

# Analysis of the relationship between double-balloon enteroscopy docking success rates and lesion detection rates: a single-center retrospective study

Hu Xinyue

[mymail0331@163.com](mailto:mymail0331@163.com)

Affiliated Hospital of Inner Mongolia Medical University

Chen Ping

Affiliated Hospital of Inner Mongolia Medical University

Cui Jie

Affiliated Hospital of Inner Mongolia Medical University

Dong Haiying

Affiliated Hospital of Inner Mongolia Medical University

Li Jia

Affiliated Hospital of Inner Mongolia Medical University

A Runa

Affiliated Hospital of Inner Mongolia Medical University

---

## Research Article

**Keywords:** double-balloon enteroscopy, reconnection rate, lesion detection rate, small intestinal diseases

**Posted Date:** October 1st, 2026

**DOI:** <https://doi.org/10.21203/rs.3.rs-11042491/v1>

**License:**   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

**Additional Declarations:** No competing interests reported.

---

# Abstract

**Background:** The small intestine poses diagnostic challenges in digestive system diseases. The advent of double-balloon enteroscopy (DBE) has significantly improved endoscopic visualization and diagnostic capabilities for small intestine diseases.

**Objective:** To investigate the correlation between DBE docking rates and small intestine disease detection rates among patients with small intestine disorders.

**Design:** Retrospective study.

**Methods:** A total of 125 patients with small intestine diseases who underwent DBE at the Department of Gastroenterology of the Affiliated Hospital of Inner Mongolia Medical University between March 2024 and July 2025 were enrolled and divided into the docking group (n=48) and non-docking group (n=77). Endoscopic findings and clinical data were retrospectively analyzed and lesion detection rates of both groups were systematically documented. Patients were also categorized according to disease types to analyze the relationship between lesion detection and the docking status.

**Results:** However, DBE docking was successful in only 48 patients (38.4%; 48/125). Lesions were detected in 78 patients (78/125 [62.4%]; docking group: 38/48 [79.2%]; non-docking group: 40/77; 51.9%). The difference in lesion detection rates between groups was statistically significant ( $\chi^2=9.336$ ;  $P=0.002$ ). Among 43 patients with small intestine disease, unexplained gastrointestinal bleeding was confirmed in 37 (docking group: 22/23 [95.6%]; non-docking group: 14/20 [70%]). The intergroup difference was not statistically significant ( $\chi^2=5.165$ ;  $P=0.023$ ). For 29 patients with small intestine ulcers, lesion detection rates were 76.5% (13/17) and 58.3% (7/12) in the docking and non-docking groups, respectively, with no statistically significant intergroup difference:  $\chi^2=1.081$ ;  $P=0.298$ . Among 17 patients with tumors, lesion detection rates were 100% (3/3) and 64.3% (9/14) in the docking and non-docking groups, respectively, with no statistically significant intergroup difference:  $\chi^2=1.581$ ;  $P=0.218$ . Differences in hospitalization duration, adverse events, and average hospitalization costs were not statistically significant.

**Conclusion:** Significantly higher lesion detection rates were associated with successful DBE docking.

## 1 Introduction

Because of its length, deep location, and active peristalsis, the small intestine poses diagnostic challenges in digestive system diseases. The advent of double-balloon enteroscopy (DBE) has significantly improved endoscopic visualization and diagnostic capabilities for small intestine diseases; therefore, it has been established as the “gold standard” for small intestine disease examinations.<sup>1</sup> One of the core objectives of DBE is to achieve a “junction” created by the simultaneous insertion of endoscopes through the oral and anal passages that meet within the intestinal lumen, theoretically enabling observation of the entire small intestine without blind spots.<sup>2</sup> However, the success rate of

achieving this junction (docking) is influenced by various factors such as anatomical characteristics of the patient, operator experience, and intestinal adhesions. Relatively few studies, particularly those lacking targeted analyses of different small intestine diseases, have investigated the effect of successful DBE docking on the final lesion detection rate.<sup>3</sup> This study aimed to retrospectively analyze cases examined using DBE at our hospital and systematically evaluate the relationship between the docking rate, overall lesion detection rate, and detection rates of different disease types (such as unexplained gastrointestinal bleeding, small intestinal ulcers, small intestinal tumors) to provide clinical evidence that could optimizing DBE examination strategies.

