

Splenic artery transposition for hepatic arterial reconstruction in a locally advanced pancreatic cancer: a case report and literature review

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Abstract. – OBJECTIVE: During pancreatic surgery for malignancies, hepatic revascularization is needed in case of en bloc resection with hepatic artery involvement. In these cases, the use of the splenic artery is described in the literature, including transposition and interposition techniques.

PATIENTS AND METHODS: We report the case of pancreatic cancer resection with involvement of the right hepatic artery, anomalous arising from the superior mesenteric artery, and hepatic revascularization with splenic artery reconstruction. A literature review to analyze the use of splenic artery in hepatic revascularization during pancreatic cancer surgery was performed.

RESULTS: A 61-year-old man with a 55-mm hypovascular tumor in the pancreatic head, in wide contact with the right hepatic artery, underwent total pancreatectomy and splenectomy. Right hepatic artery was resected, and the distal part of the splenic artery was transposed to the right hepatic artery with a termino-terminal anastomosis. Histopathological examination revealed R0 resection.

CONCLUSIONS: Hepatic revascularization with splenic artery should be considered in patients suitable to extend resectability in pancreatic cancer surgery. A multidisciplinary approach and careful pre-operative planning are essential.

Key Words:

Vascular surgery, Pancreas carcinoma, Oncovascular surgery, Personalized medicine.

Introduction

Pancreatic cancer (PC) is the sixth most common tumor and fourth cause of death in oncologic patients (22% of deaths among gastrointestinal

cancers)¹. PC is associated with a poor prognosis, with less than 5% of patients surviving 5 years after the diagnosis².

About 30-40% of all patients with PC presents with unresectable locally advanced pancreatic cancer with involvement of nearby vasculature, such as the hepatic artery (HA), celiac trunk (CT), and superior mesenteric artery (SMA)³. Hepatic revascularization is needed in case of en bloc resection with HA involvement. In these cases, the use of splenic artery (SA) is described in literature, including transposition and interposition techniques⁴.

To ensure the successful surgical resection of these advanced tumors, a multidisciplinary team, including oncologic and vascular specialists is essential from the detailed preoperative planning and co-operation to postoperative management⁵.

We report the case of PC resection with involvement of the right hepatic artery (RHA), arising from the SMA, and hepatic revascularization with SA reconstruction and literature review.

Patients and Methods

This report described the case of a patient who underwent pancreatic surgery with arterial reconstruction for a PC at Fondazione Policlinico Universitario Gemelli IRCCS in Rome, Italy. Diagnosis of pancreatic cancer was based on clinical presentation, laboratory findings, and radiological findings on computed tomography angiography (CTA). Preoperative evaluation of CTA was performed at a dedicated workstation

and multiplanar reconstructions were used. The patient was observed at regular postoperative appointments. CTA was performed 1-month postoperatively. Written informed consent was obtained from the patient for publication of this case report and accompanying images.

A literature review to analyze the use of SA in hepatic revascularization during PC surgery was performed through the PubMed registry with articles dating from January 1, 2005, to March 1, 2021. Search terms were “splenic” AND “artery” AND (“transposition” OR “interposition”) AND (“pancreas” OR “pancreatic”). Articles were excluded within this review if they reported the use of techniques different from SA transposition or interposition. Case-series analyses and single case reports were included.

Results

Case 1

A 61-year-old man was referred to our hospital for elective surgical treatment of locally advanced pancreatic head cancer. Physical examination showed jaundice and itch. Laboratory analyses revealed high levels of total bilirubin (4 mg/dL). A computed tomography (CT) revealed a 55-mm hypovascular tumor in the pancreatic head, in wide contact with the RHA originating from the SMA. Tumor markers level were elevated, including CEA (1.43 ng/mL) and CA19-9 (8 U/mL). Endoscopic ultrasonography-guided fine needle aspiration cytology was performed, and pathological findings revealed pancreatic adenocarcinoma.

Before the surgical intervention, the patient underwent neoadjuvant chemotherapy with Folfirinox (5FU 2400 mg/mq), Oxaliplatin (85 mg/mq), Irinotecan (150 mg/mq). Partial response was observed.

