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Original Article

Role of Intestinal Ultrasound versus Ileocolonoscopy in Early detection of Clinically Suspected Inflammatory Bowel Disease

Ahmed Amged Mohammed Elhady [1*]; Alaa Elden Mahmoud Hashim [1]; Galal Abdelhameed Aboufarrag[2]; Mohamed Ashraf Abdelmoniem[3]

[1] Department of Hepatology, Gastroenterology and Infectious Diseases, Damietta Faculty of Medicine, Al-Azhar University, Damietta, Egypt.
[2] Department of Hepatology, Gastroenterology and Infectious Diseases, Faculty of Medicine, Al-Azhar University, Cairo, Egypt.
[3] Department of Radiodiagnosis, Damietta Faculty of Medicine, Al-Azhar University, Damietta, Egypt.

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ABSTRACT

Background: Inflammatory bowel disease (IBD) necessitates prompt and precise diagnosis to enhance outcomes. Ileocolonoscopy with histopathology is the best diagnostic method. However, it is invasive and takes a lot of resources. Intestinal ultrasound (IUS) has developed as a non-invasive option; however, its efficacy in newly suspected IBD necessitates further investigations. Thus, this study aimed to assess the diagnostic efficacy of IUS relative to ileocolonoscopy and histopathology for the early identification of clinically suspected IBD.

Patients and Methods: This study comprised 82 patients (≥16 years) exhibiting symptoms indicative of IBD. All underwent comprehensive history taking, clinical examination, laboratory evaluation (e.g., CRP, ESR, and fecal calprotectin), ultrasound imaging, ileocolonoscopy, and mucosal biopsy. We figured out the diagnostic accuracy indices and looked at how they were related to endoscopic severity scores (Mayo for UC and SES-CD for CD).

Results: Most patients aged 21–40 years (70.8%), with a nearly equal distribution of sexes (51.2% males). Chronic abdominal pain (63.4%) and diarrhea (51.2%) were the most common symptoms. Inflammatory markers were higher in IBD than non-IBD. IUS was positive in 62.2% of patients, with bowel wall thickening (59.8%), loss of stratification (46.3%), and hyperechoic perienteric fat (43.9%) as the main results. The positivity of IUS rose significantly with endoscopic severity in both ulcerative colitis ($p = 0.002$) and Crohn's disease ($p = 0.012$). IUS had 83.6% sensitivity, 81.5% specificity, and 82.9% accuracy when compared to colonoscopy. IUS had 88.5% sensitivity, 83.3% specificity, and 86.6% accuracy compared to histopathology. Colonoscopy had 100% sensitivity, 90.0% specificity, and 96.3% accuracy.

Conclusion: Intestinal ultrasound exhibits an accepted diagnostic accuracy and a robust correlation with endoscopic and histological results in newly suspected inflammatory bowel disease (IBD). IUS could be considered as a reliable, non-invasive first-line screening tool.

Keywords: **Ulcerative Colitis; Crohn's Disease; Intestinal Ultrasound; Ileocolonoscopy; Biopsy.**

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* Corresponding author
Email: ahmedamged19882015@gmail.com

INTRODUCTION

Inflammatory Bowel Disease (IBD), which encompasses Crohn's disease (CD) and ulcerative colitis (UC), represents a significant clinical challenge due to its chronic and often debilitating nature. Affecting millions worldwide, IBD requires early and accurate diagnosis to initiate timely and appropriate treatment, thus improving patient outcomes and quality of life. Traditional diagnostic methods have predominantly relied on ileocolonoscopy, a procedure considered the gold standard for diagnosis of IBD. This method allows for direct visualization and biopsy of the intestinal mucosa, providing essential information for diagnosis and management [(1)].

Despite its diagnostic utility, ileocolonoscopy is an invasive procedure that comes with several drawbacks, including patient discomfort, the need for bowel preparation, and the potential for complications such as perforation and bleeding. These limitations necessitate the exploration of less invasive diagnostic alternatives that can provide comparable accuracy and reliability. In this context, intestinal ultrasound (IUS) has gained attention as a promising non-invasive diagnostic tool for IBD [(2)]. IUS offers several advantages over ileocolonoscopy. It is non-invasive, does not require sedation, and can be repeated as often as necessary without the risk of radiation exposure. Advances in ultrasound technology have improved the resolution and diagnostic capabilities of IUS, making it a viable option for the early detection and monitoring of IBD. Studies have shown that IUS can effectively assess bowel wall thickening, vascularization, and other inflammatory changes, which are critical markers of IBD [(3)].

Moreover, IUS is particularly useful in clinical scenarios where rapid assessment is required, such as in emergency settings or during routine follow-up visits. Its ability to provide immediate results facilitates timely clinical decision-making, which is crucial in managing the unpredictable course of IBD. Additionally, IUS can be performed at the bedside or in outpatient clinics, making it a convenient option for both patients and healthcare providers [(4)].

Despite its benefits, the use of IUS in routine clinical practice varies, and its role relative to ileocolonoscopy remains a topic of ongoing research and debate. While some studies highlight the high sensitivity and specificity of IUS in detecting IBD, others emphasize the continued importance of ileocolonoscopy, particularly for obtaining histological confirmation and assessing the extent and severity of the disease. The integration of IUS into diagnostic algorithms alongside ileocolonoscopy could potentially enhance the overall diagnostic accuracy and patient experience [(5-8)]. This study aimed to assess the role of intestinal ultrasound versus Ileocolonoscopy in early detection of clinically suspected inflammatory bowel disease.

PATIENTS AND METHODS

Study design: The research took place at the endoscopic unit of Al-Azhar University Hospitals (SAYED GALAL and NEW DAMIETTA Hospitals). These hospitals are well prepared for endoscopic treatment of gastric varices.

Study Sampling: This cross-sectional analytical study was conducted to assess the role of intestinal ultrasound (IUS) in the early detection and diagnosis of clinically suspected inflammatory bowel disease (IBD). A total of 82 patients with symptoms suggestive of IBD were enrolled. These symptoms included chronic bloody diarrhea lasting more than four weeks (this helps distinguishing IBD from infectious colitis), Chronic abdominal pain associated with suspected IBD, and Unintentional weight loss, which indicated malabsorption or severe inflammation.

Inclusion Criteria: Patients were included if they met all the following criteria for suspected IBD: Age ≥ 16 years, Chronic diarrhea lasting > 4 weeks, Chronic abdominal pain with no other identifiable cause, Rectal bleeding (hematochezia) not attributable to hemorrhoids or anal fissures and Unintentional weight loss > 5% of body weight in 3–6 months.

