Radiology Case Reports 16 (2021) 224–229

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Case Report

Immediate postoperative inferior vena cava stenting to improve hepatic venous outflow following orthotopic liver transplantation

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ARTICLE INFO

Article history:
Received 5 November 2020
Accepted 16 November 2020

Keywords:
Inferior vena cava
Stent
Orthotopic liver transplantation

ABSTRACT

Orthotopic liver transplantation can be a surgically complex undertaking, with hepatic venous outflow obstruction occurring at a rate of 1%-6% due to inferior vena cava (IVC) torsion, compression, or anastomotic stenosis. In this report, we present 2 cases of immediate postoperative hepatic venous outflow obstruction in the setting of Budd-Chiari syndrome successfully treated with immediate IVC stenting. Although IVC stenting has been reported for management of long-term IVC anastomotic stenosis after orthotopic liver transplantation, use of stenting to address immediate postoperative caval outflow obstruction is less commonly described. We describe the potential utility of immediate stenting to improve outflow from the transplanted liver and highlight the value of this approach in addressing early postsurgical IVC pathology

Introduction

Orthotopic liver transplantation is a surgically challenging but life-saving operation for the treatment of end stage liver disease [1]. Since its first report in 1963 [2], OLT has been refined and optimized to address anatomic and technical challenges. Most modern OLT procedures are performed using one of 2 methods: the conventional technique and the piggyback procedure [1]. The conventional liver transplant involves explantation of the liver along with the retro-hepatic inferior vena cava (IVC), followed by implantation of a donor liver graft as well as a donor IVC, secured by upper and lower caval anastomoses [1,3]. Conversely, the piggyback transplant involves only liver explantation, after which the donor liver is implanted with the retro-hepatic IVC sitting "piggyback" on top of the recipient native IVC [3–5]. Though it is more complicated to separate the recipient liver from the recipient IVC during the course of removal, the major benefit of the piggyback approach is avoidance of veno-venous bypass during the anhepatic phase [3].

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https://doi.org/10.1016/j.radcr.2020.11.032

One of the key challenges in OLT—found to be more common in conventional techniques than piggyback techniques—is retention of IVC integrity [6]. In the short term, caval outflow obstruction can be caused by technique-related injury, torsion, or compression of the IVC. Caval torsion is mainly due to graft enlargement and edema, resulting in rotation of the caval axis at a level above the hepatic veins, while IVC compression is a rare but well-known complication arising in 1%-2% of procedures [7]. In the long term, outflow obstruction can be caused by caval anastomotic stenosis, which occurs with an incidence of less than 2% [8–10]. Although IVC stenting has been reported for management of long-term IVC stenosis after OLT, use of stenting to address immediate postoperative caval outflow obstruction is less commonly described in the published literature [11]. Herein, we present 2 cases in which immediate postoperative IVC stenting was successfully employed to improve hepatic venous outflow in the setting of caval torsion and extrinsic compression after OLT, and highlight the value of this approach in addressing early postsurgical IVC pathology.

Case presentation

Institutional review board approval is not required for retrospective case reports and case series at the authors' institution.

Case 1

A 35-year-old woman with Factor V Leiden complicated by Budd-Chiari syndrome, ascites, and nonbleeding esophageal varices presented with liver cirrhosis. She had undergone transjugular intrahepatic portosystemic shunt (TIPS) creation approximately 20-years prior at the age of 16-year-old, with multiple shunt revisions (at least 5) to address recurrent shunt stenoses despite systemic anticoagulation. A diagnosis of end stage liver disease merited OLT, and the patient was listed until a deceased donor organ became available. Due to extensive IVC occlusion, a conventional OLT was performed.

The patient was prepared for surgery in the usual fashion, and a Chevron incision was made. The cirrhotic liver was identified amidst notable venous collaterals in the intraperitoneal tissues. The common hepatic artery and bile duct were transected between ties. The portal vein was clamped proximally and transected distally in order to retrieve the TIPS, and over sewn with 5-0 suture. The patient was placed on veno-venous bypass, and the suprarenal and infra-renal IVC was tangentially clamped and transected. The liver was removed en bloc, along with the infra-hepatic vena cava.

