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Intestinal ultrasound for follow-up after 24 weeks of biological therapy in inflammatory bowel disease patients: an Egyptian center experience during the COVID-19 pandemic

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Abstract

Background Inflammatory bowel disease is a chronic inflammatory condition of the gut. It has two major subtypes Crohn's disease and ulcerative colitis. The follow-up consists of radiologic, molecular, endoscopic, and histological assessments. Intestinal ultrasound (IUS) is a noninvasive measure that provides future hope in guiding the management of IBD patients. This study is to assess the effectiveness of IUS in IBD patients' follow-up in our tertiary center during the pandemic. This is a prospective observational study during the COVID-19 pandemic. We used IUS to assess activity of IBD at baseline and at 6-month follow-up of patients on maintenance biological therapy using the following parameters: bowel haustrations, stratification, bowel wall thickness (BWT), Doppler sign (Limberg classification), presence of lymph nodes, or fibrofatty infiltration, echogenicity of the bowel, and presence of fistulae or abscesses. We compared the IUS with other radiologic parameters, histologic, and endoscopic scores at baseline before therapy, while we compared IUS with clinical scores and laboratory parameters before and after 24 weeks of biological treatment.

Results The cohort included 50 known IBD patients from June 2021 to January 2022. The laboratory studies showed a significant improvement in the hemoglobin indices, CRP, and fecal calprotectin from baseline and after 24 weeks. BWT, lumen diameter, lymph node presence, inflammatory signs, and Doppler activity signs were the most significant parameters in detecting improvement. However, there was no significant correlation between fecal calprotectin levels and ultrasound parameters. There was a positive correlation between MR and CT enterography, endoscopic parameters, and IUS parameters at baseline.

Conclusions IUS is an effective tool for follow-up of IBD patients especially during the pandemic periods.

Keywords Inflammatory bowel diseases, IBD, Intestinal ultrasound, Bowel ultrasound, Crohn's disease, Ulcerative colitis, COVID-19

Background

Inflammatory bowel disease (IBD) is a chronic inflammatory disorder affecting the gut of the patients. There are two main subtypes: ulcerative colitis, and Crohn's disease [1].

Intestinal ultrasound (IUS) is used in clinical practice for follow-up the IBD patients with apparent success. Its main limitation is being a subjective procedure (i.e., operator-dependent). In Germany and Italy: IUS is considered

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the standard of care for the patients' follow-up. However, in the Asian-Pacific: IUS role is still limited [2]. The same limitation is present in the African countries. As a noninvasive test for follow-up of patients with IBD, IUS offers a direct visualization tool for the gut [3]. In a recent publication, the authors recommended that IUS is used by the gastroenterologists as a basic follow-up tool in the clinic, not by a higher hierarchy learnt radiologists, but through training of all young clinicians in the gastroenterology specialty [4]. In addition, IUS is suitable for trained physicians in the follow-up of children with IBD, as compared to the experienced radiologists, considering that it is a noninvasive accessible method [5]. Artificial intelligence could close the gap of inexperience for novice practitioners of IUS [6].

There are a set of parameters to assess the activity and inflammation of the small and large bowels including: bowel wall thickness (BWT), lumen diameter, wall echogenicity, presence of haustrations, Doppler signs (Limberg classification), lymph node enlargement, and mesenteric fat [7].

Diagnostic accuracy for Crohn's disease by IUS varies among studies with 67–96% sensitivity, and 79–100% specificity [2]. It is believed that IUS learning takes more time than magnetic resonance enterography (MRE) [8]. MRE has limitations including high cost [9] and unsuitability for claustrophobic patients [10], in addition to the hazard of gadolinium hypersensitivity or nephrogenic systemic fibrosis [11], with the trouble of patient's preparation before the procedure, similar to colonoscopy [12]. The gold standard for assessing the disease activity in IBD remains to be ileocolonoscopy [9]. Other methods for assessing disease activity are CT, which has a radiation hazard a risk of cancer-associated mortality of 7%, due to the cumulative radiation dose [13]. However, its high accuracy in abdominal abscess assessment makes it the standard procedure for these cases [14]. Both procedures have variable diagnostic accuracy in UC and CD ranging from 80 to 96% [15, 16].

"Deep remission" is a term meaning achieving remission endoscopically and laboratory [17]. Deep remission is defined differently in UC and CD [18]. The mild to intermediate symptomatic patients still have the increased risk of disease-related hospitalization [19]. Histological remission occurs in two-thirds of patients who achieve deep remission, with a decreased risk of the need for surgical operations [17].