Exclusion Criteria: Patients were excluded if they had previously confirmed IBD diagnosis, as the study focused on early detection.

Methods:

Patients were assessed in a standard manner (history taking, clinical examination and laboratory investigations). For laboratory investigations, blood and stool samples were taken to check for inflammation in the body and the intestines. A complete blood count was done to check for high levels of hemoglobin, white blood cells, and platelets. We measured the erythrocyte sedimentation rate and C-reactive protein levels to see how much inflammation was going on. Fecal calprotectin was measured as a non-invasive biomarker for intestinal mucosal inflammation and utilized to aid in diagnostic interpretation.

Sample Size Calculation:

The **Buderer** [(9)] formula for diagnostic accuracy studies was used to figure out how many samples were needed. The calculation included an expected intestinal ultrasound (IUS) sensitivity of 63.6% and specificity of 71.4%, along with an IBD prevalence of 321.2 per 100,000 population, as reported by **Caviglia *et al.*** [(10)]. We used a 95% confidence level. Using these assumptions, we found that the minimum sample size needed to get good statistical accuracy was 82 people.

Intestinal Ultrasound (IUS):

A radiologist with a lot of experience did intestinal ultrasonography on all of the patients using a Toshiba Aplio 500 system with a high-frequency linear probe (5–14 MHz). The thickness of the bowel wall was measured, and values greater than 3 mm in the small intestine or 5 mm in the colon were deemed abnormal and indicative of IBD. We looked at whether the normal five-layer bowel wall stratification was still there or not. If it wasn't, it meant that there was a lot of inflammation or fibrosis. We also looked at the echogenicity of perienteric fat, the patterns of Doppler vascularity, and structural problems like abscesses, fistulas, or strictures. Based on these results, patients were divided into two groups: those with positive sonographic signs of IBD and those with negative signs **(11)**.

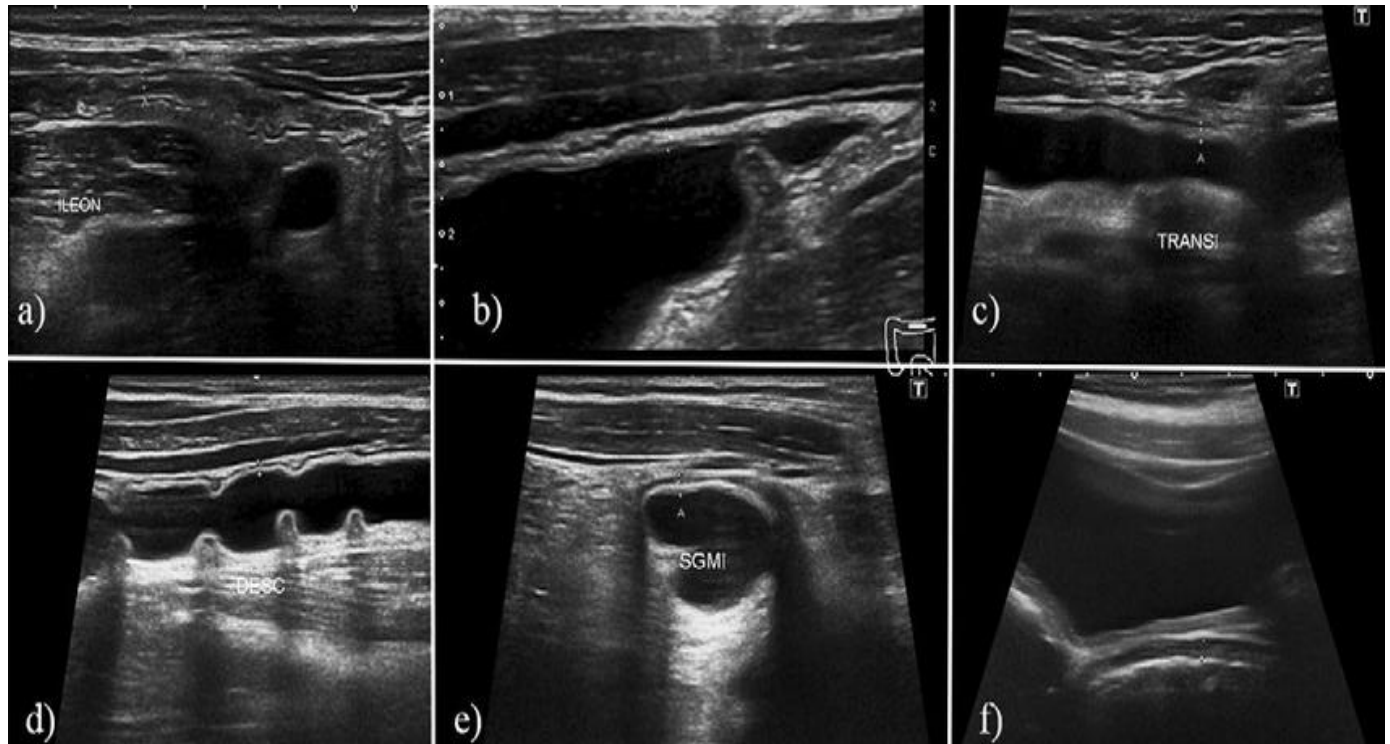

Figure (1): Normal aspect of the bowel segments: a) longitudinal scan of the terminal ileum; b) transverse scan of the ascending colon; c) longitudinal scan of the transverse colon; d) longitudinal scan of the descending colon; e) transverse aspect of the sigmoid; f) longitudinal scan of the rectum (measurements in all cases between callipers).

Endoscopic Examination:

All participants underwent colonoscopy after a standardized bowel preparation, which consisted of a clear liquid diet and the administration of a polyethylene glycol solution. Midazolam was used to put the patient to sleep. Colonoscopies were conducted utilizing a Fujifilm EPX-4450HD high-definition endoscopy system, and the degree of visualization, encompassing terminal ileum intubation, was recorded. We systematically looked at mucosal problems like erythema, friability, erosions, ulcers, and strictures. The Mayo Endoscopic Score was used to rate the severity of ulcerative colitis, while the Simple Endoscopic Score for Crohn's Disease (SES-CD) was used to measure the activity of Crohn's disease based on the characteristics of the ulcers, the mucosal surfaces that were affected, and the severity of the strictures across five bowel segments. Endoscopists were unaware of clinical and ultrasound findings, and incomplete procedures were omitted from scoring. Patients were classified as having positive or negative endoscopic findings based on characteristics indicative of IBD (12).

