CASE REPORT

Potential Use of Left Renal Vein Graft in Pancreaticoduodenectomy Combined with Long Segmental Resection of the Superior Mesenteric-Splenic-Portal Vein Confluence

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ABSTRACT

Context Various techniques for reconstruction after superior mesenteric-splenic-portal vein confluence resection during pancreaticoduodenectomy have been introduced. A certain kind of vascular grafting may be necessary especially when long segmental resection of superior mesenteric-splenic-portal vein confluence is required. **Case report** We herein report the cases of two patients who underwent left renal vein grafting in a pancreaticoduodenectomy with combined resection of the long segment of the superior mesenteric-splenic-portal vein confluence for pancreatic head cancer following neoadjuvant concurrent chemoradiation therapy as well as their long-term outcomes with graft patency without deterioration of renal function. **Conclusion** Our experience with these two cases indicates that an autologous interposition graft using the left renal vein may be considered a safe and convenient conduit in the case of long segmental resection of the superior mesenteric-splenic-portal vein confluence during a pancreaticoduodenectomy following preoperative neoadjuvant chemoradiation therapy.

INTRODUCTION

A curative pancreaticoduodenectomy with negative margins offers the only latent cure for pancreatic head cancer. The oncologic outcome of a resection with positive margins is known to be as poor as in locally advanced pancreatic adenocarcinoma without surgical extirpation [1, 2, 3]. Pancreatic cancer invasion to the superior mesenteric-splenic-portal vein confluence is frequently encountered during a pancreatico-duodenectomy due to their close anatomical relationship. However, superior mesenteric-splenic-portal vein involvement in pancreatic cancer is no longer considered a contraindication to resection, thanks to recent advances in surgical techniques as well as perioperative management, and growing evidence demonstrates a better survival rate for en bloc removal with superior mesenteric-splenic-portal vein resection for isolated involvement of pancreatic cancer [3, 4, 5,

6]. Several studies have demonstrated that venous resection during a pancreaticoduodenectomy is technically acceptable with no increase in perioperative morbidity [3, 6, 7, 8].

