



## Feasibility and Safety of Spleno-Aortic Bypass in Patients with Atheromatous Celiac Trunk Stenosis in Pancreaticoduodenectomy

Tullio Piardi<sup>1</sup> · Rami Rhaïem<sup>1</sup> · Arman Aghei<sup>1</sup> · Francesco Fleres<sup>1</sup> · Yohann Renard<sup>1</sup> · Ambroise Duprey<sup>2</sup> · Daniele Sommacale<sup>1</sup> · Reza Kianmanesh<sup>1</sup>

Received: 6 January 2019 / Accepted: 23 January 2019 / Published online: 13 February 2019  
© 2019 The Society for Surgery of the Alimentary Tract

In cases of celiac trunk (Ct) occlusion in patients requiring pancreaticoduodenectomy (PD), hepatic arterial flow must be preserved to avoid complications, such as hepatic ischemia. From January 2012 to August 2018, 183 PD were performed in the Digestive and Hepatobiliary Surgery Department-University of Reims-France. In 5 patients (2.7%), we observed, in the preoperative imaging study, a pre-occlusive atheromatous stenosis of the Ct. Among them, 3 patients deemed non-manageable by endovascular techniques. Herein, we report the results of a new strategy with a spleno-aortic bypass (SAB) associated to PD to overcome the Ct stenosis.

Hepatic arterial blood supply in patients with stenosis of the Ct is provided from the superior mesenteric artery (SMA) via collateral pathways. Trede et al.<sup>1</sup> described the existence of “additional” collateral pathways from the SMA to the hepatic and splenic arteries (HA and SA), which guaranteed a sufficient blood flow to the upper abdominal organs in spite of Ct stenosis. However, in PD for malignancy, the HA and SMA are closely dissected to ensure a complete lymphadenectomy and thus R0 resection. Therefore, the ligation of the gastroduodenal artery (GDA) in patients with Ct stenosis might compromise the arterial blood flow to the liver. In such patients, preoperative management of Ct stenosis is mandatory before PD.

In our Department, multidetector-CT scan with 3D arterial reconstruction was routinely performed in candidates for PD to study anatomical variations of HA, vascular invasion

staging, and Ct and/or SMA stenosis. In 3 patients (1.6%) (Table 1), CT scan showed a significant calcified stenosis at the origin of the Ct (Fig. 1a). Preoperative endovascular approach failed. The conservation of the hepatic arterial flow has to be maintained to allow safe postoperative course after PD. We thought of the possibility to derive the arterial flow from the aorta to the HA through the SA, using a SAB. This vascular anastomosis could shunt the stenosis at the origin of the Ct. The only condition for the safety of the procedure was the absence of extension of the stenosis to the hepatic-splenic arteries division. In our department, we routinely perform pancreaticojejunal anastomosis after PD. But, as such procedure could compromise the vascularization of the left pancreas, we extended the pancreatic resection to the left without subsequent anastomosis (Fig. 1b). Instead, a wirsungostomy, using a catheter inserted in the main duct of the remnant pancreas, was performed. We thought that it should reduce the rate of pancreatic fistula and especially of hemorrhagic complications that could be fatal.

### Surgical Technique

The patient was placed in a supine position. First, in all cases, the operation began with the exposure of the anterior surface of the pancreas. The gastroduodenal artery (GDA) was dissected and clamped. Intraoperative Doppler ultrasonography was then performed to bring out significant reduction of the arterial hepatic flow. At this time, the common hepatic artery and the origin of the splenic artery were dissected. An antegrade pancreatectomy was performed with preservation of the splenic vein. The arterial branches to the pancreas from the splenic artery were divided. The dissection of the pancreas was led until the distal 4 cm from the splenic hilum. Special care was undertaken to preserve the short vessels as they were the only remnant arterial supply for the pancreatic stump. After ligation of its distal portion, a small clamp was placed

✉ Rami Rhaïem  
rrhaïem@chu-reims.fr

<sup>1</sup> Department of General, Digestive and Hepatobiliary Surgery, Robert Debré University Hospital, University of Champagne-Ardenne, Ave Général Koenig, 51100 Reims, France

<sup>2</sup> Department of Vascular Surgery, Robert Debré University Hospital, University of Champagne-Ardenne, Reims, France

**Table 1** Pre- and postoperative characteristics of patients

Case	Age	BMI	Comorbidity	Indication	Diagnosis of Ct stenosis	Operative time (min)	Complication	TNM/R	Hospital stay	Follow-up (month)
1	78	25.6	Coronary disease	Pancreatic adenocarcinoma	CT scan	570	No	T3N0LIV0 R0 resection	13 days	15
2	63	34.6	Hypertension obesity	IPMN high-grade dysplasia	Ct scan	600	Spleen abscess	IPMN dysplasia +++	30 days	13
3	77	27.5	Coronary disease	Pancreatic adenocarcinoma	CT scan	450	No	T2N2LIV0 R0 resection	12 days	3

