JOP. J Pancreas (Online) 2009 Nov 5; 10(6):667-670.

CASE REPORT

Successful Pancreaticoduodenectomy with Immediate Vascular Reconstruction in a Patient with Cancer of the Pancreatic Head and Celiac Artery Stenosis. A Case Report

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ABSTRACT

Context Celiac artery stenosis is observed in a significant percentage of individuals in the general population. Although usually clinically silent and insignificant, due to the presence of extensive collaterals between the celiac artery and the superior mesenteric artery, celiac artery stenosis may be associated with potentially catastrophic ischemic complications in patients undergoing pancreaticoduodenectomy, due to the abrupt interruption of the collateral pathways. Therefore, revascularization may be indicated in selected patients with celiac artery stenosis undergoing a PD. **Case report** We present a patient with celiac artery stenosis diagnosed intraoperatively during a PD, who underwent vascular reconstruction at the time of the PD. In the immediate postoperative period, he developed hepatic ischemia due to stenosis at the anastomosis of the stent with the hepatic artery. He was subsequently treated successfully with the endovascular placement of a stent. In retrospect, a careful reevaluation of the preoperative abdominal CT scan showed the stenosis at the origin of celiac artery. **Conclusion** A careful evaluation of abdominal CT scan is required to preoperatively identify this not uncommon vascular obstructive disease, especially in asymptomatic patients. Otherwise, the astute surgeon should suspect celiac artery stenosis based on intraoperative findings/changes immediately following ligation of the gastroduodenal artery during a PD.

INTRODUCTION

Celiac artery stenosis is a relatively common obstructive vascular disease [1, 2, 3]. Although patients with celiac artery stenosis are usually asymptomatic, due to a collateral blood supply, pancreatico-duodenectomy (PD) in the presence of celiac artery stenosis may be associated with potentially catastrophic consequences, due to ischemia of the upper abdominal organs as a result of surgical disruption of the collateral pathways. In selected patients with celiac artery stenosis undergoing a PD, preservation of the blood supply to the upper abdominal organs is essential.

In this paper, we present a patient with cancer of the head of the pancreas who was diagnosed with celiac artery stenosis during the PD; instead of a classic PD, this patient underwent a complicated procedure which included bypass grafting between the aorta and the common hepatic artery. The relevant literature is briefly reviewed.

Received July, 4th, 2009 - Accepted August 6th, 2009

Key words Arteries; Ischemia; Mesenteric Artery; Superior; Neoplasms; Pancreas; Pancreatitis, Chronic

Abbreviations PD: pancreaticoduodenectomy

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Document URL http://www.joplink.net/prev/200911/08.html

CASE REPORT

A 64-year-old man was referred to our department for the surgical management of a neoplasia of the head of the pancreas, diagnosed during a diagnostic work-up for painless jaundice. The patient's general condition was good and his past medical history was unremarkable.

Preoperative investigation included abdominal CT which showed a large mass in the head of the pancreas, without metastases. In retrospect, a review of the preoperative CT showed a tight stenosis of the celiac artery with good patency of its branches (Figure 1). The cause of the celiac artery stenosis cannot be determined based on the findings of CT. Due to high levels of total bilirubin (30 mg/dL; reference range: 0-1.3 mg/dL), a biliary stent was placed preoperatively.

During surgery, the resectional phase of the PD was particularly tenuous because the tumor was large and contiguous with the portal vein and the superior mesenteric artery. Following a particularly difficult dissection, the neck of the pancreas was dissected free