## **2 Materials and Methods**

### **2.1 Study participants**

Data of patients with suspected small intestine disease who underwent DBE in the Department of Gastroenterology at the Affiliated Hospital of Inner Mongolia Medical University between March 2024 and July 2025 were retrospectively collected.

Inclusion criteria were as follows: clinical suspicion of small intestine disease (e.g., unexplained gastrointestinal bleeding, abdominal pain, diarrhea, suspected Crohn's disease, suspected small intestinal tumor); had undergone DBE; age 18 years or older; and complete clinical data were available.

The exclusion criteria were as follows: termination of DBE because of severe complications or patient intolerance and lack of clinical data. A total of 125 patients were enrolled in this study.

### **2.2 Research methods and grouping**

The Fujinon EN-450T5/W DBE system was used by physicians with extensive DBE experience in accordance with standard operating procedures. The approach (oral, transanal, or combined) was selected based on the patient's condition and the results of a preliminary assessment.

Docking was defined as successful convergence of two balloon enteroscopes (one inserted orally and one inserted perianally) during a single hospitalization or two closely scheduled examinations, thus allowing visualization of the complete small intestine through the lumen.

Patients were grouped into the docking group if the convergence of two balloon enteroscopes was successful (n = 48 patients), the other patients were group into the non-docking group if only one balloon enteroscope was used or the convergence of two balloon enteroscopes was not successful (n = 77 patients).

During this study, we evaluated the overall docking rate, overall lesion detection rate, lesion detection rates in the docking and non-docking groups, and detection rates of major diseases (unexplained gastrointestinal bleeding, small intestinal ulcer, small intestinal tumor) in the docking and non-docking

groups. We also compared differences in the hospitalization time, incidence of adverse events, and hospitalization expenses of the docking and non-docking groups.

## 2.3 Statistical analysis

The statistical analysis was performed using SPSS 26.0 software. Categorical data were expressed as counts (%) and intergroup comparisons were conducted using the  $\chi^2$  test or Fisher's exact probability test (when the theoretical frequency was  $< 5$ ). Continuous data with normal distribution were expressed as the mean  $\pm$  standard deviation and intergroup comparisons were performed using the independent samples t-test. Data without normal distribution were expressed as the median (interquartile range) and intergroup comparisons were performed using the Mann-Whitney U test.  $P < 0.05$  was considered statistically significant.

## 3 Results

### 3.1 Patient demographics

A total of 125 patients underwent DBE. Successful docking was achieved in 48 patients, resulting in an overall docking rate of 38.4% (48/125 patients). Among these 125 patients, small intestine lesions were detected in 78, resulting in an overall lesion detection rate of 62.4% (78/125 patients). (Table.1, Table.2)

### 3.2 Comparison of lesion detection rates between groups

Among the 48 patients in the docking group, lesions were detected in 38, resulting in a detection rate of 79.2% (38/48 patients). Among the 77 patients in the non-docking group, lesions were detected in 40, resulting in a detection rate of 51.9% (40/77 patients). The lesion detection rate in the docking group was significantly higher than that in the non-docking group, and the difference was statistically significant ( $\chi^2 = 7.885$ ;  $P = 0.005$ ).

### 3.3 Relationship between lesion detection rates and docking

Unexplained gastrointestinal bleeding was diagnosed in 43 patients and confirmed in 37 (23 in the docking group and 20 in the non-docking group). In the docking group, lesions were detected in 22 patients, resulting in a detection rate of 95.6% (22/23 patients). In the non-docking group, lesions were detected in 14, resulting in a detection rate of 70.0% (14/20 patients). The lesion detection rate in the docking group was significantly higher than that in the non-docking group, and the difference was statistically significant ( $\chi^2 = 5.165$ ;  $P = 0.023$ ). Figure 2.

