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Small intestinal arteriovenous malformation treated by laparoscopic surgery using intravenous injection of ICG: Case report with literature review

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ABSTRACT

INTRODUCTION: Approximately 5 % of gastrointestinal bleeding is due to small intestinal bleeding. Bleeding from small intestinal arteriovenous malformation (AVM) is rare, with few reported cases. Finding the precise location and boundary is difficult during surgery, so we tried using intravenous injection of indocyanine green (ICG). Use of ICG in a case of intestinal AVM is reported here for the first time, with a review of the literature.

PRESENTATION OF CASE: A 48-YEAR-old male had anemia and low hemoglobin level (Hb) 4.0 g/dL. After several examinations including small intestinal endoscopy, capsule endoscopy and angiography, AVM was identified. Preoperative diagnosis was AVM caused by branching of the ileocolic artery (ICA). Meanwhile, macroscopy showed engorgement of the vein in the ileum wall and mesentery, the boundary of which was unclear. We performed intra-operative monitoring with ICG. After intravenous injection of ICG, the boundary and location became clear. The abnormal ileum was 30 cm in length and located 130 cm from the Treitz ligament, which was different from angiographic findings. Pathology showed dilated vascular hyperplasia of the submucosa, tunica and chorionic membrane. Final diagnosis was ileum AVM. The postoperative course was uneventful and gastrointestinal bleeding stopped.

CONCLUSIONS: ICG monitoring aided diagnosis and treatment of Ileum AVM, which was treated by laparoscopic surgery.

1. Background

Small intestinal AVM is extremely rare. Diagnosis of small intestinal AVM is difficult because of uncertain bleeding origin in upper and lower endoscopy. Diagnosis is usually by enhanced CT and angiography. They are large and susceptible to re-bleeding, so usually require surgical resection [1]. Macroscopically, AVM can be difficult to determine. The precise location may be unclear and the position of the resection line cannot be easily determined. We therefore tried intravenous injection of ICG to ascertain the location and border. Intravenous injection of ICG for AVM is reported here for the first time.

2. Presentation of case

This case report is in line with the SCARE 2018 criteria [2]. A 48-year-old male had received peritoneal dialysis for chronic kidney disease (CKD) for four years. He passed melena and his hemoglobin level was low 4.0 g/dl (normal range 13.7~16.8 g/dL). After performing small intestinal endoscopy and angiography, we diagnosed ileum AVM. Medical history included chronic renal failure and peritoneal dialysis. Body mass index was 26.0. He took hypotensive drug, diuretic drug and precipitated calcium carbonate. He didn't smoke and have an allergy and psychological history.

Gastrointestinal endoscopic and colonoscopic findings were not significant. Capsule endoscopy showed verrucous mucosa in the small intestine, angiography showed arteriovenous malformation in branching of the ICA (Fig. 1). AVM in branching of the ICA was identified as the cause of anemia. We planned laparoscopic small intestinal resection. Macroscopic findings included engorgement of the veins in the ileum and mesentery (Fig. 2). We used laparoscopic ICG fluorescence imaging scope (1588 AIM and ENV, Stryker Co) to ascertain the location of AVM and used an infrared light camera system (pde-NEO, IMI Co. Ltd.) to decide the resection line. We injected 5 mg of ICG (Daiichi Sankyo Co., Tokyo Japan). The mesenteric artery and small intestine began to be shown in green 40 s after ICG injection until disappearing at 210 s. The abnormal ileum was 30 cm in length and was located 130 cm from the Treitz liga-

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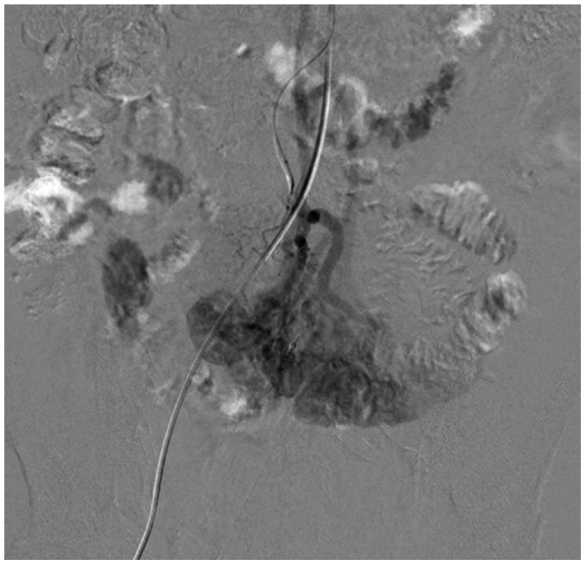

Fig. 1. AVM in branch of ICA according to CT angiography.

ment, which was different from angiographic finding. The boundary became clear (Fig. 3) after intravenous injection of ICG, and we could easily ascertain the location and determine the resection line. The operation was performed by Kenji Matsuda, M.D.,Ph.D. who is board certificated laparoscopic surgery. Macroscopic findings included verrucous mucosa (Fig. 4). A pathological finding was dilated vascular hyperplasia of submucosa, tunica and chorionic membrane. Final diagnosis was ileum AVM. The postoperative course was uneventful. He has no recurrence of ileum AVM for 16 months. We did not plan post-intervention considerations. He agree with our explanation and treatment.

