

# The Role of Intestinal Ultrasonography in Children with Inflammatory Bowel Disease

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## ABSTRACT

**Background/Aims:** Endoscopic and histopathological evaluation are important in the diagnosis and follow-up of inflammatory bowel disease (IBD), but they are invasive methods. This study aimed to evaluate the use of ultrasonography (USG), a noninvasive examination, in diagnosing and monitoring children with IBD.

**Materials and Methods:** The patients included IBD and non-IBD who underwent a prospective diagnostic colonoscopy. After colonoscopy, bowel wall thickness (BWT) of the patients was measured using USG. Ultrasonographic, endoscopic, histological, and laboratory findings were then compared.

**Results:** Of the 62 patients who underwent colonoscopy, 25 (40.3%) were female. The mean age of the patients was  $14.7 \pm 3.5$  years. Forty-three (69.4%) patients were diagnosed with ulcerative colitis, 12 (19.4%) with Crohn's disease. Seven (11.3%) patients had normal colonoscopy findings. The BWT of the terminal ileum, left colon, and sigmoid colon were significantly higher in children with IBD. The BWT cut-off was detected as 2.55 mm in the terminal ileum, 3.35 mm in the right colon, 2.5 mm in the left colon and 2.25 mm in the sigmoid colon. When BWT in the terminal ileum and left colon increased, histopathological inflammation was significantly detected. A moderate positive correlation was observed between the C-reactive protein, erythrocyte sedimentation rate, and platelet values and the BWT values.

**Conclusion:** Ultrasonography can be useful in the diagnosis of IBD patients. Specifically, BWT was found to be particularly sensitive and specific during the inflammatory period.

**Keywords:** Bowel wall thickness, inflammatory bowel disease, intestinal ultrasonography, pediatrics

## INTRODUCTION

Endoscopic examinations play a significant role in the diagnosis and monitoring of the disease. However, due to the invasive nature of colonoscopy and the possibility of rare complications, caution should be taken when performing colonoscopy in children.<sup>1</sup> Thus, there is a need for non-invasive methods as alternatives. Laboratory tests, such as fecal calprotectin and C-reactive protein (CRP), which are used especially in patient follow-up, can provide an idea about the activation of the disease.<sup>2</sup> These markers increase with inflammation and infection and do not indicate the localization of inflammation.<sup>3</sup> Ultrasonography (USG) is an easily accessible method used in the diagnosis and follow-up of inflammatory bowel disease (IBD) in adults.<sup>4-6</sup> Other imaging methods, such as magnetic resonance imaging (MRI) and computed tomography (CT), are also used in diagnosis

and monitoring, but they are expensive, contain radiation, cannot be performed at the patient's bedside, and require sedation in children.<sup>7</sup> The USG can detect bowel wall thickening, inflammation, and complications such as strictures or fistulae, key indicators of IBD activity. It can also be performed at the bedside. However, the reliability and sensitivity of USG in children with IBD remain unclear. While numerous studies exist in adults,<sup>5</sup> data in pediatric patients remain limited.<sup>6</sup>

This study aimed to evaluate the role of intestinal USG in the diagnosis and management of IBD. In line with this objective, USG findings were compared with colonoscopy—regarded as the gold standard—as well as with laboratory and histological parameters, particularly inflammatory markers such as CRP, erythrocyte sedimentation rate (ESR), and platelet count (PLT).

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## MATERIALS AND METHODS

### Study Group

Patients aged 2–20 years who underwent colonoscopy in the pediatric gastroenterology clinic at Tepecik Training and Research Hospital between December 2022 and July 2024 were followed up with a diagnosis of IBD and were pre-diagnosed with IBD were included in the study. This study was designed as a cross-sectional study.

The inclusion criteria were as follows: Patients diagnosed with IBD in the clinic and scheduled for control colonoscopy and those scheduled for diagnostic colonoscopy due to reasons such as abdominal pain, rectal bleeding, high ESR, thrombocytosis, and high CRP.

The exclusion criteria were as follows: Patients who underwent colonoscopy but had incomplete bowel preparation, with suboptimal colonoscopy, who did not consent to colonoscopy, with neurological problems, and younger than 1 year old.

After the colonoscopy procedure, all patients were evaluated with USG by the same radiologist within the same week. The patients' ESR, CRP, and PLT values before the procedure were recorded. All patients were evaluated by comparing the ultrasonographic, colonoscopic, histopathological, and laboratory findings.