The cadaveric donor liver was brought into the field, and an end-to-end anastomosis with 5-0 suture was made between the cuff of the graft hepatic vein and the patient's supra-hepatic IVC. Following this anastomosis, the liver was flushed with 500 mL of cold albumin while the infra-hepatic IVC anastomosis was achieved with 3-0 suture. Next, the portal vein anastomosis was performed with 6-0 suture. The surgery proceeded with the arterial anastomosis between the gastroduodenal and common hepatic arteries using 6-0 suture. Afterward, vascular clamps were removed, and the liver was tested for reperfusion. Though the graft reperfused successfully, some liver congestion and swelling was noticed, raising concern about the patency of the upper IVC anastomosis. Moreover, intra-operative Doppler ultrasound signal dampened. Graft torsion was suspected, as hepatic venous outflow appeared to have positional lability based on the rotational alignment of the graft, which was not stably situated. As such, the patient was referred to Interventional Radiology (IR) for inferior vena cavogram and possible IVC stenting to optimize graft outflow. The abdomen was temporarily closed with PDS #1, and the patient was transported directly from the operating room to the IR suite.

In the IR suite, the patient was placed in a supine position on the procedure table, and the right groin and right neck were prepped and draped in sterile fashion. Ultrasound was used to localize the right common femoral vein. Patency of the vessel was documented. The vessel was accessed with 21-gauge needle (Micropuncture Access Set; Cook Medical, Bloomington IN) was used to access using real-time sonographic guidance. The access was dilated to accept a 5 French vascular sheath (Pinnacle; Terumo, Somerset NJ), through which a 5-F pigtail catheter (Soft-Vu; AngioDynamics Inc., Latham NY) was introduced. The catheter was advanced into the IVC, and a cavogram was performed. A high-grade stenosis of the superior caval anastomosis was uncovered (Fig. 1), and resulted in sluggish blood flow. Given the findings and concordance with operative concerns, it was decided that stenting would be the optimal way to establish sercure outflow from the liver. Via a 16 French vascular sheath (Cook Medical) in the right internal jugular vein, 2 overlapping 20 mm x 5 cm Gianturco Z stents (Cook Medical) were sequentially deployed in the IVC, with the caudal edge positioned below the confluence of the hepatic veins and the cranial edge extended to the cavoatrial junction. Poststenting venography demonstrated markedly improved venous caliber and flow through the hepatic veins and hepatic vein confluence to the right atrium (Fig. 1). All devices were removed and hemostasis was achieved at the venous access site using manual compression. The patient was brought back to the operating room for bile duct anastomosis, and the surgery was completed.

After transplantation, the patient recovered over a 9-day postoperative course, and was then discharged home with satisfactory graft function, though alkaline phosphatase was elevated post-OLT but normalized by 2 months. Contrast enhanced CT scan (Fig. 1) and Doppler ultrasound (Fig. 1) 10-months post-OLT showed durable wide patency of the stented IVC with normal hepatic venous blood flow.

Case 2

A 30-year-old woman with a history of hypercoagulability secondary to systemic lupus erythematosus and antiphospholipid syndrome resulting in Budd-Chiari syndrome, liver cirrhosis, and hepatopulmonary syndrome. She underwent TIPS creation at the age of 18-years-old, with revisions performed 2-, 7-, and 9-year later for shunt dysfunction. The

