Thromboaspiration for Iatrogenic Thrombotic Occlusion of the Superior Mesenteric Artery during Endovascular Treatment of Pancreaticoduodenal Artery Aneurysm and Celiac Artery Occlusion

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Abstract

Herein, we present a case of superior mesenteric artery (SMA) thrombus as a complication of stent placement for celiac stenosis and coil packing of a pancreaticoduodenal artery aneurysm. The SMA thrombus was likely caused by thromboembolism from the guiding sheath in the SMA without a continuous heparin flush. It was promptly treated with aspiration thrombectomy, and there was no mesenteric ischemia. To avoid thromboembolic complications, periprocedural prophylactic antithrombotic therapy should also have been performed because a complex procedure involving the pull-through technique was performed.

Key words: Superior mesenteric artery thrombus, Thromboaspiration, Pancreaticoduodenal artery aneurysm, Celiac stenosis

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Introduction

Thrombosis is a complication of angiography; acute thromboembolic occlusion of the superior mesenteric artery (SMA) is a life-threatening disease, leading to bowel necrosis [1, 2].

Several reports have described successful endovascular revascularization of embolic SMA occlusion using several endovascular techniques, such as catheter thrombolysis and percutaneous aspiration embolectomy [3, 4]. An iatrogenic SMA thrombus caused by angiography or endovascular treatment should be treated promptly if an SMA thrombus is noted during the procedure.

Herein, we present a case of an iatrogenic SMA thrombus that developed after celiac stent placement and coil embolization of a pancreaticoduodenal artery (PDA) aneurysm. The SMA thrombus was successfully treated with aspiration thrombectomy without mesenteric ischemia.

Case Report

A 75-year-old woman who had a history of bronchial asthma underwent abdominal ultrasonography at an outpatient clinic. She was incidentally found to have a peripancreatic mass inferior to the pancreatic head. She had no related abdominal symptoms. She was referred to our institution for further evaluation by contrast-enhanced abdominal computed tomography (CT).

Contrast-enhanced CT demonstrated a narrowed-neck aneurysm arising from the PDA inferior to the pancreatic head, which measured 16 mm in diameter (**Fig. 1a**). Axial

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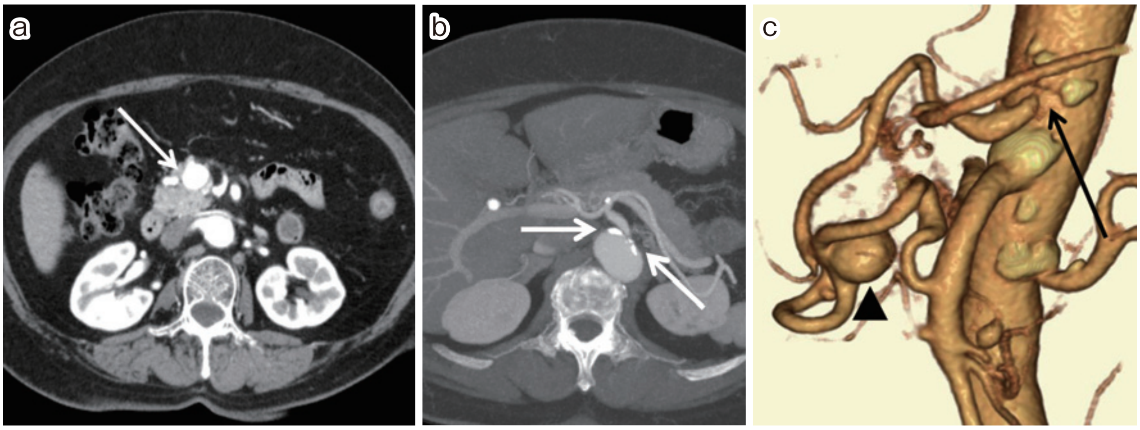

Fig. 1.
(a) The arterial phase of axial contrast-enhanced computed tomography (CT) through the level of the pancreatic head demonstrates a 16-mm arterial-enhanced lesion (white arrow), which represents a pancreaticoduodenal artery (PDA) aneurysm.
(b) Axial CT angiography shows circumferential stenosis of the ostium of the celiac artery with calcification (white arrow).
(c) Volume-rendering three-dimensional reconstructed CT angiography shows tight stenosis of the celiac artery (black arrow) and a dilated and tortuous PDA with aneurysm formation (black arrowhead).

