Journal of Gastrointestinal Cancer (2019) 50:684–688
https://doi.org/10.1007/s12029-018-0117-0

CASE REPORT

Pancreaticoduodenectomy with Replaced Common Hepatic Artery and Portal Vein Reconstruction in Primary Carcinoma Duodenum: a Case Report and Literature Review

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Published online: 17 May 2018

Introduction

The role of combined arterial and superior mesenteric-portal venous resection and reconstruction is not established in primary duodenal carcinoma [1, 2]. Arterial resections tend to result in high morbidity [2]. We present here a case of primary duodenal carcinoma wherein a combined vascular resection and primary repair was performed, along with the possible selection criteria for this procedure and a brief literature review.

Case Report

A 66-year-old lady with no comorbidities, American Society of Anesthesiologists (ASA) 2, and Eastern Cooperative Oncology Group (ECOG) 1 presented with dyspepsia and abdominal discomfort since 6 months. She was diagnosed as primary duodenal adenocarcinoma on esophagogastroduodenoscopy and guided biopsy. Computed tomography (CT) revealed replaced common hepatic artery (RCHA) arising from superior mesenteric artery (SMA) and portal vein (PV) involved in tumor (Fig. 1a, b). The variant arterial anatomy of our case is schematically shown in Fig. 2a, b and the portal- superior mesenteric vein (SMV) anatomy is schematically shown in Fig. 3a, b. Positron emission tomography-CT (PET-CT) did not show distant metastasis. Carcinoembryonic antigen (CEA) and carbohydrate antigen (CA) 19–9 were within normal limits. A pancreaticoduodenectomy (PD) with vascular resection and reconstruction was planned.

Anterior SMA first approach was performed and first jejunal vein and inferior mesenteric vein were divided. Pancreas was transected at SMA plane (which is medial to the usual plane of transection, to facilitate arterial reconstruction), involved 2.5-cm segment of SMV, and SMV-PV confluence was resected and end to end repair with 6–0 polypropylene continuous sutures was performed using operating loupes. To obtain length on portal vein for primary repair, liver was completely mobilized from its diaphragmatic attachments by dividing the falciform ligament, both triangular and coronary ligaments; hepatoduodenal ligament dissection was performed to straighten the vein along its course. Division of the splenic vein also helped in this regard. On the inferior aspect, mobilization of the root of the mesocolon and dividing the mesenteric attachments helped in achieving length of the vein for a tension-free anastomosis. The ends were marked with marking ink before division to allow perfect alignment of the cut ends and avoid a kink in the anastomosis. Intravenous 5000 international units of unfractionated heparin was given just prior to clamping of the portal vein. The cut ends were flushed with unfractionated heparin during the anastomosis.

A 3-cm resection of RCHA and end to end repair with 7–0 polypropylene continuous sutures were performed under operating microscope (Fig. 4a, b). The replaced artery had a long curved course, and hence, no intraoperative difficulties were encountered in doing an end to end primary repair for the artery.