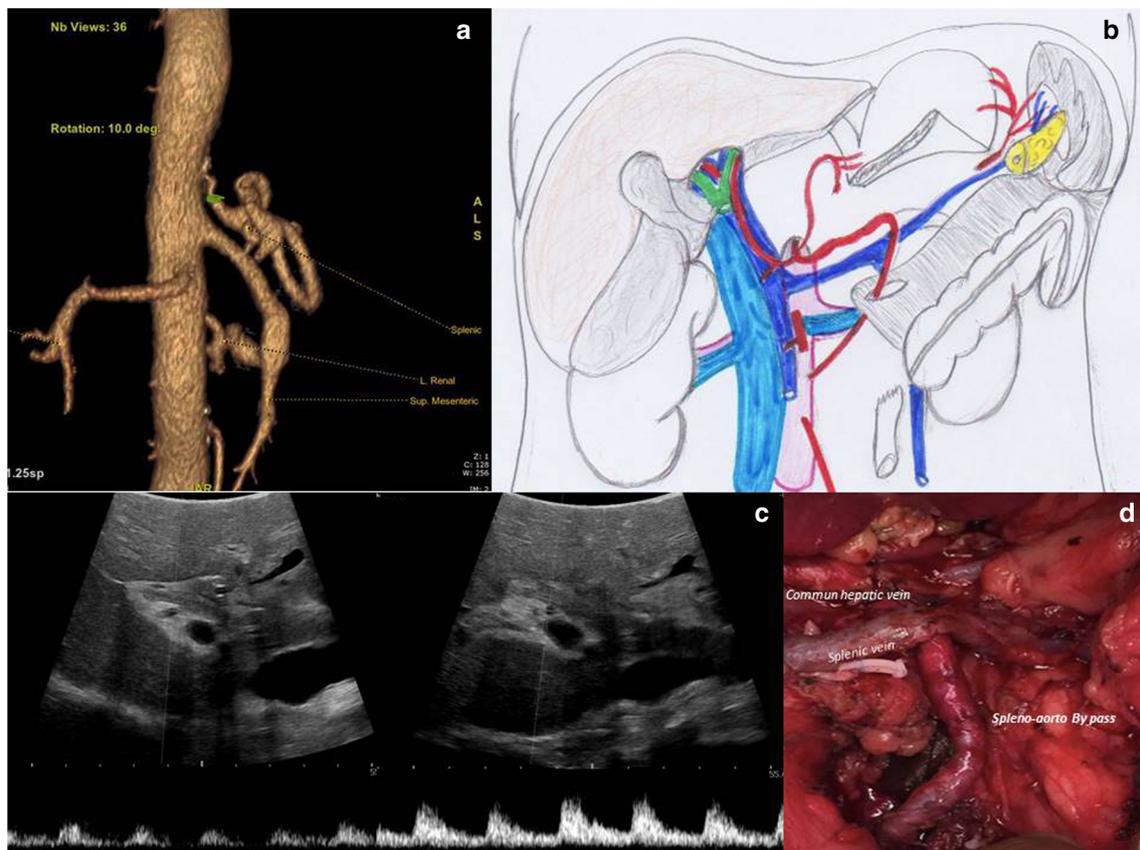
IPMN, intraductal papillary mucinous neoplasia

on the origin of the splenic artery. The anterior surface of the aorta was exposed above and under the level of the renal vein. An end to side spleno-aortic bypass was performed using 6/0 prolene suture. Depending on the length of the vascular graft confectioned using the splenic artery, the anastomosis was placed either under or above the renal vein (Fig. 1d). After the confection of the SAB, Doppler US was performed again under clampage of the GDA to check the quality of the arterial hepatic flow (Fig. 1c). Only at this time, the sections of the GDA and of the pancreas were undertaken, and a wirsungostomy catheter was inserted into the pancreatic duct

and exteriorized to drain the pancreatic juice. Then, after resection of the specimen, bilioenteric and gastroenteric anastomosis were done.

### Postoperative Care

Patients were admitted in the intensive care unit. Prophylactic heparin treatment was administrated. Routine biology tests on postoperative days 1, 3, 5, and 7 and postoperative day 7 CT scan were performed. After uneventful postoperative course,



**Fig. 1** a Preoperative CT scan 3D reconstruction: concentric stenosis of the origin of the celiac trunk. b Anatomic representation of the pancreaticoduodenectomy with spleno-aortic bypass under the level of the renal vein. c Intraoperative Doppler ultrasound before and after the

confection of spleno-aortic bypass with an improvement of Doppler signal at the level of the hepatic artery after the bypass. d Intraoperative view after the confection of spleno-aortic bypass

the drainage placed in contact of the pancreatic stump was progressively mobilized. All patients had multidisciplinary management with our endocrinology team to manage the onset of insulin-dependent diabetes.

## Postoperative Outcome

The 90-days mortality was nil. There was no graft loss. Table 1 summarizes the early postoperative results. One patient had postoperative spleen abscess (Clavien-Dindo IIIa) that required percutaneous drainage.