CT angiography showed circumferential stenosis of the ostium of the celiac artery with calcification (**Fig. 1b**), suggesting atherosclerosis rather than median arcuate ligament syndrome. CT angiography also showed dilatation of the PDA with a saccular aneurysm (**Fig. 1c**). Therefore, we diagnosed PDA aneurysm caused by celiac stenosis (CS).

The patient wanted to receive treatment for her PDA aneurysm because of the future risk of aneurysm rupture. The risks and benefits of endovascular and surgical treatments were carefully discussed with the patient and surgeons. Endovascular treatment was to be performed because the patient selected that treatment.

After discussion with the surgeons, we initially planned to embolize the PDA aneurysm using the isolation technique. To maintain hepatic arterial flow, we also planned to perform celiac stent placement before embolization of the PDA aneurysm. For celiac stent placement, we considered a retrograde approach using the pull-through technique as an alternative approach in case the anterograde approach was unsuccessful.

Right common femoral artery access was obtained using a 6-F, 55-cm sheath (Flexor; Cook, Inc., Bloomington, Indiana, USA), and the multipurpose tip was placed at the origin of the SMA. Left brachial artery access was obtained using a 6-F, 90-cm sheath (Flexor; Cook, Inc.), and the multipurpose tip was placed in the abdominal aorta. Neither sheath was connected to a continuous heparin flush. Systemic heparinization was not performed after insertion of a guiding sheath via the left brachial artery. We attempted an anterograde approach from the left brachial side because the celiac artery was facing downward. However, the guiding sheath and guidewire would not pass through the celiac artery. Furthermore, we attempted the anterograde approach using a 4-F shepherd' s hook catheter (Nishiya; Medikit Corp., Tokyo, Japan); however, we could not select the celiac artery. Therefore, the retrograde approach was attempted from the right femoral artery using the pull-through technique. Diagnostic angiography was performed using a 4-F shepherd' s hook catheter inserted through the right femoral access site. SMA angiography showed retrograde flow to the branch of the celiac axis via the dilated inferior PDA and PDA aneurysm (**Fig. 2a**). A 2.2-F, 130-cm coaxial catheter (Progreat β; Terumo Corp., Tokyo, Japan) was further advanced over a 0.014-inch, 300-cm guidewire (Command; Abbott, Chicago, Illinois, USA) through the tortuous PDA up to the celiac axis ostium and then to the abdominal aorta. It was not difficult to pass the celiac artery. The guidewire tip was snared and withdrawn from the left brachial artery sheath through a 15-mm, 6-F snare kit (ENSnare; Merit Medical, South Jordan, Utah, USA).

After the location and extent of CS were confirmed by intravascular ultrasonography, placement of the celiac stent was attempted from the left brachial access site. A 6×18-mm balloon-expandable stent (Express Vascular SD; Boston Scientific, Marlboro, Massachusetts, USA) was deployed following pre-dilation with a 3×20-mm monorail balloon (Coyote; Boston Scientific) and a 5×15-mm balloon (Sterling; Boston Scientific). After these procedures, aortography showed normal anterograde flow in the celiac, common hepatic, and splenic arteries, with multiple stenotic lesions in the PDA owing to the accordion phenomenon (not shown).

