted during thrombolytic treatment. In 3 patients with splenic artery steal syndrome, proximal splenic artery embolization was performed during thrombolytic treatment. The technical and clinical success rate was 91% (31/34), with treatment failure in 3 children. Hemorrhage was observed in 11 cases. Local necrotic foci in the transplanted liver were found on CT in 5 patients. Complications associated with the interventional procedures occurred in 2 patients. Patency rates of the hepatic artery at 1 y, 2 y, 3 y, and 5 y were 96%, 93%, 83%, and 83%. Overall survival rate at 1 y, 2 y, 3 y, and 5 y were 82%, 73%, 57%, and 57%.

Conclusions: Interventional treatment can achieve satisfactory short-term and long-term effectiveness for adult HAT.

ABBREVIATIONS

HAT = hepatic artery thrombosis, LT = liver transplantation, PT = prothrombin time

Hepatic artery thrombosis (HAT) is the most common and severe vascular complication and accounts for > 50% of all arterial complications after orthotopic liver transplantation (LT) (1,2). The incidence of HAT as a complication of LT in adults was reported to be 4%–15% (3–6), and HAT was generally more frequent after pediatric LT (3%–9% in adults vs 11%–26% in children) (7–9). Mortality related to HAT has been reported to reach 54.5% (10,11). Early diagnosis and effective treatment for HAT are crucial to organ salvage and patient survival. Generally there are 3 different treatment modalities for HAT: retransplantation, surgical revascularization, and interventional treatment. The most effective treatment approach remains controversial. Interventional treatments for HAT, such as intraarterial thrombolysis, percutaneous transluminal angioplasty (PTA), and stent placement, have been emerged as a less invasive alternative to surgical intervention (12–16). However, interventional treatment for HAT remains controversial because of potential risk of fatal intraperitoneal hemorrhage (17,18) and uncertain long-term efficacy. In the present study, the short-term and long-term effectiveness of interventional treatment of HAT were evaluated retrospectively.

MATERIALS AND METHODS

Patient Information

Between March 2003 and October 2015, 1,385 LTs (male-to-female ratio 1,162:223; mean patient age, 49.6 y ± 11.7; range, 0–81 y) were performed. Types of transplantation included orthotopic LT (n = 1,325), living donor LT (n = 48), split LT (n = 8), and reduced LT (n = 4). At 0–21 days (mean 6.5 d ± 6.0) after LT, HAT was identified in 34 patients (32 male and 2 female; mean age, 45 y; range, 7–64 y). Underlying diseases included primary hepatic carcinoma (n = 21), end-stage hepatitis B virus–related liver cirrhosis (n = 6), Wilson disease (n = 4), congenital biliary

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atresia (n = 2), and Budd-Chiari syndrome (n = 1), and LT procedures included orthotopic LT (n = 28; 2.1% of 1,325 orthotopic LTs), living donor LT (n = 5; 10.4% of 48 living donor LTs), and split LT (n = 1; 12.5% of 8 split LTs). End-to-end hepatic artery anastomosis was performed without intraoperative complications; types of arterial anastomoses between donors and recipients are listed in the Table. Blood types (ABO) between donors and recipients was identified in all 34 patients. Mean hot, cold, and warm ischemia times were 4.5 minutes (range, 0–5 min), 65 minutes (range, 43–100 min), and 6.5 hours (range, 4–12 h).

Diagnosis of HAT

Hepatic artery blood flow was monitored daily by color Doppler ultrasound during the first postoperative week and then every 2 days until patients were discharged. Liver function, kidney functions, and routine blood and coagulation function tests were measured daily. On the basis of color Doppler ultrasound and/or clinical and laboratory findings, 38 patients were suspected to have HAT. Clinical and laboratory findings included fever and hepatalgia (n = 4), and elevated serum alanine transferase and bilirubin (n = 34); 2 patients were asymptomatic. Angiography immediately identified HAT in 34 patients. Among these 34 patients, mean alanine aminotransferase, aspartate aminotransferase, total bilirubin, and conjugated bilirubin levels were 428.5 U/L ± 385.0, 294.4 U/L ± 257.0, 50.9 U/L ± 35.0, and 30.1 U/L ± 22.9. Mean prothrombin time, activated partial thromboplastin time, international normalized ratio, and fibrinogen concentration were 20.5 seconds ± 11.9, 48.49 seconds ± 12.1, 1.4 ± 0.2, and 216.8 mg/dL ± 117.9. Patients with defective coagulation function and the following conditions were excluded from interventional treatment: activated partial thromboplastin time > 3 times the control value, PT > 2.5 times the control value, international normalized ratio > 3, fibrinogen concentration < 100 mg/dL, and platelet concentration < 30×10^9/L.

Table. Types of Arterial Anastomoses (N = 34)

LT Procedures	Type of Arterial Anastomoses		Number of Cases
	Donor	Recipient	
OLT	CHA	CHA	22
	CHA	PHA	1
	CTA	CHA	4
	CTA	PHA	1
LDLT	RHA	CHA	1
	RHA	RHA	1
	RHA	LHA	1
	RHA	PHA	1
	LHA	CHA	1
SLT	LHA	CHA	1

CHA = common hepatic artery; CTA = celiac trunk artery; LDLT = living donor liver transplantation; LHA = left hepatic artery; OLT = orthotopic liver transplantation; PHA = proper hepatic artery; RHA = right hepatic artery; SLT = split liver transplantation.

Methods

A 5-F RH catheter (Cook, Inc, Bloomington, Indiana) was used for selective catheterization of the hepatic artery via a right femoral artery approach. Heparinization was performed with a weight-adjusted dosage regimen of 60 U/kg followed by 10 U/kg per hour via intravenous injection. A coaxial microcatheter (Progreat; Terumo, Tokyo, Japan) and micro–guide wire were passed to the thrombus. The coaxial microcatheter was advanced to the inside of the thrombus, and 100,000–250,000 U of urokinase (Lizhu Pharmaceutical Co. Ltd, Shanghai, China) was dissolved into 50 mL of normal saline and injected into the coaxial microcatheter during the first 15 minutes (this procedure was performed in all 34 patients with HAT). Another 250,000–750,000 U of urokinase was injected into the coaxial microcatheter during the next 30 minutes in the same way if the thrombolysis was not satisfactory (this procedure was performed in 32 patients with HAT). An additional 50,000–100,000 U was injected in the same way if the thrombolysis was still not satisfactory (this procedure was performed in 2 patients with HAT).

After most of the large thrombus was dissolved, the coaxial microcatheter was newly advanced to inside of the residual thrombus, and 250,000 U of urokinase was dissolved into 50 mL of normal saline and perfused continuously by infusion pump at a rate of 6–10 mL/h during the following 12–24 hours in the intensive care unit. Liver function and routine blood and coagulation function tests were done every 5 hours. Arteriography was performed every 8 hours during thrombolytic treatment. The coaxial microcatheter was withdrawn from the RH catheter. Arteriography of the celiac trunk and common hepatic artery was performed through the RH catheter. When the thrombus was dissolved and branches of the hepatic artery were shown clearly, thrombolysis was stopped.

The catheter sheath was retained for 2–3 days. Hepatic artery angiography was performed daily. Stents (XIENCE PRIME; Abbott, Abbott Park, Illinois) were implanted if the following conditions occurred during thrombolytic treatment: (*a*) HAT was accompanied by stenosis or kinking, (*b*) the residual thrombi were > 70% of cross section inside the hepatic artery 24 hours after thrombolysis (n = 5) or the residual thrombi were > 50% of cross section inside the hepatic artery 48 hours after thrombolysis (n = 6). If splenic artery steal syndrome was observed during the thrombolysis treatment, proximal embolization of the splenic artery with coils (Gianturco coils; Cook, Inc) was performed (Fig 1a–f). Low-molecular-weight heparin, 4,100 U in adults and 1,000 U in children (Fraxiparine; GlaxoSmithKline, Middlesex, UK), was administered for anticoagulation every 12 hours by subcutaneous injection and lasted for 1 week after recanalization of the thrombosed hepatic artery. PT was limited to approximately 25 seconds (normal range, 10–13 s).