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HOW I DO IT

Successful Use of the Recanalized Remnant Umbilical Vein as a Patch Graft for Venous Reconstruction in Abdominal Surgery

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Abstract

Various approaches have been described for the reconstruction of the portal vein (PV), superior mesenteric vein (SMV), and the inferior vena cava (IVC). We present the use of the recanalized remnant umbilical vein in various settings including transplantation, major liver resection, and pancreatic surgery. We retrospectively analyzed four cases, in which a recanalized remnant umbilical vein was used for vascular reconstruction. The graft harvesting, size of the graft, technique of application, and short-term results of vascular patency were studied. A recanalized umbilical vein was successfully harvested from the ligamentum teres hepatis in all patients with 5 cm (median, range 3–7 cm) in length and 1.3 cm (median, range 1.0–1.8 cm) in width. The preparation of the vein was technically feasible and took no more than 5 min in each patient. All grafts were used as a patch for venous reconstruction. In three cases, the graft was used for the reconstruction of the PV or SMV. In one patient, the graft was used to repair a large defect of the IVC. All vascular reconstructions were considered as successful as no bleeding or thrombosis was observed postoperatively. The remnant umbilical vein is a reliable native autologous graft. We found that it is feasible to use this graft as a patch for the reconstruction of the IVC, PV, and SMV.

Keywords Umbilical vein patch · PV resection · IVC resection · Patch patency · Venous reconstruction

Introduction

Radical resection of the hepato-pancreatico-biliary tumor often requires vascular reconstruction. Some reconstruction requires only a venous patch instead of the whole vessel. The ideal graft should be easily available, size adjustable, and cost saving while showing a high patency rate. Here, we describe such a venous graft, which was harvested from the ligamentum teres hepatis to obtain the remnant umbilical vein. Four consecutive cases were reported. The alternative currently available, autologous venous grafts were reviewed and compared.

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Patients and Methods

Patients

A total of four patients were included in this case study. In three patients, partial resection and reconstruction of the PV was performed. In one patient, tangential resection of the IVC was performed. All venous defects were repaired with a patch constructed using the recanalized remnant umbilical vein derived from the ligamentum teres hepatis. In all cases, the umbilical vein was harvested in situ, being first dissected from the fatty tissue in the umbilical region and subsequently dissected towards the portal vein. The remnant umbilical vein was opened longitudinally to create a patch and sutured onto the defect using running sutures.

Case 1

Case 1 is 3.5-month-old girl diagnosed with biliary atresia and PV hypoplasia receiving a split liver transplantation (segments

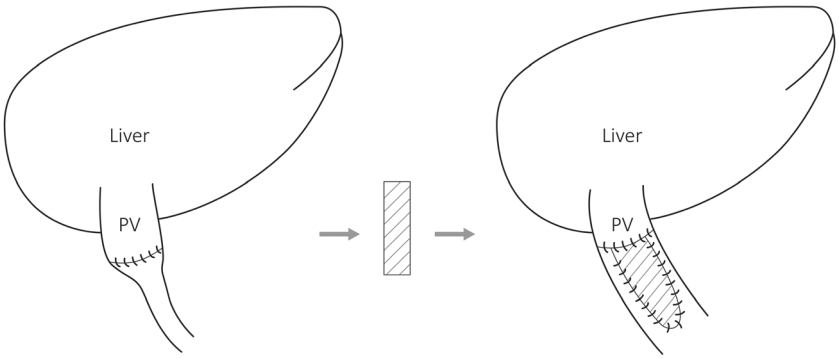

Fig. 1 Expanding the recipient PV utilizing an umbilical vein patch plastic in portal vein hypoplasia

II/III). There was size disparity between the recipient and graft PV (5 mm vs 15 mm). Postoperative ultrasound examination confirmed portal vein hypo-perfusion. The initial liver graft function was dismal. Due to persistent low PV flow, an operative revision was carried out on postoperative day 4. After ruling out a portal vein thrombosis, we decided to expand the recipient PV using a venous patch. This patch was harvested from the ligament teres hepatis of the donor (Fig. 1). A venous patch 20 × 5 mm was inserted longitudinally at the ventral side of the recipient PV using 7–0 PDS sutures. The following sonography confirmed improved PV perfusion. Instillation of 100 IE heparin was given intravenously. The recipient was listed for re-transplantation due to persistent poor graft function despite sufficient PV flow. A re-transplantation was followed. During the re-transplantation, the PV showed sufficient blood flow. The PV anastomosis of the new liver graft was performed at the confluence of the splenic vein and the superior mesenteric vein of the recipient.