Histopathological Examination:

During the colonoscopy, mucosal biopsies were taken from the terminal ileum, colon, and rectum so that they could be looked at under a microscope. Samples were processed utilizing standard methodologies and analyzed by a seasoned gastrointestinal pathologist. We looked at histologic features like crypt abscesses, granulomas, basal plasmacytosis, and epithelial abnormalities. Persistent mucosal inflammation characterized by crypt architectural distortion and cryptitis corroborated a diagnosis of ulcerative colitis, whereas non-caseating granulomas and transmural inflammation suggested Crohn’s disease (13).

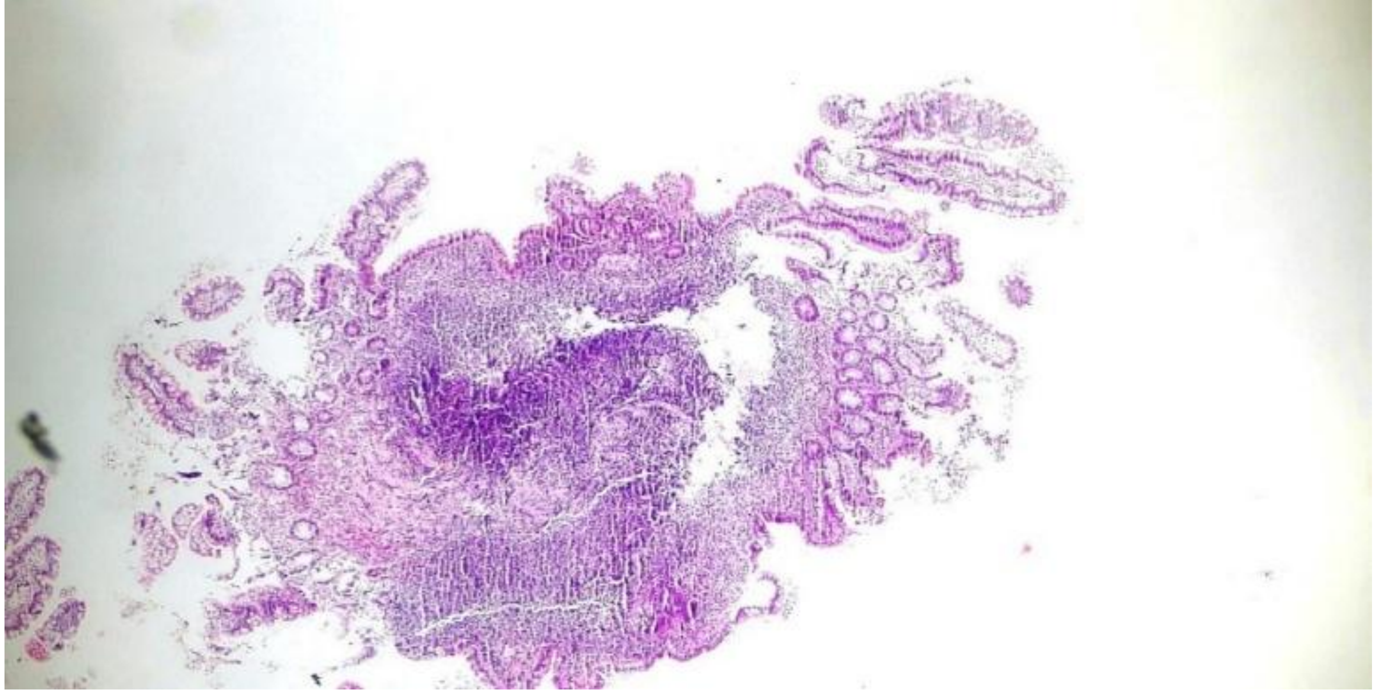

Figure (2): Snippets of ileal mucosa of Crohn's disease (CD) case showing dense lymphoplasmacytic infiltration, prominent lymphoid follicle formation, and focal crypt architectural distortion (H&E stain, magnification 10x).

