REVIEW

Inferior Pancreaticoduodenal Artery Aneurysms in Association with Celiac Axis Stenosis or Occlusion

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Purpose. To describe the pathophysiology, identification and management of inferior pancreaticoduodenal artery aneurysms in association with celiac axis stenosis or occlusion has been reported. Review findings. These aneurysms are thought to arise due to increased flow through the pancreaticoduodenal arcades. The arcades first enlarge, and then form focal aneurysms which may rupture. The aneurysms can be treated through endovascular techniques or by surgery, though the former is a preferred approach.

Keywords: Inferior pancreatico-duodenal artery aneurysm; Celiac stenosis; Celiac occlusion; Aneurysms of pancreaticoduodenal arcades.

Introduction

Inferior pancreaticoduodenal artery (IPDA) aneurysms are uncommon; however, they are known to occur following trauma, surgery, ERCP of the pancreas, pancreatitis, infections of the pancreas or of the gallbladder and less commonly as a part of systemic vasculitis.1 IPDA aneurysms in association with celiac axis stenosis or occlusion have been well described and are now considered a separate entity.2–5 In addition, these aneurysms have also been described in the presence of common hepatic artery stenosis or occlusion.6 The development of IPDA aneurysms may be related to increased retrograde blood flow through the pancreaticoduodenal arcades when there is stenosis or occlusion in the common hepatic artery or the celiac axis. Aneurysm formation is generally preceded by enlargement of the arcades to accommodate the increased blood flow. The aneurysms may rupture7 and the patients may present with acute abdominal pain and cardiovascular collapse. Endovascular and open surgical repair have been described for asymptomatic and ruptured aneurysms.8 This article describes the normal anatomy of pancreaticoduodenal arcades and associated abnormalities in the presence of celiac axis stenosis or occlusion. In addition we will discuss various therapeutic options.

Background and Clinical Presentation

Sutton et al., first described IPDA aneurysms in association with celiac axis stenosis/occlusion in 1973.1 Kadir et al., in their report of four cases suggested that such an association was more than coincidental and they postulated that increased flow through the collateral circulation may play a role in the formation of these aneurysms.2 In most of the reported cases, IPDA aneurysms are associated with celiac axis stenosis or occlusion due to atherosclerosis.2,9 However, a few cases with celiac axis stenosis secondary to median arcuate ligament syndrome have also been described.5,10 The patients may be asymptomatic and the aneurysms may be incidentally detected on CT or ultrasound imaging.9 A few patients may present with symptoms of mesenteric ischemia such as abdominal pain due to co-existent mesenteric arterial stenosis.4 Others may present with signs and symptoms of ruptured aneurysms, including hypotension, gastrointestinal bleeding, or acute abdominal pain.2,10 Rarely, they may present with symptoms of mass effect on the duodenum.11
Collateral Pathways in Celiac Axis Stenosis

The pancreaticoduodenal arcades and the dorsal pancreatic artery form the main collateral pathways between the celiac axis and the SMA. In patients with aberrant hepatic arterial anatomy, other collateral pathways exist. The artery or arc of Bühler is an inconsistent vessel that directly connects the celiac axis and the SMA.

Pancreaticoduodenal arcades

The pancreaticoduodenal arcades run in the head of the pancreas and supply the head and uncinate process of the pancreas and the duodenum. The arcades (Fig. 1) are formed by the anterior and retroduodenal (or posterior) superior pancreaticoduodenal branches of the gastroduodenal artery and the inferior pancreaticoduodenal branches of the SMA. The arcades run anterior and posterior to the head of the pancreas, the posterior arcade being more cephalad. There may be multiple arcades. The inferior pancreaticoduodenal arteries arise directly from the SMA or from its first jejunal branch. They may arise as a common trunk or the anterior and posterior branches may take origin directly from the SMA as separate branches. On routine diagnostic catheter angiography the arcades are not usually visible in the absence of celiac or SMA stenosis. In the presence of celiac or common hepatic artery stenosis or occlusion, the arcades serve as a retrograde collateral pathway to provide flow to the liver, stomach and spleen. During this process, the arteries enlarge and the arcades appear prominent on SMA arteriography.

Dorsal pancreatic artery

The origin of the dorsal pancreatic artery is variable. It may arise from the celiac axis, the splenic artery, the common or right hepatic artery (Fig. 1), the SMA or the middle colic artery. The course and the branching pattern are also variable. The right transverse branches of the dorsal pancreatic artery anastomose with the anterior and posterior pancreaticoduodenal arcades and form Kirk’s arcades. The left branches communicate with the transverse pancreatic artery, which receives communicating branches from the pancreatica magna, a branch of the splenic artery. The vertical branches anastomose directly to the SMA and form a direct longitudinal collateral pathway between the celiac axis and the SMA. The dorsal pancreatic artery may enlarge in the presence of celiac axis stenosis and aneurysms may form in its territory.

Arc of Bühler

The arc of Bühler refers to an inconsistent vertically coursing artery that directly connects the celiac axis and the SMA. This artery probably represents the vertical branch of the dorsal pancreatic artery.

