CASE REPORT

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Enhanced Vascular Collateralization Through the Pancreaticoduodenal Arcade Secondary to Median Arcuate Ligament Compression of the Celiac Axis in the Setting of Pancreatic Body Adenocarcinoma: The Ideal Scenario for the Modified Appleby Procedure

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Abstract

Background: A modified Appleby procedure for pancreatic body tumors relies upon collateral vessels maintaining blood flow to the proper hepatic artery (PHA) through the pancreaticoduodenal arcade (PDA) off of the superior mesenteric artery (SMA). Compression of the celiac axis by the median arcuate ligament (MAL) promotes the expansion of collateral vessels without preoperative intervention.

Case Presentation: A 51-year-old male with asymptomatic compression of the celiac artery presented with new onset insulin-dependent diabetes mellitus. He underwent imaging that demonstrated a locally advanced pancreatic body tumor that encased the superior mesenteric vein and portal vein confluence and involved the common hepatic artery. He had an adequate response to neoadjuvant FOLFIRINOX chemotherapy and underwent an uncomplicated modified Appleby procedure with a margin negative resection. Hepatic blood flow was adequate through the PHA as a result of collateralization of blood flow through the PDA off the SMA. The enhanced collateralization appeared to have occurred secondary to compression of the celiac axis by the MAL.

Conclusions: Herein we present a unique case in which improved collateral blood flow through the PDA and the gastroduodenal artery to the PHA occurred due to celiac artery compression by the MAL. This vascular anomaly fortuitously improved the ability to achieve an R0 resection of a locally advanced pancreatic adenocarcinoma of the body of the pancreas by a modified Appleby procedure.

Keywords: pancreatic cancer; median arcuate ligament syndrome; neoadjuvant chemotherapy; modified Appleby procedure; hepatic artery

Background

The modified Appleby procedure involves distal pancreatectomy with en bloc splenectomy and en bloc celiac axis resection for locally advanced tumors of the body and tail of the pancreas. R0 resection can be obtained following neoadjuvant therapy and demonstrates similar survival outcomes to patients with less advanced cancer.¹ The success of the surgery is depen-

dent upon adequate flow to the liver through the pancreaticoduodenal arcade (PDA) from the superior mesenteric artery (SMA) to the gastroduodenal artery (GDA) and the proper hepatic artery (PHA). The original procedure as described by Appleby allowed for R0 resection of the stomach and its blood supply for gastric carcinoma.² To achieve R0 resection, arterial reconstruction may be necessary.³ Some surgeons

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routinely perform preoperative embolization of the common hepatic artery (CHA) to encourage collateralization through the PDA.⁴

Acute angulation of the origin of the celiac artery can lead to its compression by the median arcuate ligament (MAL), resulting in postprandial epigastric pain, bloating, or nausea, known as MAL syndrome.⁵ Twenty-one percent of patients with radiographic evidence of the MAL syndrome exhibit no symptoms.⁶ The compression of the celiac axis causes decreased celiac and CHA blood flow and promotes collateralization through the PDA from the SMA in a manner similar to that of preoperative embolization of the CHA.

Presentation

A 51-year-old male presented with newly diagnosed insulin-dependent diabetes mellitus and a markedly elevated Hgb-A1C. Evaluation for this condition by computerized tomography (CT) scan revealed a central pancreas tumor encasing the superior mesenteric vein (SMV) and portal vein (PV) confluence and abutting the celiac axis (involving the CHA). The patient underwent seven cycles of FOLFIRINOX chemotherapy (leucovorin, fluorouracil, irinotecan, and oxaliplatin) and repeat imaging demonstrated a 2.2 cm mass in the neck of the pancreas abutting the CHA without involvement of the SMA, SMV, or PV (Fig. 1). The proximal celiac artery origin was flattened toward the aorta with evidence of post-stenotic dilatation, likely secondary to compression by the MAL (Fig. 2). His laboratory values after neoadjuvant therapy and the initiation of insulin therapy were notable for a CA19-9 of 55 U/mL (down from 527 U/mL) and a Hgb-A1C of 5.8% (down from 11.7%).

The patient underwent a distal pancreatectomy with en bloc splenectomy and en bloc resection of his celiac axis. Due to the compression of the celiac axis by the MAL, the patient had developed enlarged collateralization from the SMA to the GDA. There was adequate flow to the PHA through the GDA. No preoperative embolization was performed and no vascular reconstruction was necessary.³ The patient tolerated the procedure well and was discharged from the hospital on postoperative day 7 after all drains were removed. At discharge he was tolerating a regular diet and he had received his triple vaccination regimen due to his post-splenectomy status. The pathology of the surgical specimen demonstrated fibrosis with scattered microscopic foci of viable but degenerating infiltrating ductal adenocarcinoma with negative surgical margins and

FIG. 1. Axial CT scan demonstrates close relationship of pancreatic neck and body mass to the celiac axis and CHA. Red arrow denotes hypoechoic mass. Narrow yellow arrow denotes CHA, narrowed by the tumor. CHA, common hepatic artery; CT, computerized tomography.

FIG. 2. Sagittal CT arteriogram reveals the acute angulation of the origin of the celiac axis off the aorta. Red arrow denotes the celiac artery origin. The MAL narrowing is depicted about 2 cm distal to the celiac origin. Post stenotic dilatation is seen. There was no tumor at the MAL. MAL, median arcuate ligament.

zero out of twenty-three specimen lymph nodes involved. Two months postoperatively, the patient is doing well.

Conclusions

This is a unique case in which compression of the celiac axis by the MAL may have led to the advantageous development of enlarged collateral vessels from the SMA through the PDA. The vascular anatomy obviated the need for preoperative CHA embolization and allowed for a successful margin negative modified Appleby procedure without complication. The modified Appleby procedure can be complicated by delayed gastric emptying (20%), partial liver infarction (6%), and associated liver abscess (4%).⁴ Delayed gastric emptying is believed to be secondary to ischemic gastropathy,⁷ and partial liver infarction and liver abscess formation occur secondary to a decrease in proper hepatic arterial pressure and blood flow, leading to necrosis of the liver with subsequent infection as a result of contaminated bile within the necrotic liver tissue. Some of these complications may be avoided with arterial resection and reconstruction in a carefully selected patient population³ or through promotion of collateralization through preoperative embolization of the CHA. The patient presented experienced no complications and had excellent blood flow to the liver and stomach after his modified Appleby procedure. The pathology demonstrated negative resection margins and no lymph node involvement. No preoperative embolization or intraoperative vascular reconstruction was necessary as a result of the adequate collateralization that had naturally formed from the SMA secondary to his MAL compression of the celiac axis.

Author Disclosure Statement

No competing financial interests exist.

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Abbreviations Used

CHA = common hepatic artery
GDA = gastroduodenal artery
MAL = median arcuate ligament
PDA = pancreaticoduodenal arcade
PHA = proper hepatic artery
PV = portal vein
SMA = superior mesenteric artery
SMV = superior mesenteric vein

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