### Colonoscopy Procedure

**Colonoscopy preparation:** Patients were given a liquid diet for the last 3 days before the procedure, sennosides orally for the last 2 days, and enemas 1 day before the procedure.

### Main Points

- For inflammatory bowel disease patients, ultrasonography (USG), a non-invasive test, can be used to understand the activation or remission states and to assess whether inflammation is present at the time of diagnosis.
- Terminal ileum intubation is possible in every pediatric patient, and USG may be helpful in evaluating the ileum in these patients.
- Fecal calprotectin is used as an inflammation marker in monitoring, but it does not give us complete information about the inflammation area. In this case, USG is an additional advantage in showing the inflammation area.
- Unlike other pediatric studies, the colon and ileum were divided into segments, and the sensitivity and specificity of wall thickness measurements and cut-off values were compared with the gold standard endoscopic findings.

The procedure was performed under sedoanalgesia by the same team using a colonoscope (Fujifilm Co., Tokyo, Japan) appropriate for the patient's age. Colonoscopy images were included in the study for comparison with the USG, which measured the terminal ileum, right colon (distal ascending–proximal transverse colon), left colon (distal transverse colon–proximal descending colon), and sigmoid colon regions (Figure 1). Inflammation was recorded in patients with ulcers, exudates, erosions, or vascular loss on endoscopy. Inflammation was considered absent if mucosal vascular and plica structures were normal.

### Histopathological Evaluation

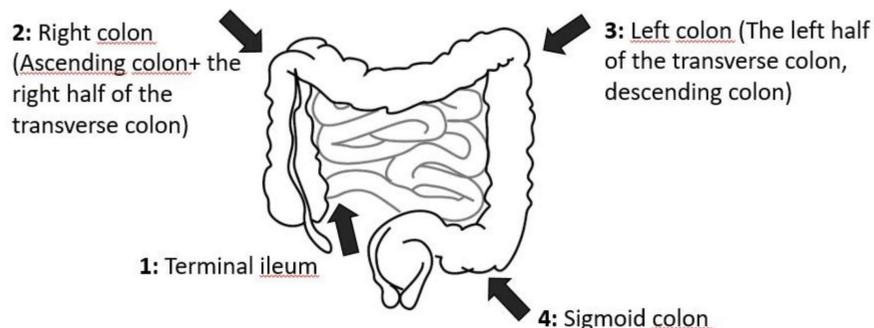
The histopathological results of biopsies taken from the terminal ileum, distal ascending–proximal transverse colon, distal transverse colon–proximal descending colon, and sigmoid colon were included in the study. Biopsy findings of cryptitis, crypt abscess, crypt distortion, or increased inflammatory cell infiltration were considered indicative of inflammation.<sup>9</sup> Inflammation was considered present when cryptitis, crypt abscess, or crypt distortion was accompanied by inflammatory cell infiltration.

### Transabdominal Ultrasonography Procedure

Wall thickness was measured in 4 regions: terminal ileum, right colon, left colon, and sigmoid colon (Figure 1). Under the guidance of the radiologist, the terminal ileum was first identified in the right lower quadrant. In the right upper quadrant, the distal ascending colon and the proximal segment of the transverse colon were visualized. In the left upper quadrant, the distal transverse colon and the proximal descending colon were identified, while in the left lower quadrant, the sigmoid colon was assessed. From each of these 4 regions, at least 3 separate measurements were obtained, and the mean bowel wall thickness (BWT) for each region was recorded.

The USG was performed per the radiologist's protocol, on the same day as colonoscopy or within 1 week thereafter. In line with routine USG requirements, examinations were conducted after a 6-hour fasting period. No specific bowel filling or emptying conditions were imposed. The USG was performed post colonoscopy, with the radiologist blinded to the patient's identification number, colonoscopy results, and clinical data.

In addition to BWT, mesenteric lymphadenopathy (LAP), increased mesenteric fatty tissue, and intra-abdominal fluid were also assessed.<sup>3</sup> As a USG device, the Philips



**Figure 1.** Classification of the regions examined by ultrasonography.

Ultrasound iU22 apparatus (Philips Healthcare, Bothell, WA, USA) was used with a linear probe (L12-5, 12-5 MHz).<sup>4</sup>

The comparison between USG and endoscopic findings was conducted by systematically recording the presence or absence of mucosal inflammation in each region defined in Figure 1, along with the corresponding BWT measurements. Likewise, in the comparison with histopathological findings, BWT was documented for each region along with the presence or absence of histopathological inflammation. Furthermore, BWT measurements and additional findings were analyzed according to patient groups. All collected data were subsequently subjected to statistical analysis.

