

Evaluation of radiologically determined small bowel wall thickness by double-balloon enteroscopy

Bayram Yeşil¹, Vedat Kılıç², Mahmut Yüksel², Meral Akdoğan Kayhan²

¹Department of Gastroenterology, Kırıkkale University, Faculty of Medicine, Kırıkkale, Turkey

²Department of Gastroenterology, Ankara City Hospital, Ankara, Turkey

ABSTRACT

Objectives: Double balloon enteroscopy (DBE) is an endoscopic method used for the evaluation of small bowel segments. Its advantage over other small bowel evaluation methods is that it allows treatment in addition to the detection of lesions. In this study, we evaluated the results of patients with small bowel abnormalities, especially wall thickness, on radiologic imaging who underwent double-balloon enteroscopy.

Methods: The data of patients who were found to have wall thickness and stenosis in the small intestine on radiological imaging and who underwent DBE between January 2007 and December 2018 at Ankara City Training and Research Hospital were retrospectively analyzed. Patients with inadequate endoscopic images or medical records were excluded from this study.

Results: The study included 112 patients. Of the patients, 69 (61.6%) were male and 43 (38.4%) were female. The mean age of the population was 45.59 ± 17 years. Abdominal pain was the main presenting symptom. The procedure was performed antegrade (oral) in 79 patients, retrograde (anal) in 25 patients, and both approaches in 8 patients. Various complications developed after 20 procedures, and no mortality was observed. Radiologically, small bowel wall thickness was most commonly detected on computed tomography, and the majority of the lesions detected were in the jejunum (63.9%). In 48 DBE procedures, no lesion was detected in the small intestine. The ulcer was the most common lesion detected during DBE (25.6%), and the majority were detected in the ileum. Crohn's disease was the most common pathology detected in the samples. Malignancy was the second most common pathology, and jejunal lymphoma was the most common malignancy.

Conclusion: DBE should be used more frequently in clinical practice to evaluate radiologically detected small bowel lesions because of the possibility of biopsy and its high diagnostic accuracy.

Keywords: enteroscopy, double-balloon, small bowel wall thickness

Double-balloon enteroscopy (DBE) is an endoscopic technique used to evaluate small bowel segments that cannot be reached by conventional endoscopy and colonoscopy. DBE using a push and pull technique was designed by Hironori Yamamoto in 2001 to facilitate small bowel evaluation because it is difficult to insert an enteroscope deeply with the push technique.¹ In the following years, in addition to

the evaluation of small bowel lesions, it has also been used to investigate the etiology of conditions such as iron deficiency anemia, gastrointestinal bleeding, and chronic diarrhea, the cause of which cannot be found by endoscopy and colonoscopy.

In a 2016 study conducted in China and covering 729 procedures, it was reported to be a useful diagnostic and therapeutic tool in the investigation of small

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Address for correspondence: Bayram Yeşil, MD., Yenişehir Ankara Yolu 7.Km. Kırıkkale Üniversitesi Kampüsü, 71450 Yahşihan/ Kırıkkale, Turkey
E-mail: drbyesil@gmail.com

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bowel diseases, and it is recommended to be used as the first step in the diagnosis and treatment of suspected small bowel diseases if performed by experienced endoscopists.² In a similar study conducted in our country, DBE was evaluated as a useful method for the diagnosis of small bowel diseases.³ In a study by Sun *et al.*⁴ evaluating small bowel obstructions, it was evaluated as an appropriate diagnostic tool to determine the cause of incomplete obstructions in patients without a history of abdominal surgery.

This study aims to share our experience with the retrospective performance, efficacy, and safety of double-balloon enteroscopy in patients with small bowel anomalies on radiologic imaging.