3. Discussion

AVM in the digestive tract is divided into three types by Moore classification [3]. Type 1 is usually acquired, seen in older patients in the ascending colon, is small and not easily visible. Type 2 is usually congenital, seen in younger patients in small intestine, it is large and more easily visible. Type 3 is inheritable, such as in Rendu-Osler-Weber disease. The current case is classified as type 2.

Table 1 shows reported cases of small intestinal AVM (18 cases) [4–17]. Age of onset is wide-ranging (19 months to 95-years). Symptoms are anemia and melena. In almost all cases, radical operation is performed without interventional radiology (IVR).

Several treatments for small intestinal AVM have been reported, including endoscopic treatment, IVR and surgery. Endoscopic treatment is advantageous in that it can be performed with less invasiveness. There are several risks, however, such as lesion not being detected and recurrence due to incomplete treatment. IVR is useful for diagnosis and embolization, but there are risks of trauma and small intestinal necrosis. There are differences between angiographic findings and surgical findings. Surgery is curative treatment. Table 1 shows the list of patients that were treated with surgery. Hybrid therapy using surgery and IVR was recently reported [5], but, it is sometimes difficult to ascertain the location and decide the resection line during surgery. Several case reports have showed the usefulness of marking clips in endoscopy, X-ray and angiography during operations [4,5,8,16]. Ono, et al. reported the use of selective angiography and ICG injection through the catheter during surgery [8]. It is sometimes difficult, however, to determine the border. Several techniques have been reported, such as measuring intraoperative mesenteric venous pressure and PO_2, using doppler ultrasound, and using methylene blue dye or ICG dye injection [4]. Such procedures are not easy to perform.

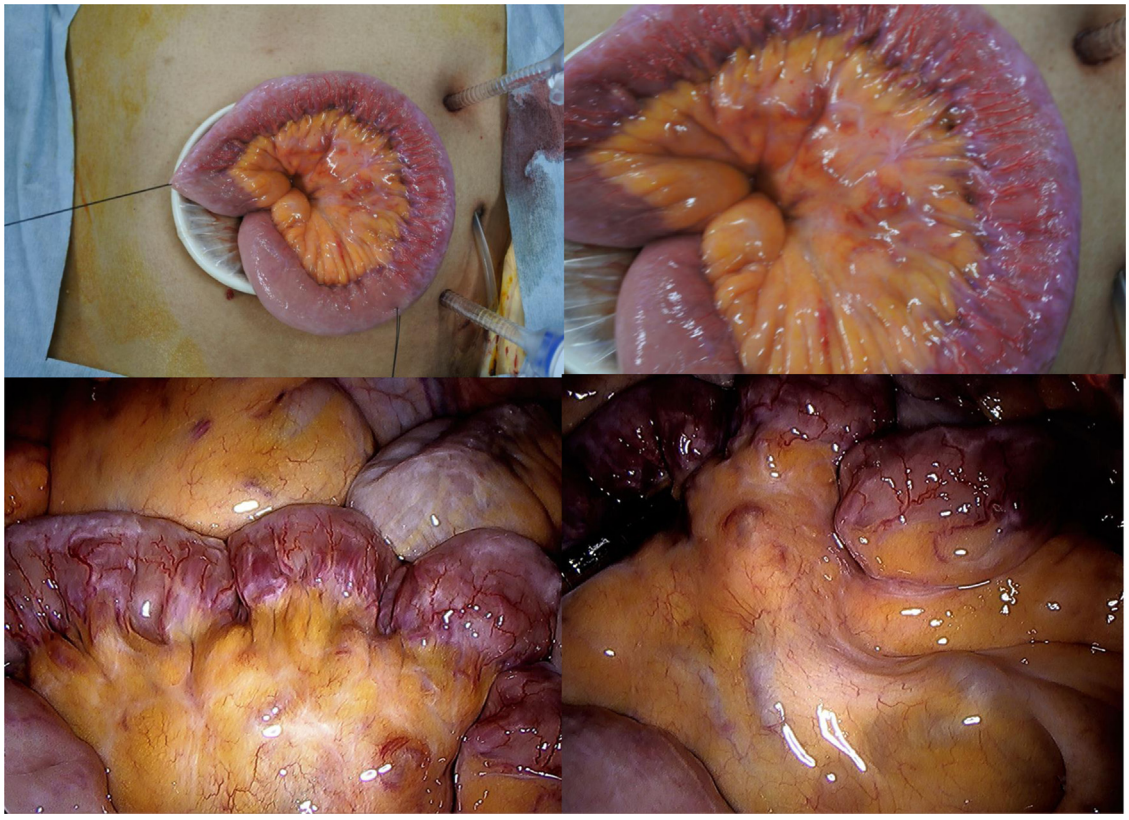

Fig. 2. Engorgement of the vein in the ileum and mesentery in operative findings.