Ethical committee approval was received from the ethics committee of Tepecik Training and Research Hospital (approval number: 2022/11-06; date: December 9, 2022). The patients were included in the study after receiving consent from both themselves and their parents.

### Statistical Analysis

The SPSS version 22.0 (IBM SPSS Corp.; Armonk, NY, USA) package was used for the statistical analysis of the data, and the MedCalc 22.014 program (MedCalc Software Ltd.; Ostend, Belgium) was used for receiver operating characteristic (ROC) analysis. Compliance with a normal distribution was examined using the Kolmogorov–Smirnov test. Continuous variables that did not conform to a normal distribution were given as the median (IQR, Q1–Q3), and categorical variables were given as the number (n) and percentage (%). The Mann–Whitney *U*-test and *t*-test were used to compare 2 independent groups that did not conform to a normal distribution. Spearman correlation analysis was used to evaluate associations between continuous variables. When evaluating categorical data, the chi-square test and Fisher’s chi-square test

were applied depending on suitability.  $P < .05$  was considered sufficient for statistical significance.

The sample size was calculated as 62 patients to determine the performance of USG in detecting endoscopic colitis with 80% sensitivity, 80% specificity, a prevalence of 50%, a type I error of 5%, and a power of 90%.

### RESULTS

Of the 62 patients who underwent colonoscopy, 25 (40.3%) were female. The mean age of the patients was  $14.7 \pm 3.5$  years (median is 15.5 years). The ages of the youngest and oldest patients were 2.4 years and 20 years, respectively. Among the patients, 43 (69.4%) had ulcerative colitis (UC), 12 (19.4%) had Crohn’s disease (CD). Seven (9.7%) patients had normal colonoscopic findings. A total of 16 newly diagnosed IBD patients were included, of whom 13 had UC. The disease duration ranged from 0 to 64 months, with a mean duration of 15.8 months. The median disease duration of the patients was 10 months. In UC patients, medications included mesalamine (63%), azathioprine (56%), prednisolone (16%), and infliximab (12%); in CD patients, mesalamine (42%), azathioprine (42%), prednisolone (17%), and adalimumab (14%).

Terminal ileum intubation could not be performed in seven patients (11.3%). Two were male and 5 were female. Of these, 3 had a body weight below  $-2$  SDS, and 1 had a body weight above  $+2$  SDS. In 4 of these 7 patients, USG detected increased BWT in the terminal ileum, which was confirmed as terminal ileitis by MRI.

When the concordance between the colonoscopic findings and USG was evaluated, the BWT measurements of the terminal ileum, left colon, and sigmoid colon were significantly higher in patients with inflammation for all cases ( $P < .05$ ) (Table 1). When UC, CD, and normal

**Table 1.** Ultrasonographic Bowel Wall Thickness According to Colonoscopic Inflammation

The Area Evaluated in USG (Bowel Wall Thickness)	Inflammatory Findings at Colonoscopy		P*
	Present	Absent	
Terminal ileum (mean ± SD) (mm)	4.11 ± 2.25	2.50 ± 0.73	<b>.007</b>
Right colon (mean ± SD) (mm)	3.12 ± 1.53	2.41 ± 0.76	.061
Left colon (mean ± SD) (mm)	4.04 ± 1.78	2.38 ± 1.18	<b>&lt;.001</b>
Sigmoid colon (mean ± SD) (mm)	3.57 ± 1.74	2.27 ± 1.10	<b>.001</b>

P < .05 was considered statistically significant  
 \*Mann-Whitney U-test.  
 mm, millimeter; SD, standard deviation.

controls were evaluated separately, terminal ileum wall thickness was significantly increased in CD compared with both UC patients and controls. Sigmoid colon wall thickness was significantly greater in UC than in CD and normal controls, while left colon thickness was higher in UC than in CD. Mean BWT values according to groups and corresponding P values are presented in Table 2.

The BWT cut-off values for sensitivity and specificity varied by region in the study. Cut-off values were 2.55 mm for the terminal ileum, 3.35 mm for the right colon, 2.5 mm for the left colon, and 2.25 mm for the sigmoid colon. The study's regional cut-off values with sensitivity and specificity values when the BWT cut-off value was taken as 2 mm for the entire colon (some studies indicate this value) are shown in Table 3.