Arc of Barkow

The arc of Barkow refers to the collateral pathway between the celiac axis and the SMA in the omentum. The right and left gastroepiploic arteries, branches of the gastroduodenal and splenic artery respectively, give branches to the greater omentum. The posterior epiploic arteries of the transverse pancreatic and the middle colic arteries (branches of the SMA) supply the greater omentum and join the gastroepiploic arteries to form the arc of Barkow.
IPDA Aneurysms in Association with Celiac Axis Stenosis

Increased retrograde blood flow through the pancreatocoduodenal arcades in the presence of celiac or hepatic artery stenosis/occlusion induces enlargement of these arteries. Both the anterior and posterior arcades may enlarge equally (Fig. 2), or one of the arcades may preferentially enlarge. Additionally, branches of the dorsal pancreatic artery may also enlarge and together with the pancreatocoduodenal arcades, may form various configurations of vascular loops around the head of the pancreas. The enlarged vascular loops may cause extrinsic impression over the duodenum, which may be observed on barium studies.

The exact pathogenesis of aneurysm formation is not known. However, it is speculated that the increased flow in the small caliber vessels results in local arterial hypertension that in turn causes focal arterial wall weakening and true aneurysm formation. The aneurysms may be small or large (Fig. 3) and in a few cases, multiple (Fig. 4) aneurysms have also been described. The IPDA aneurysms may be associated with aneurysms of the dorsal pancreatic artery or other collateral vessels.

Most of the reported symptomatic aneurysms had presented with signs and symptoms of rupture. The incidence of rupture is not known due to the small number of cases published. Factors that relate to the risk of rupture are also unknown. The diameter of ruptured aneurysms varied from a 4 mm to 70 mm (mean 22 mm) whereas the diameter of the unruptured aneurysms varied from 5 mm to 42 mm (mean 21). Thus, there appears to be no relationship between the size of the aneurysms and the risk of rupture.

Treatment of IPDA Aneurysms

Endovascular therapy, surgery or a combination have been used for treating these aneurysms. An endovascular approach is usually preferred due to lower morbidity of the procedure (Figs. 3, 4). This approach involves selective catheterization of the superior mesenteric artery and then sub-selective catheterization of the branches feeding the aneurysm sac. The aneurysm sac can be occluded with either steel or platinum regular coils or by using detachable coils. If the aneurysm sac cannot be embolized due to technical reasons, the parent artery can be occluded with coils. In such case, both inflow and outflow of the aneurysm should ideally be embolized to prevent reperfusion of the sac. A percutaneous CT guided approach may be undertaken if the aneurysm is not accessible through an endovascular technique. The aneurysm is localized on contrast enhanced CT and a small caliber needle is placed directly into the aneurysm sac and embolized with glue or thrombin.

Various surgical options exist to treat these aneurysms. They range from ligation, resection, exclusion and endoaneurysmorrhaphy.

Treatment of Celiac Stenosis/Occlusion

Concurrent treatment of celiac stenosis/occlusion during the management of the IPDA aneurysms has been recommended by a few authors. It is conceivable that treatment of celiac stenosis may decrease the recurrence of IPDA aneurysms. However, initial results from various case series have shown no recurrence of the aneurysms following successful treatment. Revascularization of celiac stenosis as the primary therapy for IPDA aneurysms has been reported with a favorable outcome. This may be explained by the fact that the slow flow through the aneurysms following celiac axis revascularization may induce thrombosis of the aneurysms. Currently there are no guidelines as to when and in whom celiac axis revascularization should be undertaken. Revascularization may be performed through angioplasty and stenting of the celiac axis (Fig. 3) in cases of atherosclerotic narrowing or through surgical division of the median arcuate ligament in patients with median arcuate ligament syndrome. In addition, a bypass graft may be created between the celiac/hepatic artery and the SMA.
Aneurysms of Other Visceral Arteries in Association with Celiac Axis Stenosis/Occlusion

As described earlier, aneurysms may form in any of the collateral pathways that enlarge in the presence of celiac axis stenosis/occlusion. Aneurysms of the arc of Bühler and dorsal pancreatic artery (Fig. 5) may occur either alone or in association with aneurysms of the pancreaticoduodenal arcades. The risk of rupture and methods of treatment are similar to those described for IPDA aneurysms.

Fig. 3. Elective endovascular coil occlusion of a large IPDA aneurysm in a 62 year old male patient. (A) Sagittal subvolume (7.5 mm thick) maximum intensity projection of a CT angiography data set shows occluded (arrow) celiac axis. (B) Axial CT image at the level of the uncinate process of the pancreas shows a moderate sized aneurysm (arrow). (C) The aneurysm was successfully embolized with coils (arrow). (D) The occluded celiac axis was treated with angioplasty and stent (arrow) placement.
Conclusion

Aneurysms in the presence of celiac axis stenosis or occlusion usually affect the pancreaticoduodenal arcades; they are often preceded by enlargement of these arcades. The number and size may vary and some may be associated with other aneurysms in the arc of Bühler and dorsal pancreatic arteries. Management is with endovascular coil embolization and/or surgical resection. Treatment of the celiac axis stenosis may help prevent recurrence.

References


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