This is the first report, to our knowledge, describing a series of patients treated with PD for pancreatic cancer and managed with a SAB to shunt a stenosis of the Ct. In the study by Gaujoux et al.,<sup>2</sup> the postoperative mortality related to ischemia after PD occurred in 5 patients with liver necrosis in 4 patients. These results highlighted that preoperative vascular analysis is of paramount interest before PD. Vascular strategy towards Ct stenosis has to be decided preoperatively especially when it is due to atheroma. In this setting, CT scan with 3D lateral reconstruction of CA and SMA is the gold standard.<sup>3, 4</sup>

The previous reported cases of revascularization of the Ct during Whipple's procedure were indicated intraoperatively after the occurrence of supramesocolic ischemia.<sup>5–8</sup> Nowadays, preoperative stenting of the CT is the best approach. It prevents from the morbidity related to the confection of a vascular anastomosis especially the risk of arterial anastomotic pseudoaneurysm secondary to pancreatic fistula. The surgical option in our cases was decided only after the failure of endovascular approach.

This technique is safe and reproducible. It allowed satisfactory hepatic arterial flow. This latter was preserved during the whole procedure as the GDA was not ligated until US Doppler verification of the flow. The extension of the pancreatic resection to the left without confection of a pancreatic anastomosis might reduce the risk of pancreatic fistula and the subsequent vascular complications. Serious and multimodal management of the postoperative diabetes could allow stable and safe glycaemic levels.

**Author's Contribution** Tullio Piardi: conception of the work, drafting the manuscript, final approval of the version to be published and agreement to be accountable for all aspects of the work.

Rami Rhaïem: conception of the work, drafting the manuscript, final approval of the version to be published and agreement to be accountable for all aspects of the work.

Arman Aghei: acquisition of data, drafting the manuscript, final approval of the version to be published and agreement to be accountable for all aspects of the work.

Francesco Fleres: acquisition of data, drafting the manuscript, final approval of the version to be published and agreement to be accountable for all aspects of the work.

Yohann Renard: interpretation and analysis of data, drafting the manuscript, final approval of the version to be published and agreement to be accountable for all aspects of the work.

Ambroise Duprey: interpretation and analysis of data, revising the manuscript, final approval of the version to be published and agreement to be accountable for all aspects of the work.

Daniele Sommacale: design of the work, revising the manuscript, final approval of the version to be published and agreement to be accountable for all aspects of the work.

Reza Kianmanesh: design of the work, revising the manuscript, final approval of the version to be published and agreement to be accountable for all aspects of the work.

## Compliance with Ethical Standards

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

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

## References

1. Trede M. Vascular problems and techniques associated with pancreatectomy and regional pancreatectomy. In: Trede M, Carter DC, editors. *Surgery of the pancreas*. 2nd ed. New York: Churchill Livingstone, 1997, p 505–16.
2. Gaujoux S, Sauvanet A, Vullierme M. P, et al. Ischemic complications after pancreaticoduodenectomy: incidence, prevention, and management. *Ann. Surg* 2009; 249: 111–117. <https://doi.org/10.1097/SLA.0b013e3181930249>
3. Yang F, Di Y, Li J, et al. Accuracy of routine multidetector computed tomography to identify arterial variants in patients scheduled for pancreaticoduodenectomy. *World J Gastroenterol* 2015; 21: 969–976. <https://doi.org/10.3748/wjg.v21.i3.969>
4. Nakayama Y, Sugimoto M, Kobayashi T et al. Impact of pancreaticoduodenal arcade dilation on postoperative outcomes after pancreaticoduodenectomy. *HPB* 2018; 20: 49–56. <https://doi.org/10.1016/j.hpb.2017.08.019>
5. Murakami Y, Uemura K, Yokoyama Y, et al. Celiac axis occlusion with replaced common hepatic artery and pancreatoduodenectomy. *J Gastrointest Surg* 2004;8: 520–522. <https://doi.org/10.1016/j.gassur.2004.01.003>
6. Okamoto H, Suminaga Y, Toyama N, et al. Autogenous vein graft from iliac artery to splenic artery for celiac occlusion in pancreaticoduodenectomy. *J Hepatobiliary Pancreat Surg* 2003; 10: 109–112. <https://doi.org/10.1007/s10534-002-0831-7>
7. Portolani N, Tiberio G, Coniglio A, et al. Emergency celiac revascularization for supramesocolic ischemia during pancreaticoduodenectomy: report of a case. *Surg Today* 2004; 34: 616–618. <https://doi.org/10.1007/s00595-004-2755-z>
8. Sakorafas G, Sarr M, Peros G, et al. Celiac artery stenosis: an underappreciated and unpleasant surprise in patients undergoing pancreaticoduodenectomy. *J Am Coll Surg* 2008;206: 349–356. <https://doi.org/10.1016/j.jamcollsurg.2007.09.002>