METHODS

This is a retrospective study conducted in a tertiary care center. Medical records of double-balloon enteroscopy (DBE) procedures performed between January 2007 and December 2018 at the Gastroenterology Clinic of Ankara City Training and Research Hospital were obtained. Age, gender, symptoms, radiological findings, enteroscopy findings, pathological diagnoses, localization of lesions, and complications were analyzed. The type of approach used during DBE, locations, types of lesions, complications, and pathologic diagnosis were confirmed by reviewing endoscopy examinations and medical records. Patients who could not continue the procedure due to inadequate bowel cleansing, looping, or device malfunction were excluded.

Double balloon enteroscopy (DBE) was performed by experienced endoscopists (Fujinon Inc., EN-450T5)-an anesthesiologist for all DBE procedures administered conscious sedation. No bowel preparation was performed before the procedure in the oral approach. It was given as standard colonoscopy preparation before the anal approach. Whether the procedure would be performed anally or orally was decided based on clinical and radiologic findings.

Lesions were categorized according to their location (duodenum, jejunum, and ileum). Complications were defined as minor and major adverse events occurring during and after the procedure, including postoperative abdominal pain, asymptomatic hyperamylasemia, hypoxia, arrhythmia, intestinal perforation, postoperative bleeding, procedure-related death, and pancreatitis.

The SPSS 25.0 (IBM Corporation, Armonk, New

York, United States) program was used to analyze the data. The suitability of univariate data for a normal distribution was evaluated with the Shapiro-Wilk test. Quantitative variables are shown as mean \pm SD (standard deviation) and median range (maximum-minimum), and categorical variables are shown as n (%).

This study has complied with the ethical guidelines of the 1975 Helsinki Declaration, which was then modified in 2008. The study was approved by the Ankara City Hospital Scientific Research Assessment and Ethics Committee (Date: 11.11.2020, Approval No. E1/1212/2020).

RESULTS

The study analyzed 120 DBE procedures performed in 112 patients. Of the patients, 69 (61.6%) were male and 43 (38.4%) were female. The mean age of the population was 45.59 ± 17 years. Abdom-

Table 1. Characteristics of the study population

Age (Mean \pm SD)	45.59 \pm 17
Gender	n (%)
Female	43 (38.4)
Male	69 (61.6)
Symptoms	
Abdominal pain	83 (74.1)
Weight loss	26 (23.2)
Vomiting	19 (17)
Diarrhea	14 (12.5)
Black stool	3 (2.7)
Bloody stools	2 (1.8)
Fatigue	2 (1.8)
Approach	
Anterograde	79 (70.6)
Retrograde	25 (22.3)
Both	8 (7.1)
Abdominal Surgery	
Yes	7 (6.25)
No	105 (93.75)
Biopsy	
Yes	75 (62.5)
No	45 (37.5)
Complication	
Yes	20 (16.7)
<i>Asymptomatic hyperamylasemia</i>	16 (13.3)
<i>Acute Pancreatitis</i>	2 (1.7)
<i>Abdominal pain</i>	1 (0.8)
<i>Hypoxemia</i>	1 (0.8)
No	100 (83.3)

Table 2. Radiological findings and localization

Radiological findings*	Localization			Total, n (%)
	Duodenum	Jejunum	Ileum	
Wall thickness on CT	3	69	34	106 (86.9)
Mass on CT	2	4	2	8 (6.6)
Stenosis on radiograph	0	3	1	4 (3.3)
Stenosis on Abdominal US	0	1	1	2 (1.6)
Involvement on PET-CT	1	1	0	2 (1.6)
Total, n (%)	6 (4.9)	78 (63.9)	38 (31.2)	122 (100)

*In some patients, more than one localization

inal pain was the main presenting symptom (74.1%), and 22 patients had more than one symptom. Bloody stools and fatigue were the least common presenting symptoms (1.8%). The procedure was performed antegrade (oral) in 79 patients, retrograde (anal) in 25 patients, and both approaches in 8 patients. There was a history of abdominal surgery in seven patients. Biopsies were taken from lesions seen during 75 procedures. Various complications developed after 20 procedures (16.7%), most commonly asymptomatic hyperamylasemia. Except for acute pancreatitis after two procedures (1.7%), no severe complications such as bleeding, perforation, and mortality occurred (Table 1).