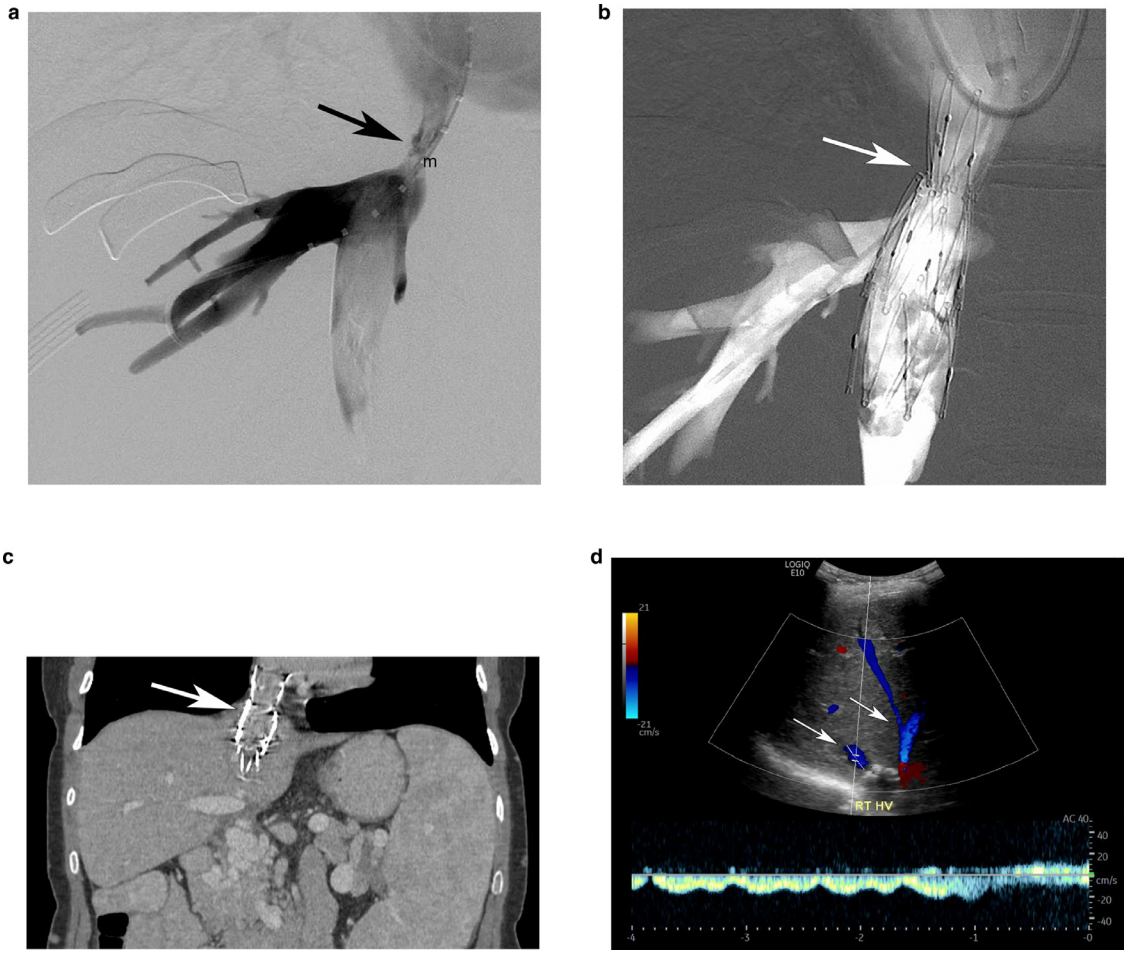

Fig. 1 – IVC stenting in 35-year-old woman with caval torsion. Digital subtraction venogram (A) demonstrates IVC stenosis (arrow). After caval stenting, digital subtraction venogram (B) shows wide patency of IVC (arrow), with durability confirmed on 10-month post-stenting coronal reconstructed contrast enhanced CT scan (C, arrow) and Doppler ultrasound (D), which displays patent hepatic veins (arrows).

patient was evaluated for OLT for end stage liver disease, and was listed until a deceased donor organ became available, at which time a conventional OLT with veno-venous bypass was undertaken.

The patient was prepared for surgery in the usual fashion, and a Chevron incision was made. The peritoneum was opened and the cirrhotic liver was identified. Due to IVC occlusion at the level of the diaphragm, a sternotomy was necessary to perform the upper caval anastomosis. The left and right hepatic arteries were transected. The hepatic artery was partially mobilized. After this, the common bile duct was circumferentially dissected, ligated, and transected. The portal vein was dissected and transected. The patient was placed on veno-venous bypass, and the cirrhotic liver was removed. The donor liver was brought into the field, and anastomoses were created between the IVC and right atrium, the supra-renal IVC of the donor and recipient, and the portal vein. Edema of the liver was noted upon reperfusion, with the graft appearing swollen and hard; there was suspicion of decreased venous outflow. As such, the patient was referred to IR for inferior vena cavogram and possible IVC stenting to optimize graft outflow. The abdominal musculature was temporarily closed with PDS #1. The patient was transported directly from the operating room to the IR suite. In the IR suite, a cavogram showed complete occlusion of the upper caval anastomosis (Fig. 2), prompting return of the patient to the operating room for anastomotic revision. The anastomotic revision was performed using a synthetic Dacron interposition graft from the hepatic level IVC to the right atrium. This resulted in satisfactory venous outflow, though there remained clinical concern for compressive occlusion of the IVC at the level of the interposition graft. As such, after completion of the surgery, the patient returned to the IR suite for IVC stenting to bolster the upper caval anastomosis.

