Case Report

Superior Mesenteric Artery–Pancreaticoduodenal Arcade Bypass Grafting for Repair of Inferior Pancreaticoduodenal Artery Aneurysm with Celiac Axis Occlusion

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We report a case of an aneurysm of the inferior pancreaticoduodenal artery (IPDA), with chronic occlusion of the celiac axis. Both surgical aneurysmectomy and endovascular coil embolization were anticipated to sacrifice IPDA, which could lead to severe acute ischemia in the celiac region. The treatment involved surgical ligation of the aneurysm after bypass grafting from the superior mesenteric artery to the anterior IPDA. A postoperative computed tomography revealed no enhancement of the aneurysm and sufficient collateral blood supply by the patent bypass graft.

Keywords: pancreaticoduodenal artery aneurysm, celiac axis occlusion, pancreaticoduodenal arcade

Introduction

Aneurysm of the pancreaticoduodenal artery (PDA) is relatively rare. Only 2% of all splanchnic artery aneurysms occur in the pancreaticoduodenal or other pancreatic vessels. Previous studies have reported various treatments,

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such as surgery, coil embolization, and hybrid therapy, depending on the patient's condition. We report a case of an aneurysm of the inferior PDA (IPDA), with chronic occlusion of the celiac axis.

Case Report

A 67-year-old man was referred to our department with a diagnosis of IPDA aneurysm. The patient was asymptomatic and had a history of smoking and chronic obstructive pulmonary disease (COPD). He underwent thoracentesis for pneumothorax, followed by pleurodesis four months before the referral for the IPDA aneurysm. The aneurysm was unexpectedly detected during examination for the pneumothorax.

A dynamic computed tomography (CT) scan showed a saccular IPDA aneurysm, with a diameter of 20 mm (**Fig. 1A**). The aneurysm was located adjacent to the origin of IPDA from the superior mesenteric artery (SMA). Moderate calcification was observed on the aneurysm wall. CT also revealed chronic total occlusion at the origin of the celiac axis from the aorta. Due to the occlusion of the celiac axis, the IPDA and anterior inferior pancreaticoduodenal artery (AIPDA) had become well developed as major collateral sources from SMA to the common hepatic and splenic arteries (**Fig. 1B**). The pancreaticoduodenal arcade arteries were very thick and entirely tortuous. We have predetermined local criteria to establish the therapeutic indications for visceral aneurysms. Treatment for visceral aneurysms, other than splenic artery aneurysms, is considered if the aneurysm size is >10 mm in diameter, regardless of the shape. The size of the aneurysm in this case met the criteria for treatment. Bilateral common iliac artery aneurysms were also occasionally detected; however, they were scheduled to be treated with stent grafting after treatment of the IPDA aneurysm.