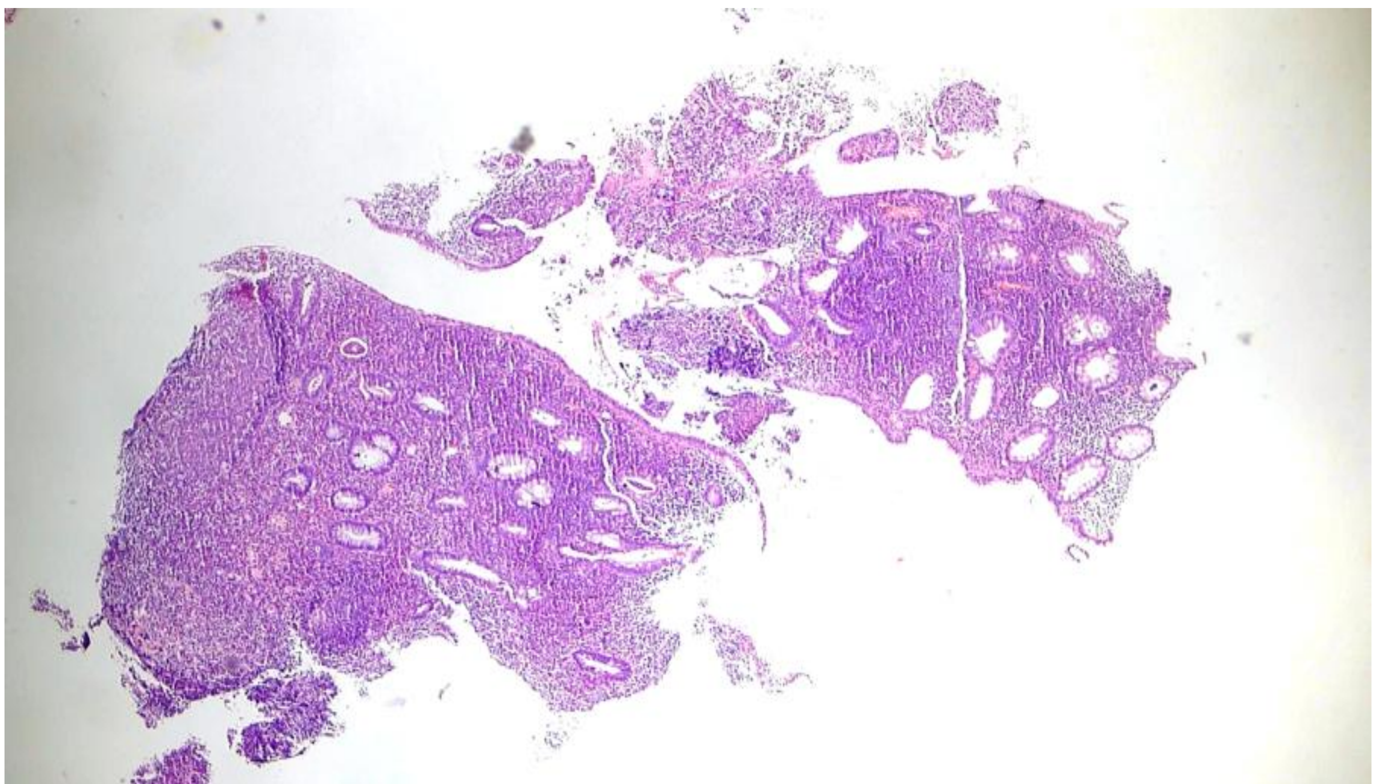

Figure (3): Sections of colonic mucosa of Ulcerative colitis case demonstrating crypt architectural distortion and irregularity, with evidence of neutrophilic cryptitis and crypt abscess formation (H&E stain, magnification 10x).

Data analysis: The collected was systematically organized, tabulated, and analyzed using appropriate statistical tests, with continuous variables represented by mean and standard deviation. However, categorical data expressed in numbers and percentages. From a statistical point of view, a P-value less than 0.05 was considered significant.

RESULTS

A total of 82 participants were included and underwent systematic evaluation utilizing standardized clinical, radiologic, and endoscopic criteria. The study population was mainly younger in age (most of patients are aged between 21 and 40 years). No special sex predominance (males represented 51.2%). In clinical

settings, chronic abdominal pain and diarrhea were the most reported symptoms. Extraintestinal manifestations occurred in a lesser proportion (peripheral arthritis was frequently linked with active disease). Laboratory tests showed significant inflammation, with high levels of ESR, CRP, and fecal calprotectin. However, there were low mean hemoglobin indicating a chronic disease burden and potential iron-deficiency anemia due to ongoing gastrointestinal blood loss or malabsorption. Intestinal ultrasound results showed that, over 60% of the cohort displayed at least one abnormal sonographic criterion (bowel wall thickening and loss of stratification were the most common characteristics). Increased Doppler vascularity and hyperechoic perienteric fat were prevalent findings, with low incidence of strictures (Table 1).

Endoscopic examination yielded additional diagnostic elucidation. In patients with ulcerative colitis, the loss of vascular pattern and mucosal friability were universally observed, while continuous erythema and superficial ulceration were frequently noted. On the other hand, Crohn's disease was marked by patchy inflammation, aphthous ulcers, and the occurrence of cobblestoning or strictures in about one-third of those affected. Non-IBD findings, such as normal mucosa, diverticulosis, and colonic polyps, constituted a significant proportion of the negative colonoscopy cohort, illustrating the diagnostic variability among symptomatic patients assessed for suspected IBD (Table 1).

Histopathologic findings closely corresponded with endoscopic observations. In individuals with positive colonoscopy results, the predominant diagnosis was ulcerative colitis, succeeded by Crohn's disease and a minor segment of indeterminate colitis. In the negative colonoscopy subgroup, the prevalence of normal histology corroborated non-inflammatory diagnoses, whereas a minority exhibited chronic nonspecific colitis or neoplastic lesions (Table 1).

Bowel wall thickening was seen in 75% of UC and 93.3% of CD patients, compared to 18.5% of non-IBD cases. Loss of stratification and hyperechoic fat were more common in IBD than non-IBD groups, while normal IUS was reported in 12.5% of UC, 26.7% of CD, and 81.5% of non-IBD patients (Table 2).

Table (3) demonstrated a statistically significant correlation between intestinal ultrasound (IUS) findings and disease severity among patients with ulcerative colitis (UC), as assessed by the Mayo endoscopic score ($p = 0.002$). IUS positivity increased progressively with higher Mayo grades, being detected in 72.7% of patients with mild UC (Mayo I), 87.5% of those with moderate UC (Mayo II), and 100% of those with severe UC (Mayo III). Conversely, IUS negativity was more frequent in the mild form (27.3%) and absent in severe cases.

Table (4) illustrated a significant positive correlation between intestinal ultrasound (IUS) findings and the severity of Crohn's disease (CD) based on the Simple Endoscopic Score for Crohn's Disease (SES-CD), with a p-value of 0.012. The proportion of IUS-positive findings increased with disease severity, being observed in 40% of patients with mild CD, 85.7% of those with moderate CD, and 100% of those with severe CD. In contrast, IUS-negative results were more common in mild disease (60%) and declined sharply as the endoscopic severity increased, disappearing entirely in severe cases.

IUS showed 83.6% sensitivity, 81.5% specificity, and 82.9% accuracy compared to colonoscopy. With a high PPV (90.2%), IUS proved to be a useful non-invasive tool with good agreement with colonoscopy (Table 5).

Colonoscopy had 100% sensitivity, 90% specificity, and 96.3% accuracy versus histopathology. Its strong predictive values confirm its high diagnostic accuracy in detecting IBD (Table 6).

IUS showed 88.5% sensitivity, 83.3% specificity, and 86.6% accuracy against histopathology. These results support its reliability as a non-invasive diagnostic option for IBD (Table 7).

Table (8) showed that colonoscopy had higher sensitivity (100%) and accuracy (96.3%) than IUS (88.5% and 86.6%, respectively), with comparable specificity and PPV. McNemar's test showed no significant difference, and Cohen's κ indicated moderate agreement, supporting IUS as a useful non-invasive alternative.

Compared to Non-IBD, UC and CD patients had significantly elevated inflammatory markers (CRP: UC=23.1 mg/L, CD=26.4 mg/L vs. Non-IBD=7.8 mg/L; fecal calprotectin: UC/CD >500 µg/g vs. non-IBD=115µg/g; both $p<0.001$) and lower hemoglobin ($p<0.001$). Demographics did not differ significantly (all $p>0.05$). (Table 9)".