Thus, "Treat-to-target" is the new aim of therapy in both CD and UC since selecting therapeutic targets in inflammatory bowel disease (STRIDE-I). It includes the dependency on both the endoscopic remission and the symptomatic clinical remission, not just the later, as previously presumed. Histological remission is an adjunctive goal. STRIDE-II states that C-reactive protein, clinical response, and remission are important factors in short-term follow-up of the patients [20].

In this study, we aimed to show the importance of IUS in follow-up of patients who receive biological therapy during the time of COVID pandemic restrictions in our center. IUS benefits during this timely crisis affecting the whole world made the shifting to a more telemedicine and noninvasive diagnostic approaches and follow-up procedures. During the quarantine period of the COVID-19, the IBD follow-up was compromised [21]. Telemedicine for follow-up of IBD patients during the pandemic provided both psychological and medical support, as patients were afraid of acquiring infections through direct contact [22].

Methods

This is a prospective cohort study conducted on 50 patients of IBD (patients diagnosed with inflammatory bowel disease and in need of biological treatment) in the Ultrasound Unit of Hepatogastroenterology Unit, Internal Medicine Department at Ain Shams University Hospitals, Faculty of Medicine. The patients were selected from the gastroenterology outpatient clinic.

Inclusion criteria

Diagnosed patients with IBD (ulcerative colitis or Crohn's disease) who are scheduled to start biological treatment in the previous year after failed oral or local immunotherapy treatment and had their first 6-month (24 weeks) follow-up during this study period from July 2021 till January 2022 in our tertiary center from both sexes, age > or = 18 years old.

Exclusion criteria

Diagnosed IBD patients in the study period who have no disease activity, or controlled on local or oral medications only (non-biological therapy), or are vitally unstable, or need urgent surgical intervention for their IBD, or with mental health issues or alcohol or drug dependency, or pregnant women, or patients receiving chemotherapy for any type of malignancy. Patients on long-term biological treatment for IBD are also excluded. In addition, we excluded patients who tested positive for COVID-19, or were a known case of COVID-associated colitis.

All patients were subjected to the following:

- Full history taking, clinical examination, and laboratory investigations including (complete blood picture, erythrocyte sedimentation rate, C-reactive protein, fecal calprotectin, and viral markers).
- PCR nasopharyngeal swab test for COVID-19.

- Baseline colonoscopy and histopathology: at diagnosis.
- IUS at the diagnosis, and at follow-up at 6 months. Montreal classification was used to assess the location of the active inflammation (E1-3 in UC, and L1-3 in CD).
- Patients were subjected to the clinical activity scores (CAI) for evaluation of IBD in the form of Crohn's disease activity index for CD cases, and Mayo score for UC cases at baseline.
- Imaging in the form of CT enterography (CTE) for UC cases, and magnetic resonance enterography (MRE) for CD cases at baseline.

Intestinal ultrasound parameters

The study was done using Toshiba ultrasound, model NemioXG, serial number 09Y6752, performed by the author SEN with 12-year experience of abdominal ultrasound, and three-year experience of intestinal ultrasound. Two ultrasound probes were used in the IUS: The first is the curved low frequency probe 3–6 MHz for the abdominal examination, and bowel screening, then a high frequency linear probe 6–15 MHz for the detailed intestinal ultrasound examination. The parts examined for different parameters are sigmoid, descending, transverse, and ascending colon, cecum, and terminal ilium.

- *BWT:* The diameter of the bowel and its content vary according to the site, the fasting/feeding state, and bowel function. Normal bowel loops usually show diameter < 2.5 mm in the small bowel and < 5 mm in the colon, even when luminal contrast agents are used. Thickness of the bowel from the serosa to the mucosa normally does not exceed 4 mm. In our study, we used a cutoff 2.5 mm in small intestine and 3.5 mm in large intestine.
- *Stratification of the wall:* Under good conditions of visualization, the ultrasonographic aspect of the normal bowel wall is stratified, with five layers of different echogenicity. Each layer marks the boundary between two different histological structures. Starting from inside, the first layer is the interface between the lumen (hyperechoic) and the mucosa (tenuously hypoechoic). Between the mucosa and muscularis propria (both hypoechoic) stands the submucosa (hyperechoic). The muscularis propria is limited by the last layer (hyperechoic).
- *Loss of haustrations:* We commented on the haustrations of the wall of the bowel whether present or not.
- *Echo pattern*: Echogenicity of the submucosa is an important feature of the bowel wall, detecting the gut inflammation.
- *Inflammatory signs*: The presence of lymph nodes or hyperechoic fibrofatty infiltration of the mesentery surrounding the bowel, or edema were assessed.
- *Color or power Doppler sonography:* and contrast-enhanced sonography may be used to estimate the perfusion of bowel abnormalities and show neovascularisation and hyperemia occurring in inflammatory bowel diseases and neoplastic lesions. Also, the spectral analysis of Doppler signals of arteries supplying the gastrointestinal tract (coeliac trunk, superior, and inferior mesenteric arteries) and the vessels draining the intestine has been used to estimate bowel perfusion and assess the activity of inflammatory bowel disease. Limberg classification was used.
- *Assess the presence of fistulae or abscesses:* This is mainly in CD.