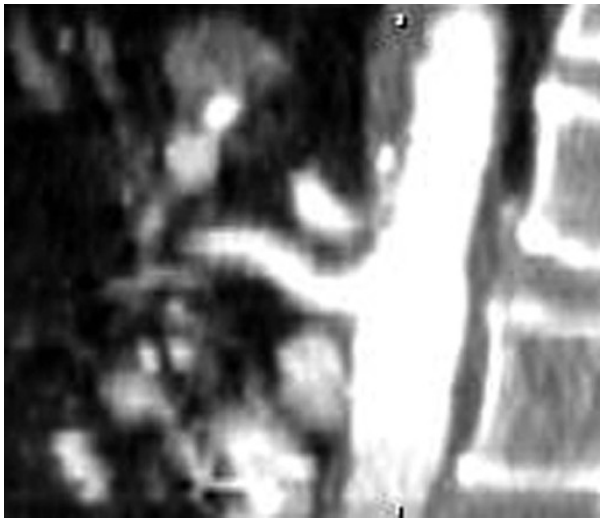

Figure 1. In retrospect re-evaluation of the preoperative CT of the abdomen showed notable stenosis at the origin of the celiac axis (sagital multiplanar reconstruction image).

from the portal vein. A decision was then made to proceed to a classical PD. The gastroduodenal artery was ligated and divided. During the subsequent stages of the PD, it was observed that the volume of the liver was significantly reduced and appeared ischemic. The common hepatic artery was recognized, but no pulsative flow of blood was identified within it. At this time, it was believed that the common hepatic artery was thrombosed; attempts to remove the possible thrombus via an arteriotomy and with a Fogarty catheter were performed. During these maneuvers, it was observed that the blood flow within the common hepatic artery was very limited. Intraoperative Doppler ultrasonography showed patency of the portal vein, but limited blood flow in the major branches of the celiac artery. At this time, the patient had metabolic acidosis (increased levels of lactic acid). The gastric wall showed evidence of tissue ischemia, without active bleeding after its transection. It was therefore thought that the patient had celiac artery stenosis, and that all the indications observed of organ ischemia were caused by ligation of the gastroduodenal artery which was the main collateral pathway (through the pancreatico-duodenal arcades) between the celiac artery and the superior mesenteric artery.

To avoid postoperative ischemia from the upper abdominal organs, the original plan for a typical PD (with typical reconstruction, following the resectional phase of the procedure) was abandoned. To avoid ischemia from the stomach (and a dangerous gastrointestinal anastomosis) and the spleen, a total gastrectomy and a Roux-en-Y esophagojejunostomy were performed. Following PD, the upper jejunum was divided about 30 cm from its open end; the long segment was used for the esophagojejunal anastomosis while the short segment was used to complete the choledochojejunal anastomosis. This short segment was anastomosed end-to-side to the long Roux jejunal loop. The spleen was preserved to insure a blood supply to the pancreatic stump. Finally, to avoid a potentially ischemic pancreaticojejunal anastomosis, a catheter (Nelaton, 8 French) was placed in the pancreatic duct of the pancreatic remnant and was exteriorized. To achieve adequate arterial blood flow to the liver, bypass grafting between the aorta and the common hepatic artery was performed (using a 4 mm polytetrafluoroethylene (PTFE) synthetic graft, anastomosed end-to-side to these two arteries). The celiac axis branches were re-examined by Doppler ultrasonography at the end of the bypass procedure and showed adequate blood flow within these branches. To prevent graft thrombosis, intravenous heparin was