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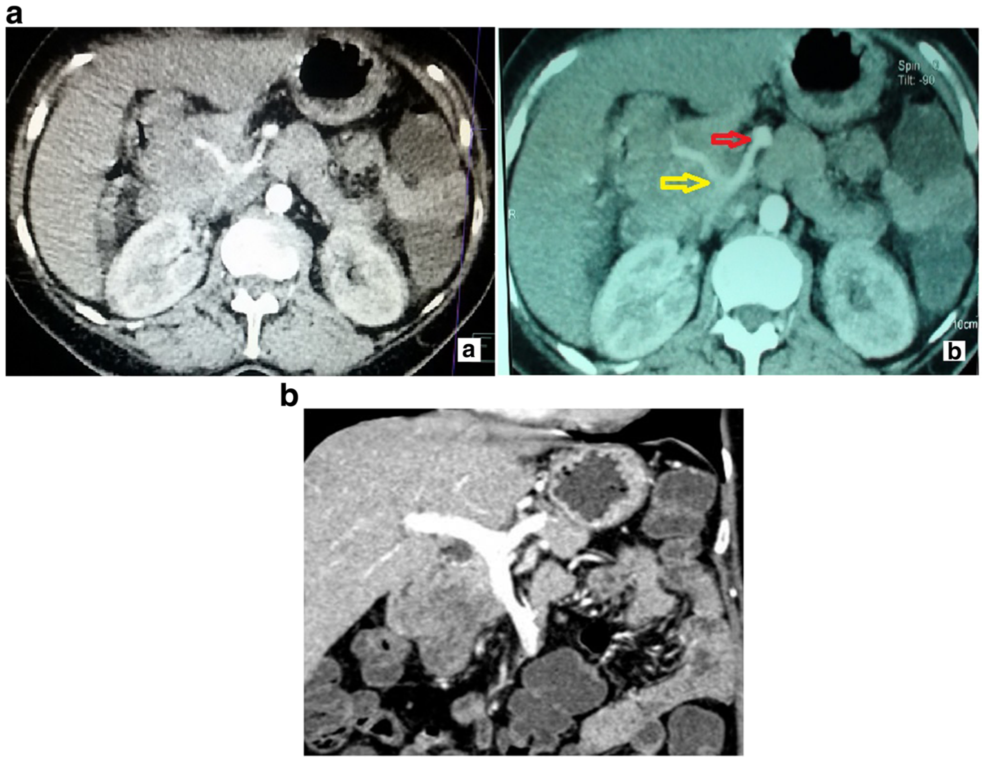

Fig. 1 **a** (a, b) Axial image and axial reconstructed image of contrast-enhanced computed tomography arterial phase showing the replaced common hepatic artery arising from superior mesenteric artery and coursing through the tumor. **b** Coronal image of contrast-enhanced computed tomography portal phase showing the involvement of superior mesenteric-portal vein junction by the tumor abutment

The arterial cut ends were also flushed with unfractionated heparin during the anastomosis. During both the vascular anastomosis, care was taken to keep the edges everted, avoid intimal tears, and avoid incorporation of adventitia between the intima. Duct to mucosa pancreaticojejunostomy (5–0 polydioxanone inner layer and 4–0 polypropylene outer layer), continuous single layer hepaticojejunostomy, and conventional antecolic 4 layer gastrojejunostomy were fashioned. A falciform sling between vascular anastomosis and bowel anastomosis was kept and a lesser sac left subhepatic drain and right subhepatic drain were placed. An intraoperative Doppler ultrasound was performed to confirm hepatic flow in both the repaired vessels.

Our postoperative protocol involved a portal vein and arterial Doppler on the third postoperative day to confirm hepatopetal flow in both the vessels and it was normal. Therapeutic anticoagulation was given for 7 days postoperatively and the patient was prescribed oral anticoagulation for 3 months due to the performance of arterial reconstruction. The patient had postoperative delayed gastric emptying which resolved on conservative management and superficial surgical site infection which was managed by dressings and secondary healing. She was discharged on day 18. Histopathology revealed pT4N1 (1/15; stage III), moderately differentiated duodenal adenocarcinoma with all margins and vascular cut ends free. CHA was coursing through pancreatic parenchyma and focal involvement by tumor was present. Six cycles of adjuvant 5-fluorouracil, oxaliplatin, and leucovorin (FOLFOX) were given. The patient has no recurrence at 18 months follow-up.

Discussion

Duodenal carcinomas comprise 0.3–1% of all gastrointestinal neoplasms [3]. Secondary involvement of duodenum by malignancies of pancreatic head, pancreatic body, and uncinate tumors is more common than primary [4]. Primary carcinoma duodenum arises from second portion of duodenum (45%) and has the most favorable 5-year outcomes among periampullary carcinomas (pancreas12–15%, CBD 27%, ampulla 39%, duodenum 56%) [3–5]. Role of neoadjuvant therapy is not established unlike pancreatic head cancer wherein patients will be given neoadjuvant chemo/radiotherapy in cases with arterial involvement [6]. Aggressive R0 surgical resection is the backbone of treatment plan for primary duodenal carcinoma [7].

