CASE REPORT

Vascular challenges from pancreatoduodenectomy in the setting of coeliac artery stenosis

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SUMMARY

Coeliac artery stenosis due to median arcuate ligament compression or atherosclerotic disease is a frequently unrecognised challenge to recovery after pancreatoduodenectomy. The described case illustrates management with intraoperative superior mesenteric artery to hepatic artery bypass graft that led to haemorrhagic challenges postoperatively but ultimately a good recovery. Aspects of preoperative diagnosis, preoperative intervention and intraoperative management options are reviewed. Surgeons need to possess these tools to prevent complications from coeliac artery stenosis when pancreatoduodenectomy is required.

BACKGROUND

Pancreatoduodenectomy (PD) remains an important treatment modality for patients with pancreatic cancer localised to the head of the pancreas. In patients with compromised blood flow at the coeliac axis origin, the collateral flow that develops over time from the superior mesenteric artery (SMA) to the hepatic artery (HA) via the gastroduodenal artery (GDA) and other pathways will likely have to be sacrificed during the oncological resection; this can result in ischaemia of the liver, stomach and pancreas remnant affecting surgical anastomoses.[1] The incidence of coeliac artery stenosis in patients undergoing PD is as high as 10% and can result from atherosclerotic disease, compression by the median arcuate ligament or fibrosis due to desmoplasia from lymph node metastasis or chronic pancreatitis.[1–8] These aberrations to the normal vascular function can result in life-threatening complications if not recognised before or at the time of pancreatic resection. Here, we present a patient who underwent PD with SMA to HA artery bypass for pancreatic adenocarcinoma of the head of the pancreas in the setting of coeliac artery stenosis and review the strategies to recognise, address and mitigate the potentially significant challenges.

CASE PRESENTATION

A 69-year-old woman presented with unintentional weight loss and jaundice due to a mass in the head of the pancreas.

INVESTIGATIONS

The workup included CT, endoscopic ultrasound scan and endoscopic biliary wall stenting. Findings suggested a cT2N0M0 head of pancreas cancer, and a 4.5 cm thoracoabdominal aneurysm with proximal coeliac artery occlusion (figure 1). Vascular surgery was consulted preoperatively and recommended consideration of bypass at the time of rejection so as to avoid any interventional stenting that would perhaps complicate the repair of the aneurysm.

TREATMENT

At PD, HA pressure after test clamping of the GDA was <20 mm Hg, with return of bright but non-pulsatile blood; after the pylorus-sparing resection, a SMA to HA saphenous vein bypass was performed (figure 2). The common hepatic duct diameter was 12 mm, and the pancreatic duct measured 4 mm within a moderately firm gland. Hepaticojejunostomy and pancreaticojejunostomy reconstructions of well-perfused tissues were performed, followed by antecolic duodenojejunostomy. Pathological analysis identified a pT3N0M0 intermediate grade pancreatic ductal adenocarcinoma, with extension into duodenum, 0 of 36 lymph nodes involved and a R0 resection.

OUTCOME AND FOLLOW-UP

Duplex ultrasound scan of hepatic inflow showed unimpaired pulsatile hepatopetal flow originating from a patent graft on postoperative day (POD) 3. The subsequent course was characterised by a grade B pancreatic fistula requiring percutaneous drainage and antibiotics. The patient was free of systemic sequelae but developed bleeding on POD 17. Angiographic workup showed no active bleeding and a patent bypass graft. The patient recovered and was discharged, but had another bleeding episode on POD 29. A pseudoaneurysm at the graft to HA site was identified, and the HA and bypass graft were coil embolised (figure 3). The patient's subsequent postoperative course was complicated with the development of a hepatic abscess 4 months after embolisation, but ultimately she made a full recovery. She was not treated with adjuvant therapy and remains free of disease more than 3 years after resection.

DISCUSSION

Coeliac arterial insufficiency is a common finding, and as our case demonstrates, can present unique operative challenges during PD and in the postoperative management of complications. This case summary adds to the available reports in the literature and highlights the challenges and pitfalls of performing PD in patients with coeliac arterial insufficiency.

