Case Report

A case of stent-graft implantation for postpancreaticoduodenectomy hemorrhage in a patient with a reconstructed gastric tube✩,✉,☆,✽

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ABSTRACT

In patients with a reconstructed gastric tube, the right gastroepiploic artery is a very important feeding artery of the tube, which must be preserved when performing a pancreaticoduodenectomy. A 76-year-old man with a reconstructed gastric tube underwent pancreaticoduodenectomy for distal bile duct carcinoma. On postoperative day 8, he had an arterial hemorrhage from a drain, apparently from a ligation of the anterior superior duodenal artery. He, therefore, underwent stent-graft placement in the gastroduodenal artery. The stent-grafts were temporarily occluded, and the gastric tube was necrotizing. However, thrombolytic therapy allowed the stent-grafts to reopen and prevented gastric tube necrosis. We believe our case of stent-graft implantation in the gastroduodenal artery is the first of this kind to successfully prevent lethal necrosis of the gastric tube.

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Introduction

During gastric tube reconstruction after esophageal cancer surgery, blood flow in the gastric tube is maintained by the right gastroepiploic artery (RGEA). However, if the RGEA is obstructed, there is a risk of ischemia and necrosis of the gastric tube [1,2]. When performing surgery for tumors in the pancreatic head region, the gastroduodenal artery (GDA) and the RGEA are preserved to maintain blood flow in the gastric

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tube [3,4]. Herein, we report a case of stent-graft implantation in the GDA for postoperative hemorrhage in a patient who underwent pancreaticoduodenectomy for distal cholangiocarcinoma after gastric tube reconstruction.

Case report

The patient was a 76-year-old man with distal bile duct carcinoma. He had esophageal cancer for which his gastric tube was reconstructed 1 year previously. This time, he underwent a pancreaticoduodenectomy, which is generally ligated at the root of the GDA in a normal surgery. However, because the gastric tube received blood flow only from the RGEA in this case, we were able to ligate the anterior superior pancreaticoduodenal artery (ASPDA) and the posterior superior pancreaticoduodenal artery, preserving both the GDA and RGEA.

On postoperative day 8, the patient had abdominal pain, and therefore, dynamic computed tomography (CT) was performed. The CT showed a hematoma in front of the remaining pancreas, leading to the need for an angiography. However, no contrast leakage or pseudo-aneurysms were found. A few hours later, arterial bleeding was observed from the abdominal drain, and dynamic CT was performed again. The re-imaged CT showed a large amount of bloody ascites in the abdominal cavity and a contrast leak anterior to the remaining pancreatic area (Fig. 1). Hemoglobin was also decreased (10.4-7.9 g/dL). Hemostasis was performed by reopening the abdomen, which revealed that the bleeding was from the ASPDA ligation.

On postoperative day 16, there was re-bleeding from the abdominal drain, and the hemoglobin was also decreased (13.1-10.7 g/dL). Since open surgery would be difficult to perform, we requested an interventional radiology. Abdominal arteriography did not indicate a contrast leak or pseudoaneurysm (Fig. 2A). However, we considered the possibility of bleeding from the ASPDA or posterior superior pancreaticoduodenal artery ligation. We decided to implant a stent-graft into the GDA to preserve blood flow to the gastric tube. A 6-F × 90 cm vascular sheath (Flexor Shuttle Tibial; Cook Medical, Bloomington, IN) was inserted through the left brachial artery and advanced to the root of the GDA using a 0.035-inch stiff guidewire (Amplatz extra-stiff; Boston Scientific, Marlborough, MA). As the target vessel diameter was 4.9-5.5 mm, a 6 mm × 2.5 cm peripheral stent-graft (Viabahn; W. L. Gore, Newark, DE) was implanted. Angiography after implantation did not delineate the proximal portion of the stent-graft, and the possibility of dissection of the proximal vessel was considered. A 6 mm × 5 cm stent-graft (Viabahn) was then placed in front of the first stent-graft in the stent, and further light crimping was performed with a balloon catheter (SABER; Cordis, Cardinal Health, Dublin, OH). Angiography after additional stent-graft implantation showed a contrast effect; however, it did not delineate the peripheral vessels (Fig. 2B). When we advanced the catheter to the periphery of the stent-grafts and performed angiography, we observed blood flow (Fig. 2C). We determined that the gastric tube was receiving blood flow from the collateral tracts and decided that no further procedures were needed at this time.

Two days after stent-graft implantation, the patient had a fever (39.4°C), and his white blood cell count (35,500/μL) and CRP (10.1 mg/dL) level were increased. A dynamic CT showed poor contrast of the wall and intramural gas in the gastric tube (Fig. 3A). An endoscopy was immediately performed, which

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**Fig. 1** – Dynamic computed tomography. Arterial phase computed tomography shows massive bloody ascites (arrowhead) and contrast leakage anterior to the remaining pancreatic area (arrow).