Other ultrasonographic parameters of inflammation were also evaluated. Endoscopic colitis findings were observed in 15 (65.2%) of 23/62 (37.1%) patients with mesenteric LAP. Intra-abdominal fluid was present in 8/62 (12.9%)

**Table 2.** Ultrasonographic Bowel Wall Thickness Across Disease Groups by Intestinal Segment

Intestinal Segment	Normal	Ulcerative Colitis	Crohn Diseases	P*
Terminal ileum	<sup>1</sup> 2.37 ± 0.5	<sup>2</sup> 2.6 ± 0.8	<sup>3</sup> 4.36 ± 2.28	P <sup>1-2</sup> = .472 P <sup>1-3</sup> = <b>.038</b> P <sup>2-3</sup> = <b>.000</b>
Left colon	<sup>1</sup> 2.43 ± 0.85	<sup>2</sup> 3.49 ± 1.81	<sup>3</sup> 2 ± 0.57	P <sup>1-2</sup> = .139 P <sup>1-3</sup> = .204 P <sup>2-3</sup> = <b>.007</b>
Right colon	<sup>1</sup> 2.41 ± 0.43	<sup>2</sup> 2.75 ± 1.22	<sup>3</sup> 2.48 ± 1.08	P <sup>1-2</sup> = .483 P <sup>1-3</sup> = .874 P <sup>2-3</sup> = .503
Sigmoid colon	<sup>1</sup> 2.16 ± 0.31	<sup>2</sup> 3.4 ± 1.77	<sup>3</sup> 2 ± 0.65	P <sup>1-2</sup> = <b>.073</b> P <sup>1-3</sup> = <b>.578</b> P <sup>2-3</sup> = <b>.011</b>

P < .05 was considered statistically significant.  
 \*Independent sample t-test.  
 Values represent ultrasonographic bowel wall thickness (mm), expressed as mean ± SD.

patients and 6 of them (75%) had endoscopic colitis findings. Increased mesenteric fatty tissue was detected in 6/62 (9.7%) patients, 5 of them (83.3%) had endoscopic colitis findings.

Regional comparison of histopathological and endoscopic findings revealed a high concordance, with histopathological inflammation frequently accompanying endoscopic inflammation (P < .05). At the same time, a positive correlation was observed between endoscopic and histopathological inflammation in the ileum and colon (r = 0.369, 0.592, respectively).

Histopathological inflammation was also compared with BWT on USG. Histopathological inflammation was detected at a high rate, consistent with increased wall thickness in

**Table 3.** Assessment of Bowel Wall Thickness (mm) by Transabdominal Ultrasonography (USG) at Different Intestinal Sites According to Cut-Off Value

Region	AUC	95% CI (Lower)	95% CI (Upper)	P	Cut-off (mm)	Sensitivity (%)	Specificity (%)	PPV	NPV
Terminal ileum	0.589	0.377	0.713	.779	>2.55	75	63	97.5	11.8
Right colon	0.710	0.551	0.838	<b>.008</b>	>3.35	40	96	99.4	7.7
Left colon	0.792	0.673	0.911	<b>&lt;.001</b>	>2.5	84	78	98.6	20.4
Sigmoid colon	0.769	0.641	0.897	.001	>2.25	83	74	96.6	42.8
Colon	0.669	0.538	0.784	<b>.015</b>	>2	84	28	74	41.7

P < .05 was considered statistically significant. Receiver Operating Characteristic (ROC) analysis.  
 AUC, area under curve; mm, millimeter; NPV, negative predictive value; PPV, positive predictive value.