Table (1): Demographic, Clinical, Laboratory, Ultrasound, Endoscopic, and Histopathologic Characteristics of the Study Population

Category		Variable / Finding	Value / Frequency (%)
Demographics	Age group	16–20; 21-30; 31-40; and > 40	12 (14.6%);34 (41.5%); 24 (29.3%); 12 (14.6%)
	Sex	Male/ Female	42 (51.2%)/ 40 (48.8%)
	Smoking Status		26 (31.7%)
	Family History of IBD		8 (10.2%)
	BMI (kg/m²)		25.8 ± 3.4
Clinical Symptoms		Chronic diarrhea (>4 weeks)	42 (51.2%)
		Chronic abdominal pain	52 (63.4%) (Most common symptom)
		Rectal bleeding	40 (48.8%)
		Weight loss (>5%)	10 (12.19%)
		Extraintestinal manifestations	12 (14.6%)
		– Peripheral arthritis	7 (8.5%)
		– Erythema nodosum	3 (3.7%)
		– Uveitis	2 (2.4%)
Laboratory Parameters		Hemoglobin (g/dL)	10.4 ± 1.8
		White Blood Cells (×10³/µL)	9.3 ± 2.3
		Platelets (×10³/µL)	377 ± 105
		ESR (mm/hr)	45.48 ± 18
		CRP (mg/L)	18.5 ± 9.3
		Fecal calprotectin (µg/g)	389 ± 210 (Elevated*)
IUS Findings		Bowel wall thickness	4.8±1.2 mm (Abnormal >5 mm (colon), >3 mm (SI))
		Bowel wall thickening (freq.)	49 (59.8%) (Major diagnostic criterion)
		Loss of stratification	38 (46.3%)
		Hyperechoic perienteric fat	36 (43.9%) (Active inflammation)
		Increased Doppler vascularity	31 (37.8%) (Active inflammation)
		Strictures	6 (7.3%) (Suggestive of chronic CD)
		No sonographic evidence of IBD	31 (37.8%)
IUS Summary		Positive (Abnormal)	51 (62.2%) (≥1 major criterion)
		Negative (Normal)	31 (37.8%)
Endoscopic Findings – Ulcerative Colitis (n=40)		Continuous erythema	34 (85%)
		Superficial ulcers	18 (45%)
		Loss of vascular pattern	40 (100%)
		Mucosal friability	40 (100%)
		Spontaneous bleeding	12 (30%)
		Pseudopolyps	10 (25%)
Endoscopic Findings – Crohn's Disease (n=15)		Patchy inflammation	12 (80%)
		Aphthous ulcers	12 (80%)
		Cobblestoning	5 (33%)
		Strictures	5 (33.3%)
Endoscopic Findings – Non-IBD (n=27)		Normal mucosa	20 (74%)
		Diverticulosis	3 (11%)
		Colorectal polyps	2 (7%)
		Colorectal mass	2 (7%)
Histopathology – Positive Colonoscopy (n=55)		Ulcerative Colitis	38 (69.6%)
		Crohn's Disease	14 (25.4%)
		Indeterminate colitis	1 (1.8%)
		Chronic nonspecific colitis	2 (3.6%)
Histopathology – Negative Colonoscopy (n=27)		Chronic nonspecific colitis	7 (25.9%)
		Adenomatous polyps	2 (7.4%)
		Colorectal cancer	2 (7.4%)
		Normal histology	16 (59.3%)

Table (2): Association Between IUS Findings and Colonoscopy Diagnoses (n = 82)

IUS Finding	UC (n=40)	CD (n=15)	Non-IBD (n=27)	Total (n=82)	Overall p-value	UC vs. CD p-value
Bowel Wall Thickening	30(75.0%)	14(93.3%)	5 (18.5%)	49(59.8%)	**<0.001**	0.90 (NS)
Loss of Stratification	25(62.5%)	11(73.3%)	2 (7.4%)	38(46.3%)	**<0.001**	1.00 (NS)
Hyperechoic Fat	20(50.0%)	13 (86.7%)	3 (11.1%)	36 (43.9%)	**<0.001**	0.12 (NS)
Increased Vascularity	18(45.0%)	11 (73.3%)	2 (7.4%)	31 (37.8%)	**<0.001**	0.42 (NS)
Strictures	0(0.0%)	5(33.3%)	0 (0.0%)	5 (6.1%)	**<0.001**	**0.006(S)**
Normal IUS	5(12.5%)	4(26.7%)	22 (81.5%)	31(37.8%)	0.14	1.00 (NS)

Table (3): Correlation Between Intestinal Ultrasound (IUS) Findings and Ulcerative Colitis (UC) Severity According to Mayo Endoscopic Score

IUS Result	Mayo I (n=11)	Mayo II (n=16)	Mayo III (n=13)	Total (n=40)	p-value
IUS Positive	8 (72.7%)	14 (87.5%)	13 (100%)	35 (87.5%)	0.002*
IUS Negative	3 (27.3%)	2 (12.5%)	0 (0%)	5 (12.5%)	
Total	11 (100%)	16 (100%)	13 (100%)	40 (100%)	

Table (4): Correlation Between Intestinal Ultrasound (IUS) Findings and Crohn's Disease (CD) Severity According to SES-CD Score

IUS Result	Mild CD (n=5)	Moderate CD (n=7)	Severe CD (n=3)	Total (n=15)	p-value
IUS Positive	2 (40%)	6 (85.7%)	3 (100%)	11 (73.3%)	0.012*
IUS Negative	3 (60%)	1 (14.3%)	0 (0%)	4 (26.7%)	
Total	5 (100%)	7 (100%)	3 (100%)	15 (100%)	

Table (5): Diagnostic Performance of Intestinal Ultrasound (IUS) Compared to Colonoscopy (n = 82)

IUS Result		Positive Colonoscopy	Negative Colonoscopy	Total
Positive (n = 51)		46	5	51
Negative (n = 31)		9	22	31
Total		55	27	82
Diagnostic Performance Measures	Sensitivity	46 / 55		83.6%
	Specificity	22 / 27		81.5%
	Positive Predictive Value (PPV)	46 / 51		90.2%
	Negative Predictive Value (NPV)	22 / 31		71.0%
	Accuracy	68 / 82		82.9%

Table (6): Diagnostic Performance of colonoscopy Compared to Histopathology (n = 82)