**Fig. 2** – Stent-graft placement for postpancreaticoduodenectomy hemorrhage in a patient with a reconstructed gastric tube. (A) Angiography does not indicate a contrast leak or pseudoaneurysm. (B) Angiography does not delineate the peripheral vessels. (C) Angiography from the catheter advanced into the peripheral vessel allows blood flow to be observed.
showed strong ischemic changes in the gastric tube (Fig. 3B). Thrombolysis was then performed against occlusion of the stent-grafts. The catheter was advanced from the GDA to the RGEA through stent-grafts with an injection of 600,000 units of urokinase. The distal RGEA was free from thrombosis due to collateral blood flow from the anastomosis with the esophagus, but the blood flow was stagnant. A catheter was placed in the RGEA, with 1.2 million units of urokinase administered continuously for 48 hours, while systemic heparinization (up to APTT 2.0) was performed simultaneously. Afterward, the stent-grafts exhibited patency, and blood flow in the peripheral RGEA improved (Fig. 3C). However, the vessel had bent and narrowed at the edge of the stent-graft; therefore, adequate systemic heparinization was continued thereafter.

The ischemic changes in the gastric tube improved on endoscopy 6 days after the thrombectomy (Fig. 3D). Heparin was changed to antplatelet medications (aspirin and clopidogrel sulfate), and the patient was discharged 53 days after surgery. The CT at 3 months after stent-graft implantation showed that the stent-grafts were occluded, but the contrast effect of the gastric tube was good. The patient did not have any symptoms.

**Discussion**

The RGEA is the main feeding artery of the gastric tube and should not be occluded. If coil embolization was performed in this case, the gastric tube would have become necrotic and potentially lethal. A stent-graft is a device that prevents bleeding and preserves blood flow to the host vessel. The stent-graft cloud covers the hemorrhagic site from the branchial ligation while maintaining blood flow to the gastric tube.

The Viabahn stent-graft is a highly flexible self-expandable stent-graft that can be safely advanced to a peripheral artery [5]. However, if implanted in a deformable vessel, such as the GDA or RGEA, occlusion at the stent-edge flexion of the vessel may be a concern, as in this case. Occasionally, stent occlusion may occur several months after stent-graft implantation and does not result in ischemic symptoms, perhaps because of the formation of collateral vessels during this time [6].

In conclusion, stent-graft placement should be considered as a treatment for postpancreaticoduodenectomy

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**Fig. 3** – Ischemia of the gastric tube due to stent-graft occlusion and thrombolysis. (A) Dynamic computed tomography shows poor contrast of the wall and intramural gas in the gastric tube (arrowhead). (B) On endoscopy, strong ischemic changes are seen in the gastric tube. (C) Angiography shows patency of the stent-grafts and improved blood flow in the peripheral right gastroepiploic artery. (D) On endoscopy, improvement in ischemic changes are seen in the gastric tube 6 days after thrombectomy.
hemorrhage in patients with a reconstructed gastric tube. Moreover, thrombolysis for acute occlusion of the stent-graft may help to avoid necrosis of the gastric tube, potentially saving lives.

REFERENCES

[1] Jansen SM, Almasian M, Wilk LS, de Bruin D M, van Berge Henegouwen M I, Strackee S D, et al. Feasibility of optical coherence tomography (OCT) for intra-operative detection of blood flow during gastric tube reconstruction. Sensors 2018;18(5):1331. doi: 10.3390/s18051331.

[2] Milstein DM, Ince C, Gisbertz SS, Boateng K B, Geerts B F, Hollmann M W, et al. Laser speckle contrast imaging identifies ischemic areas on gastric tube reconstructions following esophagectomy. Medicine 2016;95(25):e3875. doi: 10.1097/000000000003875.

[3] Orii T, Yoshimura M, Kitahara H, Karasawa Y. Pylorus-preserving pancreatoduodenectomy for pancreatic head cancer after surgery for esophageal cancer with gastric tube reconstruction in a long-term survivor: A case report. Int J Surg Case Rep 2019;55:92–8. doi: 10.1016/j.ijscr.2019.01.024.

[4] Izumi H, Yoshii H, Abe R, Yamamoto S, Mukai M, Nomura E, et al. Pancreaticoduodenectomy following surgery for esophageal cancer with gastric tube reconstruction: a case report and literature review. Surg Case reports 2019;5(1):191. doi: 10.1186/s40792-019-0751-1.

[5] Onishi Y, Kimura H, Kanagaki M, Oka S, Fukumoto G, Otani T, et al. Placement of a Viabahn stent-graft for hepatic artery pseudoaneurysm complicated by arterial dissection caused by a guiding sheath. Radiol Case Rep. 2019;14(6):711–13. doi: 10.1016/j.radcr.2019.03.021.

[6] Venturini M, Marra P, Colombo M, Panzeri M, Gusmini S, Sallemi C, et al. Endovascular repair of 40 visceral artery aneurysms and pseudoaneurysms with the Viabahn stent-graft: technical aspects, clinical outcome and mid-term patency. Cardiovasc Intervent Radiol 2018;41(3):385–97. doi: 10.1007/s00270-017-1844-5.