A Single Retrograde Revascularization onto the Superior Mesenteric Artery Using an Artificial Graft for Abdominal Angina: A Case Report

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A man in his 54 was admitted to our hospital owing to progressive postprandial pain for a month. Computed tomography (CT) scan and angiography revealed severe stenosis and calcification of the celiac artery, superior mesenteric artery, and inferior mesenteric artery. Based on the findings of CT scan and angiography, abdominal angina was established and retrograde revascularization was performed only to the superior mesenteric artery using an artificial graft. After the surgery, he remains free of postprandial abdominal pain.

Keywords: abdominal angina, retrograde revascularization

Introduction

Abdominal angina is a rare disease caused by inadequate blood flow through mesenteric vessels due to stenosis and/or occlusion of one or more mesenteric arteries.1 Because conservative therapy is not effective for abdominal angina, endovascular or surgical procedures are often required in most of the cases. Moreover, the surgical strategies including inflow sites, graft materials, and the number of anastomoses are not fully established for abdominal angina. We successfully treated a patient with abdominal angina by retrograde revascularization with synthetic bypass graft.

Case Report

A man in his 54 was admitted to our hospital with the complaints of postprandial pain for the last 4 weeks. He had an end-stage renal failure (hemodialysis for 19 years), hypertension, dyslipidemia, and moderate aortic valve stenosis. He had a history of abdominal surgery for perforation of the colon diverticulum. Contrast-enhanced computed tomography (CT) revealed severely calcified orifices of the celiac artery (CA), the superior mesenteric artery (SMA), and the inferior mesenteric artery (IMA) (Fig. 1). Angiography demonstrated severe stenotic orifices of the CA and SMA (Fig. 2). A diagnosis of abdominal angina was established due to the stenosis of all the three major abdominal arteries. Further, it was suggested that endovascular procedures might not be suitable due to the severe calcification of all the mesenteric arterial orifices. Therefore surgical revascularization was eventually planned. Pre-operative transthoracic echocardiography revealed moderate aortic valve stenosis (valve area = 1.5 cm²). Coronary angiography detected 75% luminal stenosis in the proximal region of the right coronary artery, which was previously treated with percutaneous coronary intervention. Considering the associated comorbidities, retrograde surgical bypass, which is less invasive than anterograde revascularization, was considered feasible. For the surgery, a ringed heparin-coated 5 mm artificial graft (PROPATEN, Gore-Tex, Flagstaff, Arizona, USA) to minimize the risk of graft kinking was subsequently selected. Direct contact was avoided between the graft and the abdominal organs, by placing the graft in the retro-peritoneum cavity and was anastomosed to the right external iliac artery in an end-to-side approach because all common iliac arteries were previously treated with endovascular treatment. Another side of the graft was similarly anastomosed to the SMA. Following the
surgery, there was a significant increase in the SMA blood flow volume from 35 to 88 ml/min. Adequate SMA blood flow presumed 40 ml/min approximately for the patient; thus, we believed that this procedure was satisfactory.\textsuperscript{1)} Oral aspirin and cilostazol were initiated on the next day after the surgery. He remains free of postprandial pain after the procedure. Further, we confirmed the graft patency by CT scan before the discharge (Fig. 3). He was discharged home 14 days after the surgery. We have also established the graft patency rates of 2 years following the surgery.

**Discussion**

**Pathology of abdominal angina**

Abdominal angina is a rare condition because the digestive tract is tolerant for ischemia by blood supply from the CA, SMA, and IMA.\textsuperscript{2)} A significant reduction in the blood flow of at least two of the major mesenteric arteries (CA, SMA, and IMA) can induce abdominal angina.\textsuperscript{3)} Delayed treatment may induce acute mesenteric ischemia; therefore, early and precise diagnosis and prompt treatment are necessary for abdominal angina. The symptoms of abdominal angina include progressive postprandial pain, remarkable weight loss due to food avoidance, diarrhea, and constipation. However, these symptoms are not specific to abdominal angina and even observed in other digestive diseases. Despite a growing clinical consciousness and a rapid development of laboratory and radiologic techniques, the definitive diagnosis of abdominal angina remains challenging, which could delay its effective management. In the present case, CT scanning and angiography confirmed the calcified and stenotic orifices of the CA, SMA, and IMA. The progressive postprandial abdominal pain and hemodialysis indicated the lack of mesenteric blood flow relative to the demand.

**Treatment options for abdominal angina**

Therapeutic options for abdominal angina include endovascular procedures and surgical revascularization. Although the endovascular treatment is less invasive than surgery, the rate of restenosis is reported to be high.\textsuperscript{4)} Moreover, surgical procedures are advantageous concerning low recurrence rate of symptoms.\textsuperscript{5)} The treatment strategy should be selected based on the pre-operative patient’s comorbidities and conditions. Because of the severe orifices calcification, it was difficult to obtain a
complete opening of the arteries by endovascular procedures. Therefore, a surgical revascularization was chosen in spite of the history of an abdominal surgery and cardiac comorbidities.

Surgical strategy
Surgical revascularization includes endarterectomy and bypass surgery. There have been some reports about decent graft patency rate with bypass procedure. However, the surgical strategies including inflow sites, graft materials, and a number of anastomoses are not fully established. In an anterograde bypass, the inflow graft is anastomosed onto the abdominal aorta above the CA. As it accomplishes less angulated and shorter bypass route than the retrograde one, it is usually unsuitable for high-risk patients as a supra-celiac approach is necessary. However, in retrograde bypass, a longer graft is required and could cause graft kinking. Nonetheless, the graft patency rate at 5 years has been reported to be equal between the anterograde and retrograde bypasses. In the present case, we selected less invasive retrograde revascularization because he exhibited several comorbidities (untreated moderate aortic valve stenosis and long-time history of hemodialysis). In the retrograde bypass, artificial graft is recommended to avoid graft kinking. Additionally, in comparison to autologous vein graft, a synthetic graft has no limitation with suitable length. However, it is highly vulnerable to infection. Furthermore, graft selection remains controversial and mostly depends on baseline characteristics of the patient. We previously experienced autologous vein graft occlusion after retrograde bypass in another patient. Furthermore, he had coronary atherosclerosis. Therefore, we preserved autologous vein graft and decided to use the artificial graft.

Single versus multiple anastomoses is another controversial issue for surgical strategy. In the single bypass strategy, SMA revascularization may have the priority because postprandial mesenteric blood flow changes more abundantly in the SMA. Furthermore, isolated bypass onto the SMA is as durable as multi-vessels reconstruction because extensive collateral circulation usually exists among the mesenteric arteries. Multiple revascularizations contribute to less recurrent rate after treatment has also been reported. In the present case, single revascularization of the SMA was sufficient to improve his symptoms even when all the mesenteric arteries had severe stenosis. Since he had untreated aortic valve stenosis and coronary artery disease, which could both induce mesenteric hypo-perfusion during hemodialysis, the recurrence of symptoms must be carefully followed up.

Conclusion
We performed a retrograde bypass only to the SMA using an artificial graft for abdominal angina, and the pre-operative symptom disappeared after the surgery. However, a careful follow-up is necessary to evaluate the recurrence of gastrointestinal symptoms.

Disclosure Statement
All authors have no conflicts of interest to declare.

Author Contributions
Study conception: SA
Writing: AT
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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