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Case Report

# A Successful Case of Liver Transplantation in a Recipient's Hepatic Artery Dissection and Splenic Arterial Steal Syndrome

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## Abstract

Common hepatic artery dissection (CHAD) during orthotopic liver transplantation is a rare but significant risk factor for thrombosis of the hepatic artery (HA), which can result in liver failure and death. Here, we report the successful management of a recipient CHAD and splenic arterial steal syndrome during orthotopic liver transplantation. A 50-year-old male with a 20-year history of post-hepatitis B cirrhosis underwent liver transplantation of a graft from a 61-year-old brain-death donor On October 14, 2019. Intraoperatively, a dissection was found in the recipient common hepatic artery-gastroduodenal artery (CHA-GDA) patch, with an external diameter of about 0.5 cm and constriction of the inner cavity. A novel strategy was employed that included first suturing the tunica intima and tunica externa of the CHA-GDA patch followed by anastomosis to the grafted CHA-sphenopalatine artery (SPA) patch. Angioplasty and stenting were performed immediately to ensure adequate hepatic infusion and prevent arterial anastomotic stenosis and thrombosis, while SPA coil embolization was performed to prevent splenic arterial steal syndrome. This study is in compliance with the Declaration of Helsinki and the Declaration of Istanbul. The recipient recovered uneventfully and was discharged on postoperative day 36. At 3 years after surgery, liver function was normal and the HA was unobstructed. For HA dissection, the initial use of artery revision and endovascular treatment is both safe and efficient.

**Keywords:** Hepatic Artery Dissection; Splenic Arterial Steal Syndrome; Liver Transplantation

**Abbreviations:** CHAD: Common Hepatic Artery Dissection; HA: Hepatic Artery; GDA: Gastroduodenal Artery; SPA: Sphenopalatine Artery; CT: Computed Tomography; DSA: Digital Subtraction Angiography; PSV: Peek Systolic Flow Velocity, EDV: End Diastolic Velocity; RI: Resistance Index; POD: Postoperative Day

## Introduction

Hepatic artery (HA) complications after orthotopic liver transplantation are relatively rare, occurring in 0.8% to 20% of recipients, but often associated with stenosis and thrombosis of the HA [1]. Since the HA is the only route for oxygen to reach the graft, obstruction of the HA may result in delayed recovery of the graft and biliary duct ischemia, resulting in a mortality rate of 30%–50%

[2]. Early diagnosis and treatment of vascular complications can prolong survival and improve prognosis. Traditional treatments for vascular complications include surgical revascularization, angioplasty, re-transplantation, and conservative management [3]. Here, we report the inability to locate a normal intima of a recipient common HA after a few attempts, thus a novel surgical procedure combined with intravascular intervention was employed that should be strongly considered in such cases. This study complies with the Declaration of Helsinki and the Declaration of Istanbul. The donation was according to international standards. Signed letters in English with the official seal from the institutional review board, OPO, and Dean of the University have been submitted in order to certify that no organ of a prisoner was used in the case report and that participants were neither paid nor coerced.

## Case Presentation

A 50-year-old male with a 20-year history of hepatitis B virus infection and post-hepatitis cirrhosis-related portal hypertension was admitted to our hospital for the first time on June 17, 2019, due to recurrent hepatic encephalopathy. Color Doppler ultrasonography and subsequent contrast-enhanced computed tomography (CT) revealed liver cirrhosis, portal hypertension, formation of porto-systemic venous collateral, massive ascites, and splenomegaly. Routine blood testing and indocyanine green clearance indicated poor liver function and liver function reserve. After comprehensive consideration of his condition, orthotopic liver transplantation as a salvage treatment was performed using a hepatic graft from a 61-year-old brain-death donor with the same blood type (O type).

On October 14, 2019, the patient underwent liver transplantation with a modified piggyback veno-venous anastomosis without venous bypass. Portal vein reconstruction was performed by end-to-end anastomosis. Upon the reconstruction of HA, an undetected subintimal dissection was found in the common hepatic artery (CHA) of the recipient with an external diameter of about 0.5 cm but the true inner lumen was only 1-2 mm, which resulted in decreased blood flow. Hence, attempts were made to prune the CHA-gastroduodenal artery (GDA) patch along its confluence with the splenic artery (SA), but a normal intima was lacking. The start of this dissection was elusive. The expanded SA, however, was unsuitable for anastomosis because it was severely distorted and challenging to separate from the pancreas. The SA wall also lacked flexibility and was thin.