Case 2

Case 2 is a 58-year-old male patient diagnosed with hepatocellular carcinoma (HCC) located in liver segments V–VIII and infiltration of the IVC. Laparotomy with extended right hemihepatectomy and tangential resection of IVC was performed due to infiltration and resulting thrombosis of the IVC reaching up to the right atrium. The tangential resection of IVC required a 60 × 30 mm umbilical vein patch which was anastomosed using running sutures with 5–0 Prolene (Fig. 2). Preparation of the umbilical vein took 5 min. Reopening of the IVC was performed after 43 min of preparation and suturing the patch. Intraoperative assessment of patency was performed using Doppler sonography following additional instillation of 1.000 I.E. heparin intravenously and showed sufficient blood flow. Peri- and immediate postoperative course of events was uncomplicated, and the patient was discharged from hospital 3 weeks following surgery. Follow-up of 3 months post-surgery showed the patient alive and well with recovered liver function.

Case 3

Case 3 is a 73-year-old male patient diagnosed with pancreatic adenocarcinoma. Duodenopancreatectomy (Whipple procedure) was performed. During the operation, beside the hepatic artery resection and reconstruction with an interposition from the segmental splenic artery, resection of the 7-cm-long venous segment involving the PV and the superior mesenteric vein (SMV) was necessary due to locally advanced disease (Fig. 3). After removal of the specimen, the mesenteric root was mobilized to approximate the PV and SMV. An umbilical vein patch with the dimensions of 50 × 30 mm was used for vascular reconstruction and anastomosed using running sutures with 6–0 Prolene. A bolus heparin of 1000 IE intravenously was given after reperfusion. The intraoperative assessment of patency was confirmed by Doppler sonography. Peri- and immediate postoperative course of events was regular with improvements in transition to a normal diet and mobilization. Postoperative measurements of portal vein's patency using Doppler sonography were performed postoperatively

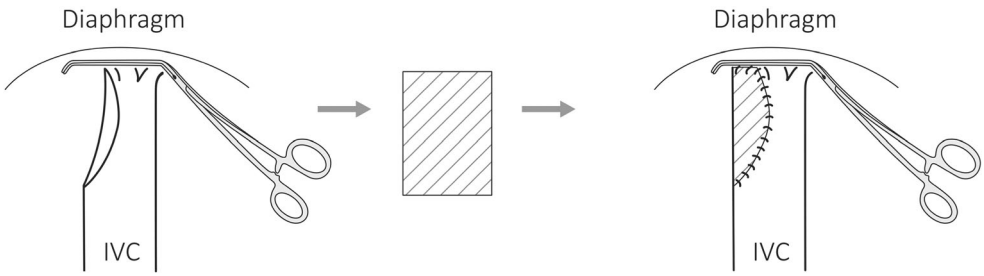

Fig. 2 Patch plastic used for IVC reconstruction following tangential IVC resection due to tumor infiltration

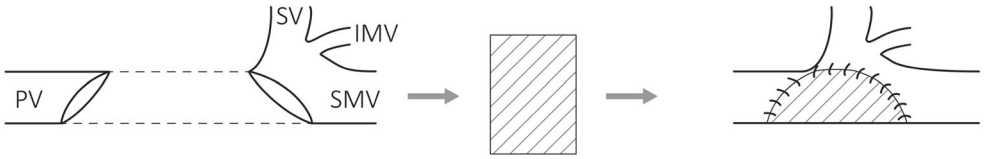

Fig. 3 Reconstruction of the PV and SMV following duodenopancreatectomy using an umbilical vein patch

and revealed normal blood flow. The patient was discharged 2 weeks following surgery. Follow-up after 3 months showed the patient alive and well.

Case 4

Case 4 is a 71-year-old male patient referred emergently after surgical management of postoperative bleeding from the hepatic artery and portal vein thrombosis 3 weeks following duodenopancreatectomy. Occlusion of the hepatic artery by sutures and erosion of the portal vein with complete portal vein thrombosis was revealed. Only an accessory left hepatic artery perfused the liver. A tangential resection (5 × 25 mm resulting defect) and thrombectomy of the portal vein was performed (Fig. 4). The defect in the portal vein was reconstructed with a 10 × 25 mm umbilical vein patch by 6–0 Prolene running sutures. Intraoperative assessment of patency was performed using Doppler sonography following additional instillation of 1.000 I.E. heparin intravenously and showed sufficient blood flow. Despite the sufficient portal flow, necrosis of the right hemi-liver as well as the biliary-enteric anastomosis developed in the next 2 weeks. The patient died 30 days later due to septic multi-organ failure.

Case Summary

Between July 2016 and August 2018, four reconstructions of venous vessels were performed using the recanalized remnant umbilical vein as a patch graft. This technique was applied in two cases due to cancer of the pancreatic head with venous infiltration and/or PV thrombosis. The additional two cases were related to surgeries of the liver: one in the context of liver transplantation and the other due to hepatocellular carcinoma of the liver with IVC infiltration. Venous reconstruction allowed for all malignancies to be resected R0. Patency was 100%. The harvesting took no longer than 5 min in all cases. All adult patients received enoxaparin 40 mg twice daily for 7 days following surgery, and then enoxaparin 40 mg once daily until discharge. The child in this case study received a continuous heparin intravenously after the transplantation.