For treating the IPDA aneurysm, coil embolization was initially considered. However, complete endovascular
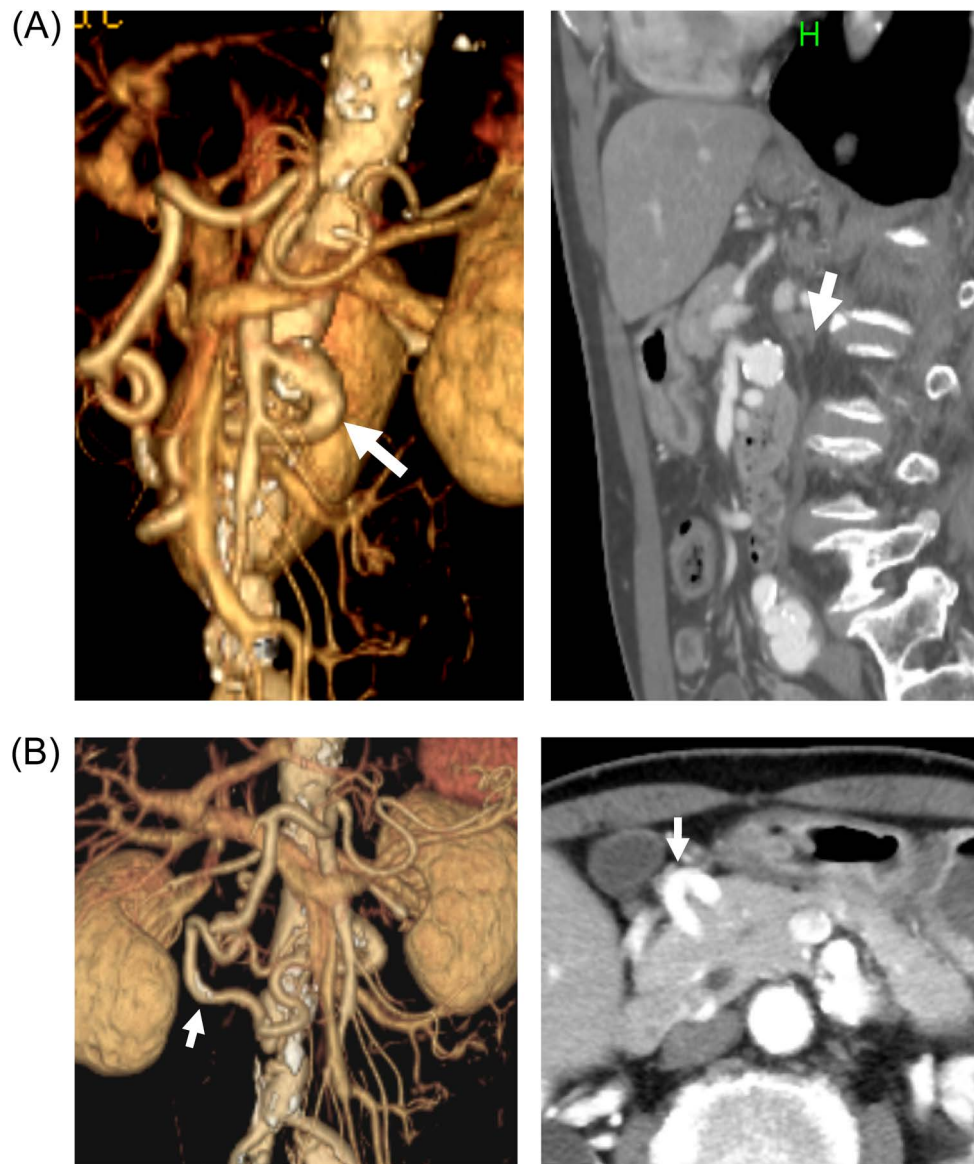
Fig. 1 Preoperative contrast-enhanced computed tomography (CT). (**A**) Three-dimensional CT scan showing an aneurysm (arrow) of the inferior pancreaticoduodenal artery (IPDA) that was adjacent to the origin of IPDA. Sagittal CT scan showing an axial section of the aneurysm with a short proximal neck (arrow). (**B**) The well-developed anterior IPDA (arrow) came up to the surface of the pancreas.

treatment seemed to be difficult because of the following issues: (1) The IPDA aneurysm was adjacent to the IPDA branching point from SMA, and the obturator placed for embolization of the IPDA aneurysm might drop off to the distal SMA, leading to acute intestinal ischemia. (2) Embolization of the IPDA aneurysm would block the dominant collateral blood flow to the celiac axis, which might cause severe acute global ischemia of the liver and spleen. To prevent severe ischemia in the celiac region, we also considered performing a balloon angioplasty at the origin of the celiac trunk prior to IPDA embolization. However, this procedure could injure the origin of the celiac axis due

to the presence of severe atherosclerosis. Moreover, emergent conversion to thoracoabdominal aortic surgery was required to be avoided in this COPD patient.