Various strategies, both preoperatively and intraoperatively, have been studied to help better

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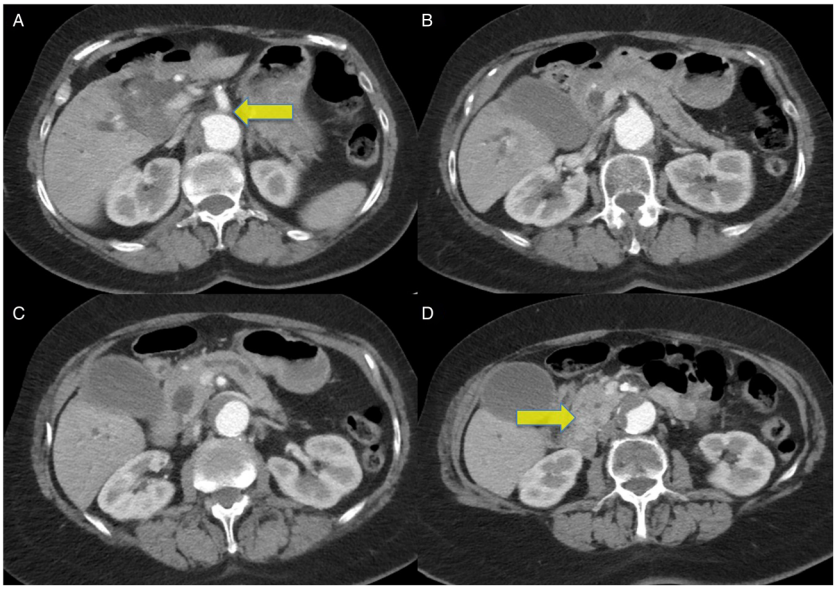

Figure 1 CT of pancreatobiliary and vascular abnormalities. (A) Contrast column defect at coeliac artery origin (arrow). (B) Biliary and pancreatic ductal distension. (C) Duct distension and aortic mural abnormalities. (D) Periampullary mass (arrow) and aortic mural abnormalities.

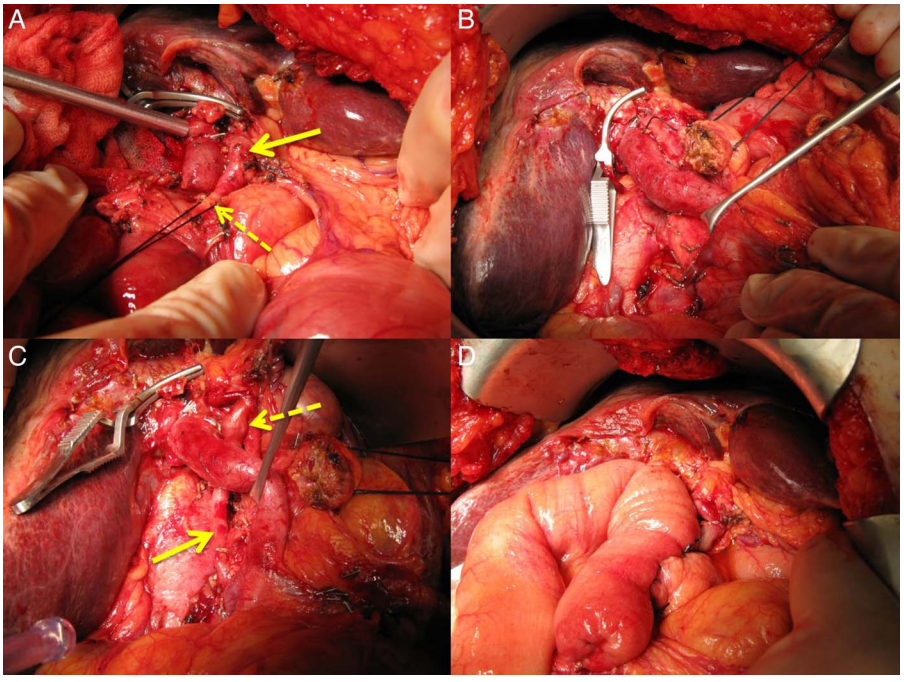

Figure 2 Intraoperative images. (A) Vascular assessment of proper hepatic artery (solid arrow) and looped gastroduodenal artery (dashed arrow). (B) Appearance after completed resection. (C) Retroportal saphenous vein bypass graft between SMA and common hepatic artery; solid arrow marks proximal graft, dashed arrow distal graft. (D) Completed hepaticojejunostomy and pancreaticojejunostomy. SMA, superior mesenteric artery.