Ethical considerations

A written informed consent was obtained from study participants after explaining the purpose of the study. Anonymity of the subjects was ensured, and the study conformed to the standards of the Ethical Review Committee, Ain Shams University (FMASU M S 709 2020/2021).

Statistical analysis

Analysis of data was done using SPSS program version 25, and jamovi version 2.5. Quantitative data were presented as minimum, maximum, mean, and SD or quartiles. Qualitative data were presented as count and percentage. Student t test was used to compare continuous data between two independent groups. Mann–Whitney test was used to compare ordinal data between two independent groups. Spearman's correlation test was used to measure correlation between two quantitative variables. Paired-samples t test was used to compare quantitative data between for the same group before and after treatment. McNemar's test was used to compare qualitative data for the same group before and after treatment. Chi-square test (or Fisher exact test) was used to compare qualitative data between different groups. *P* value less than or equal to 0.05 was considered statistically significant. *P* value less than or equal 0.01 was considered highly statistically significant.

Results

We presented the baseline clinical demographics, clinical history, and symptomatology of the whole cohort in (Table 1). The most significant laboratory investigations that showed significant change (improvement) in values before and after treatment were hemoglobin indices, CRP, and fecal calprotectin (mean level 396.8 and SD ± 138.7 before treatment and mean level of 194.7 and

Table 1 Demographic and clinical data of the whole cohort:

Characteristics	Total *n* = 50	Ulcerative colitis *n* = 41	Crohn's disease n = 9
1- Sex no. (%)			
Male	21 (42%)	13	8
Female	29 (58%)	28	1
2- Age median(Q1–Q3)	26 (22.3–31)	26(22–31)	23(23–32)
3- Montreal Classification no. according to location			
E1 = Ulcerative proctitis		1	
E2 = Left-sided proctitis		8	
E3 = pancolitis		32	
L1 = ileal			3
L2 = colonic			0
L3 = ileocolonic			6
4- Clinical activity index no		Mayo score	CDAI
Normal	3	0	3
Mild	5	1	4
Moderate	36	34	2
Severe	6	6	0
5- Clinical outcome			
Deteriorating	10	8	2
Improving	40	33	7
6- Histological activity grading			
Mild	2	2	0
Moderate	20	16	4
Severe	28	23	5
7- History and symptomatology at baseline			
a) Bleeding Per Rectum			
Negative	10	3	7
Positive	40	38	2
B) Smoking			
Negative	35	30	5
Positive	15	11	4
C) DM & HTN			
Negative	45	36	9
Positive	5	5	0
D) Abdominal pain			
Negative	2	2	0
Positive	48	39	9
E) Arthralgia			
Negative	25	20	5
Positive	25	21	4
F) Bleeding per orifices			
Negative	43	34	9
Positive	7	7	0
G) Ascites			
Negative	31	26	5
Positive	19	15	4
H) Skin lesions			
Negative	43	36	7
Positive	7	5	2

Table 1 (continued)

Characteristics	Total *n* = 50	Ulcerative colitis *n* = 41	Crohn's disease n = 9
I) LL edema			
Negative	49	40	9
Positive	1	1	0
J) Jaundice			
Negative	49	40	9
Positive	1	1	0
8- Biological used for maintenance therapy			
Infliximab *Remicade*®	32	27	5
Adalimumab *Humira*®	18	14	4

SD of ± 89.9) (Table 2). All qualitative intestinal ultrasound parameters (i.e., presence of stratification, haustrations, lymph nodes, fistulae, inflammatory signs, Doppler signs) before and after treatment are shown in Fig. 1.

In our study, on comparison between pathology results, and CT enterography or MR enterography, there was nonsignificant difference (Table 3). IUS had sensitivity for inflammatory signs of 93.8% and Doppler signs of 85.4%. However, when compared with CTE and MRE results, both showed similar specificity and sensitivity. We also calculated the diagnostic accuracy of IUS in predicting the pathology and the CTE or MRE (inflammatory signs of the IUS have a sensitivity of 93.8%, and specificity of 50%, PPV of 97.8% and NPV of 25%, while the Doppler signs have a sensitivity of 85.4%, and specificity of 50%, PPV of 97.6% and NPV of 12.5%) **(**Table 4**).** Relation between CTE, or MRE at baseline and IUS parameters is shown in Supp. Table S1. There was a significant statistical relation between clinical activity scores (CAI) in the form of CDAI for CD or Mayo score for UC at baseline, and IUS Doppler signs are shown in Supp. Table S2. Moreover, we found that clinical improvement is significant with follow-up IUS parameters.