In the IR suite, the patient was placed in a supine position on the procedure table, and real-time ultrasound guidance was used to obtain access into the right internal jugular vein and right common femoral vein. A 12 French sheath (Cook Medical) was placed in the right internal jugular vein and a 6 French sheath (Terumo) was placed in the right common femoral vein. A multisidehole catheter (AngioDynamics) was advanced through the right femoral venous access into

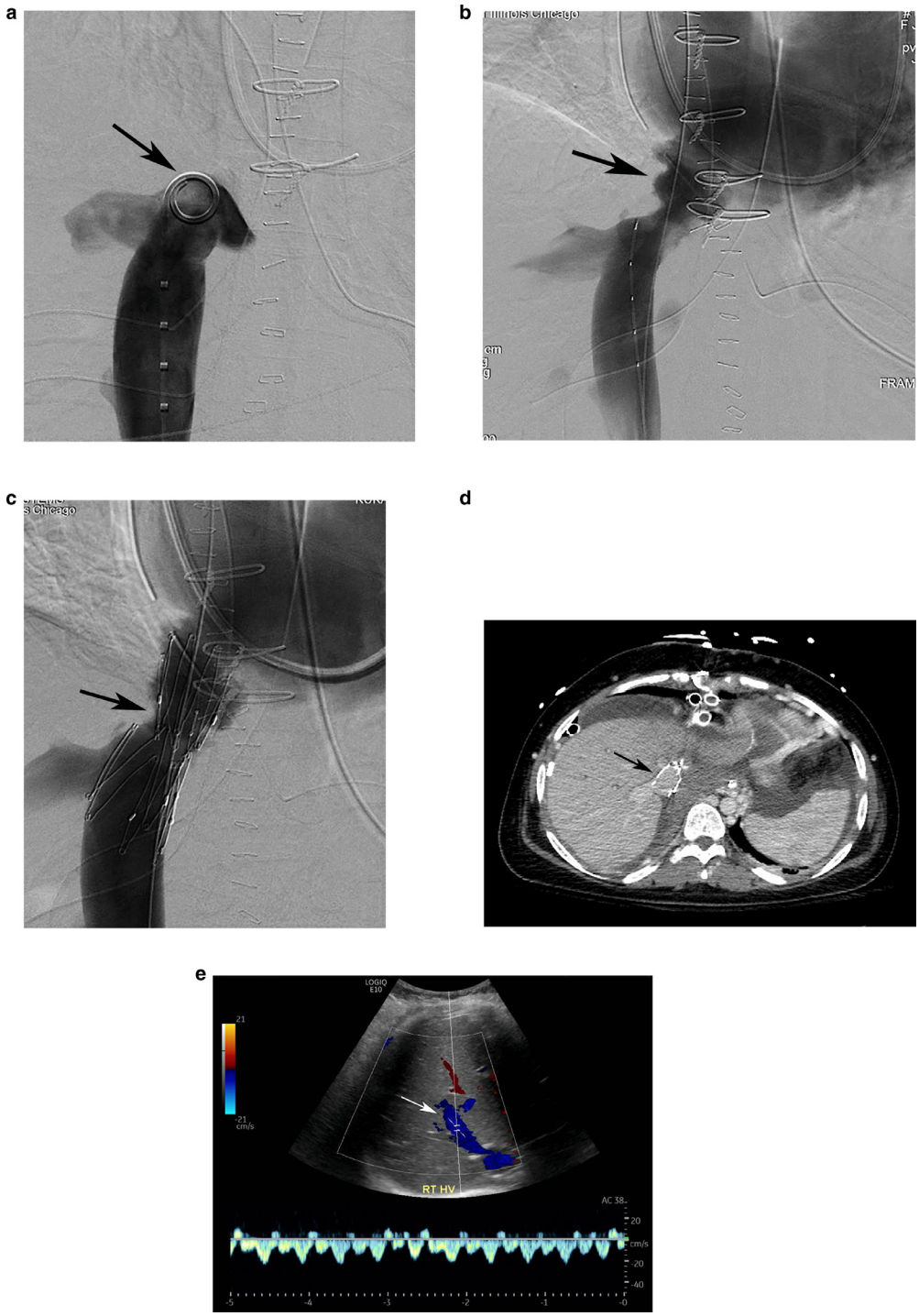

Fig. 2 – IVC stenting in 30-year-old woman with caval torsion. Initial digital subtraction venogram (A) depicts upper IVC occlusion (arrow). Digital subtraction venogram (B) performed after interposition grafting reveals patent graft (arrow), bolstered following caval stenting (C, arrow). Patency confirmed on 1-month post-stenting axial contrast enhanced CT scan (D, arrow) and Doppler ultrasound (E), which displays patent hepatic vein (arrow).