After segmental resection of the superior mesenteric-splenic-portal vein system, a reconstruction method is decided upon according to the type and extent of the vascular resection, including primary end-to-end anastomosis, patch venoplasty and interposition grafting. In general, the majority of patients who undergo venous resection of the superior mesenteric-splenic-portal vein confluence can restore portal vein flow via primary end-to-end anastomosis by mobilization of the mesentery. However, portal vein end-to-end anastomosis is often impossible not only because of longer segment of portal vein resection but also due to immobilization of the mesentery or superior mesenteric vein vessels. Inflammation extension to the mesentery by acute or chronic pancreatitis or fibrotic changes around the superior mesenteric-portal vein vessels induced by preoperative neoadjuvant concurrent chemoradiation therapy can be potential factors in sufficiently immobilizing the mesentery and the superior mesenteric vein, leading to difficulty with primary end-to-end anastomosis. In these cases, it is incumbent that the surgeon do the grafting portal vein reconstruction. In such cases, a left renal vein graft should be chosen for portal vein reconstruction because
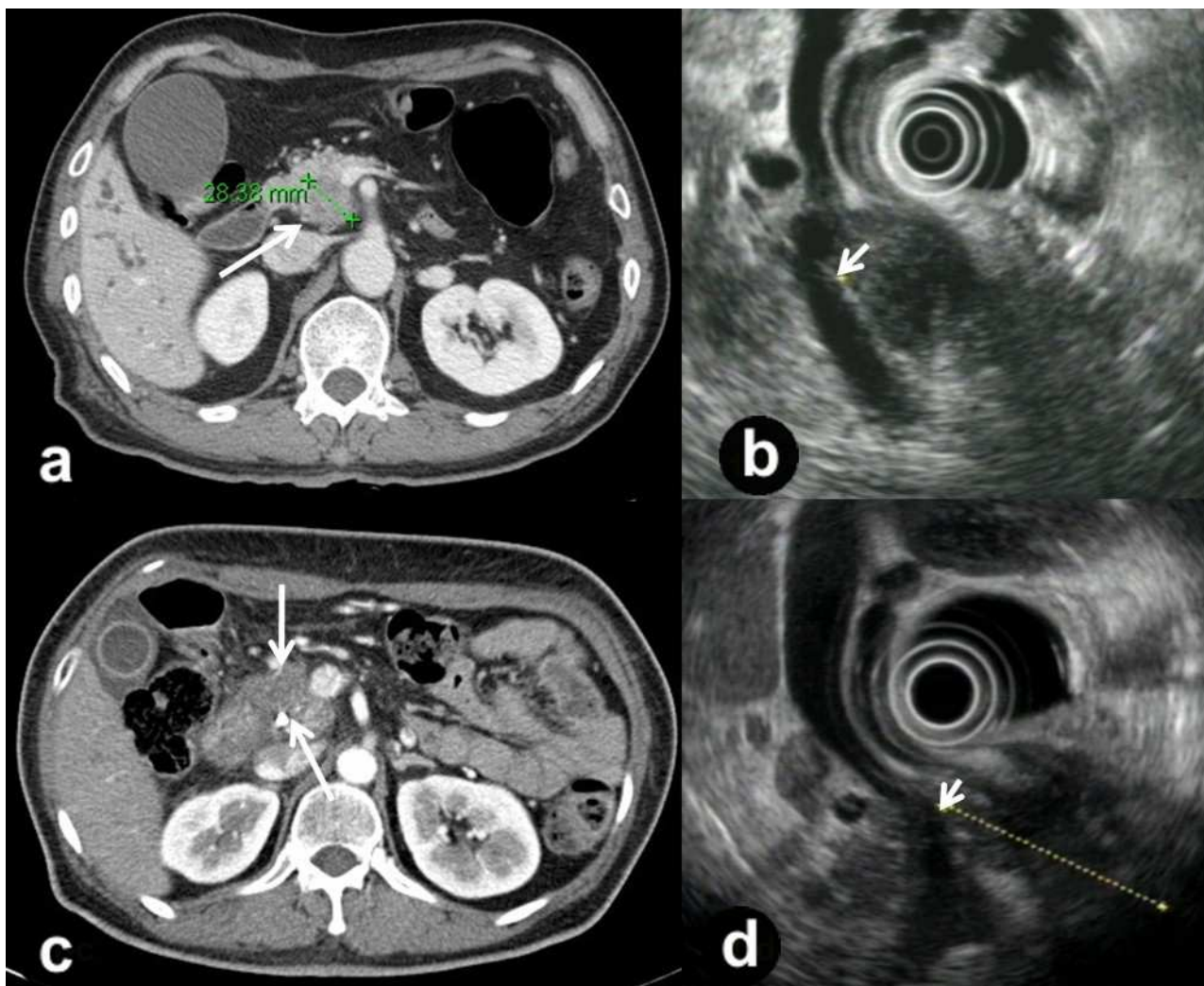
Figure 1. Preoperative imaging studies. **a.** CT of Case #1 showing pancreatic head cancer (arrow) with suspicious invasion to the portal vein. **b.** EUS of Case #1 revealing the tumor abutting on the portal vein (arrow). **c.** CT of Case #2 demonstrating pancreatic head cancer (arrows) invading the superior mesenteric-splenic-portal vein confluence. **d.** EUS of Case #2 clearly demonstrating the tumor abutting on the superior mesenteric-splenic-portal vein confluence (arrow).

the graft is more easily available and safer to use than other grafts [9, 10, 11, 12].

In this article, we report our experience with autologous vein interposition grafting using left renal vein. Follow-up imaging studies attest to the excellent outcome without deterioration of renal function and with maintenance of the graft patency.

CASE REPORTS

Case #1

A 68-year-old man presented with epigastric and back pain of 1 month duration. His preoperative CT (Figure 1a) and PET scans revealed a 3.5 cm pancreatic head cancer with suspicious invasion into the portal vein without distant metastasis, and an endoscopic ultrasonography (EUS) showed the portal vein involvement of the tumor in detail (Figure 1b). The serum CEA level was 1.55 ng/mL (reference range: 0-5.00 ng/mL) and the CA 19-9 level was 757 U/mL (reference range: 0-37 U/mL). EUS-guided fine-needle

biopsy confirmed an adenocarcinoma of the pancreas. He received neoadjuvant concurrent chemoradiation therapy according to our institutional policy for advanced pancreatic cancer. A partial response was identified on a follow-up study after the concurrent chemoradiation therapy, but vascular involvement was still suspected. We decided to perform a pancreatico-duodenectomy with a possible segmental resection of the superior mesenteric-splenic-portal vein confluence, and left renal vein interposition grafting.