Colonoscopy Result		Histopathology Positive for IBD	Histopathology Negative for IBD	Total
Positive (n = 55)		52 (True Positive)	3 (False Positive)	55
Negative (n = 27)		0 (False Negative)	27 (True Negative)	27
Total		52	30	82
Diagnostic Performance Measures	Diagnostic Measure	**Formula**		**Value**
	Sensitivity	52 / (52 + 0)		100%
	Specificity	27 / (27 + 3)		90.0%
	PPV	52 / (52 + 3)		94.5%
	NPV	27 / (27 + 0)		100%
	Accuracy	(52 + 27) / 82		96.3%

Table (7): Correlation Between Intestinal Ultrasound (IUS) and Histopathology (n = 82)

IUS Result		Histopathology IBD Positive	Histopathology IBD Negative	Total
Positive (n = 51)		46 (True Positive)	5 (False Positive)	51
Negative (n = 31)		6 (False Negative)	25 (True Negative)	31
Total		52	30	82
Diagnostic Performance Measures	Measure	**Formula**		**Value**
	Sensitivity	46 / (46 + 6)		88.5%
	Specificity	25 / (25 + 5)		83.3%
	Positive Predictive Value	46 / (46 + 5)		90.2%
	Negative Predictive Value	25 / (25 + 6)		80.6%
	Accuracy	(46 + 25) / 82		86.6%

Table (8): Comparative Diagnostic Performance and Agreement of IUS vs. Colonoscopy Using Histopathology as Gold Standard (n=82)

Parameter	IUS	Colonoscopy	Statistical Comparison
Sensitivity	88.5% (46/52)	100% (52/52)	McNemar's $p = 0.125$
Specificity	83.3% (25/30)	90.0% (27/30)	McNemar's $p = 1.000$
PPV	90.2% (46/51)	94.5% (52/55)	–
NPV	80.6% (25/31)	100% (27/27)	–
Accuracy	86.6% (71/82)	96.3% (79/82)	McNemar's $p = 0.063$
False Positives	5	3	–
False Negatives	6	0	–
Overall Agreement	82.9% (68/82)	–	Cohen's κ = 0.63 (moderate agreement)
McNemar's Test	–	–	$p = 0.267$ (no significant bias)

Table (9): Baseline Characteristics by IBD Subtype (UC vs. CD vs. Non-IBD) Based on Histopathology

Characteristic		UC (n=35)	CD (n=14)	Non-IBD (n=33)	p-value
Age (years)		29.1 ± 8.4	25.8 ± 7.2	31.6 ± 9.8	0.08
Sex (Male)		18(51.4%)	9 (64.3%)	15 (45.5%)	0.52
Smoking		12(34.3%)	6 (42.9%)	8 (24.2%)	0.38
Laboratory Markers	Hemoglobin (g/dL)	9.6 ± 1.5	9.9 ± 1.8	11.4 ± 1.4	**<0.001**
	CRP (mg/L)	23.1 ± 9.2	26.4 ±11.0	7.8 ± 3.9	**<0.001**
	ESR (mm/hr)	49 ± 17	54 ± 21	26 ± 11	**<0.001**
	Fecal Calprotectin(μg/g)	502 ± 203	532 ± 245	115 ± 80	**<0.001**

DISCUSSION

The results provided a comprehensive overview of the diagnostic performance of intestinal ultrasound and its correlation with endoscopic and histological outcomes, summarizing the spectrum of disease manifestations across ulcerative colitis, Crohn's disease, and non-IBD conditions. In our cohort of 82 patients with suspected IBD were included, most of them were young adults, (aged 21–30 years (41.5%). This was consistent with the typical age range for IBD onset. The sex distribution was nearly equal (51.2% males vs. 48.8% females), showing no strong gender predilection. Smoking was reported by 31.7%. It is a known risk factor particularly for Crohn's disease. In addition, 10.2% had a positive family history of IBD, reflecting a familiar genetic component in disease predisposition.

This demographic distribution agrees with the findings of **Parente *et al.*** [14] who conducted a large-scale prospective study involving 487 patients with chronic gastrointestinal symptoms. They reported that most IBD cases were aged 20–40 years, with a balanced sex distribution, and noted a considerable proportion of patients with a history of smoking and familial IBD.

In contrast, **Conti *et al.*** [15] evaluated 313 young adults with IBS-like symptoms and found lower rates of smoking and family history of IBD than the current work. Their methodology differed by focusing on differentiating functional from organic bowel disorders rather than exclusively targeting patients with high clinical suspicion of IBD. This broader inclusion likely accounts for the lower prevalence of traditional IBD risk factors in their study.

In our study, chronic abdominal pain was the commonest symptom (64.6%), followed by chronic diarrhea (52.4%) and rectal bleeding (48.8%). Weight loss and extraintestinal manifestations (EIMs) (peripheral arthritis (8.5%), erythema nodosum (3.7%), and uveitis (2.4%), were less frequent (13.4% and 14.6%, respectively).

These findings are comparable to that of **Conti *et al.*** [15] who conducted a prospective study aimed to evaluate the role of IUS in differentiating organic from functional bowel disorders in young adults presenting with vague abdominal symptoms. They reported abdominal pain in 98% of CD and 88% of UC patients, along with diarrhea in 67% and 81%, respectively. Rectal bleeding was reported in 50% of UC, closely matching our 48.8%. Their inclusion of a mixed symptomatic population and early use of IUS aligns well with our methodology.

In contrast, **Castiglione *et al.*** [16] aimed to compare the diagnostic performance of IUS versus magnetic resonance enteroclysis (MREC) in patients with known or suspected small bowel Crohn's disease, using ileocolonoscopy as the gold standard. Because their study focused solely on small bowel Crohn's, the clinical symptoms were different—non-bloody diarrhea was reported in 100% of patients, and abdominal pain in 95%, while rectal bleeding was completely absent (0%). These differences are likely due to their exclusion of UC and limited colonic involvement, which often contributes to hematochezia.

In the present study, bowel wall thickening emerged as the commonest IUS finding, identified in 59.8% of patients. Then, loss of wall stratification (46.3%), hyperechoic perienteric fat (43.9%), and increased Doppler vascularity (37.8%). These features are recognized as sonographic markers of active inflammation in IBD, especially in CD. The low incidence of strictures (6%) and the absence of abnormal IUS findings in 37.8% of cases could indicate early-stage disease or cases limited to mucosal involvement, which may be less evident on ultrasound.

These results are consistent with **Calabrese *et al.*** [17], who aimed to evaluate the accuracy of bowel US in the diagnosis and follow-up of CD. Their analysis revealed that bowel wall thickening was the most reliable ultrasonographic indicator, with pooled sensitivity and specificity of 79.7% and 96.7%, respectively. Moreover, they emphasized the diagnostic significance of hyperechoic mesenteric fat and loss of wall stratification, aligning with the sonographic features in the current study.