The surgical treatment was performed under general anesthesia. No hepatic metastatic lesions nor peritoneal carcinosis were reported. The planned intervention was a duodenocephalopancreatectomy (DCP). In absence of an adequate cleavage plane between the tumor on the posterior aspect of the pancreatic head and the right hepatic artery, we decided to perform an arterial resection and total pancreatectomy. We resected the RHA from the origin SMA and the neoplastic infiltration. To revascularize the RHA, we realized splenic artery transposition and sple-

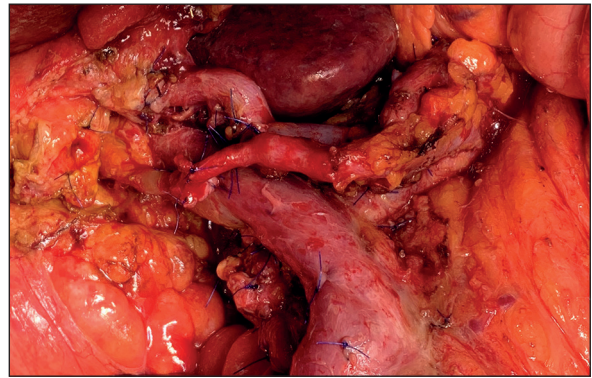


Figure 1. Intraoperative image of SA-RHA transposition.

nectomy. The distal part of the splenic artery was transposed to the RHA with a termino-terminal anastomosis (Figure 1). Termino-lateral hepatic-jejunosotomy and duodenal-jejunal anastomosis were finally performed.

The intra-operative hepatic ultrasonography scan documented regular patency and flow in RHA and its branches (Figure 2).

Histologic examination showed a ductal adenocarcinoma NAS, stage yTNM: ypT1aypN0 (0/14) (AJCC 8th ed 2017)6. Foci of adenocarcinoma were reported in resected segment of hepatic artery. All resection margins were negative (R0). Perineural infiltration and intra-arterial neoplastic emboli were present.

The postoperative course was uneventful. The patient was discharged on postoperative day 10.

At 1 month follow-up the patient was in good clinical conditions, with no fever nor abdominal pain. CT scan showed patency of the reconstructed RHA, with no stenosis nor occlusion (Figure 3).

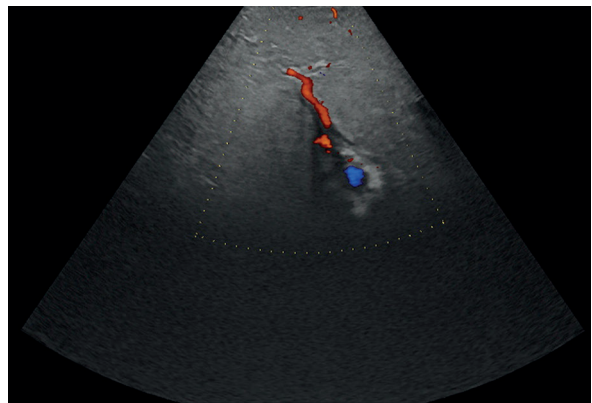


Figure 2. Intraoperative ultrasound scan showing patency and good flow in the vascular reconstruction.



Figure 3. Pre-operative 3D Volume Rendering (VR) CT-scan (A) with yellow arrows indicating the RHA arising from SMA. Post-operative 3D VR CT-scan (B) showing the SA transposition for revascularization of RHA.

Discussion

Pancreatic cancer is one of the most malignant neoplasms in the world. The main tumor types are adenocarcinoma (85% of cases) and pancreatic endocrine tumors (less than 5%). GLOBOCAN 2020 estimates as many deaths from pancreatic cancer (466000) as cases (496000) because of its poor prognosis⁷.

According to the most recent estimates of the Italian Association of the Tumor Registries (AIRTUM), 13,500 Italian patients are affected by PC, accounting for 3% of all primary tumors. Incidence is higher in men, especially in the Northern regions. PC is the fourth cause of mortality in women and the sixth in men, with life expectancy of 5% at 5 years⁸. The main risk factors are smoking, obesity, poor physical activity, alcohol consumption, chronic pancreatitis, BRCA 1, and BRCA 2 mutations. PC may be associated with genetic syndromes, as hereditary pancreatitis syndrome, hereditary non-polyposis colorectal cancer, hereditary atypical multiple mole melanoma syndrome, and the Peutz-Jeghers syndrome⁹.

Nowadays, the treatment of choice of pancreatic adenocarcinoma is still represented by the surgical resection. However, surgery is not always achievable as first treatment, because vascular structures are often encased by the tumor, making necessary arterial or venous resection and reconstruction. Neoadjuvant chemotherapy is a good approach for non-metastatic pancreatic cancer, improving resectability and pathological and clinical findings^{10,11}.

