Anastomotic stenosis of a reconstructed dissecting superior mesenteric artery aneurysm undetectable by intraoperative indocyanine green angiography: A case report

Shigeyuki Yamashita1 | Kazuto Shibuya2 | Kanetsugu Nagao1 | Toshio Doi1 | Shigeki Yokoyama1 | Akio Yamashita1 | Kazuaki Fukahara1 | Tsutomu Fujii2 | Naoki Yoshimura1

1First Department of Surgery, University of Toyama, Toyama, Japan
2Second Department of Surgery, University of Toyama, Toyama, Japan

Abstract
Intraoperative evaluation of blood flow using ICG angiography revealed no significant abnormality. However, the anastomotic stenosis was revealed by postoperative CT angiography; more precise intraoperative evaluation methods need to be developed.

KEYWORDS
dissecting superior mesenteric artery aneurysm, indocyanine green angiography, surgical repair

1 | INTRODUCTION
A 71-year-old man diagnosed with a dissecting superior mesenteric artery aneurysm underwent surgical repair. Intraoperative indocyanine green angiography was conducted, and it was confirmed that the small intestine was contrasted. However, postoperatively the patient developed paralytic ileus owing to distal anastomotic stenosis.

Indocyanine green (ICG) angiography has been used for intraoperative evaluation of blood flow during revascularization procedures in various fields.1–3 However, although ICG angiography can confirm the presence or absence of blood flow, detailed evaluation of the anastomotic morphology is sometimes difficult.4,5 In the present study, we report a case in which intraoperative ICG angiography failed to identify anastomotic stenosis during reconstruction in a patient with a dissecting superior mesenteric artery aneurysm (dSMAA).

2 | CASE HISTORY/EXAMINATION
A 71-year-old man presented with a history of aortic stenosis, hypertension, and diabetes mellitus. Computed tomography (CT) scanning performed for the preoperative evaluation of aortic valve stenosis revealed a dSMAA with a diameter of 32 mm. The dissection originated 10 mm peripherally from the origin of the SMA and extended to the ileal artery bifurcation. There was a re-entry at the bifurcation of the right colic artery, the false lumen was partially thrombosed, and the true lumen was compressed...
and narrowed by the false lumen. The true lumen of the aneurysm gave rise to three jejunal arteries, and the middle colic artery was occluded (Figure 1).

3 | DIFFERENTIAL DIAGNOSIS, INVESTIGATIONS, AND TREATMENT

Although the patient was asymptomatic, the aneurysm was more than 30 mm in diameter and the true lumen was narrowed, indicating the need for therapeutic intervention owing to the risk of rupture and intestinal ischemia. Due to the patient’s advanced age, endovascular treatment was considered as the first option. However, surgical intervention was preferred since stent-graft insertion could induce intestinal ischemia owing to the occlusion of important branches, and coil embolization of the false lumen could displace the thrombus to the distal SMA.

A midline abdominal incision was performed. After systemic heparin administration, the SMA and its branches were clamped. The false lumen was incised, and all thrombus were removed. Subsequently, the true lumen was opened through a longitudinal incision of the intimal flap from entry to re-entry. We attempted to resect the entire intimal flap; however, the distal intimal flap was remarkably thickened, resulting in inadequate resection. Therefore, the distal true lumen of the SMA was severely stenotic. The SMA was completely transected at its origin and anastomosed in an end-to-end fashion with a GSV using a 6-0 polypropylene running suture. The opened true lumen of the SMA was reconstructed using a long onlay patch from the GSV (Figure 2). Since the true lumen at the distal end of the SMA was severely narrowed by the residual thickened intimal flap, reconstruction was performed by inserting a 22-G cannula into the true lumen to avoid anastomotic stenosis.

