OPEN

PRS GLOBAL OPEN

CASE REPORT

Reconstructive

Two-way Revascularization to Manage Celiac Artery Stenosis during Pancreaticoduodenectomy: A Case Report

Hiroyuki Takasu, MD, PhD*†
Yasuyo Kuramoto, MD†
Shigekazu Yokoyama, MD, PhD‡
Hideo Ota, MD, PhD‡
Sasagu Yagi, MD*
Sawa Hisamoto, MD*
Soichi Furukawa, MD*
Yutaka Shimomura, MD, PhD§

Summary: Celiac artery (CA) occlusion, or stenosis, is not uncommon, and most cases are asymptomatic. If the CA is occluded, collateral circulation from the superior mesenteric artery (SMA) is maintained through the pancreaticoduodenal arcade. However, the pancreaticoduodenal arcade is removed if pancreaticoduodenectomy (PD) is performed, which results in ischemia of the liver, stomach, and residual pancreas. Thus, these patients require CA revascularization, which can include antegrade endovascular reconstruction and retrograde reconstruction using vascular anastomosis from the SMA system to the CA system. Both methods carry risks of restenosis or anastomotic thrombosis. We report a technique that involves a combination of both revascularization methods in an 89-year-old man who underwent PD for lower bile duct cancer. Preoperative endovascular stent placement in the CA preserved antegrade blood flow to the liver, and intraoperative vascular anastomosis of the jejunal artery and right gastroepiploic artery achieved retrograde blood flow. Although we confirmed both stent and anastomosis patency and blood circulation in our case, obstruction of 1 of these revascularization pathways would not likely lead to ischemia of the liver. Thus, our 2-way revascularization technique for managing celiac artery stenosis during PD may reduce the risk of organ ischemia. *(Plast Reconstr Surg Glob Open 2021;9:e3423; doi: 10.1097/GOX.0000000000003423; Published online 15 February 2021.)*

Celiac artery stenosis is relatively common and rarely leads to organ ischemia due to the existence of robust collateral blood flow from the superior mesenteric artery through the pancreaticoduodenal arcade. However, pancreaticoduodenectomy (PD) can eliminate this collateral blood circulation in the head of the pancreas, and revascularization is necessary to avoid ischemia of the liver, stomach, and residual pancreas. We report a 2-way revascularization technique used in a patient with celiac artery stenosis who underwent PD.

*From the *Department of Plastic Surgery, Yamaguchi University Hospital, Ube, Japan; †Department of Plastic Surgery, Hyogo Prefectural Nishinomiya Hospital, Nishinomiya, Japan; ‡Department of Gastrointestinal Surgery, Hyogo Prefectural Nishinomiya Hospital, Nishinomiya, Japan; and §Department of Dermatology, Yamaguchi University Graduate School of medicine, Ube, Japan.*

Received for publication October 23, 2020; accepted December 17, 2020.

DOI: 10.1097/GOX.0000000000003423

CASE REPORT

An 89-year-old man with a history of diabetes and angina was referred to our institution with icterus. We planned PD based on a diagnosis of lower bile duct cancer. Celiac artery stenosis was identified during surgery and we discontinued the procedure after observing that the stomach and liver were supplied by retrograde blood flow from the superior mesenteric artery. An endovascular stent was placed in the celiac artery at the radiology department of another hospital, and then PD was re-performed at our institution. In an attempt to manage the risk of stent restenosis, we performed direct anastomosis of the jejunal artery to the right gastroepiploic artery (Fig. 1). Postoperative angiography revealed patency of the celiac artery stent. Celiac arteriography revealed blood flow toward the hepatic artery and the splenic artery. Blood flow to the liver was confirmed using superior mesenteric arteriography, and patency of the anastomosis was also confirmed (Fig. 2). The patient was discharged at 1-month after surgery without any major complications.