A pre-operative CT scan score can accurately predict the need of vascular procedure. In this case, the tumor completely surrounded the right hepatic artery¹². When hepatic artery resection is performed, reconstruction is essential to maintain hepatic blood flow and reduce morbidity and mortality rates¹³.

A careful planning of abdominal surgical procedures is important, since 20% of cases presents variations of the hepatic anatomy¹⁴. One of the most popular classification of hepatic arterial variations was realized by Michels et al¹⁵ in 1966: it describes 10 types of hepatic arterial anatomy including anomalous origin of celiac trunk, common, right and left hepatic artery and presence of accessory arteries¹⁵. This classification was then modified by Hiatt in 1994 and includes six categories¹⁶.

Consequently, prior identification of any anatomical variations of the celiac and mesenteric arterial branches is important. In this case, RHA originated from the SMA. Different techniques are available to preserve liver circulation. We adopted the splenic artery transposition for hepatic arterial reconstruction. If the hepatic artery is involved distally of the CT basis, the transposition technique of the splenic artery is preferable. According to Hackert et al⁴, the principle of transposition is that the splenic artery is preserved at its origin from the celiac axis, mobilized as far as necessary, and transposed on the distal common hepatic artery or a common ostium of the right and left hepatic artery⁴. Splenic artery interposition is a possibility to bridge the resection defect

Table I. Summary of the type of hepatic artery reconstruction during DCP for pancreatic carcinoma.

Author	Cases	Neoadjuvant Chemotherapy	Pathological diagnosis	Vascular reconstruction	Tumor resection
Amano 2009 ¹⁷	1	-	-	SA-RHA transposition and LHA reimplantation with end-to-side anastomosis.	R0
Aosasa 2016 ¹⁸	3	-	-	CT-PHA with SA interposition	R0
Perinel 2016 ¹⁹	9	FOLFIRINOX Protocol	-	SMA-SA interposition (6); SA-PHA transposition (2); SA-LHA transposition (1)	R0
Tanaka 2021 ¹³	1	Gemcitabine/nab- Paclitaxel (GnP)	yp4N1 (3/27), M0	SA-RHA transposition and PV-SMV direct end-to-end anastomosis	R0
Tinelli 2021	1	Folfirinox (5FU 2400 mg/mq), Oxaliplatin (85 mg/mq), Irinotecan (150 mg/mq)	ypT1aypN0 (0/14)	SA-RHA transposition with a termino-terminal anastomosis	R0

SA, splenic artery; RHA, right hepatic artery; LHA, left hepatic artery; CT, celiac trunk; PHA, proper hepatic artery; SMA, superior mesenteric artery; PV, portal vein; SMV, superior mesenteric vein.

of the HA up to a length of 5-6 cm in cases where the basis of the celiac trunk is involved in the tumorous process.

A summary of the SA use for hepatic revascularization during PC surgery described in the literature is presented in Table I^{13,17-19}.

Both hepatic arteries have to be reconstructed, unless one is not affected by the tumor and can be preserved, or an accessory left or right artery is present. Seelig et al²⁰ explain the advantages of SA transposition compared with interposition of saphenous vein graft: SA offers the adequate length to reach the porta hepatis, one single anastomosis has to be performed and there is not any mismatch of caliber. Theoretically spleen could be preserved, since short gastric arteries provide a sufficient perfusion; however, splenectomy is usually necessary for oncologic reasons.

Zang et al²¹ report a similar case and report the advantages of this technique, resumable in easy access, use of autogenous artery, small difference of caliber and close proximity of the vessels anastomosed¹². Other possible options are proper hepatic artery-left gastric artery anastomosis, direct common hepatic artery-proper hepatic artery anastomosis or with interposition of large saphenous vein graft.

Pancreatic surgery may associate to a substantial number of postoperative complications, ranging from 40% to 70%²². Wound infections and intra-abdominal abscesses subsumed as surgical site infections represent the most common septic complication after pancreas surgery, with the consequent reduction of the quality of life of

these patients^{23,24}. Other possible complications are postoperative hemorrhage, pancreatic fistula, leakage from anastomosis, delayed gastric emptying, exocrine and endocrine pancreatic insufficiency, ascending cholangitis^{25,26}.

Conclusions

Vascular surgery plays an important role in oncologic surgery. Vascular structures are often involved by the tumor and vascular anatomical anomalies are frequent. A multidisciplinary approach and a careful pre-operative planning are essential to ensure en bloc tumor resection with vascular reconstruction.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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