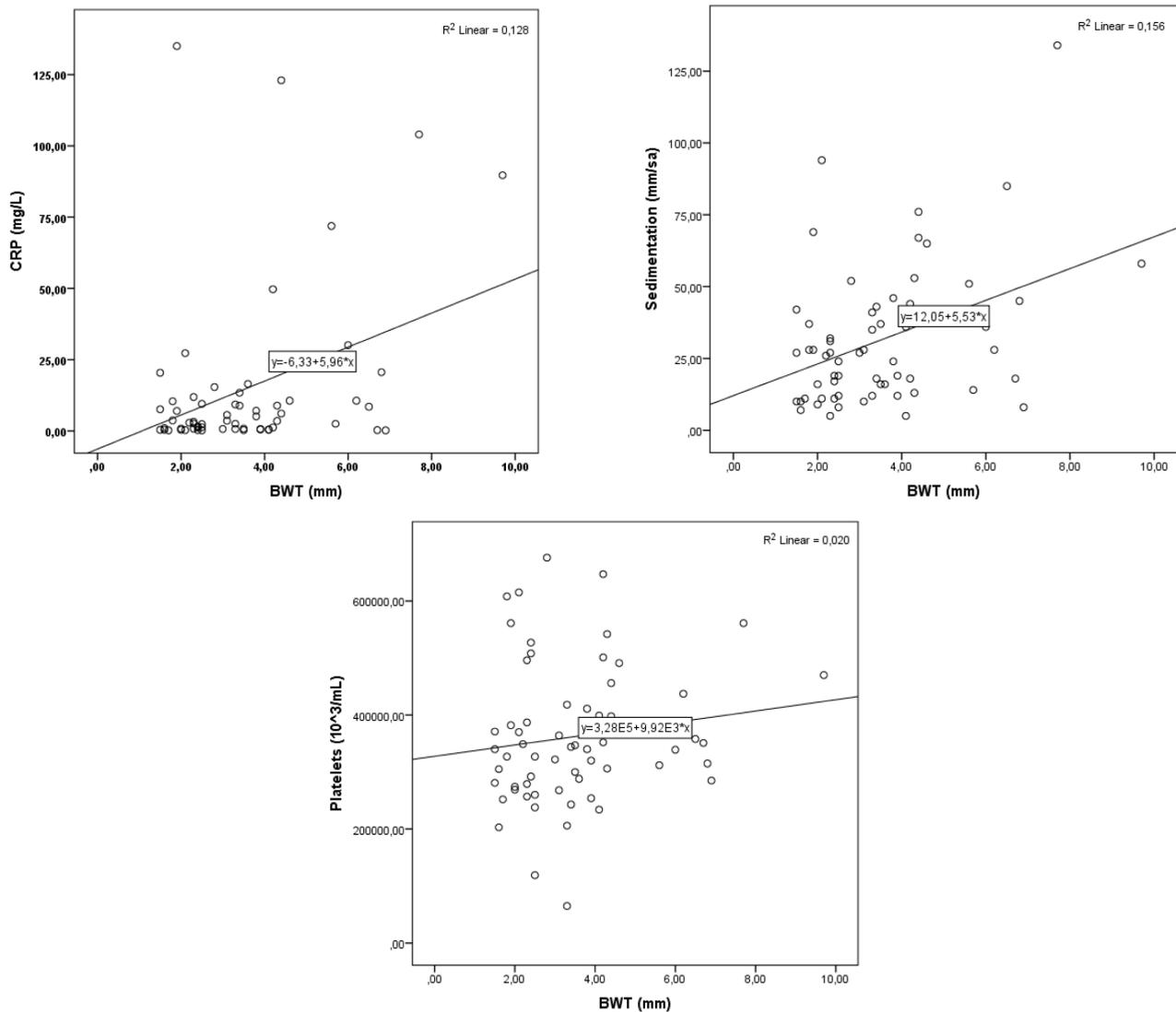
**Table 4.** Comparison of Ultrasonographic Bowel Wall Thickness and Histopathological Findings

Intestinal Segment	Histopathologic Inflammation		P*
	Present	Absent	
Terminal ileum	3.19 ± 1.61	2.29 ± 0.50	<b>.046</b>
Right colon	2.70 ± 1.01	2.59 ± 1.31	.31
Left colon	3.51 ± 1.82	2.22 ± 0.84	<b>.008</b>
Sigmoid colon	3.40 ± 1.82	2.67 ± 1.40	.12

P < .05 was considered statistically significant.  
 \* Mann-Whitney U-test.  
 Values represent ultrasonographic bowel wall thickness (mm), expressed as mean ± SD.

the terminal ileum and left colon (Table 4). Mean terminal ileum wall thickness was 5 mm in CD and 2.74 mm in UC patients, with BWT positively correlating with histopathological inflammation. The *r* values in the terminal ileum, right colon, left colon, and sigmoid colon were determined as 0.297, 0.138, 0.329, and 0.147, respectively.

The BWT demonstrated a moderate positive correlation with CRP, ESR, and PLT (*r* = 0.357, 0.395, 0.173, respectively) (Figure 2). Similarly, CRP showed a moderate positive correlation with endoscopic colitis findings in the terminal ileum, right colon, left colon, and sigmoid colon (*r* = 0.282, 0.109, 0.063, and 0.083, respectively). According



**Figure 2.** Mild correlation was detected between bowel wall thickness (BWT) and C-reactive protein (CRP), erythrocyte sedimentation rate (ESR) and platelet levels.

