Leveraging Aberrant Vasculature in Celiac Artery Stenosis: The Arc of Buhler in Pancreaticoduodenectomy

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Abstract
Background: Celiac artery stenosis and occlusion have been described rarely in patients undergoing pancreaticoduodenectomy (PD), although it occurs relatively frequently in this group. An arterial connection between the celiac and superior mesenteric arteries, known as the Arc of Buhler, provides alternative flow to the celiac distribution once the gastroduodenal artery (GDA) is ligated in PD.

Case Presentation: A 69-year-old man, in whom pre- and intraoperative efforts to stent an occluded celiac artery failed, had sufficient retrograde flow from an unrecognized Arc of Buhler to maintain adequate hepatic arterial perfusion after ligation of the GDA during a PD.

Conclusions: Although there are several case reports and case series regarding the management of celiac stenosis in PD, the impact of an Arc of Buhler variant in this setting has been rarely reported. This case report demonstrates the ability of an intact Arc of Buhler to maintain adequate hepatic perfusion after ligation of the GDA and avoid the potential morbidity of a hepatic artery bypass procedure.

Keywords: pancreatic cancer; Arc of Buhler; celiac artery stenosis; pancreaticoduodenectomy
the celiac artery, the GDA was found to be the main supply of the hepatic artery and the rest of the celiac axis. The origin of the SMA was also stenotic. A plan was made for intraoperative stent or arterial bypass.

Intraoperatively, the celiac artery was unable to be stented retrograde, so the decision was made to perform bypass after tumor resection. The entire dissection was completed before GDA ligation. After GDA ligation, however, persistent hepatic arterial Doppler signal was appreciated, originating from a presumed SMA collateral vessel on completion of angiography (Fig. 1). No further intervention was performed, and the procedure was completed without signs of ischemia or loss of flow.

He was discharged to home on postoperative day 7 after a course notable only for a transient transaminitis of 1324/1145U/L (aspartate aminotransferase/alanine aminotransferase) on the first day. These elevated liver enzymes resolved in 2 days and have not recurred, so no further imaging of the hepatic vessels has been made. Another complication was Klebsiella bacteremia of uncertain etiology but without signs of abscess, which resolved with brief hospitalization and antibiotics. Diagnosed with intraductal papillary mucinous neoplasm on final pathology, he remains without evidence of disease 1 year later.

Reanalysis of the preoperative angiography identified the collateral vessel as an Arc of Buhler (Fig. 2). However, due to the concomitant occlusion of the celiac axis and stenosis of the SMA, the arc also filled retrograde through the GDA. Division of the GDA intraoperatively had allowed for antegrade flow through the arc from SMA to celiac trunk.

**Conclusions**

Preoperative identification of CAS in PD is of utmost importance to prevent unexpected foregut ischemia. Routine angiography was once advocated, but many authors only perform one now if prompted by CAS on CT imaging. The latter imaging is recommended routinely. Intraoperatively, test clamping the GDA before ligation is also recommended to evaluate hepatic arterial flow.

To avoid the documented ischemia after GDA ligation in this setting, CAS identification pre- or intraoperatively can avoid complications through bypass, reimplantation, stent, GDA preservation, or median arcuate ligament release. Preoperative imaging is, therefore, vital to plan appropriate intervention and resection strategy. In cases of aberrant arterial anatomy, such as this one, preoperative identification of potential collateral flow to the liver can help preserve these...
vessels and avoid the need for costly reconstruction, multiple interventions, and/or surgical delay.

**Author Disclosure Statement**
No competing financial interests exist.

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**Abbreviations Used**
- CAS = celiac artery stenosis and occlusion
- CT = computerized tomography
- GDA = gastroduodenal artery
- PD = pancreatoduodenectomy
- SMA = superior mesenteric artery