

# Characteristics of Small Intestinal Diseases on Single-Balloon Enteroscopy

## *A Single-Center Study Conducted Over 6 Years in China*

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**Abstract:** The small intestine has been considered inaccessible for a long term. The development of single-balloon endoscopy has greatly improved the diagnosis and treatment possibilities for small intestinal diseases.

In this study, we aimed to explore the demographic characteristics and small intestinal diseases of patients who underwent single-balloon enteroscopy between 2009 and 2014 at our endoscopy center. We determined the enteroscopic findings for each small intestinal disease and the most susceptible age groups.

In total, 186 patients were included in the study. Their mean age was  $45.87 \pm 15.77$  years. Patients who underwent single-balloon enteroscopy were found to have neoplasms (most common age group: 14–45 years, most common lesion location: jejunum), lymphoma (46–59 and 60–74 years, ileum), protuberant lesions (45–59 years, jejunum), inflammation (14–45 and 46–59 years, ileum), benign ulcers (14–45 years, jejunum), diverticulum (14–45 years, ileum), vascular malformations (60–74 years, jejunum), polyps (14–45 years, jejunum), Crohn's disease (14–45 years, jejunum), hookworm infection (14–45 years, jejunum), lipid pigmentation (14–45 and 46–59 years, jejunum), undetermined bleeding (46–59 years, ileum), or undetermined stenosis (31 years, duodenum). Each small intestinal disease had distinct enteroscopic findings.

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**Abbreviations:** SBE = single balloon enteroscopy, OGIB = obscure gastrointestinal bleeding, MALT = mucosal-associated lymphoma tissue, SD = standard deviation.

## INTRODUCTION

The small intestine has been considered inaccessible for a long time because of its long length.<sup>1</sup> The advent of capsule

endoscopy and double-balloon or single-balloon endoscopy has enabled the exploration of the small bowel thus facilitating the detection of small intestinal diseases. Specifically, double-balloon or single-balloon endoscopy has facilitated biopsy and therapeutic interventions for small intestinal diseases,<sup>2</sup> which have greatly improved the diagnosis and treatment of small intestinal diseases.<sup>3</sup> The SBE characteristics of small intestinal diseases have not been reported recently. For enteroscopists, after they found a lesion under SBE, there is no reference for them to consider the possible small intestinal disease. For clinicians, they cannot deduce the possible disease for a patient with a possible small intestinal disease from the age group and symptoms. To explore the characteristics of small intestinal diseases, we retrospectively analyzed the results of single-balloon enteroscopy carried out at our institute.

## METHODS

This retrospective study was conducted at the endoscopy center of our academic hospital between January 2009 and December 2014. The study was approved by the Ethics Committee of Sichuan University. Single-balloon enteroscopy was performed by experienced endoscopists in all patients. Patient demographic and clinical data such as indications for enteroscopy, enteroscopy approach (antegrade, retrograde, or antegrade and retrograde), endoscopic diagnosis, and images were collected. For patients who underwent a biopsy under enteroscopic guidance, pathological findings were also collected.

Single-balloon enteroscopy was performed for obscure (unknown origin after gastroscopy and colonoscopy), gastrointestinal bleeding (overt or occult bleeding),<sup>4</sup> unexplained abdominal pain and diarrhea, and suspected tumors in the small bowel. Patients were classified into 5 different age groups<sup>5</sup>—<14 years old, 14 to 45 years old, 46 to 59 years old, 60 to 74 years old, 75 to 89 years old, and >90 years old.<sup>7</sup> Single-balloon enteroscopy was performed in patients with contraindications for gastrointestinal endoscopy, acute pancreatitis, acute biliary tract infection, severe esophageal injury, or extensive abdominal adhesion. All patients provided informed consent for the performance of single-balloon enteroscopy.

In this study, we determined the indications for single-balloon enteroscopy and compared these according to the chosen procedure approach, by using the chi-square test. The nature of the different small intestinal diseases was elucidated, and finally, we examined the demographic and clinical characteristics for each diagnosis, such as mean patient age, male-to-female ratio, susceptible age group, and susceptible location within the small intestine, as well as the enteroscopic characteristics.

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**TABLE 1.** General Data of Included Patients

	Antegrade (90) n(%)	Retrograde (59) n(%)	Antegrade and retrograde (37) n(%)	P Value*
Age	45.3 ± 16.2	41.8 ± 14.7	49.1 ± 16.6	0.51 <sup>†</sup>
Male	49 (54.4)	34 (57.6)	19 (51.4)	0.70 <sup>‡</sup>
Indications				
Overt bleeding	13 (14.4)	5 (8.5)	11 (29.7)	0.06 <sup>‡</sup>
Occult bleeding	15 (16.7)	13 (22)	7 (18.9)	0.71 <sup>‡</sup>
Abdominal pain	33 (36.7)	18 (30.5)	7 (18.9)	0.04 <sup>‡</sup>
Diarrhea	26 (28.9)	22 (37.3)	10 (27.0)	0.03 <sup>‡</sup>
Suspected tumor	3 (3.3)	1 (1.7)	2 (5.4)	0.61 <sup>‡</sup>

\* Comparison between antegrade and retrograde.

<sup>†</sup> Independent sample *T* test.

<sup>‡</sup> Chi-square test.

## RESULTS

### Demographic and Clinical Characteristics of the Study Population

In total, 186 patients underwent 196 procedures. The mean patient age was  $45.87 \pm 15.77$  years, and the mode was 46 years. The male-to-female and antegrade-to-retrograde single-balloon enteroscopy ratios were 1.2:1 and 1.5:1, respectively. The indications for single-balloon enteroscopy are shown in Table 1. These included overt bleeding, occult bleeding, and suspected tumor and did not differ according to the single-balloon enteroscopy approach used (antegrade or retrograde). Thus, the approach seemed to have been chosen not according to the indication, but perhaps depending on the lesion. However, for diarrhea, antegrade single-balloon enteroscopy was always chosen.