Tumor involvement on the lateral border of the superior mesenteric-splenic-portal vein confluence was identified during the operation. It could have been direct tumor invasion or adhesions from the concurrent chemoradiation therapy, but it appeared to be impossible to isolate the vessels from the abutting area. In such circumstances, the access plane to the retroperitoneal margin should be changed from the lateral aspect to the medial (left lateral) aspect of the superior mesenteric-splenic-portal vein confluence. This dissection plane allowed for easy detachment of
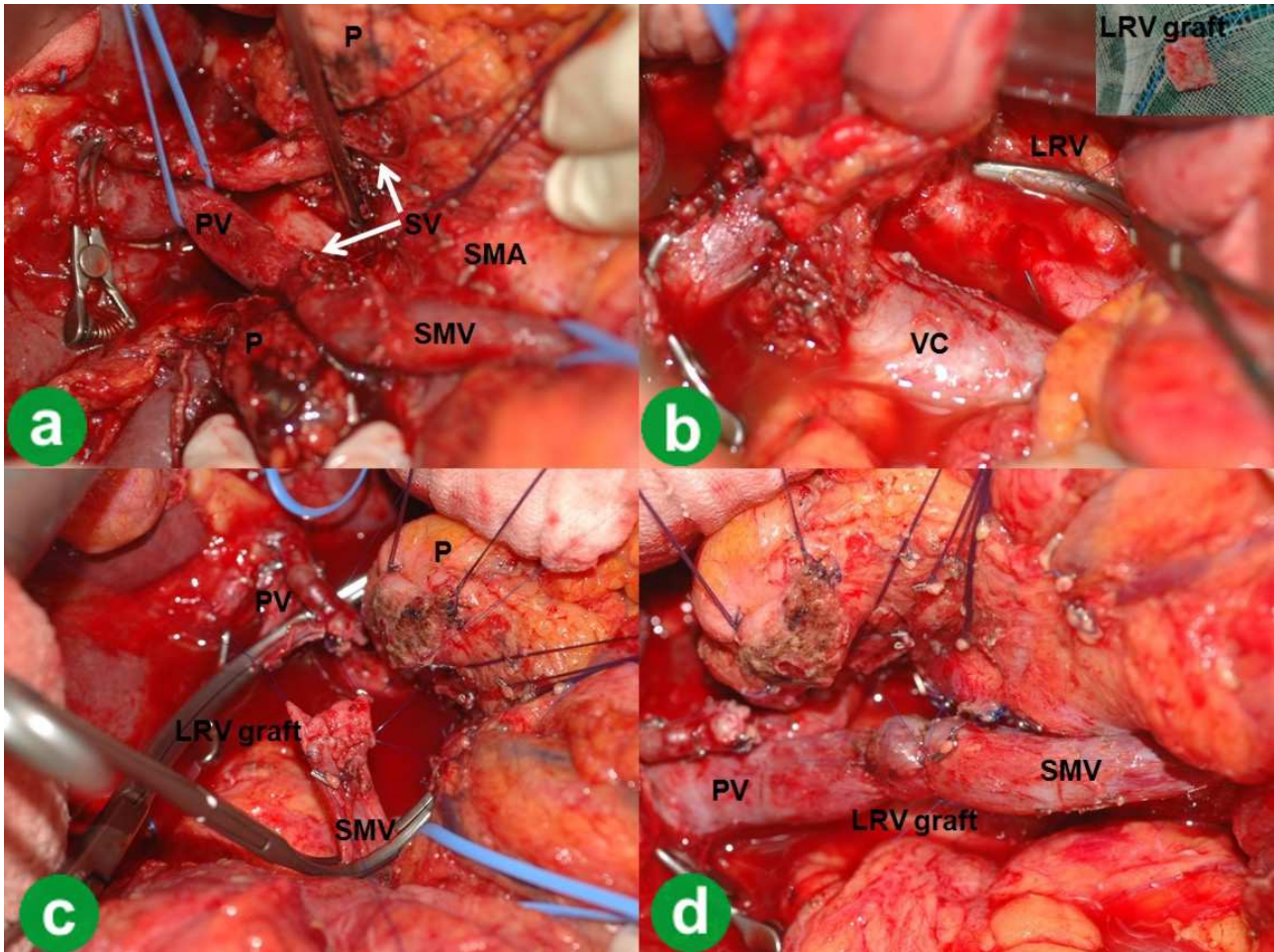
Figure 2. Operative findings of Case #1. **a.** Division of the splenic vein completely freed the specimen except for the abutting segment of the superior mesenteric-splenic-portal vein confluence. Arrows indicate the resected splenic vein. **b.** A segment of the left renal vein was grafted. **c.** A segment of the superior mesenteric-splenic-portal vein confluence was removed en bloc with the specimen and was reconstructed using a left renal vein graft. **d.** No tension was observed after reconstruction.
LRV: left renal vein; P: pancreas; PV: portal vein; SMA: superior mesenteric artery; SMV: superior mesenteric vein; SV: splenic vein; VC: vena cava