When comparing baseline IUS inflammatory signs and colonoscopy, we found nonsignificant results. Also, Doppler signs showed significant relation in some parts of the intestine like terminal ilium, left side, transverse, and sigmoid. That is very important in patients who have strictures in terminal ilium prevent terminal ilium intubation during colonoscopy. In correlation between baseline ultrasound and follow-up after treatment, it showed highly significant differences in BWT with mean of 3.68 mm and SD of ± 0.57 before treatment, and mean of 3.15 mm and SD of 0.5. Also, showed a decrease in the lumen diameter with mean of 13.2 mm and SD of 2.1 before treatment and 12.1 mm and SD 2.1 after treatment. The inflammatory signs, Doppler signs, and fibrofatty nodules showed high significant values, but strictures, haustrations, and stratifications showed nonsignificant results (Tables 5, 6). In comparing fecal

Table 2 Laboratory investigations before and after treatment:

Laboratory investigation	Mean (± SD) before	Mean (± SD) after	t*	*P* value
TLC (per microliter)	9.7 (± 3.3)	9.5 (± 2.4)	0.38	0.71 NS
Lymphocytes (per microliter)	3.3 (± 2.3)	3.5 (± 1)	0.54	0.59 NS
Neutrophils (per microliter)	5.9 (± 5.5)	5.5 (± 1.9)	0.50	0.62 NS
Eosinophils (per microliter)	0.9 (± 0.5)	0.5 (± 0.4)	4.84	< 0.001 HS
HB (gm/dl)	11.6 (± 2.1)	10.9 (± 1.7)	2.25	0.03 S
MCV (fl)	79 (± 8.8)	78.1 (± 8.1)	0.58	0.56 NS
MCH (pictogram per cell)	27.9 (± 4.8)	31.3 (± 5.89)	3.30	0.002 HS
Platelets (per microliter)	321.2 (± 121.5)	311.8 (± 93.2)	0.52	0.60 NS
ESR (mm/hr)	41.7 (± 28.9)	39.5 (± 24.3)	0.51	0.62 NS
CRP (mg/dl)	73.2 (± 40.96)	58.4 (± 32.7)	2.07	0.04 S
Fecal Calprotectin	396.8 (± 138.7)	194.7 (± 89.9)	8.89	< 0.001 HS

*Paired-samples t test (TLC; total leukocytic count, HB; hemoglobin, MCV; mean corpuscular volume, MCH; mean corpuscular hemoglobin, ESR; erythrocyte sedimentation rate, CRP; C-reactive protein)