### Single-Balloon Enteroscopic Findings

Of the 186 patients, 57 had normal findings and 129 had abnormal findings on single-balloon enteroscopy (Table 2). Among the abnormal patients, 85 underwent a biopsy or were treated. Of the patients with abnormal findings, 94 had benign disease, 27 had malignant disease, and 8 had an undetermined condition. The most common malignant disease was neoplasm, followed by lymphoma and malignant protuberant lesions. The

most common benign condition was inflammation, followed by benign ulcers, diverticulum, protuberant lesions, vascular malformations, polyps, Crohn's disease, hookworm infection, and lipid pigmentation (observation of a few white or yellow particles confirmed to be lipid by the pathological examination). For undetermined conditions, undetermined bleeding was the most common, followed by stenosis.

The procedure approach and the depth of insertion for the different small intestinal diseases are shown in Table 3. Both antegrade and retrograde procedures were performed in only 37 patients, only 7 of whom had normal findings. The depth of insertion with antegrade and retrograde procedures were  $200.50 \pm 61.57$  and  $124.07 \pm 59.30$  cm, respectively. The characteristics of the individual small intestinal lesions are shown in Table 4.

### Neoplasms

Neoplasms were found in 18 patients. Their mean age was  $46.28 \pm 16.2$  years, and the male-to-female ratio was 1.6:1. Patients in the 14 to 45 years age group were the most susceptible, and the jejunum was the most common lesion location. On enteroscopy, the neoplasms were seen as ulcers complicated with luminal stenosis ( $n=4$ ), malignant mesenchymoma ( $n=3$ ), protrusive lesions ( $n=2$ ), protrusive lesions complicated with superficial ulcers ( $n=2$ ), solitary ulcers

**TABLE 2.** Nature of Enteroscopic Lesions

	Malignant (27) n(%)	Benign (94) n(%)	Undetermined (8) n(%)	Normal (57) n(%)
Neoplasms	18 (66.7)	0 (0)	0 (0)	0 (0)
Lymphoma	8 (29.6)	0 (0)	0 (0)	0 (0)
Protuberant lesions	1 (3.7)	12 (12.8)	0 (0)	0 (0)
Inflammation	0 (0)	17 (18.1)	0 (0)	0 (0)
Benign ulcer	0 (0)	15 (16.0)	0 (0)	0 (0)
Diverticulum	0 (0)	14 (14.9)	0 (0)	0 (0)
Vascular malformation	0 (0)	13 (13.8)	0 (0)	0 (0)
Polyp	0 (0)	9 (9.6)	0 (0)	0 (0)
Crohn's disease	0 (0)	8 (8.4)	0 (0)	0 (0)
Hookworm	0 (0)	3 (3.2)	0 (0)	0 (0)
Lipid pigmentation	0 (0)	3 (3.2)	0 (0)	0 (0)
Undetermined bleeding	0 (0)	0 (0)	7 (87.5)	0 (0)
Undetermined narrow	0 (0)	0 (0)	1 (12.5)	0 (0)

**TABLE 3.** Procedure Approaches and Depths of Insertion in Different Small Intestinal Diseases

	Antegrade (n), Depth* (mean ± SD[cm])	Retrograde (n), Depth† (mean ± SD[cm])	Antegrade and Retrograde(n)
Lipid pigmentation	2, 175 ± 7.07	0, 0	1
Neoplasm	12, 158.75 ± 65.50	4, 37.5 ± 23.27	1
Inflammation	9, 205.56 ± 43.62	5, 117 ± 50.94	3
Protuberant lesions	9, 190 ± 50.11	2, 200 ± 0.00	2
Diverticulum	2, 140 ± 7.07	9, 118.33 ± 29.15	3
Hookworm	1, 100 ± 0.00	0, 0	2
Vascular malformations	6, 250 ± 57.97	0, 0	7
Polyps	3, 203.33 ± 46.18	4, 115 ± 31.09	2
Crohn's disease	3, 220 ± 51.96	3, 116.67 ± 76.38	2
Benign ulcer	8, 204.38 ± 40.66	3, 186.67 ± 55.08	4
Undetermined bleeding	3, 86.67 ± 15.28	4, 121.25 ± 32.24	0
Lymphoma	3, 130 ± 51.96	3, 18.33 ± 32.53	2
Undetermined narrow	1, 250 ± 0.00	0, 0	0
Normal	28, 235.37 ± 48.95	22, 141.82 ± 62.02	7
Total	90, 200.50 ± 61.57	59, 124.07 ± 59.30	37

SD = standard deviation.

\* The depth of insertion in the antegrade approach defines as the distance from the front tooth to the end point of SBE.

† The depth of insertion in the retrograde approach defines as the distance from ileocecum to the terminal of SBE.