4 | OUTCOME AND FOLLOW-UP

After completion of the procedure, the blood flow from the SMA to the intestines was investigated using ultrasound flowmetry and ICG angiography. The ultrasound flowmetry findings revealed good pulsatile sounds in the graft, important branches, and distal SMA. ICG angiography demonstrated good fluorescence from the proximal anastomosis site to the onlay patch and jejunal arteries; however, the ileal artery and distal SMA fluorescence were weak, and there seemed to be a slight time lag before

**FIGURE 1** Preoperative computed tomography of the superior mesenteric artery (SMA) and aneurysm. (A) Volume-rendered image. (B) Axial view. (C) Coronal view. The SMA aneurysm has a diameter of 32 mm. The dissection extends 10 mm peripherally from the origin of the SMA to the bifurcation of the ileocolic artery. There is an entry (black arrow) 15 mm from the origin, and a re-entry (white arrow) involving the right colic artery (RCA), ileocolic artery (ICA), and ileal artery (IA). The false lumen (unfilled triangle) is partially thrombosed, and the true lumen (filled triangle) is narrowed due to compression by the false lumen. Three branches of the jejunal artery (JA) originate from the true lumen of the aneurysm.
the fluorescence was seen. However, the fluorescence of the entire small and large intestine in the SMA region could be confirmed in about 30 s. The patient developed postoperative paralytic ileus that required fasting and gastric tube placement. The postoperative CT images revealed that the jejunal artery was patent; however, there was stenosis at the site of the distal SMA anastomosis just before the ileal artery bifurcation. Good collateral circulation was observed from the jejunal artery to the ileal artery (Figure 3). The patient recovered after 4 weeks of conservative treatment and was discharged on postoperative day 40.

5 | DISCUSSION

Recent reports have highlighted the safety and efficacy of endovascular treatment for dSMAA, including entry closure with a covered stent, coil embolization of the false lumen, and stenting of the narrowed true lumen. However, problems, such as the risk of intestinal ischemia owing to blockage of some branches or coil migration, the possibility of aneurysm enlargement, and rupture owing to endoleak or stent migration, persist.

Surgical techniques for the treatment of dSMAA include simple aneurysm ligation, aneurysmorrhaphy, and...
TTFM is widely used, especially for intraoperative graft flow evaluation in coronary artery bypass surgery. It is easy and quick to use and can provide not only blood flow but also many other indices, enabling comprehensive evaluation of the revascularized area. However, morphological information cannot be obtained, and even if an abnormality in blood flow or other data exists, identifying the etiology may be challenging. In addition, many of the indices are derived from the coronary blood flow data, which requires careful interpretation in areas such as the abdomen and lower limbs. X-ray angiography is still considered to be the most appropriate method for obtaining detailed information on the anastomosis site.

Problems with intraoperative angiography include the lack of feasible evaluation in the absence of an equipped hybrid operating room, the possibility of complications with the use of contrast media, and the exposure to radiation; however, it can be performed without hesitation if problems are suspected using other examination methods. In the present case, intraoperative ICG angiography showed a slight delay in the fluorescence of the distal SMA; however, there was no defect in the fluorescence of the intestinal wall, and thus, we ascertained that there was no intestinal ischemia. Therefore, intraoperative ICG angiography was unable to identify the stenosis of the distal side of the anastomosis. If a rapid and simple intraoperative evaluation method is established, reanastomosis or bypass creation would be possible.

In conclusion, we performed a surgical revascularization of a dSMAA. Intraoperative ICG angiography revealed no problem with the intestinal blood flow in the SMA dominant region. However, postoperatively, the patient developed paralytic ileus associated with intestinal ischemia, and contrast-enhanced CT scan revealed anastomotic stenosis. In some cases, intraoperative ICG angiography may not be helpful in evaluating the anastomotic morphology in detail; therefore, it is necessary to combine it with other examination methods to facilitate comprehensive evaluation.

CONFLICTS OF INTEREST
The authors have no conflicts of interest to declare.

AUTHOR CONTRIBUTIONS
Shigeyuki Yamashita involved in study conception, data collection, analysis, investigation, writing, critical review and submission, final approval, and accountability. Kazuto Shibuya, Kanetsugu Nagao, Akio Yamashita, Kazuaki Fukahara, Tsutomu Fujii, and Naoki Yoshimura involved in data collection, analysis, critical review and revision, final approval, and accountability. Toshio Doi and Shigeki Yokoyama involved in data collection, analysis, investigation, critical review and revision, final approval, and accountability.
CONSENT
Informed consent was obtained from the patient for the publication of this case.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID
Shigeyuki Yamashita https://orcid.org/0000-0002-4784-736X
Toshio Doi https://orcid.org/0000-0002-0764-1519