the uncinate process from the superior mesenteric artery. Division of the splenic vein completely freed the specimen except for the abutted segment of the superior mesenteric-splenic-portal vein confluence (Figure 2a), and the length of the vein to be resected was then measured. We usually prefer primary end-to-end anastomosis as long as it can be carried out without a graft. A long segment of the vein, however, had to be resected and we expected potential tension at the anastomosis site in this case. Therefore, we continued to harvest the left renal vein as previously planned. The left renal vein was easily exposed with further extension of the previously performed Kocher maneuver and a 3.0 cm long segment of the left renal vein was grafted just proximal to the left adrenal and gonadal veins after clamping (Figure 2b). The remaining stumps were repaired with a running 5-0 prolene suture. Proximal and distal vascular control was then achieved with Satinsky clamps, and a segment of the superior mesenteric-splenic-portal vein confluence was removed en bloc with the specimen (Figure 2c). The resected segment of the superior mesenteric-splenic-portal vein confluence was reconstructed using the left renal vein graft, and no

tension was observed (Figure 2d). The clamping time of the portal flow required about 25 minutes to complete vascular reconstruction. We systemically heparinized before vascular clamping, and neutralized with protamine sulfate immediate after the removal of the vascular clamping. After venous reconstruction, the gastrointestinal reconstructions were completed. We routinely use low molecular weight heparin (Clexane®, Sanofi-Aventis, Paris, France) after a pancreatico-duodenectomy to prevent postoperative thrombo-embolism; it is administered via subcutaneous injection for four days starting at postoperative day three. No anticoagulant therapy with warfarin or aspirin was administered postoperatively for vascular resection.