**TABLE 4.** Characteristics of Small Intestinal Lesions

Diagnosis	Mean Age ± SD	Male:Female	Susceptible Age Group	Susceptible Area	Enteroscopic Characteristics (Number of Patients)
Neoplasms	46.28 ± 16.2	11:7	14–45 years old	Jejunum	Ulcer complicated with lumina stenosis (4), malignant mesenchymoma (3), protrusive lesion (2), protrude complicated with superficial ulcer (2), solitary ulcer (2), giant ulcerative lesion (1), diverticulum complicated with ulcerative lesion (1), ulcer complicated with fistula (1), ulcer complicated with bleeding (1), and erosive lesion (1)
Lymphoma	60.25 ± 8.5	3:5	46–59 years old	Ileum	Multiple ulcers (2), solitary ulcer (2), ulcer lesion complicated with fistula (1), ulcer complicated with bleeding (1), ulcer complicated with narrow (1), and erosive lesion (1)
Protuberant lesions	50.1 ± 13.9	5:8	45–59 years old	Jejunum	Mesenchymoma (8), inflammatory hyperplasia (2), phlebotangioma (2), lipoma (1)
Inflammation	44.5 ± 16.5	11:6	14–45 and 46–59 years old	Ileum	Congestion (11), and erosion (6)
Benign ulcer	43.2 ± 13.3	9:6	14–45 years old	Jejunum	Multiple ulcers (6), ulcer complicated with bleeding (3), ulcer complicated with luminal stenosis (3), and solitary ulcer (3)
Diverticulum	31.7 ± 15.3	10:4	14–45 years old	Ileum	Solitary diverticulum (10), diverticulitis (1), diverticulum complicated with ulcer and bleeding (1), diverticulum complicated with fistula (1), and multiple diverticulum (1)
Vascular malformation	57.6 ± 15.0	4:9	60–74 years old	Jejunum	Vascular malformation complicated with bleeding (11) and vascular malformation (2)
Polyp	46.1 ± 18.1	7:2	14–45 years old	Jejunum	Solitary polyp (3) and multiple polyps (6)
Crohn's disease	43.6 ± 17.2	5:3	14–45 years old	Jejunum	Multiple ulcers (8)
Hookworm	40.1 ± 4.0	2:1	14–45 years old	Jejunum	Linear, moterial worm (3)
Lipid pigmentation	49 ± 8.7	1:2	14–45 years old	Jejunum	Leukoplasia (3)
Undetermined bleeding	35.9 ± 21.6	4:3	14–45 and 46–59 years old	Ileum, jejunum, anaastomasis, and undetermined lesion	Clear lesion area but with active bleeding (4) and unclear lesion (3)
Undetermined narrow	31	1:0	31 years old	Duodenum	Annular luminal narrow (1)

SD = Standard deviation.

(n=2), giant ulcerative lesions (n=1), diverticulum complicated with ulcerative lesions (n=1), ulcers complicated with fistula (n=1), ulcers complicated with bleeding (n=1), or erosive lesions (n=1) (Fig. 1).

### Lymphoma

Eight patients were diagnosed lymphoma. Their mean age was  $60.25 \pm 8.5$  years, and the male-to-female ratio was 1:1.7. Patients in the 46 to 59 and 60 to 74 years age groups were the most susceptible, and the ileum was the most common lesion location. On enteroscopy, the lymphomas were seen as multiple ulcers (n=2, 25%), solitary ulcers (n=2, 25%), ulcers complicated with fistula (n=1, 12.5%), ulcers complicated with bleeding (n=1, 12.5%), ulcers complicated with stenosis (n=1, 12.5%), or erosive lesions (n=1, 12.5%) (Fig. 2). Of note, the erosive lesion in this case was diagnosed as mucosa-associated lymphoid tissue lymphoma based on biopsy and pathological findings.