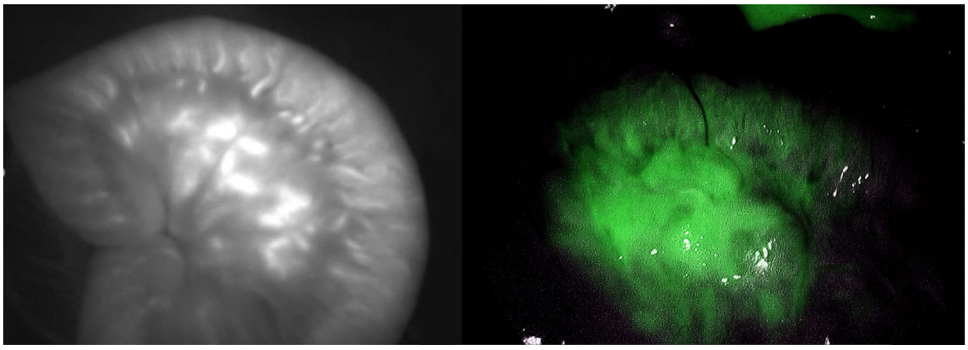

Fig. 3. After intravenous ICG injection, AVM lesion and boundary were made clear.

Table 1
Case reports of small intestinal AV.

Author	Year	Case	diagnostic method	treatment	detection of AVM(intraoperative)
Cheon	2007	30/M	colonoscopy, CT	operation	visible
Lal	2010	39/M	CT, angiography	conservation(extensional jejunum)	no operation
Matsevych	2011	55/F	laparotomy	operation	visible
Fujikawa	2012	55/M	double balloon endoscopy	operation	visible due to marking clip
Sarosick	2012	48/M	capsule endoscopy	endoscopic hemostasis	no operation
Nakayama	2013	54/M	angiography	operation	NR
Kalmer	2014	19month/F	MRI	operation	visible
Cui	2014	47/M	vascular enhanced CT	operation	visible
Gong	2014	51/M	CT,double balloon endoscopy	operation	visible
Fuji	2014	69/M	double balloon endoscopy	operation	NR
Shibi	2016	66/M	endoscopy,CT	IVR	no operation
Lee	2016	3/F	US, CT angiography	operation	visible
Ono	2016	95/M	angiopraphy	operation	selective angiography and ICG injection through the catheter
Arnautovic	2017	22/M	capsule endoscopy	endoscopic hemostasis	no operation
Kim	2017	8/F	angiography	operation	visible
Kim	2017	3/F	CT angiography	operation	visible
So	2018	50/F	angiography	embolization→recurrence→operation	failed to locate(direct vision), Using X-ray endoscopic marking
Chang	2018	28/M	angiography,enteroscopy	operation	visible, using intravenous injection of ICG
our case		48/M	angiography	operation	

AVM; arteriovenous malformation. CT; computed tomography. US; ultrasonography. NR; not reported. IVR; interventional radiology.
MRI; magnetic resonance imaging.

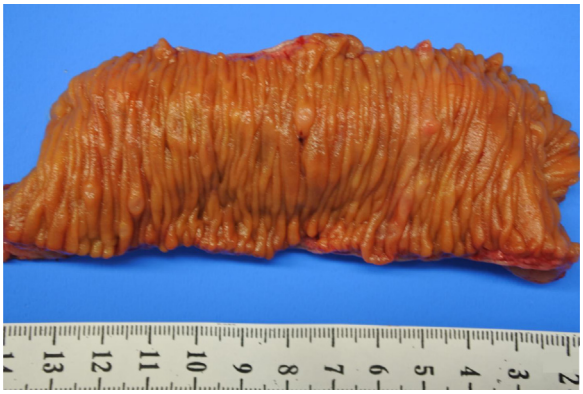

Fig. 4. Macroscopic finding, verrucous torus in mucosa.

Small intestinal AVM can cause life-threating bleeding and severe anemia, and sometimes emergent surgery is needed. Many hospitals do not have facilities for small intestinal enteroscopy or hybrid operating rooms. Although fluorescent scopes and infrared ray systems are needed, lesion of AVM can made clear by using only intraoperative injection of ICG.

In our case, ileum AVM appeared to be located in branch of ICA according to angiography. However, operative findings showed the AVM to be 130 cm from the Treitz ligament, which was different from angiographic findings. ICG dye injection allowed easy decision on where to make the resection line.

4. Conclusion

Laparoscopic surgery for ileum arteriovenous malformation was successfully performed using ICG monitoring.

Sources of funding

Not applicable.

Ethical approval

The present study was conducted in accordance with the ethical standards of our institution.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contribution

TH wrote this article. KM and HY supervised the writing of the manuscript. HY approved the final submission of the manuscript. All authors read and approved the final manuscript.

Registration of research studies

This is not a first-in-man study.

Guarantor

This is a case report. Kenji Matsuda is Corresponding author.

Provenance and peer review

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Declaration of Competing Interest

The authors declare that they have no competing interests.

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