Capsule endoscopy versus intraoperative enteroscopy in management of small bowel arteriovenous malformations

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Background
Small bowel arteriovenous malformations (AVMs) are the most common cause of obscure gastrointestinal bleeding, and they are problematic cases both in diagnosis and treatment.
Patients and methods
A total of 12 patients with small bowel AVMs admitted to Zagazig University hospitals were included in this study. Cases with previous bleeding (group I) and cases with moderate ongoing bleeding (group II) underwent both capsule endoscopy (CE) and intraoperative enteroscopy (IOE), whereas cases with massive ongoing bleeding (group III) underwent IOE only.
Results
CE picked up the diagnosis of AVMs only in 50% of cases. It underestimated the extent of the lesions in 40% of positive cases and wrongly localized the lesion in 20% of positive cases. IOE diagnosed all 12 cases of AVMs. Two cases were treated with plasma photocoagulation and 10 cases were treated with resection of the diseased segment. There was only one perioperative mortality.
Conclusion
CE has a limited diagnostic yield in cases of small bowel AVMs especially in absence of ongoing bleeding, and IOE remains the mainstay method for diagnosis and treatment of these cases.

Keywords:
arteriovenous malformations, capsule endoscopy, gastrointestinal bleeding, intraoperative endoscopy

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Introduction

Obscure gastrointestinal bleeding (OGIB) is defined as bleeding of unknown origin that persists or recurs after an initial negative panendoscopic evaluation, including oesophagogastroduodenoscopy and ileocolonoscopy [1]. It is estimated that OGIB comprises ~5% of all patients with gastrointestinal (GI) bleeding, with the majority of bleeding lesions found to be in the small bowel [2].

For decades, investigation of OGIB has often caused frustration in both patients and clinicians. Noninvasive tests, such as small-bowel follow-through, radioisotope-labeled red blood cell scan and push enteroscopy, have had suboptimal diagnostic yields in the range of 20–40% [3–5]. Capsule endoscopy (CE) approximately doubles the diagnostic yield of push enteroscopy in patients with OGIB and its yield is also far superior to that of small bowel radiography [6].

Invasive methods, such as laparotomy or intraoperative enteroscopy (IOE), may improve the yield up to 70% [7]. However, complications such as mucosal laceration, avulsion of mesenteric vessels, prolonged ileus and wound infection are not uncommon, and death has been reported in the literature [8].

Vascular lesions of the small bowel are the most frequent finding in patients with bleeding from the small bowel (~50–70% of findings). There seems to be a morphological heterogeneity of probably overlapping entities, such as arteriovenous malformation (AVM), venous or vascular ectasia, angiodysplasia, angiectasia, or even Dieulafoy's lesion. Thereby, terminology of these benign flat lesions depends somewhat on the person who describes it, being either an endoscopist or a histopathologist [9].

We focused in this research on this hidden killer, and we selected only the cases that have firm diagnoses of AVMs either by direct intraoperative finding and/or histological examination to evaluate the most accurate and appropriate method of diagnosis and the best approach to manage them.

Patients and methods

This research was conducted on patients with OGIB admitted to Zagazig University hospitals between October 2010 and September 2013.

According to their presentations, we classified our patients into three groups: group I, this group included patients presented with previous attacks

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of GI bleeding and severe iron deficiency anaemia; group II, this group included patients presented with ongoing moderate GI bleeding (melena) on admission and group III, this group included patients presented with massive GI bleeding (haematochezia) with shock and collapse.

On admission, full history taking and thorough clinical examination of all cases were performed, and full laboratory investigations were ordered. Blood transfusion was initiated in patient with haemoglobin less than 8 g% and plasma transfusion was given to all patients with ongoing GI bleeding (group II and III). Resuscitation of shocked patients (group III) was initiated immediately with intravenous crystalloids and plasma expanders until blood transfusion became available. In addition, pelviabdominal ultrasonography (US) examination was performed for all cases. ECG and other needed preoperative investigations were conducted on request.

Inclusion criteria

(1) Patients above 18 years and below 80 years of age.
(2) Patients with OGIB with negative upper and lower GI endoscopies and irrelevant data by imaging studies such as abdominal US or computed tomography.
(3) All cases should be mentally oriented and consented to join our study.