To avoid failure of the anastomosis, a new anastomosis method was adopted, in which the intima of the recipient CHA was first sutured to the tunica externa to close the dissection, and then the grafted CHA-sphenopalatine artery (SPA) was anastomosed to the recipient CHA-GDA patch (Figure 1). Biliary reconstruction was accomplished through duct-to-duct anastomosis without T-tube drainage.

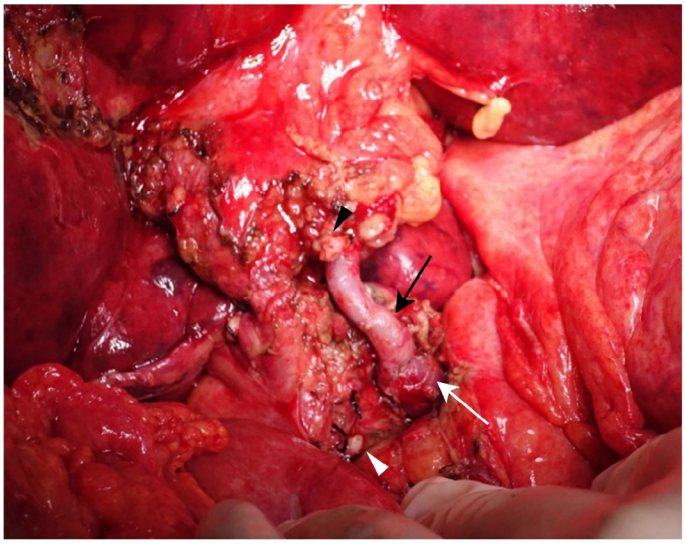

**Figure 1:** The dissection was closed by suturing the internal and external membranes first, then anastomosed to the graft's CHA-SPA patch. (White long arrow: recipient's CHA-GDA patch; White short arrow: recipient's GDA end; Black long arrow: graft's CHA-SPA patch; Black short arrow: graft's GDA end)

Intraoperative ultrasonography indicated poor blood flow in the HA. To avoid arterial anastomotic stenosis and thrombosis, the patient was promptly transferred to the complex operating room immediately once the abdominal cavity was closed. Digital subtraction angiography (DSA) revealed poor blood flow of the HA (Figure. 2A). Therefore, two 4 × 40 mm arterial stents were inserted into the arterial anastomosis. In addition, enhanced splenic infusion steal syndrome was also detected (Figure 2B), thus two coils were implanted into the upper and lower poles of the SA separately to partially block the splenic blood flow. After stent insertion and partial embolization of the SPA, DSA confirmed fluent blood flow in the HA (Figure 2C). An anticoagulant was simultaneously administered.

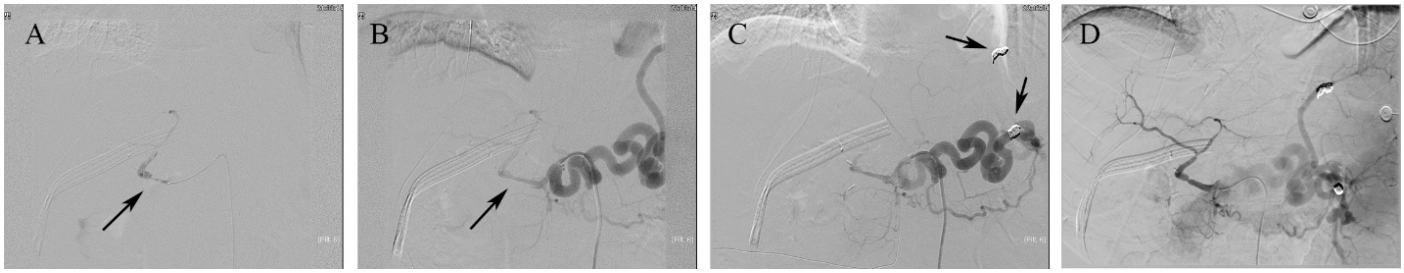


**Figure 2:** Digital subtraction angiography of anastomosed CHA and dilated splenic arterial. (A) After the end-to-end anastomosis, DSA demonstrated a poor hepatic arterial blood supply. Black arrow: Although the sutured CHA prevented the expansion of dissection, the arterial stenosis required more management. (B) The stents were inserted into the artery anastomosis, but enhanced splenic infusion could also be detected. Black arrow: 24*40 mm stents improved hepatic arterial blood supply. (C) Thus, two 4 * 40 mm coils were implanted into the upper and lower poles of splenic artery separately to partially block the splenic blood flow. Black arrow: inserted Coils. (D)On POD 3, fluent blood flow was demonstrated in hepatic artery after the stent insertion and SPA partial embolization.