*Chi-square test

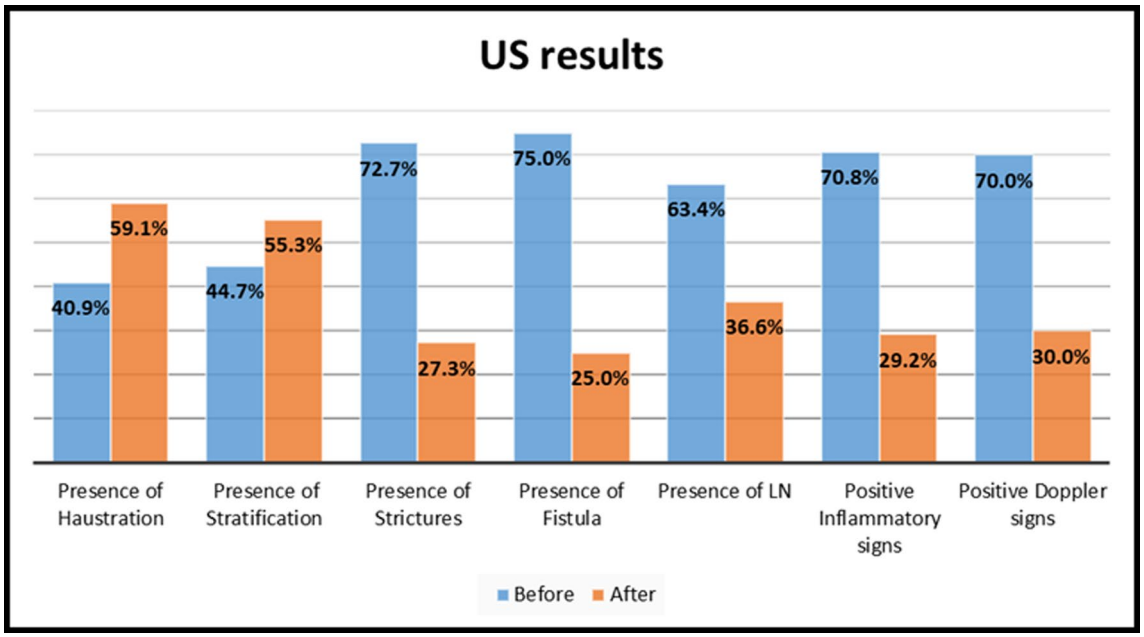

Fig. 1 Results of intestinal US before and after treatment

Table 3 Relation between *baseline* Pathology vs (IUS, CTE and MRE)

	Pathology at baseline			Test statistic	*p*-value
	Mild	Moderate	Severe		
1) IUS Inflammatory Signs				Mann Whitney U 53	0.114
Negative	1	2	1		
Positive	1	18	27		
2) IUS Doppler signs				Mann Whitney 149	0.575
Limberg 0-I	1	3	4		
Limberg II-III	1	17	24		
3) CTE				Spearman's rho 0.711	< 0.01 HS
Mild	2	0	0		
Moderate	0	14	5		
Severe	0	2	18		
4) MRE				Spearman's rho 0.8	< 0.01 HS
Mild	0	0	0		
Moderate	0	4	1		
Severe	0	0	4		

calprotectin results with all findings of intestinal ultrasound before and after treatment showed nonsignificant relation (Tables 5, 6, Supp. Tables S3, S4).

Figure 2 shows the colonoscopy pictures of a case of UC, while Fig. 3 shows the sigmoid colon before and after biological therapy in an UC case, and Fig. 4 shows IUS of a case of severe UC before treatment.

Discussion

Follow-up of IBD by IUS is reproducible, repeatable, easily tolerated, noninvasive, feasible; no preparation is needed as colonoscopy, no radiation hazard, added to being both time and cost-effective procedure [9, 23]. IUS scores are validated in clinical practice for CD. In case of UC, there is debate on the effectiveness of IUS in follow-up, and management of the patients [24]. "Mucosal healing" in IBD occurs when the mucosa is not friable, not ulcerating, nor eroding. This is associated with long-term clinical benefits: as decrease in the risk of dysplasia and surgical operations [17]. IUS provides the parameters of wall thickness, activity of inflammation, which will assess the treat-to-target in a clear and easy way, even if repeated frequently [9].

It has been documented that the use of IUS as the follow-up tool in IBD outside Europe has been comparatively slow [25]. Our prospective study was conducted in Egypt, during the COVID-19 pandemic, and we found that noninvasive techniques are needed to decrease the scare of IBD patients from colonoscopy, and risk of acquiring COVID, or other nosocomial infections, through the procedure, or from other immune-compromised patients.

Also, we found that there were some patients (3 cases) who were deteriorating clinically due to a superadded infection like: gastroenteritis (1 case), CMV colitis (1 case), and suspected COVID-19 diarrhea (1 case) (despite initial negative PCR), so intestinal ultrasound

Table 4 Diagnostic accuracy of the IUS in predicting the standard histopathology activity grading and CTE or MRE:

	Pathology			Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
	moderate/severe	Mild	Total				
Inflammatory signs							
Positive	45	1	46	93.8	50	97.8	25
Negative	3	1	4				
Doppler signs							
Positive (Limberg's II-III)	41	1	42	85.4	50	97.6	12.5
Limberg 0-I	7	1	8				
	CTE or MRE			**Sensitivity (%)**	**Specificity (%)**	**PPV (%)**	**NPV (%)**
	Moderate/severe	**Mild**	**Total**				
Inflammatory signs							
Positive	45	1	46	93.8	50	97.8	25
Negative	3	1	4				
Doppler signs							
Positive (Limberg's II-III)	41	1	42	85.4	50	97.6	12.5
Limberg 0-I	7	1	8				

Limberg Grading: grade 0: normal bowel wall with no thickening (< 4 mm), and no color Doppler flow. Grade 1: wall thickening with hypoechoic wall thickening and partially distorted stratification and no color Doppler flow. Grade 2: wall thickening with intermittent color Doppler flow vascularity. Grade 3: wall thickening with moderate stretches of color Doppler flow vascularity. Grade 4: color flow Doppler signals in both mural and mesenteric fat.