Discussion

A variety of grafts and patches have been described in the literature for use in vascular reconstruction in hepatobiliary and pancreatic surgery.[1,2] Table 1 offers an overview of the different grafts used for venous reconstruction.

The use of the recanalized remnant umbilical vein as a graft was first described in 1975 by Dardik and Dardik.[10] Initially, these grafts were used in femoropopliteal bypasses in vascular surgery. Rochon et al. published their experience of using the recanalized umbilical vein both as a patch and as a conduit graft for various reconstructions in 2012, including the use as a patch graft for the PV, IVC, and SMV.[11] The results show excellent patency rates of the umbilical vein grafts.

The use of the umbilical vein as a graft or patch has several advantages when compared to other techniques. Firstly, it is easy to harvest with the preparation of the recanalized umbilical vein usually taking no longer than 5 min.[11] Furthermore, no additional skin incision is needed, and it is located in the operating area for both pancreatic and hepatic surgeries. The umbilical vein has a uniform caliber and is valveless and branchless. The large caliber and thick wall as well as its preserved intima[12] make it an ideal graft for patches or conduits.

The use of the umbilical vein as a patch graft or interposition graft in hepatobiliary surgery has been described.[13] In our opinion, the use of the umbilical vein as an interposition graft should be critically reviewed. The necessary dilation of the vessel by use of scissors, lacrimal probes, or Fogarty catheters may cause microtrauma of the intima and present a possible pro-thrombotic element in addition to the nature of narrowing of the umbilical vein which may lead to higher rates of thrombosis. In the case study by Rochon et al., all three patients which showed postoperative thrombosis following SMV-PV confluence reconstruction had received an interposition graft. None of the patients having received a patch graft showed thrombosis.[11]

In our case study, the umbilical vein was solely used as a patch graft and not as an interposition graft. Our study demonstrates excellent patency rates for the umbilical vein when used as a patch graft for the reconstruction of the SMV, PV, and IVC. A prophylactic anticoagulation with enoxaparin was

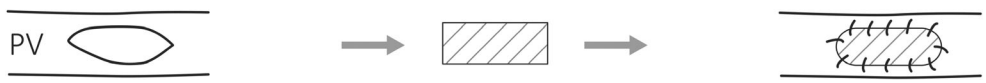

Fig. 4 Reconstruction of a portal vein defect following thrombectomy

Table 1 The different grafts used for venous reconstruction

Study	Graft	Advantage	Disadvantage
Kubota et al. 1998[3]	Right ovarian vein	- Easily exposable - No additional skin incision - Required time 15 min	- Small diameter (less than 5 mm) - Fragile with thin wall
Sakamoto et al. 2004[4]	Great saphenous vein	- Minimal postoperative disadvantage - Wide range of lengths	- Additional skin incision - Too small diameter to interpose major hepatic/portal vein without customization - Required time for customization 1 h (cylindrical graft) - Patch size $\leq 3 \times 2$ cm and $\leq 2 \times 1$ cm cylindrical graft
Hirono et al. 2014[5]	External iliac vein	- Sufficient diameter and length - No additional skin incision	- Postoperative edema of the lower leg - Postoperative pain dorsal foot
Yamamoto et al. 2009;[6] Dokmak et al. 2015[7]	Left renal vein	- Sufficient diameter - No additional skin incision	- Postoperative impairment of renal function in poor-risk patients - Inaccessibility due to adhesions possible
Fleming et al. 2006[8]	Superficial femoral vein	- Easy and safe access - Good handling and durability	- Additional skin incision - Second team may be necessary for harvest - Risk of deep venous thrombosis up to 22%
Nishibe et al. 1998[9]	Expanded polytetrafluoroethylene (PTFE) grafts	- Availability independent of patient's anatomy - No additional skin incision	- Infectious risk - Neointima not closed after 6 months - Limited commercial availability
Fleming et al. 2006[8]	Internal jugular vein	- Size match - Sufficient diameter and length	- Additional skin incision
Yamamoto et al. 2009[6]	Bilateral gonadal vein	- No additional skin incision - Easy and safe access	- Small diameter (less than 5 mm) - Fragile with thin wall - Risk of gonadal vein thrombosis
Dokmak et al. 2015[7]	Parietal peritoneum	- No additional skin incision - Easy and safe access - Depending of the need different graft possibilities due to harvest location	- Fragile with thin wall

performed, but no therapeutic anticoagulation was carried out. The patients were not put on antiplatelet medication. With a patency rate of 100%, this suggests that therapeutic anticoagulation and anti-platelet medication is not necessary to ensure better patency rates. Rochon et al. came to the same conclusion in their case study.[11] In conclusion, we point out that the umbilical vein is easy to harvest, and compared to other venous grafts, no additional skin incision is required. It took less than 5 min to completely prepare the patch in each of these cases, which is also an advantage. The patency rate is excellent, and no patch-related complications occurred.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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