Exclusion criteria

(1) Patients below 18 and above 80 years of age.
(2) Patients who refused to undergo CE or IOE.
(3) Patients whose GI bleeding was due to any cause other than small bowel AVMs.
(4) Patients whose IOE findings were negative, although their CE findings were positive for AVMs.
(5) Patients who were lost during the follow-up period.

After the initial management, all cases were prepared for upper and lower GI endoscopy, which if negative, cases of group I and II were prepared to undergo pelviabdominal US and triphasic computed tomography, and only negative cases were accepted to join the study and prepared for CE, which is usually performed on the next day. Waiting for the results, the patients were prepared for exploration and IOE. Anaemia, electrolytes imbalance and hypoalbuminaemia all were corrected then IOE was performed within 7 days of CE. Group III patients (emergency cases) with negative endoscopies were prepared for urgent exploration and IOE directly (no time for other investigations).

Capsule endoscopy

Wireless CE is a new technology that enables endoscopic visualization of the whole length of the small bowel. The capsule measures 26.4 mm in length and 11 mm in diameter. It is swallowed after 12 h of fasting and left to proceed in the gut by its peristalsis. The capsule is composed of a lens, a light source, a complementary semiconductor chip, a battery and a transmitter. Images are continuously taken two per second and immediately transmitted to a recorder that is fixed by a belt to the abdomen of the patient and then downloaded to a computer unit where they are visualized and recorded by special software. The records were revised by an expert gastroenterologist.

Intraoperative enteroscopy

Patients were prepared with oral 500 ml of mannitol 20%, 12 h before surgery. IOE was performed by two experienced endoscopists and surgery was performed by the same surgical team. First, the intestines were totally examined for obvious lesions or palpable masses then before enteroscopy, we divided any possible adhesions to make the small bowels move mobile and amenable to manipulation, but we did not perform excessive mobilization such as Kocher's technique or division of ligament of Treitz because such manoeuvres may damage major vessels while giving little advantage to the procedure. We think that completing the procedure with adding enterotomy is much less hazardous than these risky mobilizations.

Adult colonoscope of total length 2500 mm and a working length of 227 mm and loop diameter of 16 cm was used. Peroral route was tried in all cases, but if endoscopy failed to reach the terminal ileum, a small enterotomy was performed and the endoscope was completed through it after covering the shaft of endoscope with sterile plastic sheath used for the laparoscopic camera, which is temporarily sutured to the edge of the enterotomy to avoid spillage of intestinal contents. We advanced the endoscope manually through the bowel by telescoping the bowel over it gently trying not to harm the mucosa or the mesentery. Neither pressure nor tension was allowed throughout the procedure; otherwise, serious tears and lacerations of the mesentery would occur.

Minimal air insufflation was used during advancement, and desufflation of the bowel was carried out during withdrawal. The bowel was inspected during advancement of the endoscope; otherwise, petechial haemorrhage or even haematomas that would occur during manipulation might be mistaken for angioectasias on withdrawal. If a lesion was visualized during advancement of the endoscope, the segment of bowel was marked with silk sutures for later resection

and the advancement was completed to diagnose other possible lesions.

The light of the operating room was shut off to allow both internal and external examination of the transilluminated bowel by both the endoscopist and the surgeon simultaneously. Only patients with small bowel AVMs were included in this study. Other causes of bleeding were excluded to evaluate the results of CE in cases of small bowel AVMs only and to study the prognosis of these cases. Minor lesions were treated using argon laser beam through endoscopy, whereas large and wide-spread lesions were excised by resection anastomosis of the small bowel. The resected specimens were certainly sent for histopathological examination.

The operative time, amount of intraoperative blood transfusion, the site of AVMs and the method of management all were recorded.

Postoperative care

All patients were postoperatively cared in ICU with parenteral nutrition, antibiotic and other supportive measures until they became haemodynamically stable and haematologically accepted. Thereafter, they were transferred to their ordinary rooms in the hospital to complete their postoperative regimens and care. All surviving patients were discharged when surgically stable and they were followed up in the outpatient clinic for at least 2 months postoperatively and checked for overt or occult blood in stool.

Four cases were excluded from this study after joining it. The first refused to perform IOE after the CE had diagnosed jejunal AVMs; the second case was found to have bleeding jejunal diverticulitis on exploration and the third was found to bleed from an ileal lymphoma. The fourth case had CE diagnosed jejunal AVMs that did not show on IOE, and nothing was performed for this case and surprisingly this case did well during the postoperative period; bleeding did not recur through the 6 months of follow-up period and her anaemia was corrected gradually.