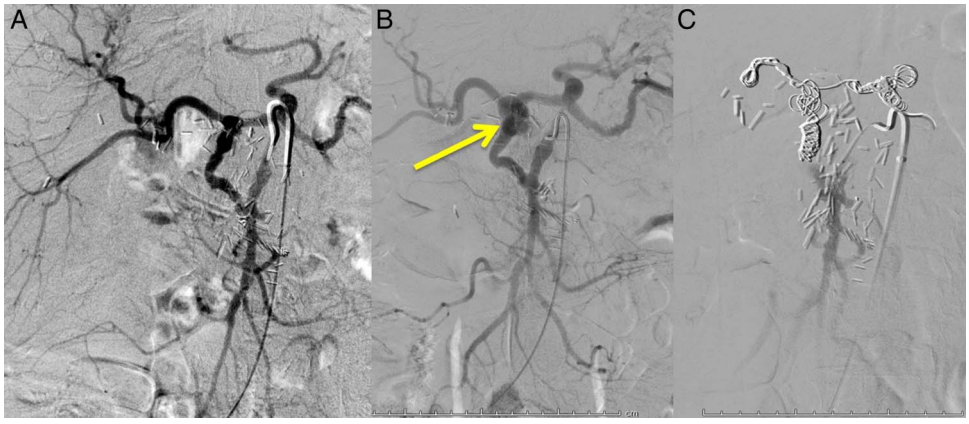

Figure 3 Angiographic findings. (A) First postoperative SMA angiography, with patent graft to CHA and coeliac contrast distribution. (B) Second postoperative SMA angiography, with pseudoaneurysm at distal anastomosis (arrow). (C) Findings after completed coil embolisation. CHA, common hepatic artery; SMA, superior mesenteric artery.

identify and mitigate complications following pancreatectomy, especially in the presence of coeliac axis occlusive disease that could result in life-threatening ischaemia following PD.[9–13] These include preoperative abdominal vascular CT, coeliac and mesenteric angiography, Doppler ultrasonography, and intraoperative techniques.[2 5 14–18] In patients undergoing PD, the presence of coeliac arterial stenosis should be included in the radiologist's report and should prompt the consultation of vascular surgery and/or an interventional radiologist. There is clear evidence that patients with high-grade stenosis should be addressed preoperatively using an endovascular approach.[4] When the stenosis is less significant, the decision becomes more difficult.

While preoperative imaging is often diagnostic, assessment and verification of vascular insufficiency is best made in the operating room. Bull *et al*[2] endorse the most widely used manoeuvre, that is, test occluding the GDA with palpation of the HA before GDA ligation to ensure adequate collateralisation. This technique was used in the presented case and yielded findings suggestive of hepatic arterial insufficiency without a revascularisation procedure; gastric and pancreas remnant blood flow were not specifically assessed, but concerns over possible malperfusion in the setting of anastomotic reconstructions lent further support in favour of a revascularisation of the coeliac system. While data supporting these practices are lacking, we routinely perform an intraoperative assessment of the hepatic arterial inflow prior to ligation of the GDA.[2 19]

Intraoperative identification of coeliac arterial insufficiency during PD should be recognised and prompt surgical revascularisation performed. Re-establishment of coeliac circulation during PD is dependent on the site and type of occlusion, and several strategies have been described (table 1).[3–8 17–22]