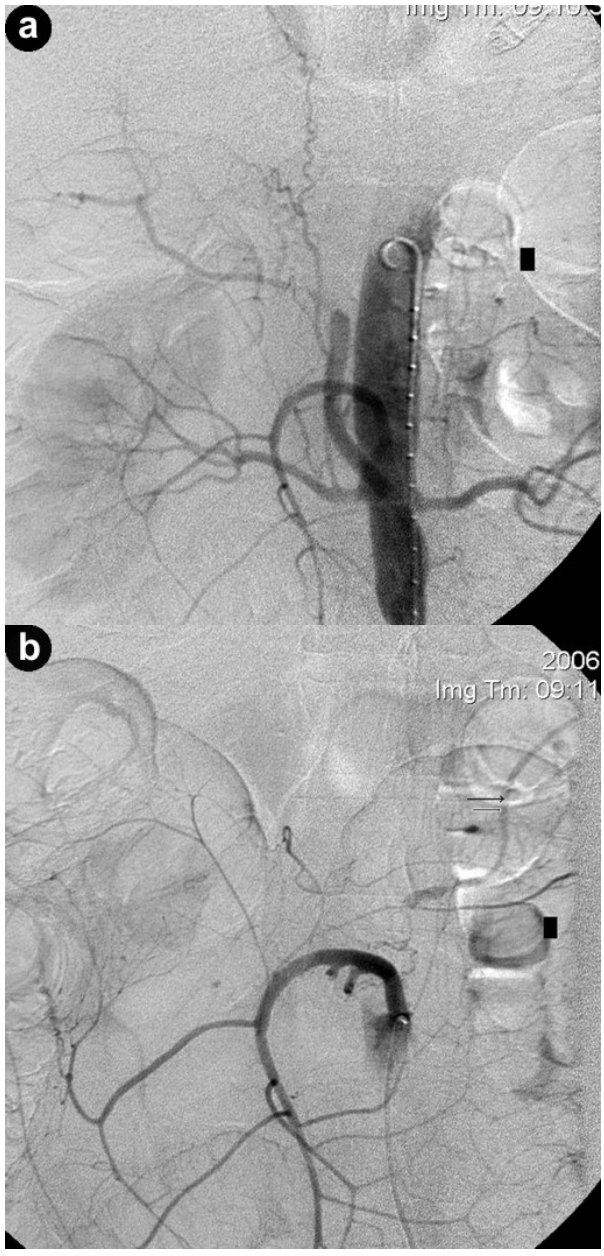

Figure 2 a. Postoperative abdominal digital subtraction angiography (DSA) showing good patency of the aortohepatic artery bypass graft, with stenosis at the distal anastomosis. **b**. Postoperative abdominal digital subtraction angiography (DSA): the celiac artery is not depicted while the splenic artery was reconstituted via collaterals (arrows).

Figure 3. Recanalization of the stenosed segment after selective catheterization of the graft using a 0.014 inch guidewire and two overlapping 4x18 mm stents.

given (full anticoagulation) both at the time of surgery as well as postoperatively.

In the immediate postoperative period, hepatic function gradually deteriorated. The patient was transferred to the interventional radiology suite. An abdominal digital subtraction angiography (DSA) was performed which showed good patency of the aorto-hepatic artery bypass graft. A stenosis was observed at the distal anastomosis (Figure 2a). The celiac artery was not imaged while the splenic artery was reconstituted via collaterals (Figure 2b). Recanalization of the stenosed segment was performed with two overlapping 4x18 mm stents, after selective catheterization of the graft using a 0.014 inch guidewire (Figure 3). Completion digital subtraction angiography showed resolution of the stenosis (Figure 4).

The postoperative course was complicated by pneumonia of the lower right lobe which was successfully treated using appropriate antibiotic therapy. A fluid collection adjacent to te pancreatic remnant was treated by CT-guided percutaneous drainage and yielded amylase-rich fluid; a culture showed the presence of *Escherichia coli* (infected peripancreatic fluid collection).

The patient was discharged on postoperative day 42. During his hospitalization, drainage of the pancreatic fluid through the catheter placed within the pancreatic duct was minimal. He is well, 14 months after surgery.