Results

This study included 12 patients with final diagnosis of small bowel AVMs, eight men and four women (male : female, 2 : 1). Their ages ranged between 32 and 79 years with mean age of 49.75±14.28 years. Three patients presented with previous OGIB (group I) and severe iron deficiency anaemia, seven patients presented with ongoing OGIB on admission (group II) and two patients presented with massive GI bleeding and shock (group III). Clinical examination and provisional investigations of the cases revealed diabetes mellitus in five patients, hypertension in six patients, ischaemic heart disease in three patients and previous cerebral stroke in two patients. All patients were anaemic with variable degree; their haemoglobin concentration ranged from 4 to 8.5% at presentation with average concentration 5.9±1.39 g% (Table 1).

Results of capsule endoscopy

CE diagnosed small bowel AVMs only in five (50%) patients of total 10 patients who underwent this investigation in the study. They were two jejunal and three ileal AVMs patients, including four of seven patients of group II with ongoing bleeding and only one of three patients of group I without active bleeding.

The capsule was retained only in one patient in the terminal ileum and was removed during the exploration for IOE. The cause of retention was not obvious. In addition, it failed to reach the colon during the recording time in one case mainly due to delayed gastric evacuation. CE did not have a place in cases with massive bleeding of group III due to lack of time and theoretically unsuitable field for it.

Results of intraoperative enteroscopy

The IOE picked up the diagnosis of small bowel AVMs in all 12 cases included in the study. There were five cases of jejunal AVMs, five cases of ileal AVMs and two cases of multiple jejunal and ileal AVMs (Photos 1–3).

Eight (66.7%) patients were diagnosed by simple naked eye examination of small bowel at exploration and four (33.3%) patients were diagnosed by combined endoscopic examination and transillumination of the bowel (Photos 4–6).

Table 1 Patient's age, sex, group, haemoglobin% and associated medical diseases

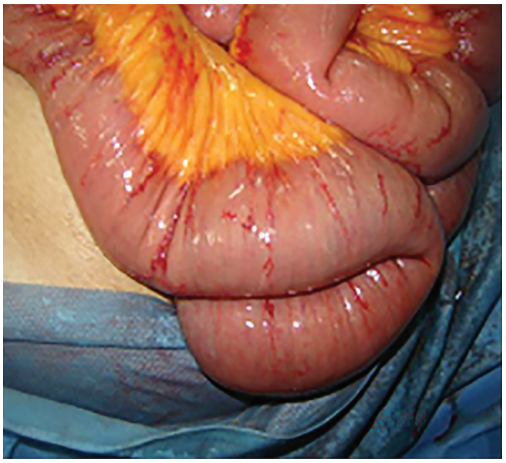
Case numbers	Age (years)	Sex	Group	Hb (g%)	Associated medical diseases
1	63	Male	I	4	DM, HT
2	43	Male	II	6.5	–
3	46	Male	II	7	DM
4	38	Female	III	8	–
5	56	Male	II	5	DM, HT
6	42	Male	I	5.5	HT
7	68	Male	II	4.5	HT, CS
8	35	Female	II	6	DM
9	52	Male	I	4.5	HT, IHD
10	79	Female	III	5.5	HT, IHD, CS
11	32	Female	II	8.5	–
12	43	Male	II	6	DM

CS, cerebral stroke; DM, diabetes mellitus; Hb, haemoglobin; HT, hypertension; IHD, ischaemic heart disease.