The pathologic report confirmed a ductal adeno-carcinoma of the pancreas and complete R0 resection. He had delayed gastric emptying during the postoperative period, but this was resolved with conservative management. A follow-up CT demonstrated a patent graft (Figure 3a), good collateral flow and a well-perfused left kidney (Figure 3b). Postoperative follow-up serum creatinine levels were maintained within the normal range (varing between 0.60 and 1.16 mg/dL; reference range: 0-50-1.40
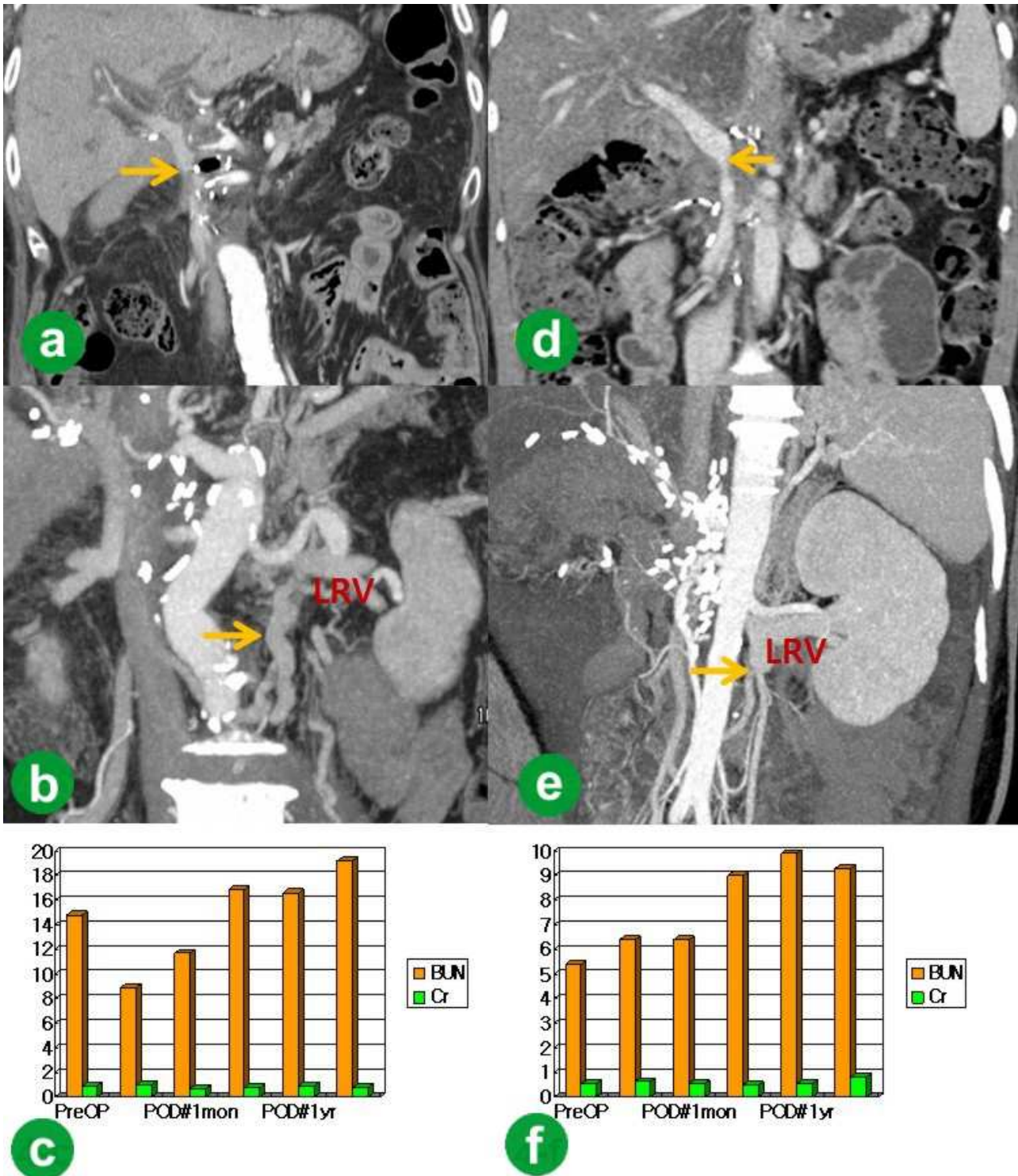
Figure 3. Follow-up of Cases #1 and #2. **a.** CT of Case #1 demonstrating a patent portal flow (arrow). **b.** CT of Case #1 showing development of collaterals (arrow) and a well-perfused left kidney. **c.** Postoperative follow-up serum creatinine levels of Case #1 were maintained within the normal range. **d.** CT of Case #2 showing a patent portal flow (arrow). **e.** CT of Case #2 revealing well-developed collaterals (arrow) and good perfusion of the left kidney. **f.** The postoperative follow-up serum creatinine levels of Case #2 were maintained within the normal range.
Cr: creatinine; BUN: blood urea nitrogen; LRV: left renal vein; POD#1mon: 1-month postoperative; POD#1yr: 1-year postoperative; PreOP: preoperative

mg/dL) (Figure 3c). Renal function preservation was verified by the development of collaterals on follow-up CT. He was revealed to have multiple liver metastasis 19 months after the operation, and died after 21 months.