Conversely, a lower detection rate for bowel wall thickening was reported in the **Bove study** [18]. In that study, only 38% of patients exhibited this key IUS finding. The reduced detection rates may be attributed to operator dependency or limited experience. This highlights the critical role of training and standardization, which likely contributed to the higher diagnostic accuracy observed in our study, where all ultrasound exams were conducted by highly experienced radiologists.

After IUS, patients then underwent colonoscopy, and endoscopic evaluation revealed that all patients with UC exhibited mucosal friability and decreased vascular pattern. However, continuous erythema was observed in 85%, and superficial ulcers in 45%. CD showed characteristic patchy inflammation and aphthous ulcers in 80% of patients, with cobble stoning and strictures (each reported in approximately 33%). Among the non-IBD group, 74% had normal mucosa. These endoscopic patterns are consistent with the classical features used to differentiate UC and CD, supporting the clinical utility of colonoscopy in diagnosing and characterizing IBD subtypes.

Our findings agree with those reported by **Maconi et al.** [19], who included 83 adult UC patients and noted that colonoscopy reliably detected typical UC features such as mucosal friability and loss of vascular pattern. In that study, 100% of patients with active disease had at least one of these signs, aligning well with our observation. Their study also emphasized the value of correlating endoscopic activity with ultrasonographic findings to improve disease assessment [20].

Conversely, in a systematic review by **Pal *et al.*** analyzing 99 articles on IUS and its correlation with UC endoscopic findings, endoscopic signs were less consistently present. For example, only 70–80% of patients demonstrated mucosal friability, and spontaneous bleeding was observed less frequently. This discrepancy may be attributed to variations in disease severity at presentation and differences in the inclusion criteria across the reviewed studies [21].

The association between IUS findings and colonoscopy-based diagnoses demonstrated a strong correlation between abnormal IUS features and confirmed inflammatory bowel disease (IBD). Bowel wall thickening was present in 75% of UC and 93.3% of CD cases, while only 18.5% of non-IBD patients showed this finding. Similarly, loss of wall stratification, hyperechoic perienteric fat, and increased Doppler vascularity were significantly more frequent in IBD patients (both UC and CD) than in non-IBD. Strictures were exclusively observed in CD patients (33.3%), reflecting the transmural and fibrostenotic nature of the disease. Notably, 39.2% of patients overall had normal IUS findings, with the highest proportion (81.5%) among non-IBD cases, underscoring the specificity of sonographic features in detecting active diseases.

These findings are well-aligned with those of **Parente *et al.*** [14], who studied 487 patients with chronic abdominal symptoms using IUS, colonoscopy, and histopathology. In their IBD group (132 patients), bowel wall thickening was found in 92% of CD and 78%

of UC patients, closely mirroring our results. Loss of stratification and increased vascularity were also significantly more common in IBD versus non-IBD patients. Their large sample size and consistent methodology validate the strength of IUS as a non-invasive tool for early detection and differentiation of IBD types.

Moreover, our study aligns with **Sagami *et al.*** **[22]**, who conducted a prospective cross-sectional study involving 53 patients with UC and applied both clinical and imaging parameters to assess correlation with histological data such as the Nancy Histological Index. They found that bowel wall thickness (BWT) on ultrasound had the highest sensitivity (95.5%) for predicting active histological inflammation (NHI >1), supporting our findings. The Mayo Endoscopic Score (MES) among 40 UC patients showed that the majority had moderate disease (score 2) in 40%, followed by severe disease (score 3) in 32.5%, and mild disease (score 1) in 27.5%. Notably, none of the patients had a normal mucosa (score 0), indicating that all cases presented with active endoscopic inflammation. These findings reflected patients predominantly in the moderate-to-severe spectrum of disease, reinforcing the importance of early and accurate assessment for appropriate therapeutic planning.

In the study of **Calabrese *et al.*** **[17]**, 50 adult UC patients undergoing colonoscopy and US. They reported that 44% of patients had MES 2 and 32% had MES 3, closely paralleling our rates of 40% and 32.5%, respectively. Their study highlighted the strong correlation between endoscopic severity and sonographic parameters, particularly bowel wall thickening and loss of stratification, which were more pronounced with higher MES grades.

In contrast, **Bove *et al.*** **[18]** reported a milder endoscopic profile in their study of 61 patients with gastrointestinal complaints, including 18 with UC. Most of their UC cases had mild or inactive disease at the time of colonoscopy. This discrepancy likely stems from differences in the study population, as their cohort included both confirmed IBD cases and patients with functional symptoms, leading to less active disease compared to our findings.

Importantly, our study specifically focused on suspected cases of inflammatory bowel disease referred to as an initial diagnostic evaluation. This explains the higher proportion of patients presenting with moderate to severe endoscopic disease, as those referred for colonoscopy typically exhibit more prominent or persistent clinical symptoms warranting further investigation.

At the end of our study, patients' biopsies underwent histopathological analysis which revealed that among the 55 patients with positive colonoscopic findings, 69.6% were diagnosed with ulcerative colitis (UC) and 25.4% with Crohn's disease (CD). Conversely, among the 27 patients with negative colonoscopic findings, 59.3% exhibited normal histology, while others had chronic non-specific colitis (25.9%), adenomatous polyps (7.4%), or colorectal cancer (7.4%). These results underscore the critical role of histopathology in confirming IBD diagnoses and distinguishing them from other colonic pathologies. In contrast, a previous study reported a high concordance between endoscopic and histological inflammation ratings, with a correlation coefficient of 0.84. This suggests that, in certain contexts, endoscopic findings may closely reflect histological activity. However, the study's focus on patients already diagnosed with IBD during follow-up assessments may account for this concordance, differing from our study, which concentrated on initial diagnostic evaluations where histopathology plays a pivotal role **[23]**.

The aim of our study was to evaluate IUS compared to colonoscopy. IUS had a sensitivity of 83.6% and a specificity of 81.5% when compared to colonoscopy for detecting IBD. These findings are consistent with existing literature, underscoring the reliability of IUS as a diagnostic tool in IBD assessment.

A systematic review and meta-analysis by **Frias-Gomes** **[24]** reported that bowel US exhibited a sensitivity of 88% and specificity of 97% in diagnosing Crohn's disease, highlighting its high diagnostic accuracy.