Small intestine ulcers (including inflammatory bowel disease, nonsteroidal anti-inflammatory drug-associated ulcers, and ulcerative colitis) were diagnosed in 29 patients and confirmed in 20 (17 in the docking group and 12 in the non-docking group). In the docking group, lesions were detected in 13 patients (76.5%; 13/17). In the non-docking group, lesions were detected in seven patients (58.3%; 7/12).

Lesion detection rates were not significantly different between these groups ( $\chi^2 = 1.081$ ;  $P = 0.298$ ). Figure 3.

Small intestine tumors (comprising benign tumors such as stromal tumors and adenomas and malignant tumors such as adenocarcinoma, lymphoma, and metastatic carcinoma) were diagnosed in 17 patients (Figure 1.4.) (3 in the docking group and 14 in the non-docking group) and confirmed in 12. In the docking group, lesions were detected in three patients, resulting in a detection rate of 100% (3/3 patients). In the non-docking group, lesions were detected in nine patients, resulting in a detection rate of 64.3% (9/14 patients). Lesion detection rates were not significantly different between these groups (Fisher's exact probability test,  $P = 0.218$ ).

The diagnoses of 36 patients were unclear before DBE. The final diagnosis through small bowel endoscopy was small intestinal foreign body, small intestinal protein loss, small intestinal imaging abnormalities. Among these patients 5 of them were docking group but didn't diagnosed, 31 of them were non-docking group, but 9 of 31 non-docking group patients were exactly diagnosed.

### **3.4 Subgroup analysis: hospital length of stay, adverse events, and hospitalization costs**

Differences in the length of hospitalization, incidence of examination-related adverse events (such as perforation, hemorrhage, pancreatitis), and average medical expenses associated with hospitalization between the docking and non-docking groups were not statistically significant (all  $P > 0.05$ ).

The results of this study indicated that among patients with small intestine diseases who underwent DBE examinations at our institution, the overall lesion detection rate was 38.4%, which is similar to the rates reported by some domestic and international studies, suggesting that achieving full small intestine coverage remains challenging. The overall lesion detection rate in the docking group (79.2%) was significantly higher than that in the non-docking group (51.9%), and this difference was statistically significant ( $P = 0.005$ ). This finding strongly demonstrates that successful DBE docking is a critical factor that can improve the overall detection rate of small intestinal lesions. Theoretically, successful docking enables comprehensive observation of the small intestine mucosa without blind spots, thus significantly reducing the risk of missed diagnoses attributable to the limited examination scope, particularly in segments that are difficult to access via a single enteroscope pathway.<sup>4</sup>

A thorough analysis of different diseases revealed that enhanced lesion detection was most prominent in patients with unexplained gastrointestinal bleeding. The lesion detection rate of patients with unexplained gastrointestinal bleeding in the docking group was 95.6%, which was significantly higher than that in the non-docking group (70.0%) ( $P = 0.023$ ). Unexplained gastrointestinal bleeding, which often presents intermittently and insidiously, is the most common indication for small bowel DBE examinations, and bleeding foci (such as vascular malformations, small ulcers, Dieulafoy lesions, and microtumors) could be located in any part of the small intestine.<sup>4</sup> Successful docking enables exploration of the entire small bowel, thereby greatly increasing the opportunity to detect these micro

foci or actively bleeding foci in the intermediate intestinal segments. This finding aligned with those reported by multiple studies that have emphasized the high diagnostic value of a full examination of the small bowel to assess unexplained gastrointestinal bleeding.<sup>5</sup>

For small intestine ulcerative diseases, the lesion detection rates were 76.5% and 58.3% ( $P = 0.298$ ) in the docking and non-docking groups, respectively. For small intestine tumors, the lesion detection rates were 100% and 64.3% ( $P = 0.218$ ) in the docking and non-docking groups, respectively. Although the detection rates in the docking group were higher, the intergroup differences were not statistically significant, possibly because of the ulcer distribution characteristics. Furthermore, inflammatory ulcers, such as those associated with Crohn's disease, often exhibit segmental and skip-like distributions with relatively large lesions and distinct morphological features, and the main lesions may be identified through single-path endoscopy.