Radiologically, small bowel wall thickness was most commonly detected on computed tomography (86.9%), and in some patients, radiological anomalies were detected in more than one localization. The

majority of the lesions detected were in the jejunum (63.9%). In four patients, small bowel segmental stenosis was found on radiography and in 2 patients on abdominal US. In two patients, PET-CT for metastasis showed uptake in small bowel segments (Table 2).

In 48 DBE procedures (40%), the small intestines were normal. Abnormal findings were detected in 72 procedures (60%). In some patients, more than one pathology was found during the procedure. An ulcer was the most common lesion (25.6%), and the majority were detected in the ileum. Edematous mucosa was the second most common pathology and was primarily observed in the jejunum. Tumoral formation was detected in 12 (10.3%) of the procedures, most commonly in the jejunum. In addition to small bowel lesions, two polyps and one diverticulum were detected in the colon (Table 3). Endoscopically, fibrotic stenosis was found in 6 patients and inflammatory stenosis

Table 3. Double balloon enteroscopy (DBE) findings and localization

DBE findings	Localization				Total, n (%)
	Duodenum	Jejunum	Ileum	Colon	
Tumor	2	9	1	0	12 (10.3)
Polyp	0	5	2	2	9 (7.7)
Angiodysplasia	0	2	0	0	2 (1.7)
Ulcer	2	11	17	0	30 (25.6)
Fibrotic stenosis	0	2	4	0	6 (5.1)
Inflammatory stenosis	0	6	4	0	10 (8.5)
Brid	0	2	0	0	2 (1.7)
Dilated segment	0	10	0	0	10 (8.5)
External compression	0	0	1	0	1 (0.9)
Nodular appearance	2	4	0	0	6 (5.1)
Edematous Mucosa	1	12	6	0	19 (16.3)
Diverticulum	0	0	0	1	1 (0.9)
Xanthoma	0	2	0	0	2 (1.7)
Scalloped appearance	2	3	0	0	5 (4.3)
Pearlescent lesion	1	1	0	0	2 (1.7)
Total, n (%)	10 (8.5)	69 (59)	35 (29.9)	3 (2.6)	117 (100)

Table 4. Pathology results of samples taken from the stenoses

Diagnosis	Fibrotic stenosis	Inflammatory stenosis	Total, n
<i>Crohn's disease</i>	3	6	9
<i>Celiac disease</i>	0	1	1
<i>Lymphoma</i>	0	1	1
<i>Ulcerative ileitis</i>	2	0	2
<i>Vasculitis</i>	1	0	1
<i>Non-diagnostic</i>	0	2	2
Total, n (%)	6	10	16

in 10 patients. Biopsy results were compatible with Crohn's disease in 9 patients and non-diagnostic in 2 patients. Other pathology results are shown in Table 4.

In 52 of 112 patients (46.4%), the DBE procedure yielded diagnostic results. Crohn's disease was the most common pathology detected in the samples (38.5%), and more than half were found in the ileum. Malignancy was the second most common pathology (26.9%), and jejunal lymphoma was the most common malignancy (9.6%) (Table 5).

A total of 104 DBE procedures (67 antegrade, 23 retrograde, seven both) were performed in 97 patients with small bowel wall thickness on radiologic imaging, and 35 patients (38 procedures) had no endoscopic abnormality. The final diagnosis was made in 43 of 62 patients with endoscopic abnormalities. Crohn's disease was the most common pathologic diagnosis, followed by celiac disease and lymphoma. Biopsy results were non-diagnostic in 19 patients (Table 6).