the IVC, and inferior vena cavogram revealed patency of the upper IVC anastomosis (Fig. 2). Through-and-through wire access was established from the right internal jugular vein to the right common femoral vein. The upper caval anastomosis was then stented using a 25 mm Gianturco Z-stent (Cook Medical). A final inferior vena cavogram revealed excellent patency and flow across the stented caval anastomosis (Fig. 2). All devices were removed, and hemostasis was achieved at the venous access sites using manual compression.

Postoperatively, the patient had a protracted hospital course complicated by *E. coli* septic shock and intracranial hemorrhage leading to diminished neurological function. However, contrast enhanced CT scan (Fig. 2) and Doppler ultrasound (Fig. 2) performed 35 days after OLT showed patency of the stented IVC with normal hepatic venous blood flow.

Discussion

Venous outflow obstruction following OLT is a rare but serious complication, with a reported incidence of 1%-6% [6]. Venous outflow obstruction may be caused by 2 different mechanisms: [1] immediate postsurgical outflow obstruction precipitated by technique-related vessel torsion [7]; [2] late venous stenosis caused by hyperplasia or fibrosis at the vascular anastomosis [6]. This is particularly common in states of hypercoagulability and autoimmunity, where thrombosis and scarring have already damaged the native IVC and threaten to damage the donor IVC. Because the coagulation cascade is activated by endothelial damage, the anastomoses that take place during OLT can aggravate this cascade [12,13].

When outflow obstruction is encountered after OLT, the options are typically either re-operation or endovascular therapy performed using balloon angioplasty and/or stenting [8]. Re-operation is often associated with surgical risk to the patient, and balloon angioplasty may be insufficient to sustain patency of the IVC due to recoil of fibrotic tissue. As a result, stenting has been shown to be very effective in the treatment of post-OLT venous stenosis [11,14–17], with prior reports demonstrating long-term caval patency post-OLT at more than 5-year follow-up (11). While the existing literature reports stenting for early post-OLT stenoses in the range of 4 weeks after surgery [11], the cases presented herein demonstrate that stenting can also be effective immediately postliver transplant.

The value of our cases to the OLT literature is in establishing that stenting can be a minimally invasive solution to address immediate postoperative caval torsion and/or compression, effectively addressing outflow obstruction and ensuring caval patency. In the cases presented herein, the first patient required stenting for a concerning proximal IVC anastomosis in the setting of vessel torsion, and the second patient required stenting due to suspected IVC compression. The implications this procedure has for patient care is 2-fold. First, immediate stenting post-OLT may reduce the likelihood that the patient will require re-operation for an occluded IVC, and by that route, may reduce risk associated with secondary procedures. Second, creating an immediate outflow tract reduces the risk of further complications that can arise after OLT, ranging from relatively mild ascites and lower extremity edema to more severe variceal bleeding, thromboembolism, and hepatic congestion [6]. Stenting may be preferred to re-operation as the latter is often associated with surgical risk to the patient, and there is limited surgical literature recommending re-operation. Conversely, balloon angioplasty is widely discussed to be insufficient in sustaining patency of the IVC due to recoil of fibrotic tissue [16]. As a result, stenting may be the superior option, and the Gianturco Z-stent is widely reported in the literature as a suitable choice due to its radiopacity and subsequent ease of accurate positioning, large caliber, and high radial strength [16].

In summary, immediate postoperative IVC stenting can improve hepatic venous outflow following OLT. While clinical practice recommendations cannot be firmly made on the basis of 2 cases lacking long-term patency, the approach may be a valuable option for patient's whose transplant surgeries are complicated by occlusive conditions or immediate post-OLT caval torsion or compression. In this setting, immediate stenting may provide a solution to enhance vessel patency and reduce the likelihood of future interventions.

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