Postoperative bedside Doppler ultrasonography was performed daily to monitor blood flow in the HA, portal vein, and hepatic vein. The HA peak velocity was slightly low at about 27 cm/s and the flow resistance index (RI) was relatively normal at about 0.53 on postoperative day 1 (POD 1). Except for a RI of 0.56, there was no abnormality on POD 2. On POD 3, the HA could not be clearly detected by ultrasonography, and the blood flow signal was ambiguous. Besides, a well-bounded hypo-echo region of about 12 × 10 mm was detected in the left lobe of the liver. Therefore, emergency DSA was performed, which confirmed patency of the HA (Figure 2D). FK506 (tacrolimus) and mycophenolate mofetil were used as per our usual protocol. Serum levels of transaminase and bilirubin gradually returned to normal. The patient developed a low-grade fever on POD 19. Direct enhancement of the upper abdomen with multi-slice CT suggested splenic infarction, which was not initially observed immediately after surgery (Figure 3A and 3B). The low-grade fever, which was treated with physical cooling and Celebrex, was likely caused by intraoperative embolization of the SA. The subsequent postoperative course was uneventful and the patient was discharged on POD 36. Long-term administration of aspirin after discharge was recommended to prevent thrombosis of the CHA. The patient was doing well at 26 months after surgery without recurrence of arterial dissection and enhanced CT of the upper abdomen confirmed fluent hepatic blood flow (Figure 3C).

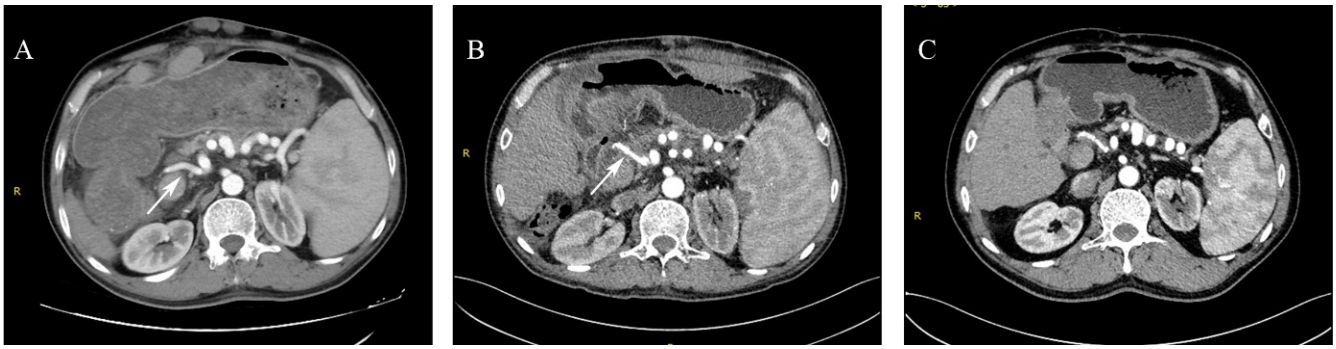


**Figure 3**: The hepatic artery was detected by enhanced CT before and after liver transplantation. (A) Before LT, abundant filling of the splenic artery, which also showed increased size and flow. The arrow shows the common hepatic artery with no dissection before surgery. (B) On POD19, deployment of vesicular stents, followed with selective catheterization of the splenic artery, which improved hepatic arterial perfusion. The arrow shows the fluent hepatic artery postoperative. (C) 2 years after transplantation and anticoagulation therapy, hepatic artery maintains patency and enlarged spleen also shrink as the partial arterial embolization

## Discussion

Hepatic artery dissection (HAD) is a rare arterial complication following orthotopic liver transplantation, which can cause serious complications, including graft dysfunction and necrosis in addition to various biliary complications. A retrospective study reported an incidence of HAD after living donor liver transplantation (LDLT) of 5.8% (43/737), with 67.4% of cases occurring on POD 7 or earlier. The extent of HAD was variable, but most occurred in the proper HA or CHA and sometimes extended into the celiac trunk, as described previously [4].