DISCUSSION

Double balloon enteroscopy has been the preferred endoscopic method for the evaluation of the small intestine in tertiary care centers since its introduction in 2001. It has advantages over non-invasive examinations (such as video capsule endoscopy and magnetic resonance enterography) that allow evaluation of the small intestine, such as taking biopsies from detected lesions and performing endoscopic treatments. In the literature review, studies evaluating small bowel stenosis and tumors with DBE were found.^{5,6} Although there are studies evaluating small bowel wall thickness with computed tomography⁷⁻⁹, there are no studies evaluating it with DBE. In this study, radiologically detected small bowel anomalies, especially wall thickness, were evaluated by double enteroscopy.

In this study, a total of 120 examinations were performed on 112 patients, and small bowel lesions were

Table 5. Pathological diagnoses and localizations

Diagnosis	Localization			Total, n (%)
	Duodenum	Jejunum	Ileum	
<i>Adenocarcinoma</i>	1	2	0	3 (5.8)
<i>Lymphoma</i>	0	5	0	5 (9.6)
<i>Gastrointestinal stromal tumor</i>	0	3	1	4 (7.7)
<i>Metastasis</i>	1	1	0	2 (3.8)
<i>Neurofibroma</i>	0	1	1	2 (3.8)
<i>Intestinal lymphangiectasia</i>	0	4	0	4 (7.7)
<i>Crohn's disease</i>	0	9	11	20 (38.5)
<i>Celiac disease</i>	3	3	0	6 (11.5)
<i>Eosinophilic enteritis</i>	0	0	1	1 (1.9)
<i>Ulcerative ileitis</i>	0	0	3	3 (5.8)
<i>Vasculitis</i>	0	1	0	1 (1.9)
<i>Infective enteritis</i>	0	0	1	1 (1.9)
Total, n (%)	5 (9.6)	29 (55.8)	18 (34.6)	52 (100)

Table 6. Pathologic diagnoses of patients with wall thickness detected on CT

Diagnosis	Localization		Total, n (%)
	Radiological	DBE	
<i>Adenocarcinoma</i>	Jejunum	Jejunum	2 (4.7)
<i>Lymphoma</i>	Jejunum	Jejunum	5 (11.6)
<i>Gastrointestinal stromal tumor</i>	Jejunum	Jejunum	1 (2.3)
<i>Metastasis</i>	Duodenum-Jejunum	Duodenum-Jejunum	2 (4.7)
<i>Neurofibroma</i>	Jejunum	Jejunum	1 (2.3)
<i>Intestinal lymphangiectasia</i>	Jejunum	Jejunum	3 (7)
<i>Crohn's disease</i>			17 (39.5)
	İleumx10	İleumx10	
	Jejunumx6	Jejunumx6	
	Duodenumx1	Duodenumx1	
<i>Celiac disease</i>			6 (14)
	Jejunumx5	Jejunumx3	
	Duodenum-Jejunumx1	Duodenum-Jejunumx3	
<i>Eosinophilic enteritis</i>	İleum	İleum	1 (2.7)
<i>Ulcerative ileitis</i>	İleum	İleum	3 (7)
<i>Vasculitis</i>	Jejunum	Jejunum	1 (2.7)
<i>Infective enteritis</i>	İleum	İleum	1 (2.7)
Total, n (%)			43 (100)

detected in 72 procedures. The lesion detection rate was 60%. Gurudu reported the diagnostic rate of double-balloon enteroscopy for small bowel disease to be 82.4% to 86.8%, which is higher than our rate. The majority of our study population was male; the mean age was 45.59 years, and our findings were compatible with the data in similar studies.¹¹ In studies evaluating the data of double-balloon enteroscopy of the small intestine, abdominal pain was the most common symptom after gastrointestinal bleeding symptoms.¹² Although our study was performed in a specific patient population, the most common presenting symptom of our patients was abdominal pain.

The complication rate is high (16.7%). The possible reason for this is that transient conditions such as asymptomatic hyperamylasemia, abdominal pain, and hypoxia, which are not considered complications in the literature, were considered minor complications in our study. Acute pancreatitis, hemorrhage, perforation, and mortality were defined as significant complications similar to the literature.¹³ Although acute pancreatitis (1.7) was observed in only two patients in our study, it was proportionally higher than the rates reported in other studies.¹³ Other significant complications were not observed.

The most common abnormality found radiologically in the small intestine was wall thickness (86.9%), and the majority was observed in the jejunum. No en-

doscopic abnormality was detected in 48 double-balloon enteroscopy procedures (40%) performed according to imaging findings. Inflammatory findings such as ulcers and edematous mucosa were the most common endoscopic findings, similar to previous studies.^{12,14} Biopsy results obtained during the procedures revealed Crohn's disease, most commonly followed by malignancy. The majority of malignancies were in the jejunum. The most common small bowel malignancy is adenocarcinoma.¹⁵ The most common malignancy we found in this study was lymphoma, and adenocarcinoma was the third most common malignancy. Gastrointestinal stromal tumors (GISTs) are mesenchymal neoplasms and usually arise in the stomach or small intestine.¹⁶ GISTs were the second most common malignancy in this study.

Small bowel strictures are a rare condition. However, they are challenging to diagnose, characterize, and treat. Identifying the cause of the stricture is crucial in directing appropriate treatment. Previous studies have identified Crohn's disease as the most common cause of small bowel stricture.¹⁷ In this study, Crohn's disease was the most common underlying cause in patients with endoscopic stenosis.

Small bowel wall thickening is a common but non-specific finding on abdominal computed tomography (CT) performed for gastrointestinal symptoms.⁹ Malignant and benign etiologies can cause intestinal wall

thickness. In a study where all bowel segments were evaluated in a small number of patients, adenocarcinoma was found to be the most common etiological cause.¹⁸ In a different study conducted with more patients and evaluating small intestine wall thickness, inflammatory causes, especially Crohn's disease, were determined to be the most common etiology.⁹ In our study, double balloon enteroscopy was normal in 35 of 97 patients with small bowel wall thickness on computed tomography. Sixty-two patients had an abnormal endoscopy, and 43 of them had a final diagnosis. Crohn's disease was the most common cause of wall thickness. Malignancies were the second most common cause, and lymphoma was the most common malignancy.

Celiac disease is an autoimmune disorder that damages segments of the small intestine.¹⁹ It can cause wall thickening. In a study in which the MRI findings of 31 patients were evaluated, bowel wall thickness was detected in 5 patients (16.1%).²⁰ In our study, we detected celiac disease in 6 patients (6.1%) with wall thickness on CT. Eosinophilic enteritis and vasculitis were found to be less common causes of wall thickening.

The most important limitation of the study is that it was retrospective. Another limitation is that the duration of the procedure and the depth of the examination need to be specified. Nevertheless, our results are valuable because they include a specific patient population with small bowel abnormalities on radiologic imaging.

CONCLUSION

In our study, Crohn's disease and malignancies were the most common causes of small bowel wall thickness. Another important finding was that the majority of endoscopically found strictures were secondary to Crohn's disease. Therefore, patients with small bowel abnormalities on radiologic imaging should be carefully evaluated, and an enteroscopic examination should be performed. In this patient population, double balloon enteroscopy may be the procedure of choice with low significant complication rates.

Conflict of Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Financial Disclosure

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Ethical Approval

The protocol of the study was approved by the Medical Ethics Committee of Ankara City Hospital, Ankara, Turkey. (Decision number: E1/1212/2020, date: 11.11.2020).

Authors' Contribution

Study Conception: BY; Study Design: BY; Supervision: MAK; Funding: BY, MY; Materials: BY, MY, MAK, VK; Data Collection and/or Processing: BY, MY, MAK, VK; Analysis and/or Data Interpretation: BY, MY, MAK, VK; Literature Review: BY, MY, MAK, VK; Critical Review: MAK; Manuscript preparing: BY, MY, MAK, VK.

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