Regarding the characteristics of neoplastic diseases, small intestine tumors (particularly larger ones) often present with symptoms (e.g., obstruction, significant bleeding) that require medical consultations and imaging studies (e.g., computed tomography enterography/magnetic resonance enterography), which may provide suggestive findings, resulting in more targeted single-path DBE. In this study, the number of patients with tumors was relatively small ( $n = 17$ ), and only three of these patients were in the docking group, resulting in insufficient statistical power and possibly explaining the lack of statistical significance. Notably, tumors were detected in all patients in the docking group; however, tumors were undetected in five patients (35.7%) in the non-docking group, suggesting that docking may be important to avoiding missed diagnoses, especially for patients with small or flat tumors. However, the relatively small sample size included in the subgroup analysis may have affected statistical power.

Furthermore, no significant differences in hospitalization duration, adverse events, and hospitalization costs were observed between the docking and non-docking groups. This indicates that, under the premise of ensuring safety, efforts to achieve docking to improve diagnostic rates did not significantly increase the burden on patients or medical costs.

This single-center retrospective analysis confirmed that successful DBE docking significantly improved the overall detection rate of small intestine lesions. Docking is particularly valuable for enhancing the diagnostic rate of unexplained gastrointestinal bleeding. For patients with suspected unexplained gastrointestinal bleeding, DBE docking should be actively attempted and completed whenever possible.<sup>6</sup>

Although the detection rate of endoscopic examinations was higher for small intestinal ulcers and neoplastic diseases, a statistically significant advantage was not demonstrated in this study. However, because endoscopy enables comprehensive observation of the entire small intestine without blind spots, it should be pursued in clinical practice for patients with difficult diagnoses or suspected mid-intestinal lesions to improve the diagnostic rate.<sup>7</sup> The implementation of endoscopy did not significantly increase the hospitalization duration, risk of adverse events, or hospitalization costs. Therefore, clinicians and operators should prioritize and continuously optimize docking techniques.<sup>8</sup>

This study was limited by its single-center, retrospective design and relatively limited sample size, which may have affected the generalizability of the results. Future large-scale, prospective, multicenter studies are required to further validate the findings and explore factors that influence docking success rates and optimization strategies.

## Conclusion

The findings of this study highlight the importance of improving the success rate of DBE docking, particularly for patients with unexplained gastrointestinal bleeding, to enhance the diagnostic accuracy of small intestine diseases.

## Declarations

### Human ethics and participant consent statement

Human ethics statement: This study was carried out in accordance with the ethical principles outlined in the Declaration of Helsinki. The research protocol obtained approval from the Ethics Committee of the Affiliated Hospital of Inner Mongolia Medical University (approval No. KY2026210).

### Consent to Participate declaration

Participant consent statement: This is a retrospective study based on existing clinical medical records. The ethics committee granted a waiver for written informed consent. All patient data were de-identified to maintain participant confidentiality.

**The name of the Approval Committee or the Internal Review Board (IRB) in the Ethics Approval:** Ethics Committee of Affiliated Hospital of Inner Mongolia Medical University .

**Chief Examiner:** Zhang Guojian , Lin yu

**Funding Declaration:** This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Author Contribution

**\*\*Hu Xinyue\*\*** conceived the study together with the corresponding author, collected and extracted the clinical and endoscopic data, performed the statistical analysis with SPSS, and drafted the original manuscript. **\*\*Chen Ping\*\***(Corresponding Author) supervised the study, conceived and coordinated the overall project, secured the clinical resources, finalized and approved the manuscript for submission, and is responsible for correspondence with the journal. **\*\*Cui Jie\*\***(Corresponding Author) contributed to the study design, methodological guidance, and data interpretation, and critically revised the manuscript. **\*\*Dong Haiying\*\*** and **\*\*Li Jia\*\*** participated in patient enrollment, data collection, and chart review. **\*\*A**

Runa\*\* assisted with data curation, statistical support, and figure preparation. All authors read and approved the final manuscript and agree to be accountable for all aspects of the work.