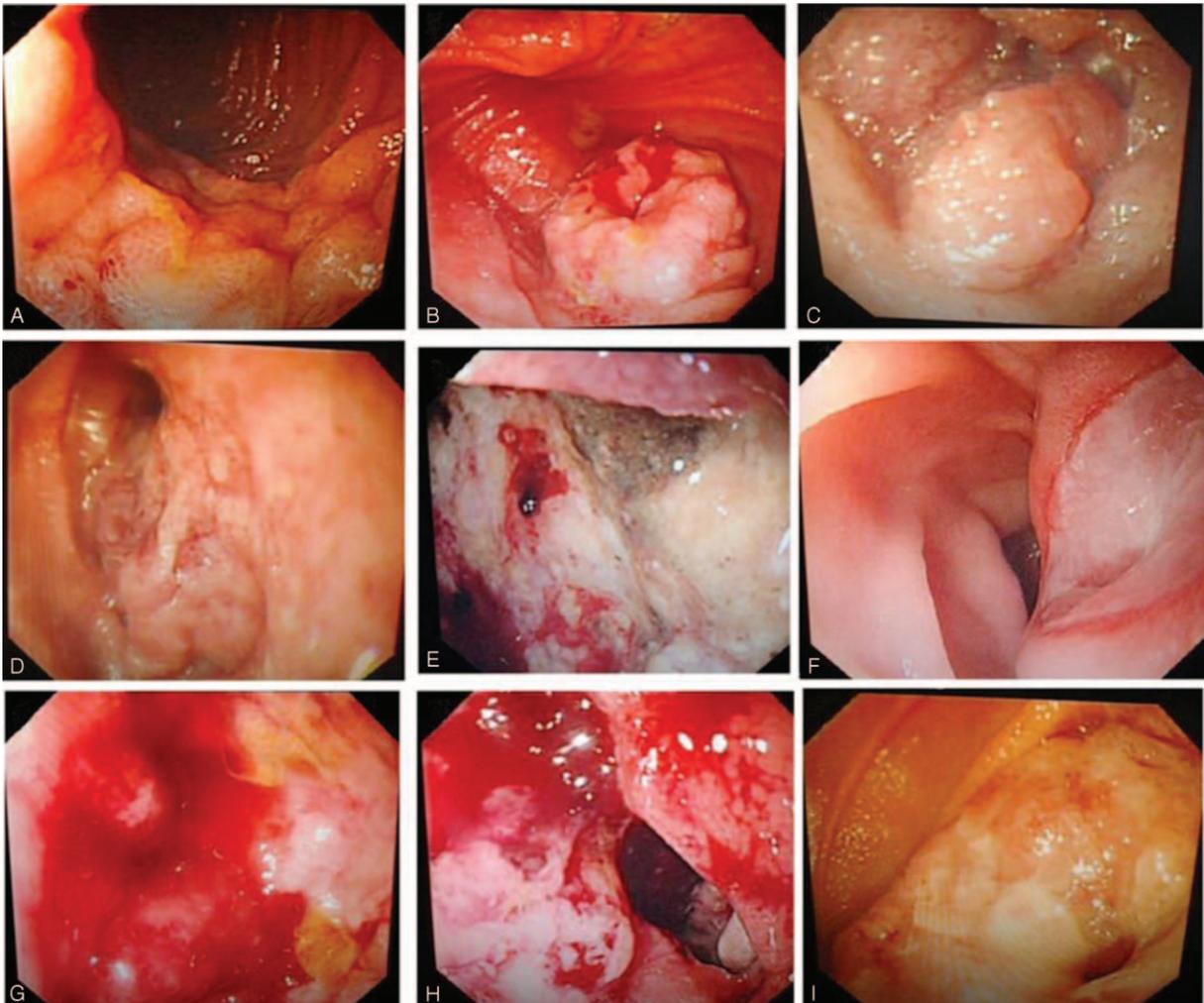
### Protuberant Lesions

Fourteen patients had protuberant lesions. "Protuberant" was defined as elevation above the mucosa.<sup>6-8</sup> The mean

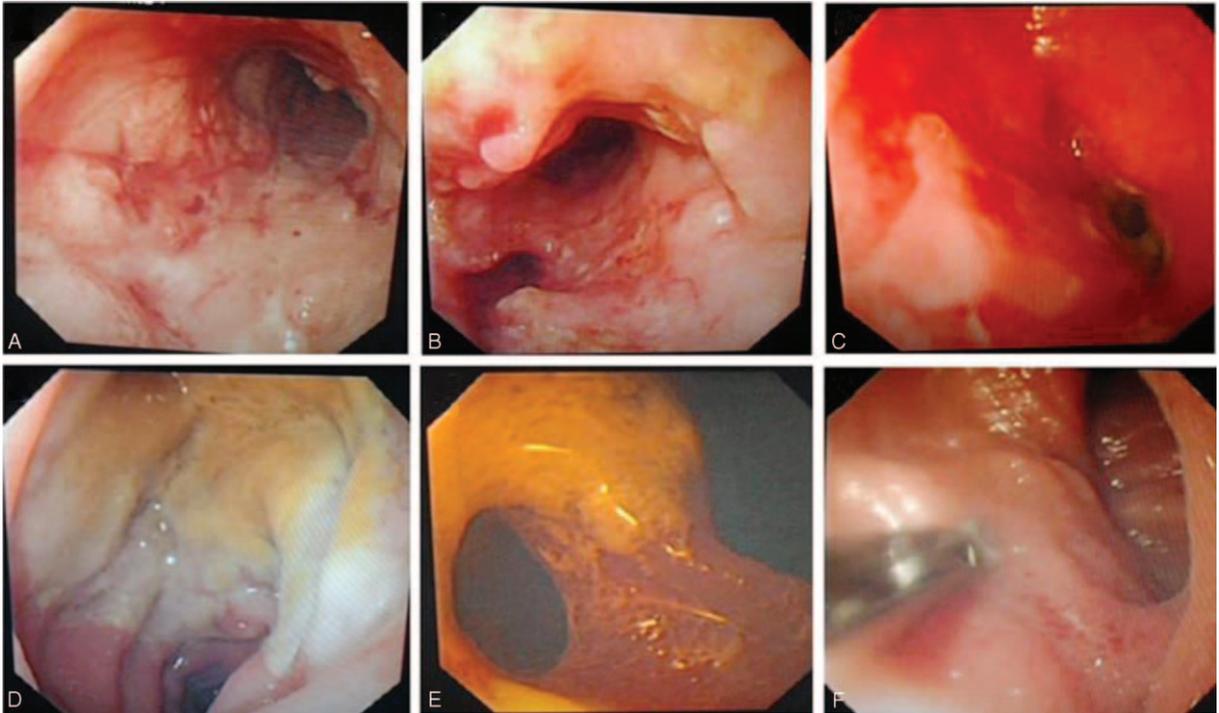
patient age was  $50.1 \pm 13.9$  years, and the male-to-female ratio was 1:1.8. Patients in the 45 to 59 years age group were the most susceptible, and the jejunum was the most common lesion location (n=7), followed by the ileum (n=3), and duodenum (n=3). On single-balloon enteroscopy, protuberant lesions were seen as mesenchymoma (n=8, 61.5%), inflammatory hyperplasia (n=2, 15.4%), phlebotangioma (n=2, 15.4%), or lipoma (n=1, 7.7%) (Fig. 3). Mesenchymoma was diagnosed by the pathological examination of surgical specimens, and 1 of these lesions was considered to be a neoplasm based on the pathological examination. Inflammatory hyperplasia was diagnosed by biopsy; phlebotangioma was mainly diagnosed by gross observation, based on light blue coloration; and lipoma was diagnosed based on biopsy and gross observation.