Preoperatively planned vascular resection achieves better surgical preparation and has better outcomes compared to intraoperative decision. Detailed knowledge of vascular anatomy is necessary for planning and execution of resection major vessels in periampullary region [2]. Superior mesenteric vein (SMV) tributaries to identify and consider while planning surgery include gastrocolic (Henle) trunk (right gastroepiploic, anterior superior pancreaticoduodenal, and accessory right colic vein in 60%) or the gastropancreatic trunk (if the accessory right colic vein does not open into it), middle colic vein, ileal and jejunal veins, inferior pancreaticoduodenal vein, and inferior mesenteric vein if it opens into SMV [8].

The venous involvement in our case is zone 3a by Alemi et al. classification and according to the International Study Group

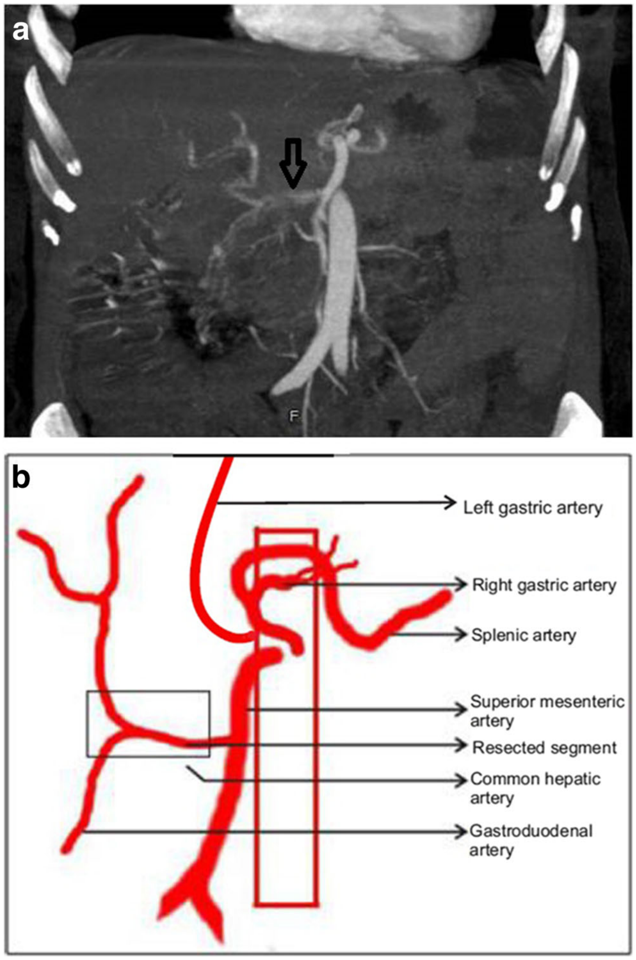

Fig. 2 **a** Coronal reformatted image of contrast-enhanced computed tomography arterial phase showing the variant anatomy with replaced common hepatic artery (arrow) arising from superior mesenteric artery and coursing through the tumor. **b** Schematic representation of the variant arterial anatomy and tumor-involved segment in our case