Photo 1

Large jejunal AVMs

Photo 2

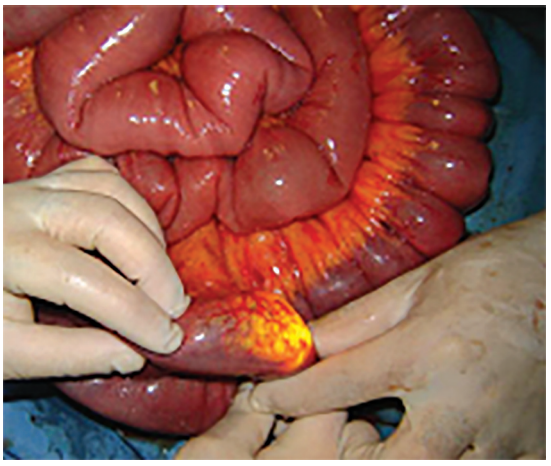


SmallIleal AVMs

Photo 3

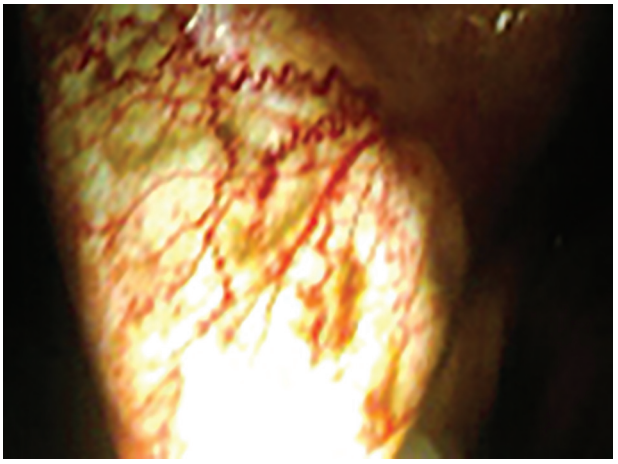
Multiple jejunal and ileal AVMs

Photo 4



Trans-illumination of small jejunal AVMs

Photo 5



Trans-illumination of smallileal AVMs

Photo 6

Trans-illumination ofsmallileal AVMs

Transoral approach succeeded to reach the terminal ileum in seven (58.3%) patients, whereas in the remaining five (41.7%) patients endoscopy was completed through small enterotomies in the mid-length of the small bowel.

The mean operative time was 165 min. The intraoperative blood transfusion was 2.5 U on average. Argon plasma coagulation was used in two cases with small localized AVMs, whereas in the remaining 10 cases, resection of the diseased segment was performed. The mean length of the resected segment was 75 cm (Table 3). All sent specimens were histopathologically confirmed to have AVMs.

Evaluation of capsule endoscopy findings

We regarded the results of intraoperative endoscopy as the standard data against which the results of CE were compared. This is because the results of IOE are the most accurate criteria upon which the treatment options were chosen. In addition, most of the results of IOE were histopathologically confirmed.

The overall diagnostic yield of CE in small bowel AVMs was only 50% (five of 10 patients) and it was only 33.3% in cases with previous bleeding and 57.1% for those with ongoing bleeding (Table 2). In addition, there was underestimation of the extent of AVMs in two cases of wide-spread jejunal and ileal lesions (case nos 3 and 8). In addition, CE failed to diagnose the accurate site of AVMs in one case (case no. 11) when it diagnosed jejunal AVMs, whereas IOE revealed multiple ileal AVMs, which were resected (Table 3).

Regarding complications, CE had only two complications: retention in one case and battery failure in one case. IOE had numerous complications: mesenteric haematomas in eight cases, mesenteric tears in six cases, serosal tears in five cases and prolonged ileus more than 3 days in two cases (Table 4).

Postoperative results

We recorded postoperative complications in four cases: two cases showed prolonged ileus; one case developed postoperative heart failure and pulmonary oedema, which resolved on the ninth postoperative day and one case had a postoperative myocardial infarction superimposed on previous myocardial ischaemia and died on the third postoperative day (case no. 10). Otherwise, the remaining eight cases did well and recovered almost completely and were discharged surgically free. All surviving patients improved during the follow-up period and anaemias were corrected and bleeding did not recur during the follow-up period. It is worth to mention that one patient (case no. 2) presented with subacute intestinal obstruction 7 months after surgery. Conservative measures failed to bring improvement and he was re-explored where there was a stricture at the previous anastomosis, which was revised, and the patient recovered well postoperatively.

Table 2 Results of capsule endoscopy

CE results	[*n* (%)]		
	Group I (previous OGIB) (*N* = 3)	Group II (ongoing OGIB) (*N* = 7)	Total (*N* = 10)
Positive cases	1 (33)	4 (57)	5 (50)
Negative cases	2 (64)	3 (43)	5 (50)
Sensitivity (%)	33	57	50

CE, capsule endoscopy; OGIB, obscure gastrointestinal bleeding.

Discussion

Small bowel AVMs are the most common cause of OGIB. They may produce considerable and fatal bleeding that may end the patient's life before the traditional investigations can diagnose or localize the site of bleeding.