## References

1. Yamamoto H, Sekine Y, Sato Y, et al. Total enteroscopy with a nonsurgical steerable double-balloon method. *Gastrointest Endosc.* 2001;53:216–20.
2. Endoscopic physicians branch of China medical doctor association small intestine endoscopy professional committee. China small intestine endoscopy clinical application guidelines (2022, shanghai). *Chin J Dig Endosc.* 2022;39:601–12.
3. Pennazio M, Rondonotti E, Despott EJ, et al. Small-bowel capsule endoscopy and device-assisted enteroscopy for diagnosis and treatment of small-bowel disorders: European Society of Gastrointestinal Endoscopy (ESGE) Guideline – Update 2022. *Endoscopy.* 2022;55:58–95. EPub.
4. Xin L, Liao Z, Jiang YP, et al. Indications, detectability, positive findings, and outcomes of double-balloon enteroscopy in China: a systematic review. *J Dig Dis.* 2015;16:511–7.
5. Li X, Zhao YJ, Dai J, et al. Double-balloon enteroscopy effectively diagnoses occult small bowel bleeding in patients with negative capsule endoscopy. *Med (Baltim).* 2019;98:e15735.
6. Ang TL. Gastrointestinal endoscopy during COVID-19 pandemic. *J Gastroenterol Hepatol.* 2020;35:701–2.
7. Watanabe K, Fukushima H, Fujiwara Y et al. Comparison of diagnostic yield between double-balloon endoscopy and capsule endoscopy for small-bowel tumors: a systematic review and meta-analysis. *Gastroenterol Res Pract* 2021; 2021: 6611116.
8. Shinozaki S, Yamamoto H, Yano T, et al. Long-term outcome of patients with obscure gastrointestinal bleeding investigated by double-balloon endoscopy. *Clin Gastroenterol Hepatol.* 2009;8:151–8.

## Tables

**Table 1: Lesions and Diagnoses Confirmed by Small Bowel Endoscopy (N=78)**

|                                                 | Diseases                                    | Patients |                                                | Diseases                                    | Patients |
|-------------------------------------------------|---------------------------------------------|----------|------------------------------------------------|---------------------------------------------|----------|
| <b>Hemorrhage of the digestive tract</b>        | Small intestinal vascular malformation      | 15       | <b>Small intestine ulcer (non-hemorrhagic)</b> | Non-specific ulcer                          | 10       |
|                                                 | Small intestine ulcers related to NSAID use | 10       |                                                | Behcet disease                              | 1        |
|                                                 | Meckel's diverticulum                       | 8        |                                                | Crohn's disease of the small intestine      | 2        |
|                                                 | Jejunum stromal tumor                       | 4        |                                                | Small intestine ulcers related to NSAID use | 7        |
|                                                 | Diseases                                    | Patients |                                                | Diseases                                    | Patients |
| <b>Small intestine tumors (non-hemorrhagic)</b> | Intestinal adenocarcinoma                   | 3        | <b>Other</b>                                   | Foreign body in the small intestine         | 5        |
|                                                 | Adenoma                                     | 5        |                                                | Loss of small intestine protein             | 1        |
|                                                 | Lymphadenoma                                | 1        |                                                | Lymphangiectasia of the small intestine     | 3        |
|                                                 | Carcinoma Metastatic                        | 1        |                                                |                                             |          |
|                                                 | Interstitial                                | 2        |                                                |                                             |          |

NSAID = non-steroidal anti-inflammatory drug.

Table 1 Lesions and diagnoses confirmed by small-bowel endoscopy (N=78)

This table summarizes the disease spectrum of 78 patients with detected lesions. It lists the categories and case numbers of hemorrhagic, ulcerative, neoplastic and other small-intestinal disorders, and reflects the disease distribution of enrolled subjects.

Table 2: Relationship between Docking and Lesion Detection Rates

| Variable   | Patients | Confirmed diagnosis n (%) | Undetermined diagnosis n (%) | $\chi^2$ | P     |
|------------|----------|---------------------------|------------------------------|----------|-------|
| Docking    | 48       | 38 (79.2)                 | 10 (21.3)                    | 9.336    | 0.002 |
| No docking | 77       | 40 (51.9)                 | 37 (48.1)                    |          |       |

Table 2 Relationship between DBE docking status and lesion-detection rates

The table compares the proportions of confirmed and undetermined diagnoses between the docking and non-docking groups. Statistical results reveal a significant inter-group difference in lesion-detection rates, verifying that successful docking improves diagnostic yield for small-intestinal lesions.