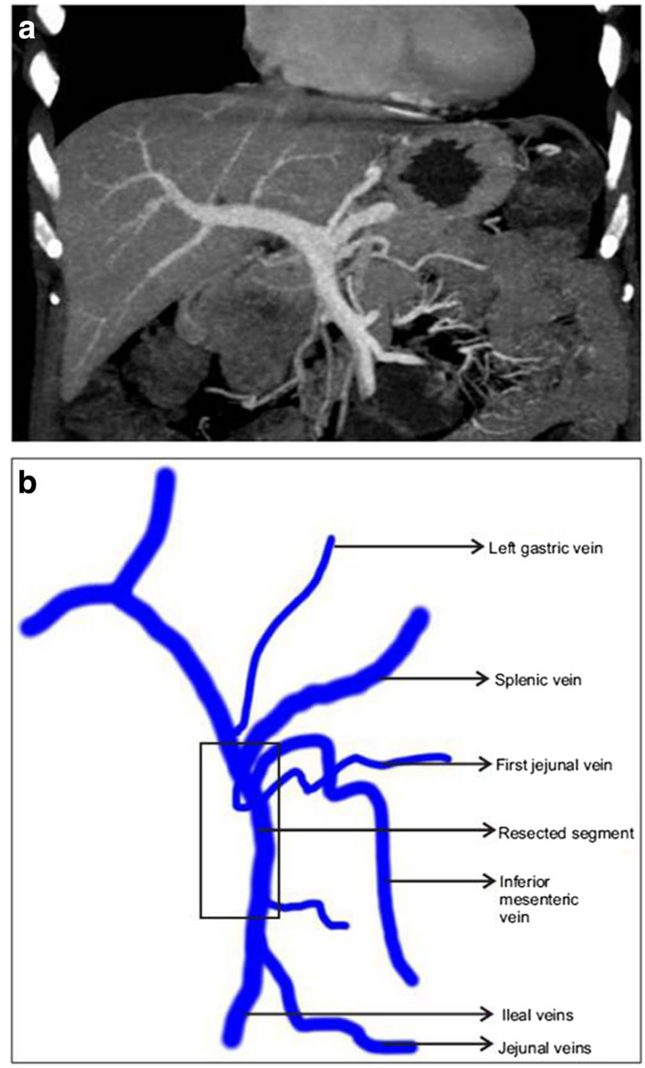

Fig. 3 **a** Coronal image of contrast-enhanced computed tomography portal phase showing the anatomy and involvement of superior mesenteric-portal vein junction by the tumor abutment. **b** Schematic representation of the superior mesenteric-portal venous anatomy and tumor-involved segment in our case

on Pancreas Society (ISGPS); we performed a type III venous reconstruction [9, 10]. Type I (primary venorrhaphy), type II (patch repair), and type IV (venous conduit or graft repair) are the other options for venous reconstruction [10].The key criteria is to identify and preserve the vein which has more than 1.5 times the diameter of SMA to avoid bowel ischemia. Venous reconstruction is now an accepted standard in pancreatic surgery where indicated [2].

Technical aspects for a good venous reconstruction include preoperative planning to identify the need for a graft, appropriate draping and preparation of the graft site, complete dissection of the specimen such that it hangs only at the site of the vascular involvement, and individual control of jejunal and ileal veins as well as the proximal vein before dividing the involved segment. A clamp test can be performed before resecting the planned jejunal or ileal vein to see the extent of small bowel congestion on clamping the vein and avoid small bowel ischemia in those cases by not dividing the vein. The ileal branch is preferred for reconstruction because of its craniocaudal direction, thick walls compared to jejuna vein, its anterior course in relation to SMA, and hence less anastomotic complications. Superior mesenteric artery clamping is advised when the superior mesenteric venous occlusion time is more than 25 min to prevent small bowel congestion due to already occluded venous return [9–11].

Length of up to 4 cm can be achieved for primary end to end venous repair by mobilization of liver and root of mesocolon, splenic vein division, and loosening of self-retaining retractors as performed in our case. For venous reconstruction, the available options for grafts include autologous internal jugular vein, great saphenous vein, left renal vein, splenic vein turndown, and iliac veins or a polytetrafluoroethylene (PTFE) graft. Among these options, there are no differences in terms of infection rates, morbidity, mortality, and patency rates in recent studies. A