DISCUSSION

Celiac artery occlusion, or stenosis, is not uncommon and is observed in 12.5%–49% of patients during

Disclosure: *The authors have no financial interest to declare in relation to the content of this article.*

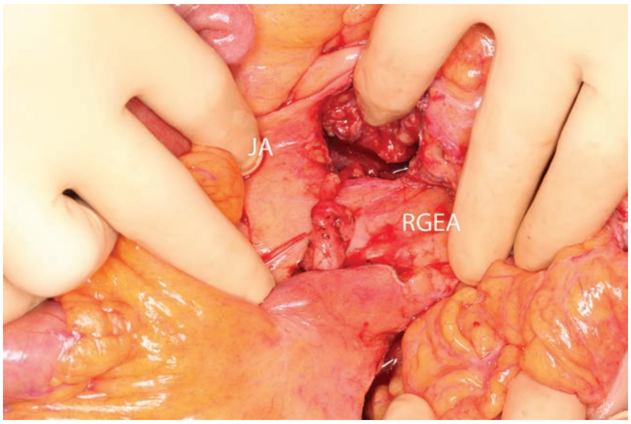

Fig. 1. Jejunal artery (JA) to right gastroepiploic artery anastomosis (RGEA).

angiography.[1] The causes of the stenosis include compression by the median arcuate ligament (MAL), atherosclerosis, periarterial fibrosis, acute and chronic dissection (during angiography), or congenital stenosis.[2] The most common causes are arteriosclerosis (which is prevalent among Western individuals) and MAL compression (which is widely found among Asian individuals).[1] A condition known as celiac axis compression syndrome has also been reported, which manifests with gastrointestinal symptoms (eg, nausea, vomiting, postprandial abdominal pain, and weight loss), although most cases are asymptomatic.[3] In the event of celiac artery occlusion, the collateral blood circulation from the superior mesenteric artery is maintained through the pancreaticoduodenal arcade. However, PD removes the pancreaticoduodenal arcade and interrupts retrograde blood flow, which results in ischemia of the liver, stomach, and residual pancreas.

Angiography and multi-detector computed tomography are useful for diagnosing celiac axis stenosis.[4] In addition to the findings of celiac artery stenosis, dilation of the collateral blood vessels is observed in patients with severe stenosis. However, preoperative contrast-enhanced computed tomography did not identify the stenosis in our case, which was identified only during the initial operation.

Treatments to address celiac artery stenosis include incision of the MAL, preservation of collateral circulation, and revascularization.[4–6] Incision of the MAL is the first procedure to be performed when it is the cause of the stenosis, although the incision alone may not be sufficient in cases of stenosis caused by long-term compression. Ischemic symptoms do not occur if the collateral circulation can be preserved, although this is often impossible in patients with malignant tumors. The stenosis in our case was caused by arteriosclerosis and it was impossible to preserve the collateral circulation. Intraoperative clamping of the gastroduodenal artery (GDA) is important for determining whether revascularization is necessary.[2,3] We clamp the GDA to identify pulsation in the hepatic artery and attempt revascularization if decreased blood flow is observed.

Endovascular revascularization strategies have been reported for celiac artery stenosis.[7,8] In these cases, stent placement increases the patency rate, although there is a risk of technical difficulty and stent damage if the stenosis is caused by MAL compression.[7] There is also a risk of restenosis, with a rate of 12% reported by Shrafuddin et al.[7] Nevertheless, a preoperative diagnosis of celiac artery stenosis is helpful in guiding endovascular treatment before the initial PD procedure because it shortens surgery time.