Case #2

A 48-year-old woman was admitted with weight loss of one month duration and jaundice of five days duration. Her preoperative CT also demonstrated pancreatic head
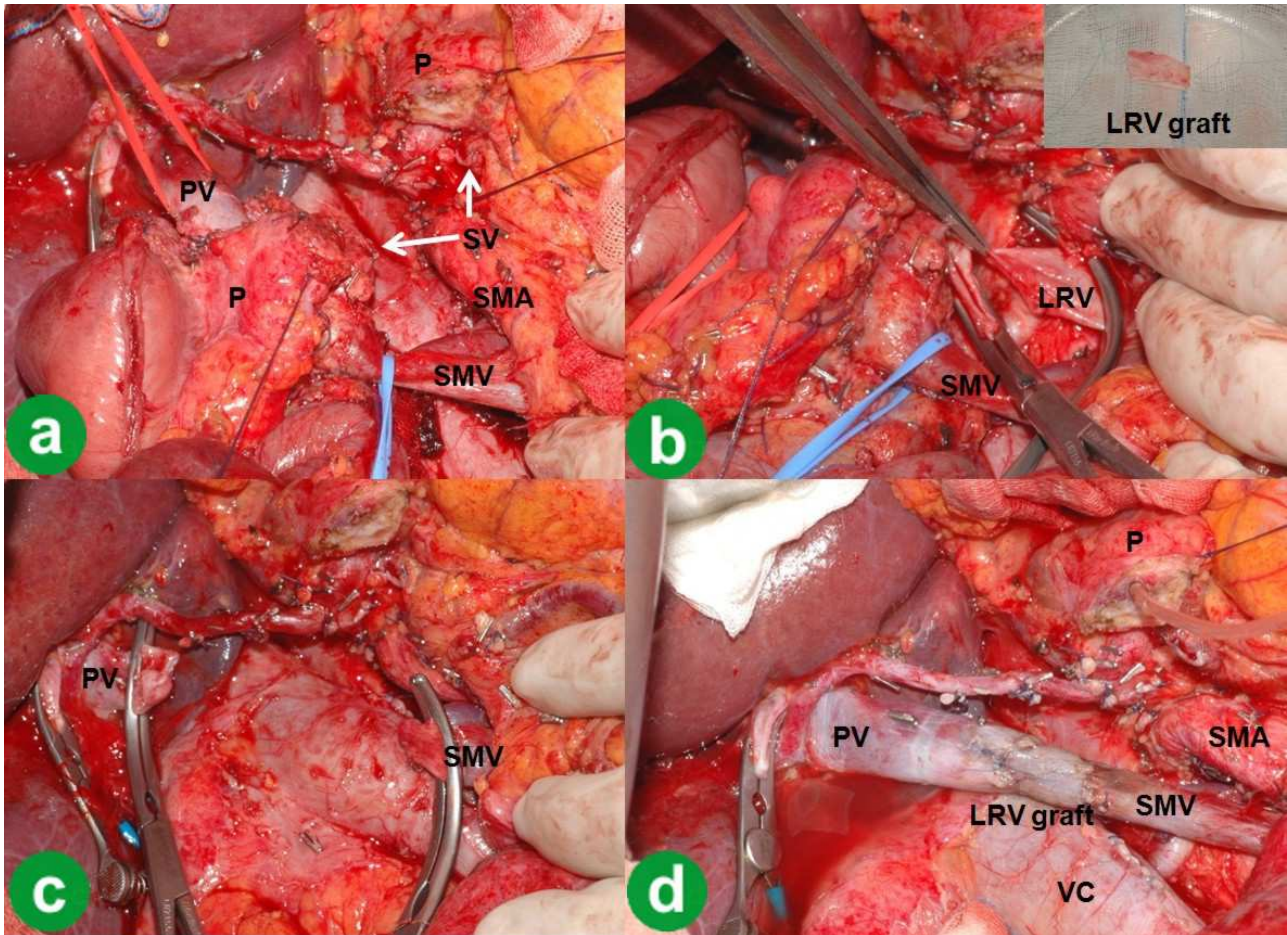
Figure 4. Operative findings of Case #2. **a.** Division of the splenic vein completely freed the specimen except for the abutting segment of the superior mesenteric-splenic-portal vein confluence. Arrows indicate the resected splenic vein. **b.** A segment of the left renal vein was grafted. **c.** A segment of the superior mesenteric-splenic-portal vein confluence was removed en bloc with the specimen. **d.** No tension was observed after reconstruction.
LRV: left renal vein; P: pancreas; PV: portal vein; SMA: superior mesenteric artery; SMV: superior mesenteric vein; SV: splenic vein; VC: vena cava.

cancer invading the superior mesenteric-portal vein confluence (Figure 1c), and mild uptake was identified on a PET scan. EUS clearly showed the 4.0 cm pancreatic head cancer abutting on the superior mesenteric-splenic-portal vein confluence (Figure 1d). The serum CEA level was 3.40 ng/mL and the CA 19-9 level was 660 U/mL. Adenocarcinoma of the pancreas was confirmed by EUS-guided fine-needle biopsy. Neoadjuvant concurrent chemoradiation therapy for advanced pancreatic cancer was carried out, and stable disease was identified on follow-up studies after concurrent chemoradiation therapy.

Vascular involvement of the pancreatic head cancer was still suspected; therefore, she also underwent a pancreaticoduodenectomy combined with a segmental resection of the superior mesenteric-splenic-portal vein confluence and left renal vein interposition grafting using almost the same technique as in Case #1 (Figure 4). The length of the left renal vein graft was 3.5 cm and the portal flow clamping time was 20 minutes. Clexane® was also administered for four days without warfarin or heparin.