Subsequently, we attempted to embolize the PDA aneurysm. However, the guidewire was difficult to withdraw because strong tension was felt owing to friction between the vessel wall and microwire. Therefore, the microcatheter and microwire were withdrawn together. Thereafter, we at-

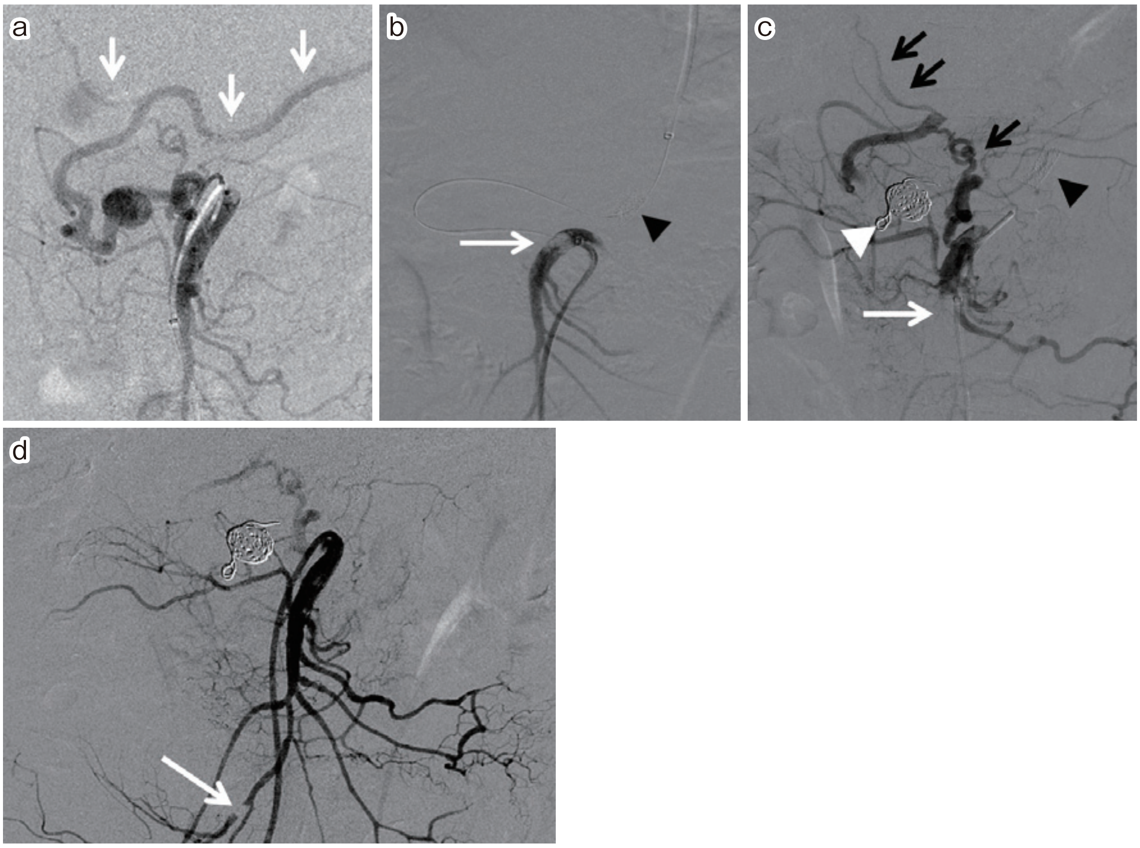

Fig. 2.

(a) Superior mesenteric artery (SMA) angiography before celiac stent placement; the hepatic and splenic arteries (arrows) can be visualized through retrograde flow from the pancreaticoduodenal artery (PDA). Note the aneurysm arising from the origin of the inferior PDA.

(b) SMA angiography after celiac stent placement (black arrowhead) shows a filling defect at the tip of the SMA sheath owing to the formation of a thrombus (white arrow).

(c) SMA angiography after coil packing (white arrowhead) and stent placement (black arrowhead) demonstrates no arterial flow into the PDA aneurysm and collateral flow from the dorsal pancreatic artery to the hepatic artery (black arrows). An SMA thromboembolism is also apparent (white arrow).