Table 5 Intestinal ultrasound quantitative parameters before and after treatment:

Parameter	Mean (± SD) before	Mean (± SD) after	t*	*P* value
A) BWT (mm)	3.68 (± 0.57)	3.15 (± 0.5)	6.67	< 0.001 HS
B) Lumen diameter (mm)	13.2 (± 2.1)	12.1 (± 2.1)	3.52	< 0.001 HS

*Paired-samples t test

was crucial for follow-up of those cases during their antiviral or antibiotic treatment.

Although, there is a low prevalence of COVID-19 infection in IBD patients; the patients' outcome could be worsened by mesalamine or corticosteroids therapy [26]. IBD patients, because of their caution from acquiring infection, strictly follow social distancing during the COVID-19 pandemic, as they are aware of their immune-compromised state. This may impact their follow-up visits [21], despite the results that show COVID-19 seroprevalence in IBD patients is similar to those without IBD [27].

In our study, correlation between the results of fecal calprotectin and BWT in patients who had sigmoiditis and left sided colitis was nonsignificant before and after treatment. This indicates that fecal calprotectin could be misleading in assessing inflammation of the bowel in IBD as compared to IUS. This is in accordance with *Paredes* et al. where the authors found that fecal calprotectin did not vary with transmural complications as IUS, and was only correlated with activity in the IUS in the weak range with a cutoff value of 100 ug/g and AUC of 79% [28]. This could be attributed to the mechanism of both tests in long-term follow-up (in our study it is a 6-month follow-up period) as fecal calprotectin is used in evaluating gut inflammation depending on neutrophil activity [29], while the BWT depending on the infiltration (edema or cellularity or fibrous tissue accumulation). Thus, on long-term (> 4 weeks) the fibrous tissue is accumulated without apparent inflammatory neutrophil infiltration [30]. It is known that fecal calprotectin has higher levels in active versus inactive disease [31]. In our study, the fecal calprotectin was significantly lower after treatment, and improvement of the patients' clinical condition (see Table 5).

In our study, there was a non-statistically significance relation regarding the haustrations, and stratifications in IBD patients before and after treatment indicate that these are chronic inflammatory process with permanent fibrosis in the mucosa and submucosa. This

Table 6 Intestinal ultrasound qualitative parameters before and after treatment:

Parameter		Haustrations after		*P* value*
		Lost	Present	
A) Haustrations before	Lost	21	11	0.06 NS
	Present	3	15	
		Inflammatory signs after		
		Negative	Positive	
B) Inflammatory signs before	Negative	4	0	< 0.001 HS
	Positive	27	19	
		Stratification after		
		Lost	Present	
C) Stratification before	Lost	14	15	0.42 NS
	Present	10	11	
		Strictures after		
		Absent	Present	
D) Strictures before	Absent	42	0	0.06 NS
	Present	5	3	
		Fistula after		
		Absent	Present	
E) Fistula before	Absent	47	0	0.50 NS
	Present	2	1	
		Mesenteric LN after		
		Absent	Present	
F) Mesenteric LN before	Absent	5	0	< 0.001 HS
	Present	19	26	
		Doppler signs after		
		Negative	Positive	
G) Doppler signs before	Negative	8	0	< 0.001 HS
	Positive	24	18	

*McNemar's test

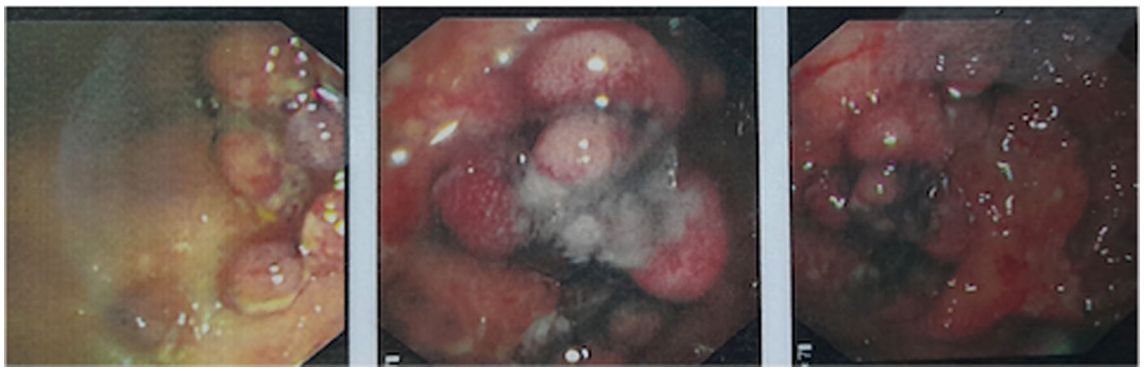

Fig. 2 Colonoscopy showing severe inflammatory polyps in the sigmoid colon in an UC case

nonsignificant relation could be attributed to the small sample of our study. While the BWT, lumen diameter, inflammatory signs, Doppler signs, and lymph nodes improved with follow-up. In a recent review by *Frias-Gomes* et al., it was shown that after 12 weeks of treatment the following parameters improved in IUS: BWT, mesenteric fat proliferation, haustrations, and fluid collection [30]. None of our studied patients had any ascetic collection.