In patients with impingement by the median arcuate ligament or desmoplastic or inflammatory fibrosis as the source of coeliac occlusion, division of the median arcuate ligament or adjacent fibrosis, respectively, is sufficient and appears to be associated with minimal added morbidity (table 2).[3 7 8] However, atherosclerotic lesions of the coeliac axis, especially if not amenable to interventional endovascular approaches such as in our patient, may necessitate an arterial bypass. Multiple techniques have been described previously and include end-to-end anastomosis between the middle colic and GDA, aortohepatic bypass grafting, reimplantation of the coeliac trunk, splenomesenteric arterial reimplantation and venous graft bypass between the iliac artery and the splenic artery.[1 9–11] The latter may theoretically place the arterial anastomosis more remotely to a pancreatic anastomosis. Owing to anatomic considerations and the presence of aortic aneurysmal abnormalities, a SMA to common heptatic artery (CHA) reversed saphenous vein bypass graft was performed in the presented patient, and her postoperative

Table 1 Summary of reported patients with coeliac arterial insufficiency who underwent pancreatoduodenectomy

Author, year	Patients, n (frequency in study)	Aetiology of occlusion (n)	Intervention, n	Outcome (n)
Fortner, 1981[17]	2 (CR)	Compression (2)	MAL release, 2	Uneventful
Kohler, 1990[3]	1 (CR)	Compression (1)	MAL release, 1	Uneventful
Okamura, 1998[18]	1 (CR)	Compression (1)	No intervention, 1	Uneventful
Berney, 1998[19]	15 (CR)	Compression (2)	MAL release, 2	Pancreatic fistula and death (1)
		Atheromatous (13)	Reconstruction, 2	Uneventful
			Collateral preservation, 2	Uneventful
			No intervention, 9	Transient liver ischaemia (2), pancreatic fistula (2)
Kurosaki, 2004[8]	5/126 (4%)	Compression (5)	MAL release, 3	Uneventful
			Collateral preservation, 2	Uneventful
Nara, 2005[7]	7/357 (2%)	Compression (1)	MAL release, 1	Uneventful
		Atheromatous (2)	Reconstruction, 1	Uneventful
			Collateral preservation, 1	Uneventful
		CHA injury during angiography (1)	No intervention, 1	Liver abscess (1)
		Unknown, (3)	No intervention, 3	Liver abscess (1)
Shima, 2005[20]	1 (CR)	Compression (1)	Reconstruction, 1	Uneventful
Farma, 2007[6]	14/332 (4%)	Compression (14)	MAL release, 10	CA reocclusion requiring stent placement (1)
			Reconstruction, 3	Uneventful
			CHA endarterectomy, 1	HA occlusion, biliary fistula, hepatic abscess (1)
Nakano, 2007[21]	1 (CR)	Compression (1)	MAL release, 1	Uneventful
Gajoux, 2009[4]	25/545 (4.6%)	Compression (23)	MAL release, 23	CA injury (1), CA thrombosis and death (1) CA insufficiency requiring stent placement and pancreatic fistula (1)
		Atheromatous (2)	Reconstruction, 1	Pancreatic fistula (1)
			Preoperative stent, 1	Pancreatic fistula (1)
Berselli, 2010[22]	1 (CR)	Atheromatous (1)	Reconstruction, 1	Pancreatic fistula, splenic artery pseudoaneurysm (1)
Sugae, 2012[5]	12/561 (2.1%)	Compression (12)	MAL release, 8	Reoperation for gastric ischaemia, 1
			Reconstruction, 2	Uneventful
			Collateral preservation, 1	Uneventful

CA, coeliac artery; CR, case report; HA, hepatic artery; MAL, median arcuate ligament.

Table 2 Outcomes of pancreatoduodenectomy in 85 patients with coeliac arterial insufficiency by aetiology and type of repair

	Total n	Morbidity n (%)	Mortality n (%)
Aetiology			
External compression	63	6 (9.5%)	2 (3.2%)
Atheromatous	18	7 (16.7%)	0
Other	4	2 (50%)	0
Type of repair			
MAL release	51	6 (11.7%)	2 (3.9%)
Vascular reconstruction/ bypass	12	3 (33%)	0
Collateral preservation	6	0	0
Endovascular stent	1	1 (100%)	0
Endarterectomy	1	1 (100%)	0
No intervention	14	6 (42.9%)	0

MAL, median arcuate ligament.
Source: publications listed in table 1.

course was complicated by a pancreatic fistula and pseudoaneurysm formation that required coil embolisation. Whether the ileosplenic bypass described by Okamoto *et al*[11] would have precluded this complication is uncertain; however, technical considerations to mitigate complications after extensive operative intervention warrant consideration. Similarly, preservation of collateral blood flow in appropriately selected patients, usually without underlying malignancy, has also been described and seems to avoid the technical challenges and potential complications associated with vascular reconstruction (table 2).