### Small Intestinal Inflammation

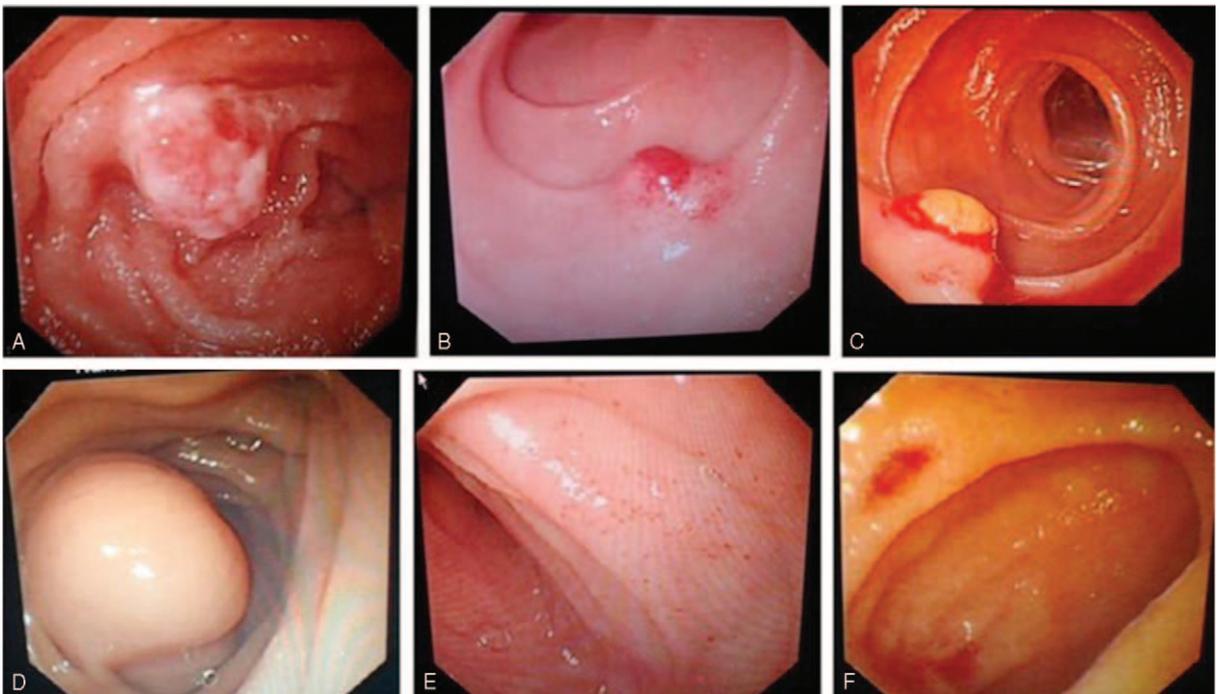
Seventeen patients had small intestinal inflammation. Their mean age was  $44.5 \pm 16.5$  years, and the male-to-female ratio was 1.8:1. Patients in the 14 to 45 and 46 to 59 years age groups were the most susceptible, and the ileum was the most common lesion location (n=8), followed by the jejunum



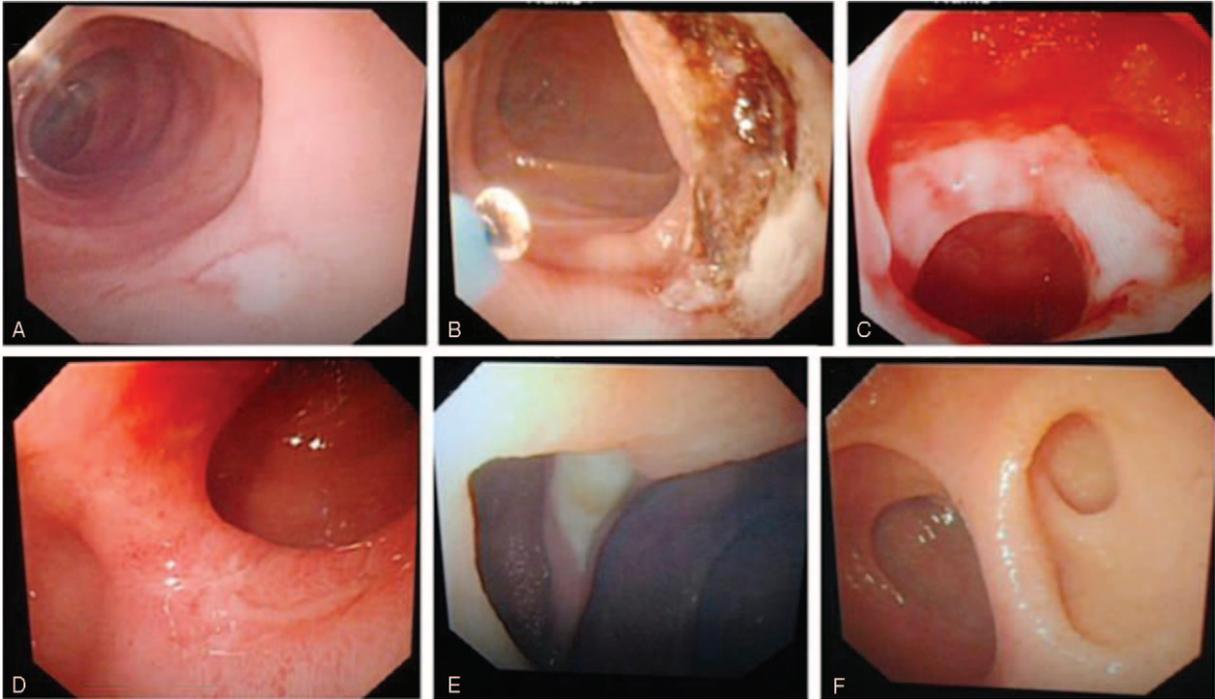
**FIGURE 1.** Neoplasms. A, ileum erosive and coarse lesion; B, ileum malignant mesenchymoma; C, ileum protrusive lesion; D, ileum solitary ulcer; E, jejunum giant ulcerative lesion; F, jejunum protrusive lesion complicated with superficial ulcer; G, jejunum ulcer complicated with bleeding; H, jejunum ulcerative lesion; I, jejunum ulcer complicated with luminal stenosis.



**FIGURE 2.** Lymphoma. A, Duodenum ulcer complicated with bleeding; B, ileum ulcer; C, ileum ulcer complicated with bleeding; D, jejunum solitary ulcer; E, ulcer complicated with fistula.