Bypass surgery to the celiac region under abdominal exploration was considered necessary to secure the blood flow to the pancreaticoduodenal arcade before the removal of the IPDA aneurysm. Regarding possible inflow vessels for bypass grafting, the abdominal aorta and bilateral iliac arteries could not be used due to aneurysms or severe atherosclerosis. Both renal arteries exhibited mild atherosclerotic stenosis. SMA was the only available inflow vessel. Regarding target vessels, in addition to the
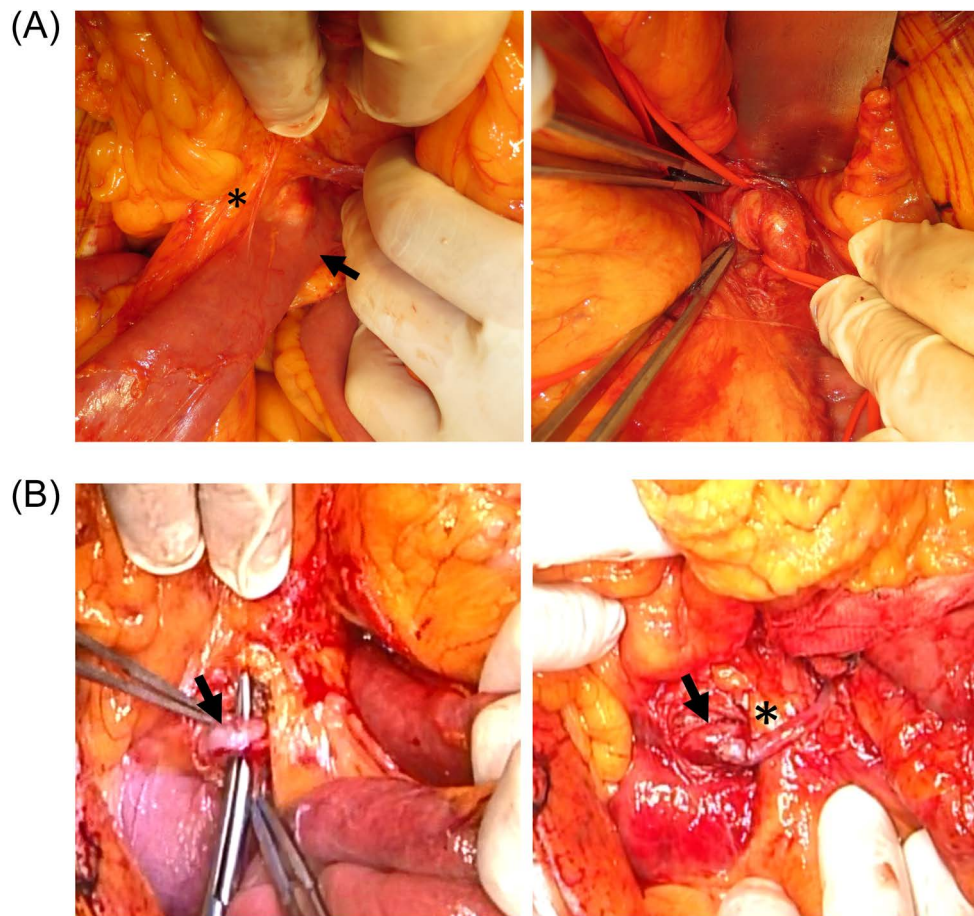
Fig. 2 Intraoperative findings. (**A**) An aneurysm was detected and encircled between the origin of the jejunum (arrow) and the root of the mesentery (asterisk) that includes the superior mesenteric artery. (**B**) The well-developed anterior inferior pancreaticoduodenal artery (AIPDA, arrow) was controlled by minimal manipulation. Grafting using a saphenous vein graft (asterisk) was performed in a wide operation field.

common hepatic artery, AIPDA was available because it was well developed and emerged from the surface of the pancreatic head. In this case, SMA–AIPDA bypass grafting was thought to be better because it would require minimal manipulation and would avoid acute curvature of the graft.