REFERENCES
1. Yamamoto M, Orihashi K, Nishimori H, et al. Indocyanine green angiography for intra-operative assessment in vascular surgery. J Vasc Surg. 2012;43(4):426-432.
2. Cavallo C, Gandhi S, Zhao X, et al. Applications of microscope-integrated indocyanine green videoangiography in cerebral revascularization procedures. Front Surg. 2019;6:59.
3. Yamamoto M, Nishimori H, Handa T, et al. Quantitative assessment technique of HyperEye medical system angiography for coronary artery bypass grafting. Surg Today. 2017;47(2):210-217.
4. Yamamoto M, Nishimori H, Fukutomi T, et al. Influence of vessel stenosis on indocyanine green fluorescence intensity assessed by near-infrared fluorescence angiography. Surg Today. 2017;47(7):877-882.
5. Yamamoto M, Ninomiya H, Tashiro M, et al. A case of anastomotic stenosis of a peripheral arterial bypass graft undetected in indocyanine green angiography. Ann Vasc Dis. 2018;11(2):233-235.
6. Wu XM, Wang TD, Chen MF. Percutaneous endovascular treatment for isolated spontaneous superior mesenteric artery dissection: report of two cases and literature review. Catheter Cardiovasc Interv. 2009;73(2):145-151.
7. Patelis N, Doukas P, Dodos I, et al. Endovascular repair of a complex isolated dissecting aneurysm of the superior mesenteric artery. EJVES Short Rep. 2019;44:5-8.
8. Mkangala AM, Liang H, Dong XI, Su Y, Hao Hao L. Safety and efficacy of conservative, endovascular bare stent and endovascular coil assisting bare stent treatments for patients diagnosed with spontaneous isolated superior mesenteric artery dissection. Wideochir Inne Tech Maloinwazyjne. 2020;15(4):608-619.
9. Ullah W, Mukhtar M, Abdullah HM. Diagnosis and management of isolated superior mesenteric artery dissection: a systematic review and meta-analysis. Korean Circ J. 2019;49(5):400-418.
10. Picquet J, Abilez O, Pénard J, Jousset Y, Rousselet MC, Enon B. Superficial femoral artery transposition repair for isolated superior mesenteric artery dissection. J Vasc Surg. 2005;42(4):788-791.
11. Hirai S, Hamanaka Y, Mitsui N, Isaka M, Kobayashi T. Spontaneous and isolated dissection of the main trunk of the superior mesenteric artery. Ann Thorac Cardiovasc Surg. 2002;8(4):236-240.
12. Gouëffic Y, Costargent A, Dupas B, Heymann MF, Chaillou P, Pata P. Superior mesenteric artery dissection: case report. J Vasc Surg. 2002;35(5):1003-1005.
13. Matsumoto R, Shibuya T, Saijo F, Watanabe K, Sawa Y. Successful repair of superior mesenteric artery aneurysm with reconstruction of branches. Ann Vasc Dis. 2020;13(4):450-453.
14. Nicauss L. Techniques and standards in intraoperative graft verification by transit time flow measurement after coronary artery bypass graft surgery: a critical review. Eur J CardioThorac Surg. 2017;51(1):26-33.
15. Hol PK, Lingaas PS, Lundblad R, et al. Intraoperative angiography leads to graft revision in coronary artery bypass surgery. Ann Thorac Surg. 2004;78(2):502-505. discussion 505.
16. Mücke T, Reeps C, Wolf KD, Mitchell DA, Fichter AM, Scholz M. Objective qualitative and quantitative assessment of blood flow with near-infrared angiography in microvascular anastomoses in the rat model. Microsurgery. 2013;33(4):287-296.
17. Yamamoto M, Ninomiya H, Tashiro M, et al. Evaluation of graft anastomosis using time-intensity curves and quantitative near-infrared fluorescence angiography during peripheral arterial bypass grafting. J Artif Organs. 2019;22(2):160-168.

How to cite this article: Yamashita S, Shibuya K, Nagao K, et al. Anastomotic stenosis of a reconstructed dissecting superior mesenteric artery aneurysm undetectable by intraoperative indocyanine green angiography: A case report. Clin Case Rep. 2021;9:e04923. https://doi.org/10.1002/ccr3.4923