**FIGURE 3.** Protuberant lesions and inflammation. A, Ileum angioma; B, jejunum inflammatory hyperplasia; C, jejunum lipoma; D, jejunum mesenchymoma; E, jejunum congestion; F, ileum erosion.



**FIGURE 4.** Benign ulcer and diverticulum. A, Ileum ulcer; B, jejunum solitary ulcer complicated with bleeding; C, jejunum ulcer complicated with luminal stenosis; D, ileum diverticulitis; E, ileum diverticulum complicated with ulcer; F, jejunum multiple diverticulum.

( $n = 5$ ), and duodenum ( $n = 4$ ). On enteroscopy, small intestinal inflammation was seen as congestion ( $n = 11$ , 64.7%) or erosion ( $n = 6$ , 35.3%) (Fig. 3).

### Benign Ulcer

Fifteen patients were diagnosed with benign ulcers. Their mean age was  $43.2 \pm 13.3$  years, and the male-to-female ratio was 1.5:1. Patients in the 14 to 45 years age group were the most susceptible, and the jejunum was the most common lesion location ( $n = 6$ ), followed by the ileum ( $n = 5$ ), duodenum ( $n = 1$ ), stomach ( $n = 1$ ), jejunum and duodenum ( $n = 1$ ), and anastomosis ( $n = 1$ ). The mean diameter of the benign ulcers was 0.5 cm (range: 0.2–0.8 cm). On enteroscopy, benign ulcers were seen as multiple ulcers ( $n = 6$ , 40%), ulcers complicated with bleeding ( $n = 3$ , 20%), ulcers complicated with luminal stenosis ( $n = 3$ , 20%), or solitary ulcers ( $n = 3$ , 20%) (Fig. 4).

### Diverticulum

Fourteen patients were diagnosed with diverticulum. Their mean age was  $31.7 \pm 15.3$  years, and the male-to-female ratio was 2.5:1. Patients in the 14 to 45 years age group were the most susceptible, and the ileum was the most common lesion location ( $n = 10$ ), followed by the jejunum ( $n = 4$ ). On enteroscopy, small intestinal diverticulum was seen as solitary diverticulum ( $n = 10$ , 71.4%), diverticulitis ( $n = 1$ , 7.1%), diverticulum complicated with ulcers and bleeding ( $n = 1$ , 7.1%), diverticulum complicated with fistula ( $n = 1$ , 7.1%), or multiple diverticulum ( $n = 1$ , 7.1%) (Fig. 4).

### Vascular Malformation

Thirteen patients were diagnosed with vascular malformation. Their mean age was  $57.6 \pm 15.0$  years, and the male-to-

female ratio was 1:2.25. Patients in the 60 to 74 years age group were most susceptible, and the jejunum was the most common lesion location ( $n = 8$ , 61.5%), followed by the ileum ( $n = 2$ , 15.4%), colon and ileum ( $n = 1$ , 7.7%), jejunum and ileum ( $n = 1$ , 7.7%), and jejunum and duodenum ( $n = 1$ , 7.7%). On enteroscopy, vascular malformation was seen as vascular malformation complicated with bleeding ( $n = 11$ , 84.6%) or vascular malformation without bleeding ( $n = 2$ , 15.4%) (Fig. 5).

### POLYP

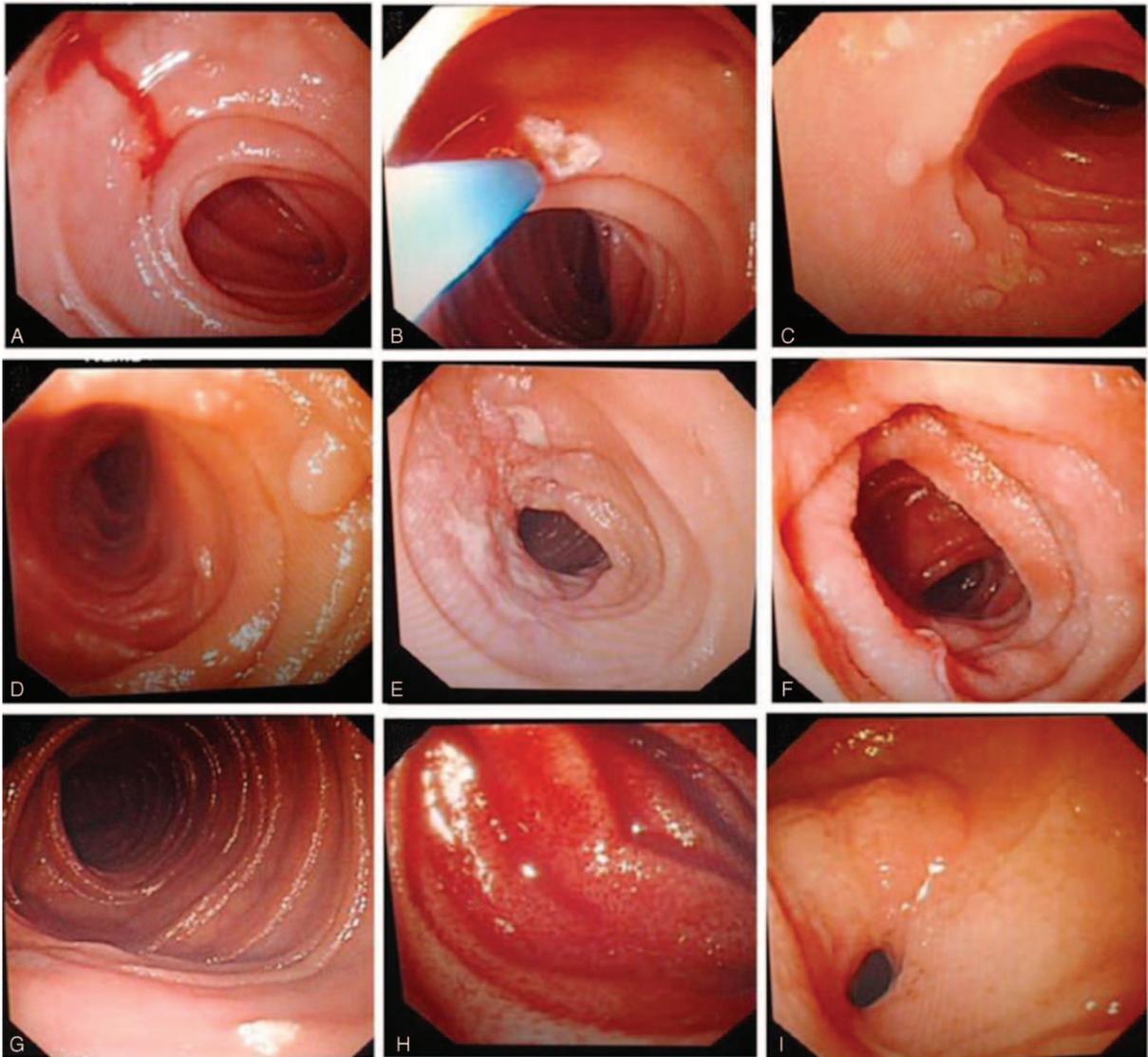
Nine patients had polyps. Their mean age was  $46.1 \pm 18.1$  years, and the male-to-female ratio was 3.5:1. Patients in the 14 to 45 years age group were the most susceptible, and the jejunum was the most common lesion location ( $n = 4$ , 44.4%), followed by the ileum ( $n = 2$ , 22.2%), duodenum ( $n = 2$ , 22.2%), and colon ( $n = 1$ , 11.1%). The mean diameter of the polyps was 0.4 cm (range: 0.2–0.6 cm). On enteroscopy, the polyp were found to be solitary ( $n = 3$ , 33.3%) or multiple ( $n = 6$ , 66.7%) (Fig. 5).