**Table 3: Analysis of Double-Balloon Enteroscopy Examination Results and Pathological Detection Rates**

|                                                    |                                    | Patients<br>(n) | Lesions<br>detected<br>(n)                              | Pathological<br>detection<br>rate (%)                   | Significance                                            | P     |
|----------------------------------------------------|------------------------------------|-----------------|---------------------------------------------------------|---------------------------------------------------------|---------------------------------------------------------|-------|
| Overall                                            |                                    | 125             | 78                                                      | 62.4                                                    | -                                                       | -     |
|                                                    | Docking                            | 48              | 38                                                      | 79.2                                                    |                                                         |       |
|                                                    | Non-docking                        | 77              | 40                                                      | 51.9                                                    |                                                         |       |
| Comparison of<br>overall lesion<br>detection rates | Docking group vs.Non-docking group |                 |                                                         |                                                         | χ <sup>2</sup> =7.885                                   | 0.005 |
| Lesion detection rates across different diseases   |                                    |                 |                                                         |                                                         |                                                         |       |
| Unexplained<br>gastrointestinal<br>bleeding        | Docking<br>group                   | 23              | 22                                                      | 95.6                                                    | χ <sup>2</sup> =5.165                                   | 0.023 |
|                                                    | Non-docking<br>group               | 20              | 14                                                      | 70.0                                                    |                                                         |       |
| Small intestine<br>ulcers                          | Docking<br>group                   | 17              | 13                                                      | 76.5                                                    | χ <sup>2</sup> =1.081                                   | 0.298 |
|                                                    | Non-docking<br>group               | 12              | 7                                                       | 58.3                                                    |                                                         |       |
| Small intestine<br>tumors                          | Docking<br>group                   | 3               | 3                                                       | 100.0                                                   | Differences<br>were not<br>statistically<br>significant | 0.218 |
|                                                    | Non-docking<br>group               | 14              | 9                                                       | 64.3                                                    |                                                         |       |
| Other diseases                                     | Docking<br>group                   | 5               | 0                                                       | 0.0                                                     | -                                                       | -     |
|                                                    | Non-docking<br>group               | 31              | 9                                                       | 29.0                                                    |                                                         |       |
| Subgroup<br>analysis                               | Groups                             | Patients<br>(n) | Hospital<br>length of<br>stay                           | Adverse<br>events                                       | Hospitalization<br>expenses                             | P     |
|                                                    | Docking<br>group                   | 48              | Differences<br>were not<br>statistically<br>significant | Differences<br>were not<br>statistically<br>significant | Differences<br>were not<br>statistically<br>significant | >0.05 |
|                                                    | Non-docking<br>group               | 77              |                                                         |                                                         |                                                         |       |

Table 3 Analysis of DBE examination outcomes and lesion-detection rates

This table aggregates case numbers, lesion-detection rates and P-values for the overall cohort, docking/non-docking subgroups, and individual disease subgroups. It further compares length of hospital stay, adverse-event incidence and hospitalization costs, comprehensively evaluating the diagnostic impact, safety and economic indicators of successful DBE docking.