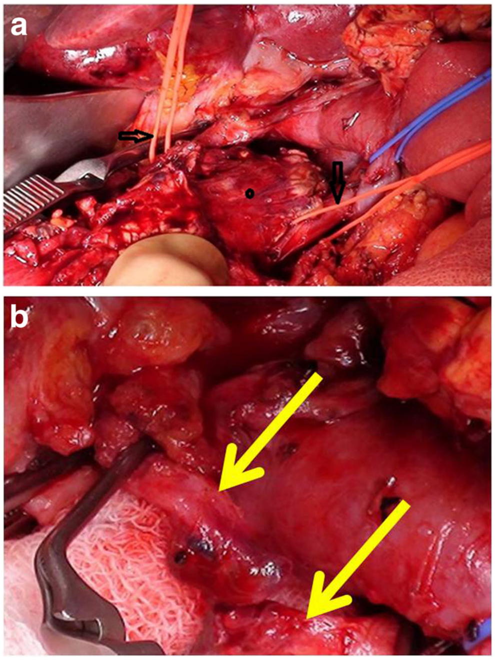

Fig. 4 **a** Intraoperative image shows the replaced common hepatic artery looped proximal and distal to the tumor (dot) by red vascular loops (arrows). **b** Intraoperative image showing alignment of the arterial cut ends at the beginning of microvascular repair

growth factor in venous reconstructions is leaving the last suture a bit loose to provide 125–150% expansion and avoid purse string effect and is recommended [2, 11].

RCHA arises from SMA in 1.5–6%. Revascularization is important to prevent ischemia of the biliary-enteric anastomosis [2, 12]. The Michel's classification had 10 variations in hepatic artery origin out of which IX and X were CHA arising from SMA and left gastric artery respectively [13]. This was modified to Hiatt classification with six variations of which V and VI were CHA arising from SMA and aorta respectively [14]. Higashi and Hirai described the course of RCHA in relation to PV and pancreas wherein the RCHA coursed behind the PV from right or left in I and II, respectively, whereas in IIIA and P, RCHA coursed anterior or posterior to pancreas. In type VA/P, it coursed posterior to SMV and then anterior or posterior to pancreas [15].

The involvement of RCHA is a different situation than involvement of SMA as SMA involvement implies disease spread beyond the confines of surgery, whereas focal involvement of replaced artery is within the limits of surgery [2, 12]. If the primary end to end repair is not feasible due to length of the resected segment, splenic artery is the best graft available in the operative field, which can be transposed keeping its root with celiac axis intact, if possible or it can be resected and used as an interposition graft if the root is not being preserved due to celiac axis resection. Saphenous vein graft, gastroduodenal artery graft, and left gastric artery are the other grafts that can be used [2, 12, 16].

As described by Yamamoto et al., the options to deal with RCHA in cases of periampullary malignancies include the options of preserving the artery within pancreatic parenchyma by dividing parenchyma which risks margin positivity and tumor spread, and hence is not preferred. If artery is ventral to pancreas, it can be dissected. If there are collaterals (left gastric/accessory), it can be divided without reconstruction or pylorus-preserving pancreaticoduodenectomy with preservation of right gastric artery and division without reconstruction of RCHA can be performed. When the artery is intraparenchymal with tumor infiltration as in our case, resection with repair/reconstruction is the best option [11].

The patency of the anastomosis can be confirmed by intraoperative Doppler ultrasound evaluation for hepatopetal flow and postoperative Doppler evaluation as per the patient's clinical condition or the institutional protocol. We perform a postoperative Doppler on the third day as a routine for all patients. Intravenous unfractionated heparin on therapeutic doses is administered by some units for all vascular reconstructions for 7 days followed by oral anticoagulation for 3–6 months [2, 9, 10, 12]. We prescribe this regime only for arterial reconstruction and not for isolated venous reconstruction. A stringent follow-up for vascular patency as well as for disease-specific management is the key to a successful outcome of this complex surgery.

Conclusion

Pretreatment differentiation of duodenal carcinoma from pancreatic cancers is important to plan treatment. Imaging for vascular involvement and variations is critical for surgical planning. SMA first approach is useful so is division of pancreas in arterial plane. If vascular resection achieves R0 resection, it is recommended in PD for duodenal carcinoma.

Author Contributions Gunjan Desai and Prasad Pande have worked for the literature review and the manuscript preparation under the creative inputs, critical evaluation, and guidance of Rajiv Shah and Palepu Jagannath.

Compliance with Ethical Standards

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

Informed Consent Informed consent was obtained from the patient for this publication.

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