Similarly, another meta-analysis by **Alshammari *et al.*** **[25]** focusing on the detection of colonic inflammation in IBD patients found that ultrasound had a sensitivity of 82% and specificity of 90%, further supporting its efficacy.

However, it is important to note that the diagnostic performance of IUS can vary depending on the specific segment of the bowel being examined. For instance, a study by **Sagami *et al.*** **[22]** indicated that ultrasound has higher diagnostic accuracy for detecting inflammation in the colon than in the rectum, with sensitivities of 86.4% for the colon and 74.5% for the rectum. This suggests that while IUS is a valuable tool for assessing IBD, its effectiveness may be influenced by the location of the disease within the gastrointestinal tract.

When comparing the diagnostic performance of IUS and colonoscopy using histopathology as the gold standard in our cohort, both modalities demonstrated a high diagnostic efficacy. Colonoscopy showed perfect sensitivity (100%) and a slightly higher overall accuracy (92.7%) compared to IUS, which had a sensitivity of 93.9% and accuracy of 90.2%. However, IUS outperformed colonoscopy in specificity (84.8% vs. 81.8%) and NPV (90.3% vs. 100%), while both had nearly identical PPV (90.2% for IUS vs. 89.1% for colonoscopy). The false positive rate was slightly lower for IUS (n=5) compared to colonoscopy (n=6), though colonoscopy had no false negatives, while IUS missed 3

histologically confirmed cases. Statistical comparison using McNemar's test revealed no significant difference in sensitivity or specificity between the two modalities. The overall agreement between IUS and histopathology was moderate, with a Cohen's κ of 0.63, indicating substantial concordance. These findings suggest that IUS, while not a replacement for colonoscopy, can serve as a highly reliable, non-invasive initial diagnostic tool, particularly in settings where endoscopy is unavailable or contraindicated.

These findings are aligned with the meta-analysis by **Malik *et al.*** [26] which synthesized data from 20 studies involving 1,094 IBD patients. The pooled sensitivity of BUS was 88.6%, specificity 86%, and overall diagnostic accuracy 66%, while PPV and NPV were 94% and 74%, respectively. Notably, small-intestine contrast-enhanced ultrasonography (SICUS) achieved even higher sensitivity at 97%. While the overall accuracy was slightly lower than our result (likely due to study heterogeneity and timing differences between BUS and endoscopy). However, the comparable sensitivity and specificity figures support our study's conclusion regarding the reliability of IUS in clinical practice. Furthermore, the higher accuracy and NPV in our study may be attributed to strict adherence to protocol, consistent use of >3 mm bowel wall thickness as a diagnostic threshold (as in 75% of Malik et al.'s included studies), and relatively short intervals between IUS and confirmatory colonoscopy/histopathology. Importantly, our study uniquely focuses on suspected IBD cases, whereas most meta-analyzed studies involved patients with established IBD—further validating IUS as a front-line diagnostic tool in early disease detection [26].

However, variability in IUS performance across centers has been documented. A prospective multicenter study by **Bove *et al.*** [18] involving 128 patients found that while IUS had a sensitivity of 65% and specificity of 80%, these values improved when stratified by operator experience, reaching 73.1% sensitivity and 89.7% specificity in the latter half of the study as trainees gained proficiency. The overall accuracy (AUC) rose from 0.67 to 0.81, indicating the impact of learning curves and experience in IUS performance. This suggests that while IUS can approach colonoscopy in diagnostic yield, operator skill and timing remain critical factors influencing its effectiveness.

Our findings demonstrated that intestinal ultrasound (IUS) positivity increased proportionally with the severity of inflammation in both ulcerative colitis (UC) and Crohn's disease (CD), and these results are in strong agreement with previously published data. Several studies have established IUS as a highly sensitive, non-invasive tool for assessing disease activity in inflammatory bowel disease (IBD), particularly in moderate and severe stages.

Calabrese *et al.* [17] and **Novak *et al.*** [27] reported that IUS sensitivity in UC ranged between 80% and 100%, with specificity between 70% and 95% when compared with endoscopic findings.

Bots *et al.* [28] similarly demonstrated a strong correlation between bowel wall thickness measured by IUS and the Mayo endoscopic score ($r = 0.94$, $p < 0.001$).

In CD, **Maaser *et al.*** [29] found sensitivity between 82% and 88% and specificities up to 97% for detecting active disease. In accordance with these findings, our study recorded a sensitivity of 87.5% for UC and 73.3% for CD, with IUS positivity reaching 100% among patients with severe diseases. This confirms that IUS performance improves with increasing inflammatory activity, supporting previous observations that IUS is a reliable and repeatable tool for evaluating disease severity and response to therapy in IBD.

Despite these similarities, some aspects of our results differ from previous reports and reflect methodological considerations.

Although our IUS sensitivity for UC lies within the range documented by **Maaser *et al.*** [29], the absence of a control group in our cohort prevented accurate estimation of specificity.

In contrast, **Panes *et al.*** [30] reported specificities of 85–90% for UC when both bowel wall thickness and color Doppler vascularity were considered. Furthermore, our lower sensitivity for CD (73.3%) compared with the 84–88% reported by Allocca et al. (2023) may be explained by the difficulty of detecting subtle mural changes in mild or early-stage disease.

Like observations by **Novak *et al.*** [27], our study suggests that IUS is more effective in identifying moderate-to-severe inflammation than minimal activity, where ultrasonographic findings may remain normal. Moreover, the absence of false-positive results in our series may overestimate specificity and likely reflect the limited sample size and inclusion of confirmed IBD cases only.

Previous multicenter trials, such as the TRUST study by **Bove *et al.*** [18] reported specificity ranging between 80% and 94% depending on disease segment and operator experience. Therefore, while our findings reinforce the diagnostic utility of IUS in active IBD, they also highlight the need for broader validation studies including non-IBD controls and standardized scoring systems to enhance diagnostic precision and reproducibility.

Lastly, this study provides a comprehensive, prospective evaluation of the diagnostic utility of intestinal ultrasound (IUS) compared to colonoscopy and histopathology in a cohort of 82 patients with clinically suspected inflammatory bowel disease

(IBD). A key strength lies in the structured and standardized diagnostic workup (including clinical examination, laboratory biomarkers, IUS, colonoscopy, and histopathology) all performed within a short time frame, minimizing inter-test variability. All ultrasound scans were conducted by experienced radiologists, enhancing the reliability of sonographic findings. