Case Report

Arterial grafts as a conduit in inflow reconstruction in postoperative hepatic artery thrombosis after orthotopic liver transplantation: a case report

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Received July 20, 2017; Accepted May 4, 2018; Epub August 15, 2018; Published August 30, 2018

Abstract: Hepatic artery thrombosis (HAT) and hepatic artery stenosis (HAS) are common complications of orthotopic liver transplantation (OLT) and can lead to hypopexia or dysfunction of the transplanted liver or death. In these 2 cases, we attempted to achieve hepatic artery patency through the use of interventional thrombolysis and anticoagulation, but the thrombosis was repeated. After several attempts, transplanted liver function continued to deteriorate, which led us to perform emergency hepatic artery reconstruction. We report 2 cases of patients with HAT and HAS after OLT treated surgically by connecting the transplanted liver with the recipient’s abdominal aorta by the donor’s iliac or splenic artery. The results suggest that this approach could be used to treat emergency cases of HAT and HAS.

Keywords: Orthotopic liver transplantation, thrombosis, stenosis, artery reconstruction

Background

After orthotopic liver transplantation (OLT), complications affecting the hepatic artery may cause ischemia and further result in hypopexia or dysfunction of the transplanted liver or death of the patient [1]. Hepatic artery thrombosis (HAT) is not only the second main cause of transplantation failure other than primary dysfunction of the transplanted liver, but also the most common complication of OLT. Generally, there are 3 therapeutic options for HAT: revascularization, retransplantation, and observation [2]. With the development and popularization of transcatheter endovascular interventional technique, it has also been applied to the treatment of HAT. Currently, the typical therapies of HAT include surgical revascularization, percutaneous puncture thrombolysis, percutaneous transluminal angioplasty, liver retransplantation, and expectant treatment [3]. Liver retransplantation used to be the only way to treat HAT and similar conditions, but has been associated with high mortality of patients and represents a waste of scarce sources [4]. Through emergency treatment procedures for transplantation, great progress has been made in the treatment of HAT or hepatic artery stenosis (HAS) [5, 6], while revascularization can only be performed when HA diseases are discovered through Doppler ultrasonography in the early stage [7, 8]. We report 2 cases of patients with hepatic cirrhosis or primary liver cancer who suffered early repeated hepatic artery stenosis and thrombosis after liver transplantation. The life span of transplanted livers and patients was successfully prolonged by using allogenic arteries as vascular grafts for reconstruction of blood supply of the hepatic arteries (Table 1). These 2 cases provided experience for diagnosis and treatment of HA stenosis and recurrent thrombosis after liver transplantation and provided a new approach for hepatic artery reconstruction with allogenic artery grafts.

Case report

Case 1 is a 44-year-old man with history of hepatitis who underwent piggyback orthotopic liver transplantation on February 24, 2016 because...
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of liver cirrhosis and primary liver cancer. Pre-operative computed tomography (CT) showed massive hepatocellular carcinoma with intrahepatic multiple metastases, liver cirrhosis, and multiple small lymph nodes in the bilateral axillae and portal branch obscurity. Preoperative PET-CT didn’t show carcinoma with extrahepatic metastases but the patient showed liver dysfunction before the surgery. In liver transplantation, after hepatic hilus detachment, we cut off the hepatic artery at the distal bifurcation of left and right hepatic artery, implanted the donated liver, trimmed the bifurcation of gastroduodenal artery into funnel shape, and made continuous eversion suture to the donor’s hepatic artery with 6-0 Prolene suture. After anastomosis, the hepatic artery graft became patency with significant arterial pulse. After anastomosis, the hepatic artery graft became patency with significant arterial pulse. 

Table 1. Patients’ information in 2 cases

<table>
<thead>
<tr>
<th>Case Number</th>
<th>Gender</th>
<th>Age (years)</th>
<th>Primary Disease</th>
<th>The Time Interval Between LT and Hepatic Artery Reconstruction (days)</th>
<th>Arterial Graft</th>
<th>The Time of Follow-up (months)</th>
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<tbody>
<tr>
<td>1</td>
<td>Male</td>
<td>44</td>
<td>Liver cirrhosis, primary liver cancer</td>
<td>15</td>
<td>Cryopreserved iliac artery</td>
<td>&gt;17</td>
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<tr>
<td>2</td>
<td>Male</td>
<td>39</td>
<td>Hepatic failure, hepatic encephalopathy</td>
<td>11</td>
<td>Splenic artery</td>
<td>&gt;16</td>
</tr>
</tbody>
</table>

Figure 1. Liver function changes of Case 1 after liver transplantation in the curve. A: Graph shows Case 1 recipient’s change of concentration of ALT and AST after liver transplantation along with the time; B: Graph shows Case 1 recipient’s change of concentration of TBIL and DBIL after liver transplantation along with the time.

Figure 2D. At POD 7 and 10, color Doppler ultrasonography was performed on the transplanted liver, which showed an obscure hepatic artery. At POD 15, DSA showed post-transplantation celiac trunk thrombosis.
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and poor outcome of stenting and thrombolysis were observed, which led us to perform emergency hepatic artery reconstruction (Figure 2E).

Hepatic artery reconstruction: We cut off the hepatic artery at the common hepatic artery and took out the visible clots from the hepatic artery. Then we flushed the intrahepatic artery with urokinase 50,000 IU + heparin saline 20 mL and ligated the artery at the division site of the receptor’s side. After dissection of the abdominal aorta under the superior mesenteric at the mesenteric root, we occluded the abdominal aorta with an occlusion clamp and then trimmed a 2 cm incision on the abdominal aorta at occlusion site. Cryopreserved allogenic iliac artery were first thawed at 20°C for 30 min and then rapidly rewarmed to 37°C, sutured to the broken site of donor artery with 6-0 Prolene suture. After opening the blood flow, the intraoperative color Doppler ultrasonography suggested satisfactorily intrahepatic artery pulse.

After hepatic artery reconstruction, the patient was administered urokinase at 4000 IU/min and 2500 IU of heparin sodium by continuous pump via DSA thrombolysis catheter for 11 days, which was followed by testing the patient’s coagulation function and sustained heparinization daily. From POD 1 to POD 3 after hepatic artery revascularization, the level of ALT, AST, TBIL, and DBIL was almost normal; color Doppler ultrasonography suggested that the hepatic arterial trunk and left branch spectrums were detectable. At POD 5, 8, 11, and 14 after hepatic artery reconstruction, DSA angiography suggested no evidence of stenosis in the anastomotic stoma, bypass artery is fluent.

Case 2 is a 39-year-old man with history of jaundice hepatitis, hepatitis B, and fatty liver underwent piggyback orthotopic liver transplantation on December 9, 2015 because of acute hepatic failure and hepatic encephalopathy. Preoperative CT showed fatty liver and...
a small amount of perihepatic effusion. The patient underwent multiple rounds of preoperative plasmapheresis and hemodialysis because of hepatic dysfunction, poor coagulation function, and hepatic encephalopathy-induced coma. The first time liver transplantation was performed according to classical piggyback liver transplantation. After anastomosis, the hepatic artery became patent with a significant arterial pulse. Figure 3A and 3B show the change of ALT, AST, TBIL, and DBIL during POD 1-9. From POD 2 to POD 5 after surgery, the color Doppler ultrasonography showed that there was a clear lumen and no abnormal filling defect in the hepatic artery. At POD 3, CTA and contrast-enhanced CT showed slight stenosis of lumen at the origin of hepatic artery and clear abdominal aorta and celiac trunk (Figure 4A). During POD 6-9, the level of ALT, AST, TBIL, and DBIL continuously increased. At POD 8, the color Doppler ultrasonography of transplant- ed liver showed no significant hepatic artery ultrasonogram. The DSA at Emergency Department showed hepatic artery stenosis with thrombosis. The thrombolytic therapy was provided by injecting 200,000 IU urokinase with indwelling arterial catheter and by continuous pumping of urokinase at 200,000 IU/min for continuous thrombolytic therapy (Figure 4B). But the DSA at POD 9 showed hepatic artery occlusion with thrombosis, the interventional therapy failed to make the hepatic artery patent (Figure 4C). As a result, the patient underwent the second allogeneic liver transplantation at POD 11.

The second liver transplantation and hepatic artery reconstruction was performed on De-
December 20, 2015. After cutting off the transplanted liver graft of the first time, then the second liver graft’s suprahepatic and infrahepatic inferior vena cava and portal vein were sutured. Then the abdominal aorta was dissected under superior mesenteric artery at mesenteric root and occluded with an occlusion clamp. A 2 cm incision was trimmed on the abdominal aorta at occlusion site. Since there was no appropriate cryopreserved iliac vessel, the untrimmed donor’s splenic artery was used as the bypass graft for hepatic artery bypass. We bluntly dissected the artery at the root of Traitz ligament with hemostatic forceps to create a stoma, let the splenic artery pass through the stoma to the broken site of abdominal aorta, and then made end-to-side anastomosis between the splenic artery and abdominal aorta with 6-0 Prolene suture. After opening the blood flow, color Doppler ultrasonography suggested satisfactory intrahepatic artery pulse.

Color Doppler ultrasonography of transplanted liver on the right postoperative day showed that the reconstructed hepatic artery was clear. CTA and contrast-enhanced CT showed that the hepatic artery bypass was clear (Figure 4D). From POD 2 to POD4 after hepatic artery reconstruction, the level of ALT, AST, TBIL, and DBIL gradually decreased. CTA and contrast-enhanced CT showed that the hepatic artery bypass was slightly locally bent and stenosed with clear branches at distal hepatic artery (Figure 4E). At POD 19 after hepatic artery reconstruction, the liver function was almost recovered. At POD 26 after reconstruction, the level of transaminase, bilirubin and γ glutamyltranspeptidase (γ-GGT) temporarily increased (ALT 280 U/L, AST 138 U/L, TBIL 59.2 μmol/L, DBIL 25.8 μmol/L, GGT 1096 U/L). CT showed no special change of transplanted liver and hepatic puncture biopsy suggested mild rejection reaction. Then the patient was administered methylprednisolone and larger dose of immunosuppressor for impact treatment. In consideration of the continuous increase of bilirubin, biliary tract disease was suspected. The patient underwent endoscopic retrograde cholangiopancreatography (ERCP) for examination and showed significant stenosis at the biliary anastomatic site. A stent was placed after transcatheter dilation of stenosis to enhance liver-protecting therapy. At POD 47 after hepatic artery reconstruction, color Doppler ultrasonography suggested a slightly high resistance index of the hepatic artery bypass and DSA showed no sign of stenosis at the anastomotic site of hepatic artery bypass but slow liver blood perfusion (Figure 4F). At present, the patient has had his hepatic artery constructed for more than 16 months, and remains under follow-up.

Discussion and conclusions

Over the past few decades, despite the remarkable development of vascular anastomotic techniques, and a few occurrences of vascular complications associated with OLT have been reported. It has been reported that the incidence of vascular complication ranges around 0.8%-20%, with a mortality rate about 11%-20% [9-12]. OLT-associated vascular complications include thrombosis, stenosis, and pseudo-angioma of the hepatic artery, stenosis and thrombosis of the portal vein, and thrombosis and thrombosis of the postcava and hepatic arteries [13]. Among these complications, HAT is the most common singularly occurring complication of orthotopic liver transplantation [13]. The incidence of HAT after orthotopic liver transplantation was 1.6%-30% [14-17] while a large sample statistics reported it as 3%-9% [18], but it may cause an early mortality up to 58% after the transplantation [19]. The cause of HAT is still under debate. It is believed that over 20% of HAT is caused by surgical techniques in artery anastomosis, such as arterial diameter mismatch between the donor and receptor, poor donor quality, complex arterial revascularization, or arterial tortuosity [20]. In addition, non-surgical factors also play a role, such as the donor being aged above 60, prolonged cold ischemia time, preservation injury, different blood type between donor and recipient, positive cytomegalovirus in the donor, tendency for hypercoagulation in the recipient’s blood, and primary sclerosing cholangitis in the donor or recipient [21-24]. However, the most common cause of HAT is vascular collapse cause by long hepatic arteries, organ rejection, and advanced age of the donor, slow blood flow, narrowed lumen, arterial revascularization, and re-transplantation of liver [25-28]. As another common vascular complication of OLT, the incidence of HAS is between 2%-15% [29-35]. Reports showed [31] that poor surgical techniques, transplant rejection, and crush injury are the risk factors of HAS.
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In view of the severity of vascular complications after liver transplantation, early discovery and diagnosis are the key to their treatment [36]. It is reported that about 2.3% of the early acute HTA can be diagnosed from the increased aminotransferase, early biliary fistula, and acute graft dysfunction [37], and the occurrence of HAS is also manifested by increased aminotransferase. However, with the incidence of asymptomatic HAS as high as 20%-27% [38, 39], imaging is required for proper evaluation. Imaging is the most useful method to evaluate the OLT-associated complications, and commonly used methods include color Doppler ultrasonography, CT, CTA, and transcatheter endovascular interventional techniques. Since color Doppler ultrasonography is both sensitive and specific to the detection of hepatic artery thrombosis, it is capable of detecting absent blood flow velocity in hepatic artery and its branches. It is also considered as the gold standard in detecting hepatic artery thrombosis [40]. Some reports also claimed daily routine post-operative ultrasound examinations are helpful to the early detection of hepatic artery thrombosis and stenosis. However, in some cases, post-operative color Doppler ultrasoundography may perform poorly or inconclusive in detecting hepatic arterial flow and thus additional imaging methods are required [41]. In Case 1 where the patient suffered from liver cirrhosis, even as albumin was used to reduce the ascetic fluids before surgery, gastrointestinal tract congestion, and severe intestinal tympanites were still found during the procedure. Post-operative color Doppler ultrasonography found poor performance of hepatic arteries, so transcatheter endovascular interventional technique was conducted. For patients with hepatic artery thrombosis and flow absence in the hepatic arteries, the diagnostic accuracy of MR angiography (MRA) is equal to the color Doppler ultrasonography [42], while the diagnostic accuracy of 3-dimensional CT is equal [43] or higher than [44] the color Doppler ultrasonography. 3-dimensional CT can visualize the locations of hepatic artery stenosis [45] which can be treated by percutaneous hepatic angioplasty and surgical procedures [46, 47].

Transcatheter endovascular interventional techniques have been used for treatment of multiple arterial obstructive diseases, especially acute obstruction of coronary arteries. For HAT and HAS, interventional therapy can be used both for diagnosis and for treatment. In addition to confirming the diagnosis, interventional therapy allows endovascular treatment for HAT and HAS at the affected part of hepatic artery. Due to the presence of complicating massive hemorrhage, it was not recommended to conduct interventional therapy for early HAT after OLT [48]. However, with the advancement of interventional techniques, there have been reports [49] that have claimed that interventional thrombolysis is an effective and safe approach for treatment of early HAT after OLT. In Case 1, the blood bilirubin of the patient increased at POD 6. With poor performance of color Doppler ultrasonography in detecting hepatic arteries, interventional therapy was conducted through hepatic arterial thrombolysis and stenting treatment with no occurrence of massive hemorrhage and other complications, which demonstrated the safety of transcatheter endovascular interventional techniques. In Case 2, the patient underwent DSA at POD 8 after the initial liver transplantation and hepatic artery stenosis and thrombosis were shown. Then the flow of hepatic arteries recovered after interventional thrombolysis, which also demonstrated the efficacy of interventional therapy. It is reported [49] that early HAT after OLT may cause extensive thrombosis of the hepatic arterial system. Since a thrombus in the hepatic arterial system may cause increased post-hepatic load, simply improving the techniques of hepatic arterial anastomosis is insufficient for the improvement of hepatic arterial flow, and reduction of post-hepatic load stress needs to be performed concurrently with the treatment of HAT. In Case 1, the patient had a slow hepatic arterial flow before and after hepatic artery bypass grafting, and continuous thrombolysis and anticoagulation after intervention not only reduced the risk of thrombosis, but also prevent increased pressure of hepatic arterial system caused by thrombosis so as to further reduce the risk posed by thrombosis.

Re-transplantation of liver is an effective way to treat HAT and HAS, however, the lack of liver donors is a common obstacle for this approach. Thus hepatic artery reconstruction presents a solution to HAT and HAS with which the intervention approach can’t deal. There are several reported cases where iliac arteries were used in place of hepatic arteries to perform hepatic...
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For liver re-transplantation, we performed a novel procedure of hepatic artery bypass grafting between the donor’s splenic artery and the receptor’s abdominal aorta, which successfully improved the function of the donated liver. Since the iliac and splenic arteries can be procured and easily saved when harvesting the organ, this approach not only provides a new way to use for cryopreserved iliac and splenic arteries, but also presents a new idea for transplant surgeons to treat HAT and HAS in emergency cases and perform hepatic artery revascularization during liver re-transplantation, which can hopefully reduce the need for liver re-transplantation for patients.

Acknowledgements

This study was supported by a grant from the Xinjiang Joint Funds of the National Natural Science Foundation of China (No. U1403222).

Disclosure of conflict of interest

None.

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References


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<th>Authors</th>
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<th>Origine of Vascular Allografts</th>
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<td>Mabrut JY et al., 2012 [55]</td>
<td>3</td>
<td>Cryopreserved iliac artery allograft from deceased donors in a tissue bank</td>
<td>Hepatitis B cirrhosis; Acetaminophen-induced acute liver failure; hepatitis C cirrhosis with hepatocellular carcinoma</td>
<td>Liver transplantation</td>
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<td>Jashari R et al., 2013 [56]</td>
<td>2506</td>
<td>Cryopreserved arterial allograft from brain death donors and deceased donors in the European Homograft Bank</td>
<td>Infections, critical limb ischemia, congenital cardiac malformations, arterial injury and prosthetic graft thrombosis</td>
<td>Cardiac surgery and vascular surgery</td>
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<td>Mourad MM et al., 2014 [57]</td>
<td>10</td>
<td>The donors’ iliac arteries from donation after circulatory death donors</td>
<td>–</td>
<td>Arterial reconstruction during liver transplantation</td>
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<td>Touma J et al., 2014 [58]</td>
<td>54</td>
<td>Cryopreserved arterial allografts from brain deceased multiple organ donors</td>
<td>Native aortic infection and prosthetic graft infection</td>
<td>Aortic reconstruction</td>
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<td>Heng WL et al., 2015 [59]</td>
<td>9</td>
<td>Cryopreserved iliac artery grafts and iliac vein (n=1) graft in tissue bank</td>
<td>Primary sclerosing cholangitis; Liver cirrhosis; Acute liver failure; Hepatitis B flare; Right mycotic internal carotid artery aneurysm</td>
<td>Living-donor liver transplantation; Reconstruction of right internal carotid artery</td>
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<td>Ali MA et al., 2015 [60]</td>
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<td>Ha TY et al., 2016 [61]</td>
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<td>Cryopreserved iliac arterial allografts from brain death donors</td>
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<td>Upper arm hemodialysis vascular access grafts</td>
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