In case ligation or resection of the aneurysm was impossible for some reason, coil embolization could be performed within several days of surgery by the time of bypass occlusion.

During surgery, abdominal exploration and harvesting of a saphenous vein graft (SVG) were performed simultaneously. The dorsal side of the jejunal mesentery was entered between the origin of the jejunum and the inferior mesenteric vein; then, the aneurysm and IPDA were identified on the left dorsal side of SMA (**Fig. 2A**). SMA was identified ventral to the jejunal mesentery and then encircled just proximal to the right colic artery. After lifting up the transverse colon, the well-developed AIPDA was

identified on the surface of the pancreatic head (**Fig. 2B**). The vessel was encircled very carefully to avoid injury to the pancreatic capsule. SMA–AIPDA bypass grafting was performed before ligation of the aneurysm (**Fig. 2B**). The SVG–AIPDA and SMA–SVG anastomoses were created using 7-0 polypropylene sutures in an end-to-side manner. The bypass blood flow volume was 368 mL/min, as measured by a flow meter. The Doppler flow pattern seemed to be acceptable. The proximal neck of the aneurysm was carefully dissected and then doubly ligated, followed by ligation of the distal neck. A drainage tube was placed near the pancreatic head to monitor the concentration of amylase in the drainage fluid. The surgery duration was 5 h, and blood loss amounted to 130 mL. Preoperatively collected autologous blood (400 mL) was transfused during the perioperative period. The postoperative course was uneventful. The concentration of amylase in the drainage fluid peaked out on postoperative day (POD) 3. The first postoperative CT performed on POD 3 showed no evi-
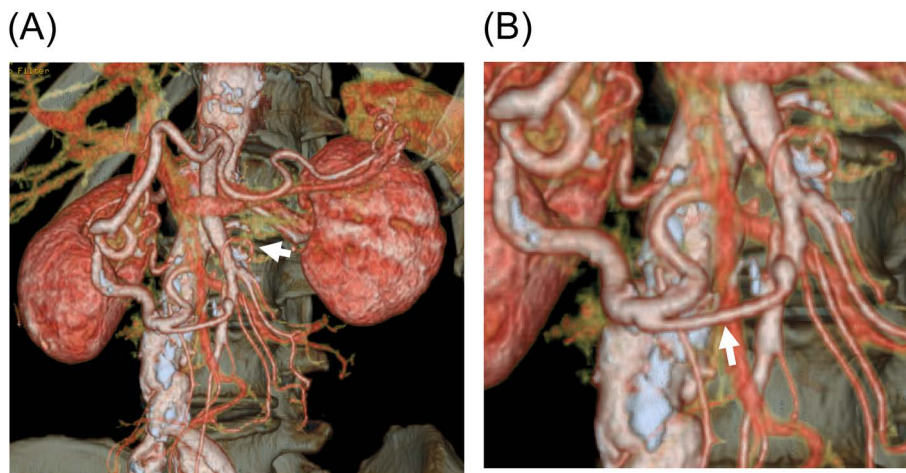
(A) (B)

Fig. 3 Postoperative computed tomography (CT). (**A**) Three-dimensional CT scan showing no enhancement of the inferior pancreaticoduodenal artery (IPDA) aneurysm (arrow) behind the superior mesenteric artery (SMA). (**B**) Patent saphenous vein graft (arrow) between the SMA and anterior IPDA. The IPDA and superior pancreaticoduodenal artery are well enhanced.

dence of acute pancreatitis, no enhancement of the IPDA aneurysm (**Fig. 3A**), and good patency of the bypass graft (**Fig. 3B**). The patient was discharged on POD 20. CT performed at 24 months after surgery showed a patent SVG graft.