**Table 5.** Comparison Between C-reactive Protein (CRP), Erythrocyte Sedimentation Rate (ESR) and Platelet Values According to Bowel Wall Thickness (BWT) Cut-Off Values

BWT Cut-Off Values (mm)	CRP (mg/L) (Mean ± SD)	ESR (mm/sa) (Mean ± SD)	Platelet (10 <sup>3</sup> /μL) (Mean ± SD)
<b>Terminal ileum</b>			
≥2.55	22.1 ± 33.7	41.1 ± 27.8	399 ± 112
<2.55	8.6 ± 23.3	23.6 ± 18	332 ± 124
<i>P</i>	.18	.15	.92
<b>Right colon</b>			
≥3.35	33 ± 44.9	51.2 ± 32.9	413 ± 99
<3.35	10.3 ± 22.3	26.9 ± 19.5	350 ± 125
<i>P</i>	<b>&lt;.001</b>	.08	.35
<b>Left colon</b>			
≥2.5	22.0 ± 33.2	39 ± 28.4	383 ± 118
<2.5	8.3 ± 23.6	25.0 ± 18.4	344 ± 125
<i>P</i>	<b>.02</b>	<b>.03</b>	.89
<b>Sigmoid colon</b>			
≥2.25	19.2 ± 30.3	37.3 ± 27.6	372 ± 119
<2.25	10.8 ± 28.1	25.1 ± 20.4	349 ± 141
<i>P</i>	.43	.28	.38

BWT, bowel wall thickness; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; mm, millimeter; SD, standard deviation. Mann–Whitney *U*-test.

to BWT cut-off values, CRP and ESR were significantly higher in patients with increased wall thickness in the right and left colon compared with those without (*P* < .05). Laboratory values by other regions are summarized in Table 5. Laboratory findings were analyzed by disease

group, with UC and CD patients exhibiting leukocytosis, thrombocytosis, anemia, and hypoalbuminemia compared with controls.

**DISCUSSION**

Colonoscopy is an indispensable method that allows for objective and histopathological evaluation for the diagnosis and management of IBD during exacerbations. Colonoscopy is an invasive procedure that limits its frequent use in the follow-up of pediatric patients. Although rare, colonoscopy may require special conditions and may be discontinued in cases of poor bowel preparation. In addition, ileal intubation is not possible in every patient. In this study, ileal intubation could not be performed in 7 out of 62 patients (11.3%) and in 12 out of 33 patients (36%) in another study.<sup>9</sup> Therefore, alternative diagnostic and follow-up methods are gaining importance, with ultrasonographic assessment increasingly recognized in pediatric patients. In this study, the benefits of bowel wall evaluation with USG, a non-invasive and easily accessible method, in the diagnosis and during inflammation of pediatric patients with IBD were investigated.

Given the lifelong nature of IBD, radiation exposure and cost are key considerations in selecting imaging methods. The USG provides real-time imaging of the intestines without exposure to radiation or the need for sedation.

**Table 6.** Current Study and Other Studies in the Literature That Correlated Colonoscopy with Ultrasonography

	Mean/Median*Age	Number of Patients	Cut-off (mm)	Sensitivity (%)	Specificity (%)
This study	14.7 ± 3.5 15.5*	62	TI 2.55	TI 75	63
			RC 3.35	AC+TC 40	96
			LC 2.5	DC+TC 84	78
			SC 2.05	SC 87	58
Bremner <sup>9</sup>	12*	44	TI 2.5	TI 75	92
			C 3	AC 46	88
				TC 67	90
				DC 54	100
				SC 50	88
Haber <sup>12</sup>	11.2	78	TI 1.5	TI 100	72
			C 2	AC 72	81
				TC 74	94
				DC 74	89
Ziech <sup>13</sup>	14	28	3	55	100
Civitelli <sup>14</sup>	50	50	3	RC 75	100
				TC 86	100
				LC 96	100
Faure <sup>15</sup>	11.1	38	TI 2.5	TI 100	92
			C 2	RC 77	91
				TC 80	90
				SC 93	100

AC, ascending colon; C, colon; DC, descending colon; LC, left colon; mm, millimeter; RC, right colon; SC, sigmoid colon; TC, transvers colon; TI, terminal ileum.