Our review of the literature reveals that the morbidity and mortality in patients with coeliac stenosis may differ depending on the aetiology and type of repair employed (table 2). In addition, some series suggest an increased incidence of postoperative pancreatic fistula in patients with coeliac arterial insufficiency, owing to decreased splenic arterial blood flow and subsequent reduction in pancreatic remnant perfusion.[1] However, data are sparse and publication bias very likely exists, with poor outcomes predictably under-reported. In general, published outcomes of patients with coeliac artery insufficiency who undergo PD appear to be comparable to historic controls of PD. While the frequency of complications may be comparable, the clinical impact of these same complications may differ in patients with coeliac arterial insufficiency. A quantitative measure of the severity of the complication is a more accurate reflection of the ultimate morbidity burden of an operation and has not been measured in this group of patients.[12] This potential difference is illustrated well in this case presentation. Our patient developed a pancreatic fistula that resulted in a pseudoaneurysm and haemorrhage from the bypass graft. After coil embolisation, she subsequently developed hepatic abscesses that required drainage. In addition to the proposed increase in clinical burden of complications that occur following PD in patients with coeliac stenosis, our case also illustrates the unique challenges these patients pose in managing postoperative complications. Owing to the physiological disturbance posed by a technically demanding operation, we feel strongly that non-invasive approaches are much preferred to minimise the burden of a complication. Interventional coiling is successful in stopping postpancreatectomy haemorrhage 80% of the time and can avoid reoperation for which results are generally inferior.[13]

The role of interventional vascular techniques for coeliac axis obstruction prior to PD in reducing postoperative complications is controversial for low-grade lesions, but have clear indications for lesions with >60% stenosis.[16] Endovascular stents are used preoperatively to avoid technical challenges and potential morbidity associated with performing a vascular bypass at the time of PD.[4 14 15] However, predicting which patients will develop clinically relevant ischaemia following PD is challenging due to the highly variable nature of the collaterals that develop; this is an ongoing area of research.[7] Smith *et al*[16] found no association between coeliac occlusion and increased postoperative morbidity when they analysed patients with <60% stenosis. Yet, in at-risk patients with radiographic evidence of high-grade coeliac stenosis with development of retrograde flow through the CHA, preoperative endovascular approach is a necessary intervention.[4]

In conclusion, coeliac arterial insufficiency is a relatively uncommon finding that can present unique operative challenges during PD. The presence of coeliac arterial stenosis should be included in the radiologist's report and should prompt the consultation of vascular surgery and/or an interventional radiologist. There is clear evidence that patients with high-grade stenosis should be addressed preoperatively using an endovascular approach. If unrecognised it can result in significant morbidity and mortality. Surgeons should have a heightened suspicion for this challenge preoperatively and should be prepared to address the problem intraoperatively. Intraoperative assessment of hepatic and coeliac arterial flow prior to and again after ligation of the GDA is crucial, and insufficiencies should prompt surgical revascularisation by means of arcuate ligament release or via vascular bypass if necessary.

Learning points

- Coeliac arterial insufficiency is a relatively uncommon finding that can present unique operative challenges during pancreatoduodenectomy, and if unrecognised it can result in significant morbidity and mortality.
- Surgeons should have a heightened suspicion for this challenge preoperatively and should be prepared to address the problem preoperatively or intraoperatively if necessary.
- Intraoperative assessment of hepatic and coeliac arterial flow prior to and again after ligation of the gastroduodenal artery is crucial, and insufficiencies should prompt surgical revascularisation by means of arcuate ligament release or via vascular bypass if necessary.

Competing interests None declared.

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