Possible causes of HAD include intraoperative clamp injury, intimal deformity, atherosclerosis, fibromuscular dysplasia of the recipient HA, connective tissue disease, iatrogenic factors, such as endovascular treatment, and other unidentified reasons [5]. After carefully examining the preoperative CT, no dissection was found in the recipient celiac artery or HA. Hence, arterial skeletonization and intraoperative clamping might have resulted in mechanical trauma to the intimal membrane and subsequent intimal dissection of the HA. Therefore, gentle procedures during surgery are strongly recommended to prevent arterial dissection.

Various reports have described alternative methods of reconstruction of the HA unsuitable for anastomosis. Figueras et al. first described hepatic arterial inflow reconstruction using the recipient SA and donor HA in 1995 [6]. Steinbrück et al. suggested the use of the right gastroepiploic artery in LDLT because of its accessibility, safety, and lack of tension after anastomosis [7]. Özbilgin et al. reported autologous grafting of the inferior mesenteric artery for revascularization of the HA [8]. The left gastric, middle colic, cystic, and gastroduodenal arteries have been described as alternatives for arterial anastomosis in liver transplantation. More options include prosthetic arterial conduits or extra-anatomic jump graft reconstruction performed from the right iliac artery to the grafted HA using the great saphenous vein [9].

In the present case, the SA was excluded as it was tortuous and behind the pancreas with enormous abdominal adhesions. Although the recipient CHA was restricted, the diameter of the true lumen was about 1-2 mm and the blood flow was accessible. So, a novel anastomosis method was adopted, which included suturing of the inner and outer membranes of the HA in order to prevent further expansion of a false cavity and to shorten the anastomosis time to reduce the occurrence of postoperative complications with the bile duct. Although the false cavity did not expand further, the pulse of the reconstructed artery was weak, as expected. Therefore, close monitoring of the blood flow of the anastomotic HA with DSA is critical for early diagnosis and timely treatment to prevent ineluctable graft failure [10].

A retrospective study by Hwang et al. reported spontaneous improvement of the recipient HAD without further complications in most cases, indicating the reliability of conservative treatment of asymptomatic HAD after LDLT [4]. However, timely treatment of perioperative HAD is especially important. Traditional methods of treatment include re-transplantation, arterial reconstruction, surgical excision of the diseased artery followed by surgical revascularization, and anticoagulation therapy. In the present case, endovascular stenting combined with anticoagulation was performed as soon as possible, but blood flow was only slightly increased.

Splenic arterial steal syndrome is a rare complication before or after orthotopic liver transplantation with a reported incidence of 0.6%–10.1% [11]. In the present case, preoperative portal hyper-perfusion induced vasospasms of the HA and intraoperative hepatic arterial stenosis caused a shift in blood flow into the enlarged SA, which attenuated the hepatic blood supply. Although SA ligation and splenectomy have been reported previously, these strategies are sometimes associated with a greater risk of complications, such as severe spleen infraction, splenic vein-portal vein thrombosis, and overwhelming post-splenectomy infection [12,13]. In order to maintain adequate hepatic arterial inflow, DSA and SA embolization were performed for early diagnosis and treatment of splenic arterial steal syndrome. Since the SA was partially blocked by the implanted coils, the HA had recovered and the only complaint of the patient was absorption heat resulting from a mild splenic infarction.

## Conclusion

Here we described a rare case of hepatic artery dissection (HAD) and splenic arterial steal syndrome during the liver transplantation, while a unique technique was adopted to restore normal vascular anatomy by reconstructed the recipient's CHA-GDA patch and anastomosed to the graft's CHA. It turns out that in addition to selecting alternative vessels for anastomosis, restoring normal vascular anatomy and subsequent intervention therapy is also a good manner.

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**Ethical Considerations**: This study is in compliance with the Declaration of Helsinki and the Declaration of Istanbul. The donation was according to international standards. Signed letters

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**Conflicts of Interest**: The authors have declared no conflicts of interest.

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