Additionally, it is a preferred follow-up method due to its tolerability, reproducibility, and low cost. Ultrasonography can also assess inflammation localization and extraluminal complications, including fistula, abscess, stricture, and ileus. BWT has been especially shown to be useful in the evaluation and follow-up of IBD patients in adult studies.<sup>4,10,11</sup> In this study, BWT was significantly higher in the left and sigmoid colon in cases with endoscopic inflammation compared with those without ( $P \leq .001$ ), and a borderline difference was found in the right colon ( $P = .06$ ). BWT cut-off values from previous studies with those obtained in the study are presented in Table 6.<sup>9,12-15</sup> According to the findings, the BWT cut-off values differed according to the regions of the colon: 3.35 mm in the right colon, 2.5 mm in the left colon and 2.25 mm in the sigmoid colon. The highest sensitivity and specificity values were observed in the left colon (84% and 78%, respectively). Sensitivity variation across intestinal regions is mainly attributable to technical aspects of USG. Terminal ileum and sigmoid colon are technically easier to assess, yielding higher sensitivity, while gas interference may reduce sensitivity in other regions. For example, a 1-cm endoscopic colonic ulcer may be missed on USG, representing a key limitation. In a study of CD patients, ileal BWT increased (mean  $4.7 \pm 1.9$  mm) in cases with colonoscopically detected ileal inflammation.<sup>15</sup> In this study, UC patients with terminal ileitis also showed a similar increase in ileal wall thickness ( $4.11 \pm 2.25$  mm). In the study, the mean age was 14.7 years vs. 11.1 years in the previous study, which may explain differences in sensitivity and specificity outcomes.

Among USG inflammation indicators, mesenteric lymph nodes have been reported as significant in adult studies,<sup>16,17</sup> however; pediatric studies have not demonstrated statistically significant findings.<sup>14,18,19</sup> In this study, BWT, increased mesenteric fat, and mesenteric LAP were evaluated using USG. Doppler USG and echogenicity assessment were not performed. Previous studies in adults have demonstrated a positive correlation between Limberg score, assessed by Doppler USG, and IBD activity.<sup>20,21</sup> Further studies including Doppler evaluation are warranted in the pediatric population. In the study, mesenteric LAP was detected in 37.1% (23/62) of the patients, and endoscopic colitis findings were observed in 65.2% ( $n = 15$ ) of these patients. Few pediatric studies have been conducted on the increase in mesenteric fatty tissue. One study reported good sensitivity and specificity (65% and 92%, respectively), whereas another found no significant findings.<sup>9,22</sup> In the study, increased mesenteric fatty tissue

was detected in 9.7% (6/62) of the patients. In 83.3% ( $n = 5$ ) of these cases, endoscopic colitis findings were present; however, due to the low number of patients (9.7%) with this finding, the sensitivity was considered to be low.

Histopathology provides definitive diagnostic and follow-up information but may not always align with endoscopic findings. In this study, endoscopic findings of terminal ileitis were detected in 25% (13/53) of the patients. In 92.3% ( $n = 12$ ) of these patients, histopathological findings of IBD were observed. It is noteworthy that histopathological findings of IBD were observed in 62.5% ( $n = 25$ ) of cases in which inflammatory findings were not detected on endoscopy. In Scoparin et al's<sup>23</sup> study, the terminal ileum was observed as normal in 72.5% ( $n = 58$ ) of the patients, similar to the findings, and histopathological inflammation was detected in 51.7% ( $n = 30$ ) of these patients. In the study, histopathology was normal in 7.7% of the patients with endoscopic inflammation. In another study, this rate was found to be 27.6%.<sup>23</sup> In the study, a moderate correlation was observed between endoscopic and histopathological detection of ileitis and colitis ( $r = 0.369, 0.592$ , respectively). Similarly, Fabian et al<sup>24</sup> reported a moderate correlation between microscopic inflammation severity and the Simple Endoscopic Score for CD in 63 patients.

The association between BWT and histopathological findings differed across bowel regions. In the study, patients with histopathologically confirmed ileitis and left colonic colitis showed significantly higher BWT compared with those without inflammation ( $P = .046$  and  $.08$ , respectively). However, no significant difference was found in the ultrasonographic and histopathological findings in the right colon and sigmoid colon ( $P > .05$ ). In 1 study, sensitivity and specificity were found to be 68% in the terminal ileum compared with the USG and histopathological findings.<sup>12</sup> In the literature, sensitivity and specificity were found to be higher in BWT in cases with histologically severe inflammatory findings (83%, 81%). If the inflammation was mild, the sensitivity of the USG was observed to decrease significantly (23%).<sup>25</sup> A weak positive correlation was observed between increased intestinal wall thickness and histopathological inflammation in the ileum and entire colon ( $r = 0.138-0.329$ ). Lower sensitivity and specificity of histopathology and USG vs. colonoscopy suggest that minimal microscopic inflammation may not substantially increase wall thickness. Studies have also shown that, as the severity of the disease increases, ultrasonographic findings become more sensitive and specific.<sup>25,26</sup>