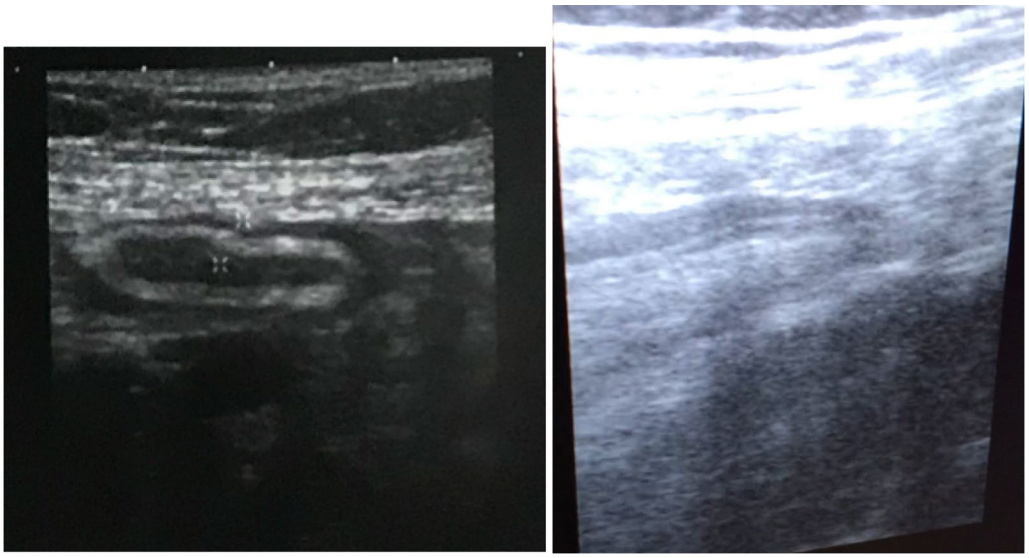

Fig. 3 IUS showing increased BWT of the sigmoid colon at baseline with increased echogenicity of the submucosa and mild loss of stratification and haustrations in an UC case in the left figure. The IUS parameters improved in the second right figure after biological treatment

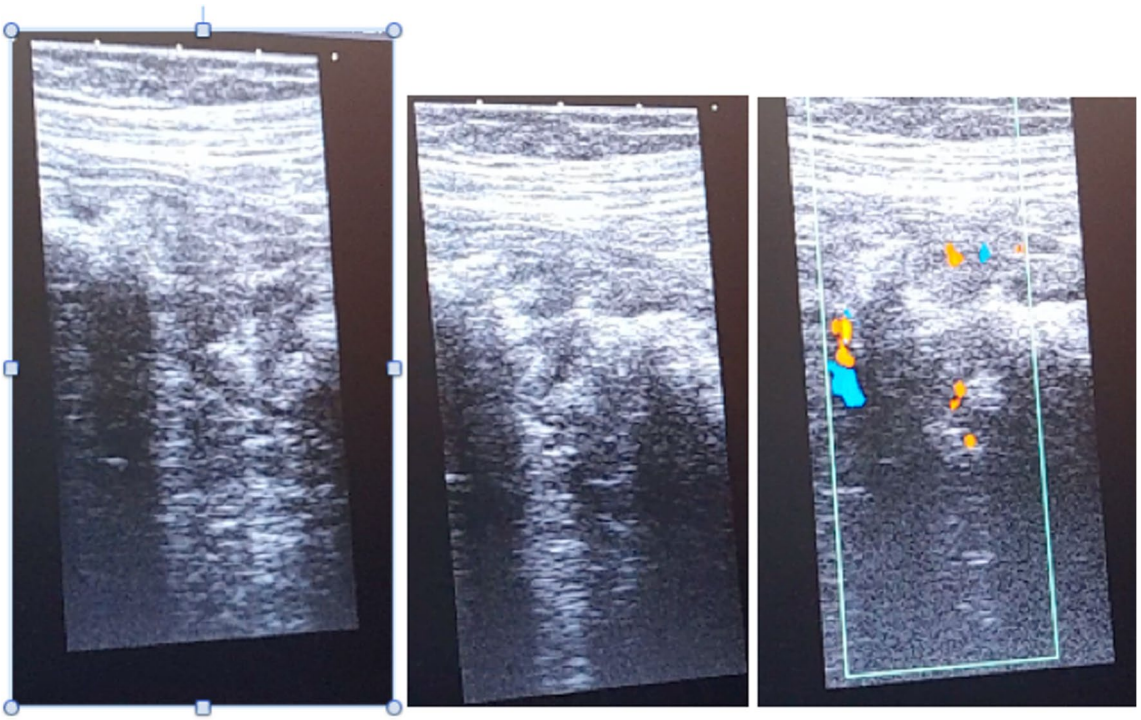

Fig. 4 Intestinal ultrasound shows increased thickness of the sigmoid wall with positive Doppler Limberg sign grade III, and submucosal polyps and crypt abscesses