Although the CE acquired an excellent reputation in diagnosis, the cause of OGIB and its sensitivity reached

Table 3 Comparison between capsule endoscopy and intraoperative enteroscopy findings and methods of treatment

Case numbers	Group	CE finding	IOE finding	Action
1	I	Negative	Multiple jejunal AVM	Resection of 35 cm
2	II	Ileal AVM	Multiple ileal AVM	Resection of 28 cm
3	II	Ileal AVM	Multiple jejunal and ileal AVM	Resection 135 cm
4	III	Not done	Large ileal AVM	Resection of 17 cm
5	II	Negative	Small-sized jejunal AVM	Argon plasma coagualtion
6	I	Ileal AVM	Multiple ileal AVM	175 cm resection (right hemicolectomy)
7	II	Negative	Multiple jejunal AVM	Resection of 45 cm
8	II	Jejunal AVM	Multiple jejunal and ileal AVM	Resection of 145 cm
9	I	Negative	Small-sized jejunal AVM	Argon plasma coagulation
10	III	Not done	Large ileal AVM	Resection of 30 cm
11	II	Jejunal AVM	Multiple ileal AVM	Resection of 65 cm
12	II	Negative	Multiple jejunal AVM	Resection of 75 cm

AVM, arteriovenous malformation; CE, capsule endoscopy; IOE, intraoperative enteroscopy.

Table 4 Complications of capsule endoscopy and intraoperative enteroscopy

Complications of CE (total *n* = 10)	*N* (%)	Complications of IOE (total *n* = 12)	*N* (%)
Capsule retention	1 (10)	Mesenteric haematoma	8 (66.6)
Battery failure	1 (10)	Mesenteric tears	6 (50)
		Serosal tears	5 (41.6)
		Prolonged ileus	2 (16.6)

CE, capsule endoscopy; IOE, intraoperative enteroscopy.

more than 75% in many literatures [6,10,11]. However, its sensitivity in detection of small bowel AVMs seems to be lower than this figure; CE had only 50% sensitivity in this study. This may be explained by that CE lacks both air insufflation and suction of secretion during the whole technique. Air insufflation causes stretch of mucosal folds and allows better inspection of hidden lesions. In contrast, suction of intestinal secretion or possible food residues improves the view and unmasks small lesions. In addition, AVMs may be discovered better through the external surface of the intestines or by transillumination of the wall rather than through its mucosal surface.

CE underestimated the extent of the lesions in two (40%) cases of its positive cases (five cases) and wrongly localized the site of lesion in one (20%) case of its positive cases; this underestimation may be due to the fact that CE sometimes moves quickly through a long segment of the bowel with hyperperistalsis.

In addition, CE lacks the ability of immediate intervention or even obtaining biopsies for histological confirmation. Again, CE is a tedious investigation that wastes much time both in performance and interpretation of its results. This time may be very precious in case of moderate and massive GI bleeding.

Our CE had only 10% incidence of retention and 10% of failure due to finish of battery life before completion of the procedure, and these rates are comparable with other studies [10,12–14].

In our research, the transoral method of IOE failed to reach the terminal ileum in five (41.6%) cases, and this failure rate is higher than that reported by other studies [7,8]. This may be due to the fact that we used the adult colonoscope not the paediatric one, which is rather more flexible and more easily manipulated.

This study was not designed to evaluate the diagnostic yield of IOE because its results were used as the standard criterion against which findings of CE were blotted. However, IOE appears to be the most sensitive method in management of small bowel AVMs because it combines endoscopic inspection, naked eye visualization and transillumination of the small bowel in addition to its ability to provide histopathological confirmation of the findings and the feasibility of simultaneous immediate management of the lesions.

Being an invasive investigation, IOE had much higher incidence of complications than CE. However, this high rate of complications can be lowered with more experience of the operators and rising of the learning curve.

We have one perioperative mortality (8.3%), which lies within range of the published different studies [7,8,10–12,15–22]; they recorded mortality rate between 0 and 18%.

In conclusion, CE has a limited diagnostic yield in cases of small bowel AVMs especially in absence of ongoing bleeding, and IOE remains the mainstay method for diagnosis and treatment of these hidden killers.

Because of the relative rarity of the small bowel AVMs, the number of cases in this study was too small to perform a statistical analysis; hence, we recommend performing a more extended multicentre study to re-evaluate the role of CE in these cases.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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