DISCUSSION

Celiac artery stenosis is frequently observed in the general population; its incidence ranges from 2 to 50% [1, 2]; the most accurate estimation of its incidence is probably between 10 and 25% [3, 4, 5]. Celiac artery stenosis is usually asymptomatic, due to the rich collateral anastomoses between the celiac artery and the superior mesenteric artery, mainly through the pancreaticoduodenal arcades and the dorsal pancreatic artery. During a PD, however, the gastroduodenal artery is typically ligated and divided, thereby abruptly disrupting effective collaterals. Therefore, ischemia of the upper (supracolic) abdominal organs, supplied by the celiac artery and its branches, may result. This ischemia may be associated with significant postoperative morbidity (liver failure, intrahepatic abscesses, anastomotic ischemia and leakage (from the pancreaticojejunostomy, bilioenteric anastomosis, and gastrojejunostomy), etc.). Therefore, an astute surgeon should be able to recognize celiac artery stenosis in patients undergoing a PD. Celiac artery stenosis can be diagnosed either preoperatively (ideally, but rarely) or during surgery. Nowadays, since angiography is not routinely performed during the diagnostic evaluation of patients who are scheduled to undergo a PD, the preoperative diagnosis of celiac artery stenosis is possible based on the findings of the CT scan (usually, the presence of enlarged and extensive collateral pathways) [6]. Intraoperative diagnosis of celiac artery stenosis during a PD can be made by using intraoperative Doppler ultrasonography and/or the gastroduodenal artery clamping test, either alone or, preferably, in association with intraoperative Doppler ultrasonography [1]. Moreover, the surgeon should

Figure 4. Completion digital subtraction angiography (DSA) showing resolution of the stenosis.

look for any clinical indication of visceral ischemia during the PD after the ligation/transection of the gastroduodenal artery as this could be due to celiac artery stenosis (as occurred in our patient).

Management options depend on the etiology of the celiac artery stenosis. If the celiac artery stenosis is known to be caused by pressure from adjacent tissue (such as the median arcuate ligament, or enlarged neural or fibroinflammatory tissue), the division of this tissue is a simple and highly effective therapeutic maneuver [7]. In Eastern countries, external compression is the most common cause of celiac artery stenosis while, in Western countries, celiac artery stenosis is most commonly due to atherosclerotic disease which typically causes ostial celiac artery stenosis [8, 9]. This is the presumed cause of celiac artery stenosis in our patient. In this case, if the diagnosis is known preoperatively, preoperative intraluminal stenting of the stenosed artery is a highly attractive management option since it is a minimally invasive technique achieving effective treatment of the stenosis, thereby avoiding extensive and prolonged surgical revascularization in addition to another major abdominal surgery (i.e. a PD) [8, 9, 10]. When celiac artery stenosis is diagnosed during a PD (which probably is the most common clinical scenario), surgical revascularization should be considered. In this case, two options are available: arterial bypass grafting (most common) [1, 11] or re-implantation of the celiac axis to the aorta [1, 7, 11, 12]. Preservation of the gastroduodenal artery is another proposed strategy [13]; however, GDA preservation is a extremely difficult from a technical point of view and, more importantly, it is contraindicated in the presence of malignant disease. A prudent choice might be a more extensive resection (i.e. a typical Whipple procedure instead of a pylorus-preserving PD, even total gastrectomy, splenectomy) in order to diminish the metabolic demands of the upper abdominal viscera, as occurred in our patient. Obviously, in this case, the avoidance of a pancreaticojejunostomy should be considered and the pancreatic remnant could be managed by external drainage, by placing a catheter within the pancreatic duct in association with peripancreatic drains (as in our patient).

In conclusion, celiac artery stenosis is not an uncommon vascular disease. Although clinically insignificant for the general population (due to the presence of extensive collaterals between the celiac artery and/or its branches and the superior mesenteric artery), celiac artery stenosis poses a potentially catastrophic ischemic threat in patients undergoing a PD. A preoperative abdominal CT scan should be carefully evaluated in order to detect this not so uncommon vascular obstructive disease, especially in asymptomatic patients (direct visualization of the stenosis or extensive and enlarged collaterals between the superior mesenteric artery and the branches of the celiac artery). Otherwise, the astute clinician should be able to recognize celiac artery stenosis based on intraoperative findings/changes following ligation of the gastroduodenal artery. Following celiac artery stenosis identification, the surgeon should be able to preserve the blood supply to the upper abdominal organs following a PD. Experience in vascular surgery or close collaboration with a vascular surgeon and an experienced interventional radiologist is essential in order to minimize postoperative morbidity and mortality under these difficult circumstances.

Conflict of interest The authors have no potential conflicts of interest

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