## Figures

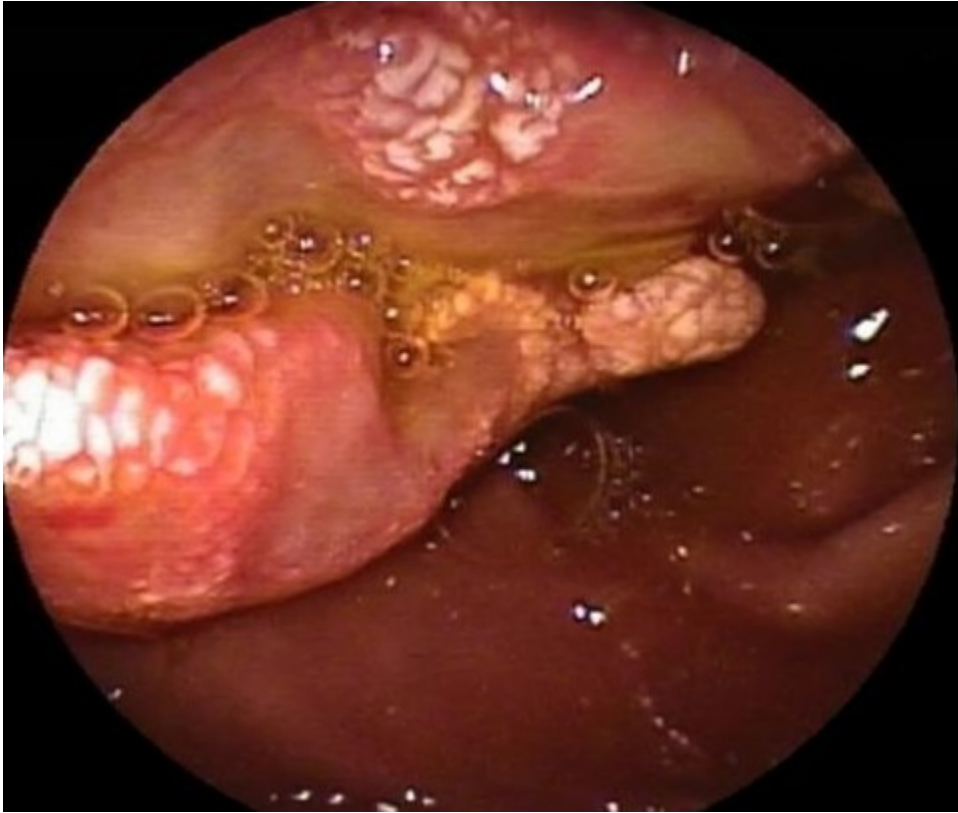


**Figure 1**

Small-intestinal lymphoma

Endoscopic image of small-intestinal lymphoma obtained by double-balloon enteroscopy (DBE). It demonstrates the endoscopic morphology of small-intestinal neoplastic lesions enrolled in this study and provides visual endoscopic evidence for the tumor subgroup.