### Crohn's Disease

Eight patients had Crohn's disease. Their mean age was  $43.6 \pm 17.2$  years, and the male-to-female ratio was 1.7:1. Patients in the 14 to 45 years age group were the most susceptible, and the jejunum was the most common lesion location ( $n = 5$ ), followed by the ileum ( $n = 3$ ). Crohn's disease was seen as multiple ulcers on enteroscopy in all patients (Fig. 5).

### Hookworm Infection

Three patients were diagnosed with hookworm infection. Their mean age was  $40.1 \pm 4.0$  years, and the male-to-female



**FIGURE 5.** Vascular malformation, polyp, Crohn’s disease, Hookworm, lipid pigmentation, and undetermined narrow and bleeding. A, Preoperative jejunum vascular malformation complicated with bleeding; B, postoperative jejunum vascular malformation complicated with bleeding preoperative postoperative; C, ileum multiple polyps; D, jejunum solitary polyp; E, jejunum multiple ulcers (Crohn’s disease); F, jejunum hookworm; G, jejunum leukoplakia; H, undetermined bleeding; I, undetermined narrow.

ratio was 2:1. All 3 patients were in the 14 to 45 years age group, and the lesions were located in the jejunum in all of them. Either one or many mobile worms were seen on enteroscopy (Fig. 5).

**Lipid Pigmentation**

Three patients had lipid pigmentation. Their mean age was  $49 \pm 8.7$  years, and the male-to-female ratio was 1:2. They were in the 14 to 45 or 46 to 59 years age group. Lesions in all 3 were found in the jejunum and were seen as leukoplasia on enteroscopy (Fig. 5).

**Undetermined Bleeding**

Seven patients had undetermined bleeding. Their mean age was  $35.9 \pm 21.6$  years, and the male-to-female ratio was 4:3.

Patients in the 14 to 45 and 46 to 59 years age groups were most susceptible, and lesions were located in the ileum (n=2), jejunum (n=1), anastomosis (n=2), or undetermined areas (n=2). On enteroscopy, the causative lesions could not be identified because of active bleeding in clear lesions (which could not be biopsied without considerable risk) (n=4) or unclear lesions (n=3) (Fig. 5).

**Undetermined Stenosis**

Only 1 patient had undetermined stenosis; this was a 31-year-old male patient. The lesion was located in the duodenum. Because of the annular luminal stenosis, the depth of insertion of the enteroscope into the small intestine was limited, although the condition of the mucosa was good (Fig. 5). Therefore, pathological findings were inconclusive.

## DISCUSSION

Single-balloon enteroscopy enables deep insertion into the small intestine, which not only enables diagnosis as with methods such as capsule endoscopy, but also facilitates lesion biopsy in order to identify the nature of small intestinal lesions and stop bleeding with techniques such as electrocoagulation.

The mean age of patients who underwent enteroscopy in our study was 45.87 years, which is less than that reported in 2 studies in the USA<sup>9–10</sup> but similar to 2 other studies conducted in developing countries.<sup>11–12</sup> This could suggest that the age of patients with small intestinal disorders or suspected small intestine disorders differs according to economic levels; however, there is no relevant epidemiological report to support this.