(d) SMA angiography after aspiration thrombectomy shows complete removal of the thromboembolism in the main stem of the SMA. There is a small residual thrombus in the ileal branch (white arrow).

tempted to employ the isolation technique once again; however, the tip of the microcatheter was not positioned at the distal side of the PDA aneurysm owing to the stiff shaft of the microcatheter. Therefore, we decided to perform coil packing instead of the isolation technique. After celiac stent placement, the patient complained of mild intermittent nausea. At that point, in retrospect, a thrombus was noted at the tip of the SMA sheath (**Fig. 2b**). After the aneurysm was packed using three metallic coils, the patient complained of severe nausea, and the intensity of her epigastric pain increased. Because the patient was unable to remain at rest on the angiography bed, we suspected significant vascular complications might occur. Therefore, SMA angiography was performed, which showed occlusion of the main trunk of the SMA. The PDA aneurysm was not seen, even though the proper hepatic artery was visualized through the dorsal pancreatic artery (**Fig. 2c**). Because treatment of the SMA thrombus was a priority for the patient, aspiration thrombectomy was attempted. We expected that clot formation would be promoted, even though the PDA aneurysm was not densely packed (the calculated packing density of the PDA aneurysm was 9%) because flow through the PDA was decreased and anterograde after celiac stent placement.

After a 4-Fr, 80-cm shepherd's hook catheter was inserted through the 6-Fr, 55-cm guiding sheath, selective catheterization of the SMA using the 4-Fr catheter was performed, and a 6-Fr guiding sheath was then introduced into the proximal segment of the SMA. A 0.035-inch hydrophilic guidewire (Radifocus; Terumo, Tokyo, Japan) was first navigated into the distal segment of the SMA. Thereafter, a 4-Fr catheter was advanced to the distal segment of the SMA over the guidewire, and a 6-Fr guiding sheath was advanced

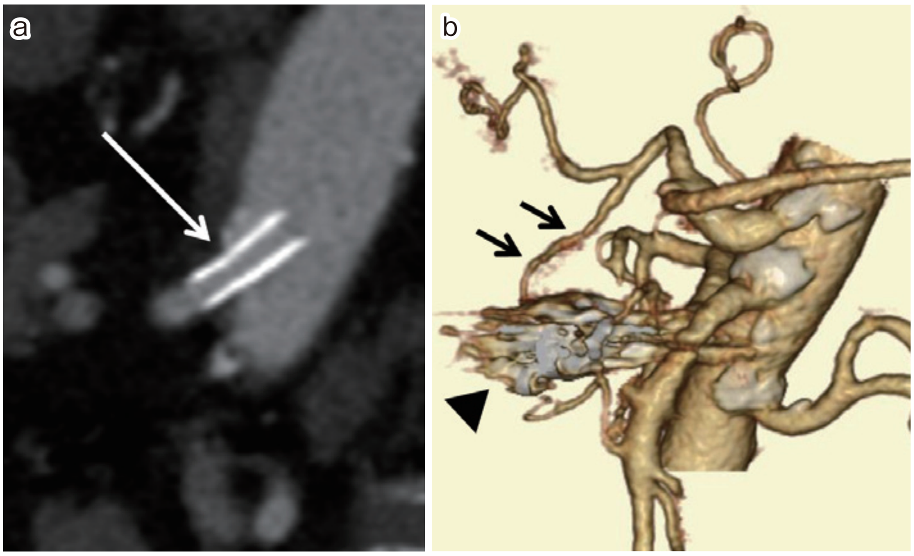

Fig. 3.
(a) Oblique sagittal reformatted image of follow-up computed tomography (CT) that shows a patent celiac stent in a stable position (white arrow)
(b) Follow-up volume-rendering three-dimensional CT angiography shows that the pancreaticoduodenal artery (PDA) returned to its normal caliber (black arrows, see Fig. 1c); this indicates improvement of the celiac stenosis. Note the metallic coils in the PDA aneurysm (black arrowhead).

over the 4-Fr catheter. Finally, a 6-Fr guiding sheath was placed beyond the thrombus. After removal of the 4-Fr catheter and guidewire, a 20-mL syringe was connected to the 6-Fr guiding sheath. Aspiration of the SMA embolus was performed manually via the 6-Fr guiding sheath several times. The aspirated embolus was observed on the gauze. Angiography after repetitive thrombectomy showed nearly complete disappearance of the SMA thrombus (**Fig. 2d**). Although residual thrombus was present in the distal ileal branch at the completion of SMA angiography, the clot was small, and collateral flow was intact. The patient's symptoms improved immediately after thrombectomy.