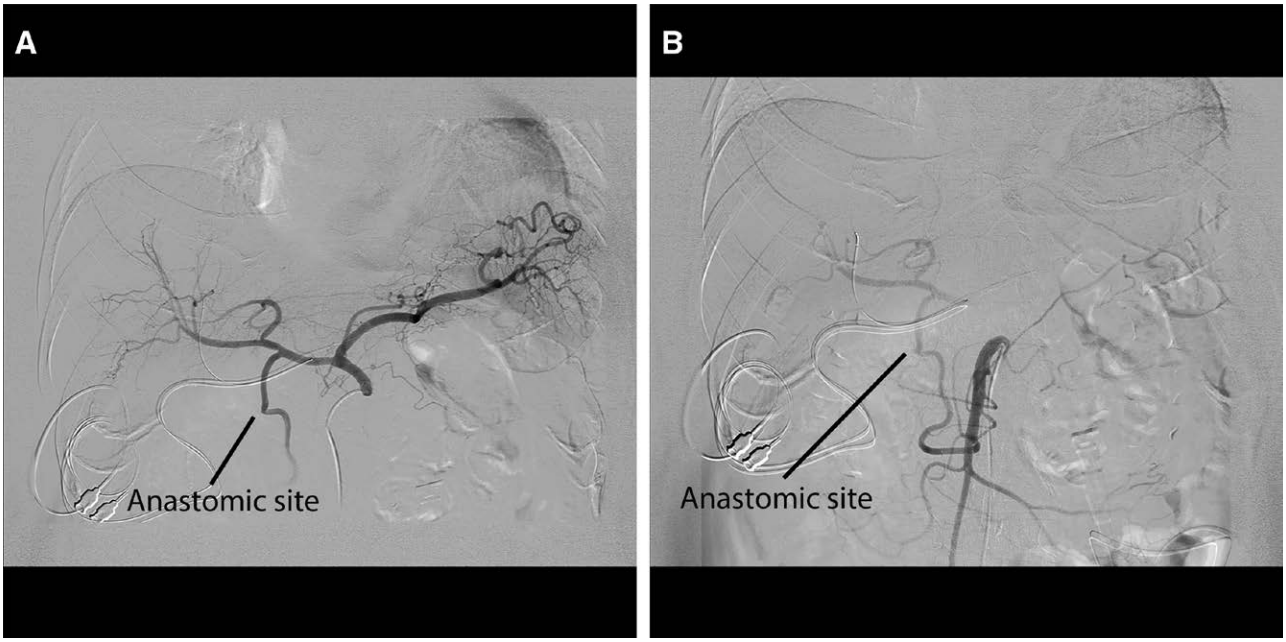

Fig. 2. Postoperative angiography at 1 month after the jejunal artery to right gastroepiploic artery anastomosis. The hepatic artery was supplied by both the celiac artery and the superior mesenteric artery. A, Celiac artery angiography. B, Superior mesenteric artery angiography.

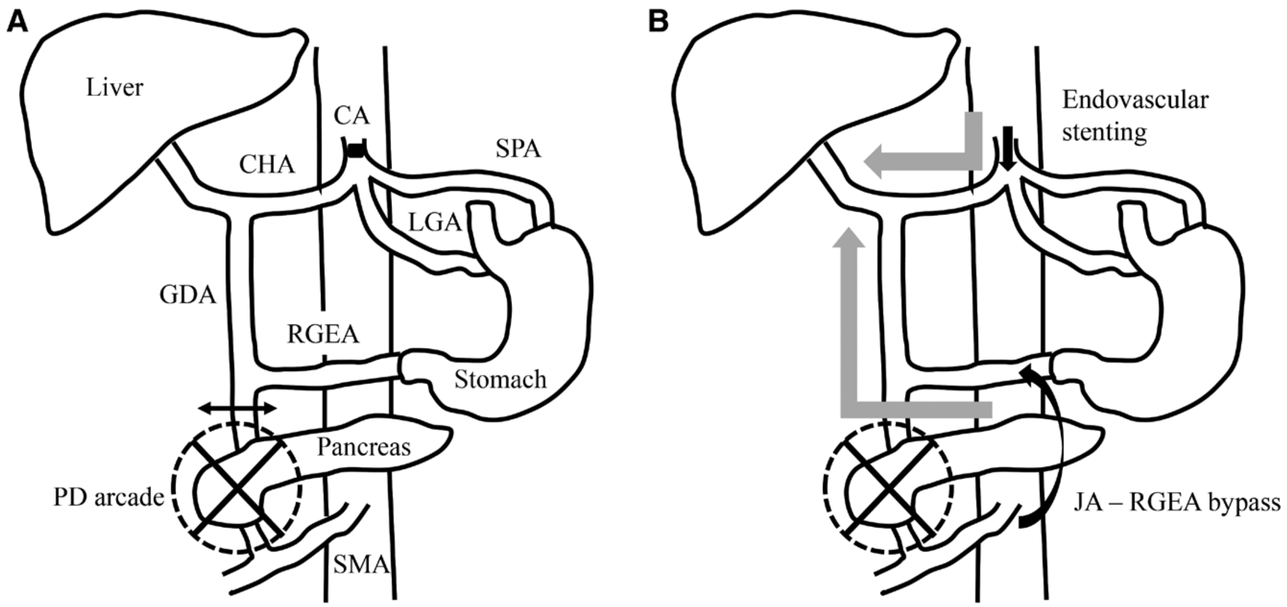

Fig. 3. Schema of our 2-way revascularization strategy. A, Blood flow in the hepatic artery decreases after celiac artery stenosis and pancreatoduodenectomy. Double-headed arrow indicates that blood flow is interrupted from the PD arcade by the PD procedure. B, Endovascular stenting allows for antegrade flow, and JA–RGEA bypass allows for retrograde flow. CA: celiac artery, CHA: proper hepatic artery, SPA: splenic artery, GDA: gastroduodenal artery, LGA: left gastric artery, RGEA: right gastroepiploic artery, PD arcade: pancreatico-duodenal arcade, SMA: superior mesenteric artery.