Most of the included patients had benign lesions (73%), and only 21% had malignant diseases, similar to the findings of another study conducted in China.<sup>13</sup> Eight patients (6%) could not be diagnosed with enteroscopy because of bleeding or luminal stenosis, with most patients in the undetermined conditions group having undetermined bleeding, similar to the findings of a study in the USA.<sup>14</sup>

Neoplasms were located mainly in the jejunum, similar to the case in another Chinese study.<sup>15</sup> The male-to-female ratio in our study was 1.6:1, similar to the results of another study. However, that study reported a different susceptible age group (~46 years old).<sup>16</sup>

For small intestinal lymphomas, the male-to-female ratio was 1:1.7 in our study, which is different from the 1.3:1 ratio reported in a previous study, and the mean patient age (60 years old) was higher than previously reported.<sup>17</sup> Small intestinal lymphomas in our study were noted mainly in the ileum. However, the jejunum and ileum were found to be susceptible locations in a previous Asian study.<sup>18</sup>

The mean age of patients with Crohn's disease was lower than previously reported values.<sup>19</sup>

Here, we described the enteroscopic characteristics of different small intestinal diseases—neoplasms, lymphomas, protuberant lesions, small intestinal inflammation, benign ulcers, diverticulum, vascular malformation, polyps, Crohn's disease, hookworm infection, lipid pigmentation, undetermined bleeding, and undetermined stenosis and determined the susceptible age groups. Further studies on the characteristics of small intestinal diseases can provide references for enteroscopists to consider the possible small intestinal disease after finding a lesion under SBE. Moreover, it also can help clinicians to deduce the possible disease for a patient with a possible small intestinal disease from the age group and symptoms.

Some limitations need to be considered. First, the sample size was small. Second, this was a retrospective analysis. All of these cannot ignore selection bias.

Small intestinal diseases examined by single-balloon enteroscopy were most commonly found in young patients (<45 years old) except for lymphoma, protuberant lesions, vascular malformations, and undetermined bleeding. The lesions and enteroscopic characteristics differ for different small intestinal diseases.

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## REFERENCES

1. Mauro Manno, Carmelo Barbera, Helga Bertani, et al. Single balloon enteroscopy: technical aspects and clinical applications. *World J Gastrointest Endosc.* 2012;4:28–32.
2. Upchurch Bennie R, Vargo John J. Single-balloon enteroscopy. *Gastrointest Endosc.* 2009;19:335–347.
3. Mohan Ramchandani D, Reddy Nageshwar, Gupta Rajesh, et al. Diagnostic yield and therapeutic impact of single-balloon enteroscopy: series of 106 cases. *J Gastroenterol Hepatol.* 2009;24:1631–1638.
4. Raju GS, Gerson L, Das A, et al. American Gastroenterological Association (AGA) Institute technical review on obscure gastrointestinal bleeding. *Gastroenterology.* 2007;133:1697–1717.
5. Haibach P, Slobounov S, Newell K. Egomotion and vection in young and elderly adults. *Gerontology.* 2009;55:637–643.
6. Lin Wang, Shi-Yao Chen, Ying Huang, et al. Selective endoscopic ligation for treatment of upper gastrointestinal protuberant lesions. *World J Gastroenterol.* 2013;19:5581–5585.
7. Umetani N, Muto T, Kawamura YJ, et al. Superficial depressed early carcinoma that developed into protuberant advanced carcinoma in the transverse colon. *J Gastroenterol.* 2001;36:48–51.
8. Rodríguez Campello A, Roquer J, Munteis E, et al. Miller–Fisher syndrome associated with a bilateral tegmental protuberant lesion of probable vascular origin. *Neurologia.* 2001;16:50–51.
9. David J, Frantz MS, Dellon Evan S, et al. Single-balloon enteroscopy: results from an initial experience at a U.S tertiary-care center. *Gastrointest Endosc.* 2010;72:422–426.
10. Upchurch Bennie R, Madhusudhan R, Ana Rocio Lopez Sanaka, et al. The clinical utility of single-balloon enteroscopy: a single-center experience of 172 procedures. *Gastrointest Endosc.* 2010;71:1218–1223.
11. Varayu Prachayakul, Morakod Deesomsak, Pitulak Aswakul, et al. The utility of single-balloon enteroscopy for the diagnosis and management of small bowel disorders according to their clinical manifestations: a retrospective review. *BMC Gastroenterol.* 2013;13:103.
12. Rajiv Bajjal, Praveen Kumar, Gupat Deepak, et al. Single balloon enteroscopy: a single-center experience of 48 procedures. *Indian J Gastroenterol.* 2014;33:55–58.
13. Fa-Chao Zhi, Hui Yue, Bo Jiang, et al. Diagnostic value of double balloon enteroscopy for small-intestinal disease: experience from China. *Gastrointest Endosc.* 2007;66:S19–21.
14. Upchurch Bennie R, Sanaka Madhusudhan R, Ana Rocio Lopez, et al. The clinical utility of single-balloon enteroscopy: a single-center experience of 172 procedures. *Gastrointest Endosc.* 2010;71:1218–1223.
15. Wen-Guo Chen, Guo-Dong Shan, Hong Zhang, et al. Double-balloon enteroscopy in small bowel tumors: a Chinese single-center study. *World J Gastroenterol.* 2013;19:3665–3671.
16. Guo X, Mao Z, Su D, et al. The clinical pathological features, diagnosis, treatment and prognosis of small intestine primary malignant tumors. *Med Oncol.* 2014;31:913.
17. Ding D, Pei W, Chen W, et al. Analysis of clinical characteristics, diagnosis, treatment and prognosis of 46 patients with primary gastrointestinal non-Hodgkin lymphoma. *Mol Clin Oncol.* 2014;2:259–264.
18. Kim SJ, Jung HA, Chuang SS, et al. Extranodal natural killer/T-cell lymphoma involving the gastrointestinal tract: analysis of clinical features and outcomes from the Asia Lymphoma Study Group. *J Hematol Oncol.* 2013;16:86.
19. Jang HJ, Choi MH, Eun CS, et al. Clinical usefulness of double balloon enteroscopy in suspected Crohn's disease: the KSAID multi-center trial. *Hepatogastroenterology.* 2014;61:1292–1296