The patient was followed up at our outpatient clinic and received antiplatelet therapy (clopidogrel, 75 mg/day) without any symptoms related to bleeding or mesenteric ischemia. Follow-up CT angiography performed 4 months after endovascular treatment demonstrated regular stent patency (**Fig. 3a**) without recurrent SMA thrombus or dilatation of the PDA (**Fig. 3b**).

Discussion

Embolic SMA occlusion is the most common cause of acute mesenteric ischemia and is associated with high mortality rates [1]. Delayed treatment of an SMA occlusion often leads to serious consequences, including intestinal necrosis, resection, and even death. Lande and Meyers [5] reported iatrogenic embolization of the SMA in 10 of the 780 patients who underwent selective SMA catheterization. Clots had formed owing to the lack of catheter heparinization. The use of a continuous arterial perfusion pump reduced this complication drastically.

Several reports have described successful endovascular revascularization of embolic SMA occlusions by several endovascular techniques, such as catheter thrombolysis and percutaneous aspiration embolectomy [3, 4]. In addition, intravenous administration of heparin should have been performed when the guiding sheath was inserted via the left brachial artery [6]. Heparin is used as a periprocedural prophylactic antithrombotic agent to prevent distal and proximal arterial thromboembolic complications, reduce the formation of thrombi on catheters, and prevent the formation of blood clots within catheters [7]. A continuous heparin flush is considered necessary whenever there is any space between the sheath and the catheter [8]. The lack of administration of heparin and continuous flushing of the sheath lumen might cause fatal complications, such as thromboembolism. In addition, the patient should have received antiplatelet therapy before the procedure.

Unfortunately, in our case, the procedure was complicated with the presence of an SMA thrombus. The cause of the SMA occlusion was embolism from extrusion of the thrombus that formed in the guiding sheath. After celiac stent placement, the patient complained of intermittent nausea, which might have resulted from mesenteric ischemia. The subsequent development of epigastric pain was likely related to occlusion of the SMA. During interventional procedures, a serious complication should be suspected when abdominal symptoms persist or worsen. Because aspiration thrombectomy was performed promptly, sufficient revascularization was achieved, and the patient did not develop mesenteric ischemia. Percutaneous aspiration may be complicated by SMA dissection and distal embolization [3]. Although there was a small gap between the 6-Fr guiding sheath and the 4-

Fr catheter, careful manipulation of the 6-Fr guiding sheath could prevent SMA dissection. At the same time, a distal embolism developed during advancement of the guiding sheath. Because the residual thrombus was small and collateral flow was intact, the patient did not develop bowel ischemia, and no further treatment was needed.

PDA aneurysms may progressively enlarge and spontaneously rupture if left untreated. According to a previous report [9], the rate of the risk of rupture of PDA aneurysms was 24% (5 of 21 cases). An endovascular approach for PDA aneurysms caused by CS has been increasingly utilized [10]. In our case, stent placement for CS was primarily performed to reduce the pressure overload of the PDA and, consequently, the PDA aneurysm [10]. Restoring anterograde flow in the celiac artery via stent placement could have changed the flow dynamics of the PDA, which may have prevented the enlargement of the PDA aneurysm or the development of new PDA aneurysms. In addition, a decreased retrograde PDA flow may have contributed to clot formation in the PDA aneurysm, even though the packing density of the coils was relatively low.

In summary, we have presented a case of an iatrogenic SMA thrombus, which was successfully and promptly treated with thromboaspiration without mesenteric ischemia. However, the SMA thrombus could have been avoided by a continuous heparin flush and intravenous administration of heparin during our complex procedure.

Conflict of interest: The authors declare that they have no conflicts of interest to report.

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