Another revascularization strategy involves reconstruction of the collateral circulation, which can involve anastomosis of various blood vessels. For example, reported anastomoses include the inferior pancreaticoduodenal artery (IPDA) and GDA,[4] the middle colon artery and GDA,[5] bypass using the great saphenous vein of the IPDA and the splenic artery,[6] bypass using a great saphenous vein graft from the common hepatic artery and the aorta,[9] and bypass using the great saphenous vein of the iliac artery and splenic artery.[10] Nevertheless, there remains a risk of postoperative re-occlusion caused by thrombosis at the anastomosis, although this risk is lower than for endovascular treatment.

Guilbaud et al advocated a 2-step treatment that involved stent placement after MAL incision.[8] We also attempted to reduce the risks related to re-occlusion by combining the endovascular and anastomotic strategies. In this context, MAL incision and endovascular treatment improve antegrade blood flow. Ischemic symptoms do not occur if the collateral circulation can be preserved, although endovascular treatment improves antegrade blood flow, preservation of collateral circulation and/or reconstruction through vascular anastomosis preserves retrograde blood flow (Fig. 3). Although re-stenosis and/or thrombosis are potential concerns for both endovascular treatment and vascular anastomosis, the combination of these techniques may reduce the risk of ischemia.

CONCLUSIONS

We performed a 2-way revascularization technique that combined antegrade and retrograde reconstruction for celiac artery stenosis during PD. This technique may reduce the risk of organ ischemia after PD.

Hiroyuki Takasu, MD, PhD
Department of Plastic Surgery
Yamaguchi University Hospital
1-1-1 Minami-Kogushi
Ube, 755-8505
Japan
E-mail: htakasu@yamaguchi-u.ac.jp

REFERENCES

1. Park HM, Lee SD, Lee EC, et al. Celiac axis stenosis as a rare but critical condition treated with pancreatoduodenectomy: report of 2 cases. *Ann Surg Treat Res.* 2016;91:149–153.
2. Giovanardi F, Lai Q, Garofalo M, et al. Collaterals management during pancreatoduodenectomy in patients with celiac axis stenosis: a systematic review of the literature. *Pancreatology.* 2018;18:592-600.
3. Sapadin A, Misek R. A typical presentation of median arcuate ligament syndrome in the emergency department. *Clin Pract Cases Emerg Med.* 2019;3:413–416.
4. Sugae T, Fujii T, Kodera Y, et al. Classification of the celiac axis stenosis owing to median arcuate ligament compression, based on severity of the stenosis with subsequent proposals for management during pancreatoduodenectomy. *Surgery.* 2012;151:543–549.
5. Miyata T, Yamamoto Y, Sugiura T, et al. Pancreaticoduodenectomy with hepatic arterial revascularization for pancreatic head cancer with stenosis of the celiac axis due to compression by the median arcuate ligament: a case report. *J Surg Case Rep.* 2018;2018:rjy002.
6. Shibuya K, Kamachi H, Orimo T, et al. Pancreaticoduodenectomy with preservation of collateral circulation or revascularization for biliary pancreatic cancer with celiac axis occlusion: a report of 2 cases. *Am J Case Rep.* 2018;19:413–420.

7. Sharafuddin MJ, Olson CH, Sun S, et al. Endovascular treatment of celiac and mesenteric arteries stenoses: applications and results. *J Vasc Surg*. 2003;38:692–698.
8. Guilbaud T, Ewald J, Turrini O, et al. Pancreaticoduodenectomy: Secondary stenting of the celiac trunk after inefficient median arcuate ligament release and reoperation as an alternative to simultaneous hepatic artery reconstruction. *World J Gastroenterol*. 2017;23:919–925.
9. Nara S, Sakamoto Y, Shimada K, et al. Arterial reconstruction during pancreatoduodenectomy in patients with celiac axis stenosis–utility of Doppler ultrasonography. *World J Surg*. 2005;29:885–889.
10. Okamoto H, Suminaga Y, Toyama N, et al. Autogenous vein graft from iliac artery to splenic artery for celiac occlusion in pancreaticoduodenectomy. *J Hepatobiliary Pancreat Surg*. 2003;10:109–112.