In this study, BWT showed a moderate positive correlation with CRP, ESR, and PLT. There are very limited data on this subject in the literature. In an adult study by Chao Ma et al,<sup>26</sup> a similar moderate correlation was found between CRP and ESR and BWT ( $r$  values 0.48 and 0.432, respectively). The CRP, like USG, is an easily accessible, non-invasive marker of inflammation and was evaluated alongside USG in pediatric patients. Although CRP is a useful inflammation marker, it does not indicate the site of intestinal involvement, limiting its utility compared with USG. Moreover, inflammation may also persist despite normal CRP levels. In the study, a moderate correlation was observed between CRP and USG findings, suggesting that their combined use may offer greater clinical utility. The CRP showed a modest positive correlation with endoscopic findings across the terminal ileum, right colon, left colon and sigmoid colon ( $r = 0.282, 0.109, 0.063, \text{ and } 0.083$ , respectively). These findings suggest that CRP parallels endoscopic inflammation, underscoring the continued role of endoscopy and histopathology in comprehensive assessment.

Compared with healthy controls, UC and CD patients commonly showed leukocytosis, thrombocytosis, anemia, and hypoalbuminemia. These findings align with previous reports indicating that systemic inflammation and nutritional deficiencies are common in pediatric IBD.<sup>27</sup> These laboratory abnormalities likely reflect active inflammation and the chronic nature of IBD. Consequently, comprehensive assessment of pediatric IBD should combine laboratory, imaging, and endoscopic findings for accurate evaluation of disease activity.

The primary aim of the study was to evaluate whether USG can serve as an indicator of inflammation in children without the need for endoscopy. As the therapeutic goal of treatment is mucosal healing, patients in remission are expected to exhibit normal endoscopic findings, whereas persistent inflammation may indicate inadequate treatment response. Therefore, it is not believed that the medications used in these patients would have influenced the outcomes relevant to the objectives of the study.

Radiological imaging studies in IBD have primarily utilized MRI and CT. The MR enterography demonstrated a sensitivity of 57% and specificity of 75%-100% for IBD diagnosis.<sup>13</sup> Contrast-enhanced MRI demonstrated 84% sensitivity and 100% specificity for the terminal ileum.<sup>28</sup> The CT demonstrates low sensitivity (68%) for detecting bowel inflammation.<sup>29</sup> The MRI is an expensive method with a long scanning time and a need for sedation in

young children. The CT involves radiation exposure, and neither CT nor MRI can be performed at the bedside. Despite the advantages of USG, it also has disadvantages. Measurement outcomes may vary according to the examiner's experience. Patient compliance is crucial, and peristalsis-related variations in haustra and folds should be considered during measurement. To ensure consistency and reduce inter-observer variability, all measurements were performed by a single experienced radiologist using the same device.

Considering the weight and height values that vary with age in pediatric patients, unlike in adults, it is thought that this may also affect the intestinal wall thickness.<sup>17</sup> This situation may be a problem for standardization. In terms of standardization, it is necessary to study a larger number of cases and create data according to regions. Increased intestinal wall thickness is a non-specific finding and can also be seen with infectious, ischemic, and other inflammatory causes. What is detected here is the visualization of the inflammatory response of the intestine.<sup>12</sup> Therefore, colonoscopic and histopathological examinations maintain their importance in the diagnosis of IBD.

Transabdominal USG is used in measuring intestinal wall thickness in adults and in the presence of IBD complications and is increasingly being used in gastroenterology practice because it is an easily accessible and non-invasive method. However, there are different data regarding sensitivity, specificity, and accuracy in children. Studies have shown that USG can be useful in the follow-up of IBD patients and can raise awareness in the diagnosis of patients. In the study, it was observed that among the parameters measured by USG, BWT was especially sensitive and specific in IBD patients. It would be beneficial to conduct studies with more cases to standardize BWT cut-off values in children.

**Data Availability Statement:** The data that support the findings of this study are available on request from the corresponding author.

**Ethics Committee Approval:** Ethical committee approval was received from the Ethics Committee of Tepecik Training and Research Hospital (Approval no: 2022/11-05, Date: December 9, 2022).

**Informed Consent:** Written informed consent was obtained from the patients and parents who agreed to take part in the study.

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– S.K., I.K.; Data Collection and/or Processing – S.C., E.H, S.K.; Analysis and/or Interpretation – B.A., S.C., Y.C.A.; Literature Search – I.K, B.A., E.H.; Writing – S.C., B.A.; Critical Review – S.C., Y.C.A., M.B.

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