In a recent cross-sectional study on fifty-one IBD patients in Malaysia, they found that BWT, mesenteric fat proliferation, Doppler signs, and stratifications loss were highly correlated with clinical and endoscopic parameters. Moreover, they found the most common IUS parameter detecting activity in colonoscopy was BWT > 3mm, with 72% sensitivity [32].

Our experience during the pandemic showed that the noninvasive IUS could be efficiently, and safely used in detecting inflammation activity and monitoring drug response, when compared to other radiologic investigations as MRE and CTE on baseline before starting biological treatment. Also, can be an effective method of follow-up in patients not tolerating endoscopy or in fear of an invasive procedure, limiting these procedures to unestablished cases or those with suspected complications.

A recent "one-case" study proposed that patients with severe UC could self-monitor by a handheld ultrasound device. They introduced a patient without a medical background and specifically learnt IUS to monitor himself. The case was reverted to surgery based solely on the BWT worsening, despite absent clinical worsening [33]. Moreover, we found in our study that the most significant parameters with the clinical and endoscopic parameters at baseline were Doppler activity, bowel thickness, and inflammatory signs presence. It is shown in previous studies that the bowel thickness is the single most important parameter in assessing the activity of the IBD as compared to clinical scoring as Harvey–Bradshaw index and CDAI scoring [34, 35].

Recently, a retrospective cohort study showed that, when comparing the IUS with the biomarkers and other clinical and endoscopic modalities, IUS does not differentiate between symptomatic and asymptomatic CD; however, in a previous cohort study, the treatment plans were changed according to the degree of inflammation detected by the IUS (more than half of the cases had inflammatory signs), this led mostly to increasing the dose or starting a new medication in half of those cases where inflammatory signs were detected by IUS. In addition IUS shows good correlation with endoscopy and MRE exceeding 80% [31].

Hemoglobin indices, CRP, and fecal calprotectin are parameters used for follow-up, and initial diagnosis in clinical practice, but carry the burden of high cost for the patients. Besides, the laboratory results are not immediately present during examination, thus delaying decision; this gives IUS a time advantage. In addition, these indices may be affected more slowly than IUS. This is consistent with previous literature that shows that IUS parameters are more related to the quick change in disease activity than fecal calprotectin [36]. Moreover, CRP showed a null-correlation with IUS findings in the previous studies on CD patients [28].

Conclusions

The IUS was comparable to the colonoscopy and other imaging modalities. IUS was a useful and effective noninvasive procedure for follow-up of biological maintenance therapy during the COVID-19 pandemic. The relation between IUS and fecal calprotectin for long-term follow-up needs further assessment.

Abbreviations

CD	Crohn's disease
CRP	C-reactive protein
CT	Computerized tomography
DM	Diabetes mellitus
ESR	Erythrocyte sedimentation rate
HTN	Hypertension
IBD	Inflammatory bowel diseases
IUS	Intestinal ultrasound
MRE	Magnetic resonance enterography
UC	Ulcerative colitis

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s43055-024-01332-w.

Additional file 1.

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Author contributions

SN was involved in ultrasound assessment of the patients, formulation of the research idea, supervision of the data collection, and drafting and revision of the manuscript. EN contributed to supervision of the work, formulation of the idea, and revision of the manuscript. FA took part in collection of the patients' data, data analysis, and revision of the manuscript. MS was responsible for clinical assessment of the patients, data analysis, and revision of the manuscript.

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Availability of data and materials

The data collected and/or analyzed during the current study are available by the corresponding author on a reasonable request.

Declarations

Ethics approval and consent to participate

This study protocol had the ethical approval of the Ethical Committee of Faculty Medicine, Ain Shams University, Cairo, Egypt. Approval Number of the protocol is (FMASU M S 709 2020/2021). Informed written consent was taken from all the patients before inclusion in the study. All methods were carried out in accordance with Helsinki guidelines and regulations. All research participants filled an informed consent form.

Consent for publication

Not applicable. As, no individual or personal data were used in this study.

Competing interests
All authors declare that there is no conflict of interest on conducting the study.

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