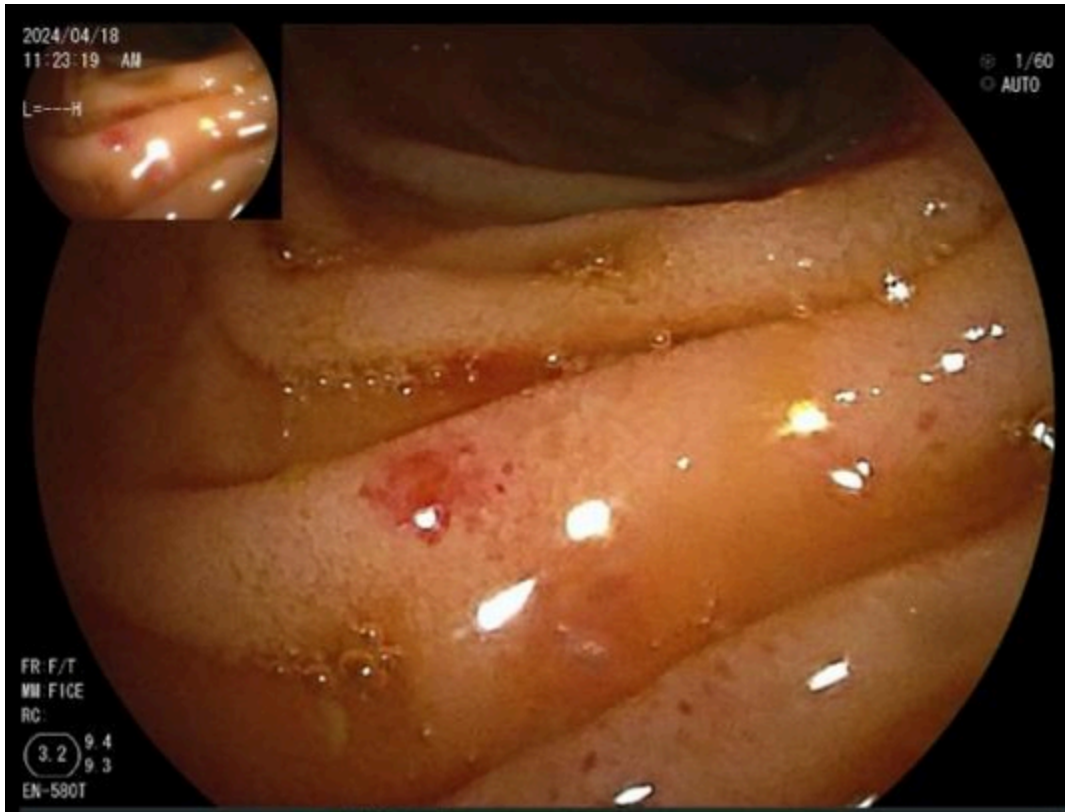


**Figure 2**

### Small-intestinal telangiectasia

DBE image of small-intestinal telangiectasia. This lesion represents a common cause of obscure gastrointestinal bleeding in the present study and intuitively shows the endoscopic appearance of bleeding-origin foci.

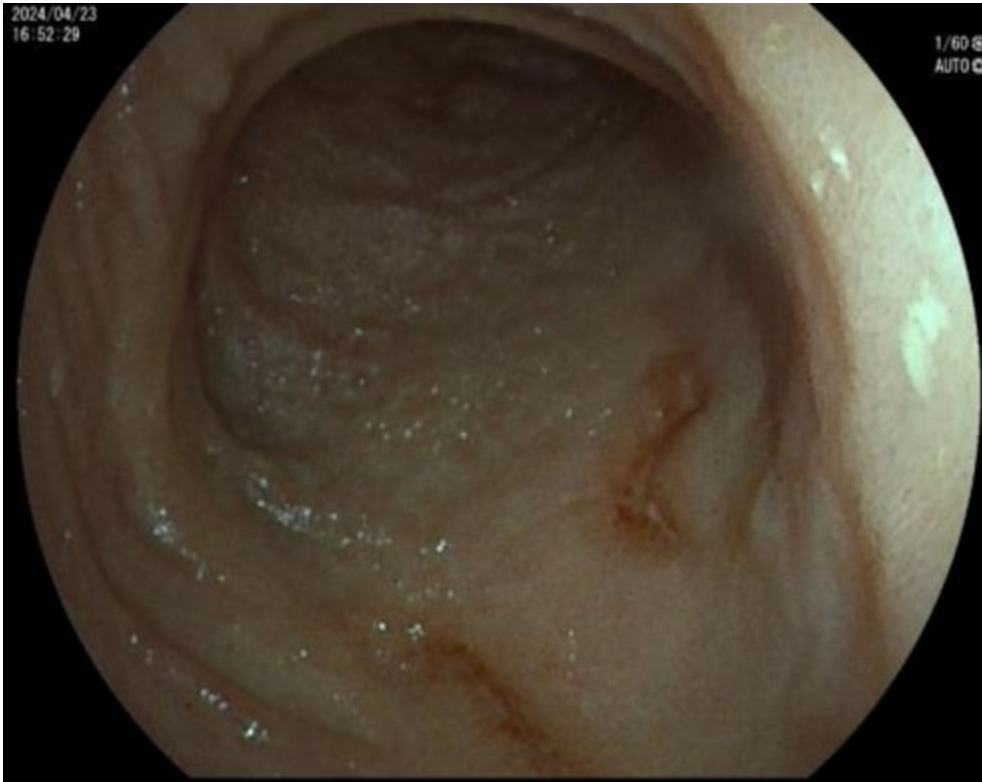


**Figure 3**

Small-intestinal ulcer

DBE image of small-intestinal ulcer. Corresponding to the small-intestinal ulcer subgroup in this research, it presents the endoscopic morphology of target ulcerative lesions.



## Figure 4

### Small-intestinal adenocarcinoma

DBE image of small-intestinal adenocarcinoma, a malignant small-intestinal tumor. It supplies typical visual endoscopic data for the tumor subgroup.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [TableandFigure.docx](#)