The histopathological examination of the en bloc specimen disclosed a ductal adenocarcinoma of the pancreas and an R0 resection. She was discharged on the 16th operative day after an uneventful recovery. A follow-up CT scan one month postoperatively also showed a patent graft (Figure 3d), good collateral flow and a well-perfused left kidney (Figure 3e). Postoperative follow-up serum creatinine levels were maintained within the normal range (between 0.33 and 0.86 mg/dL) (Figure 3f). She showed no evidence of recurrence at her last follow-up (23 months postoperatively).

DISCUSSION

Isolated superior mesenteric-splenic-portal vein confluence involvement by malignancy is no longer regarded as a contraindication for resection of pancreatic head cancer, even though some argue that the prognosis depends on the depth of invasion [13]. Isolated venous involvement of the tumor is distinct from invasion of the circumferential (left lateral) wall of the superior mesenteric-splenic-portal vein confluence or the superior mesenteric artery, which demonstrates frequent involvement of the mesenteric neural plexus and makes it impossible to achieve a tumor free margin [3, 13, 14]. Therefore, surgical

strategy for isolated venous involvement is thought to have potential oncologic benefits [15].

Options for a venous conduit for reconstruction after superior mesenteric-splenic-portal vein confluence resection include prosthetic, autologous or cryopreserved cadaveric vein grafts. Despite its ready availability and valid size match, the use of a prosthetic graft such as polytetrafluoroethylene (PTFE) is not indicated due to the potential risk of infection and thrombosis [16]. The portal vein has medium velocity but a high volume flow. Therefore, some reports have demonstrated that the use of PTFE interposition grafts did not increase the risk of thrombosis [17]. However, Smoot *et al.* [18] reported a higher percentage of thrombosis in PTFE grafts, and they changed to the left renal vein as the preferred conduit. As for selecting potential autologous grafts for the superior mesenteric-splenic-portal, the internal jugular, femoral, great saphenous, gonadal, common iliac, external iliac and splenic veins are all candidates [8, 11, 12, 16, 19]. However, the great saphenous and gonadal veins have a size disparity which requires some modification to be applied as a portal vein graft. Therefore, these veins cannot be used in the same way as the internal jugular vein and the others listed above. Furthermore, harvesting these autologous veins requires creating an additional wound and is associated with other postoperative complications, such as lymphedema and venous thrombosis. From this point of view, the left renal vein has several advantages, such as suitable length, comparable caliber to superior mesenteric-splenic-portal vein confluence, easy accessibility during pancreaticoduodenectomy and the fact that it is a safe procedure [9, 10, 11, 12, 20]. Furthermore, all routes for central venous access can be maintained when using the left renal vein, which is especially important in patients who have undergone a major operation such as a pancreaticoduodenectomy. Left renal vein grafting is also justified because the left renal vein has various collateral branches, such as the inferior phrenic and adrenal tributaries, the gonadal vein, renal-azygos communication, and splenorenal communication; therefore, there is no deterioration of renal function after harvesting the left renal vein [10, 12, 20, 21]. The follow-up CT in our cases clearly showed that the development of collaterals enabled the preservation of the renal function. The segment of the left renal vein can be extended onto the portion just distal to the renal-azygos branch to preserve the gonadal and renal-azygos venous drainage essential for preservation of the renal function [9, 22]. This usually provides a segment of about 3-4 cm in length of renal vein graft [10, 11]. Harvesting of the graft and resection of the involved segment of the superior mesenteric-splenic-portal vein confluence should follow the completion of the dissection of the retroperitoneal margin so as to properly assess the need for interposition grafting and minimize the clamping time of the portal flow. In our cases, left renal vein resection did not increase the serum creatinine level during long-term follow-up, and the graft patency and well-maintained collateral flow was confirmed by follow-up radiologic images. The patients' survival outcome was acceptable.

In conclusion, our preliminary experience with these two patients indicates that autologous interposition grafting using the left renal vein can be considered as a safe and convenient conduit for segmental resection of the superior mesenteric-splenic-portal vein confluence during pancreaticoduodenectomy following pre-operative neoadjuvant concurrent chemoradiation therapy in pancreatic cancer initially designated as being non-resectable.

Disclosure The authors have no conflicts of interest or financial ties to disclose

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