Discussion

The prevalence of PDA aneurysms accounts for 2% of all splanchnic artery aneurysms.[1] Given that imaging modalities are being widely used recently, the likelihood of detecting PDA aneurysms is increasing.[2] PDA aneurysm can occur due to various causes such as atherosclerosis, infection, congenital defects, pancreatitis, fibromuscular dysplasia, connective tissue disorders, and trauma.[3] Asymptomatic aneurysms are incidentally discovered using angiography and enhanced CT. Treatment should be performed regardless of the aneurysm size.[4] The risk of PDA aneurysm rupture is unrelated to its size. It is difficult to predict the risk of rupture; hence, rapid treatment of all true PDA aneurysms is recommended.[4,5]

PDA aneurysm associated with occlusion of the celiac axis was first reported by Sutton in 1973. Current evidence supports the theory that persistently increased blood flow and high intra-arterial pressure to the fragile walls of PDAs in the presence of celiac axis stenosis/occlusion may be responsible for the formation of aneurysms.[6,7]

Many therapeutic options are available, of which surgical treatment includes ligation, resection, and pancreaticoduodenectomy. These may be combined with the treatment of celiac axis stenosis. An endovascular approach to treat these aneurysms has several advantages. It is less invasive than surgery and can be safely used, with minimal complications.[7] However, treatment strategies for PDA aneurysms with celiac axis occlusion or stenosis are influenced by the extent to which collateral blood supply to the celiac arteries can be preserved. If hepatic blood supply would be completely sacrificed by endovascular therapy, surgical treatment with vascular reconstruction is recommended. Surgery and endovascular therapy are complementary and not exclusive.[8]

Consistent with previous papers, unassisted endovascular treatment was difficult to use in our particular case of IPDA aneurysm accompanied with celiac axis occlusion. Moreover, it was difficult to occlude the proximal neck of the aneurysm with both endovascular and surgical treatments due to anatomical limitations. Endovascular placement of the obturator in the neck of the aneurysm had a risk of drop-off into SMA, and surgical ligation of the neck had a risk of uncontrollable bleeding. In such cases, surgery and endovascular therapy must be used complementarily. Although we managed to surgically ligate the proximal neck of the aneurysm, endovascular assistance was on standby in case of surgical failure. Preoperative discussion among vascular surgeons, interventionists, and abdominal surgeons was essential for safe management. We placed a bypass from SMA to AIPDA first to secure blood flow to the celiac region. This is the first report of a case in which an SMA–AIPDA bypass was placed for the treatment of an IPDA aneurysm with celiac axis occlusion. Although an earlier case of IPDA reconstruction using an interposition vein graft between SMA and IPDA has been reported,[9] interposition following aneurysmectomy is not always feasible, particularly when the aneurysm is located

adjacent to the origin of IPDA. The bypass anastomosis was performed very close to the pancreatic head; hence, we took special care of the pancreas, such as in measuring the amylase concentration in the drainage fluid.

Once the bypass graft was successfully placed in the celiac artery region, we did not have sufficient time for complete exclusion of the aneurysm, because the connection between two unobstructed arteries has the risk of acute occlusion due to flow competition in the bypass graft. Regarding the long-term clinical course, the bypass might gradually become narrowed; however, collateral blood supply is also expected to develop gradually. Regarding the treatment of celiac occlusion, retrieving the stenosis is generally recommended.[7] In case of atherosclerotic celiac occlusion, gentle and careful angioplasty after treatment of the aneurysm may prevent further degeneration of pancreaticoduodenal arcades.

Conclusion

We present a case of bypass grafting from SMA to AIPDA that enabled the successful treatment of an aneurysm located at the bifurcation point of IPDA from SMA, concomitant with celiac artery occlusion. This bypass strategy can be the choice of treatment when dominant collateral vessels have to be sacrificed in a patient with a severe atherosclerotic aorta or iliac arteries.

Disclosure Statement

The authors have no conflict of interest to declare.

Author Contributions

Writing: AM

Performance of the operation: AM, MS, KA
Critical review and revision: all authors
Final approval of the article: all authors
Accountability for all aspects of the work: all authors

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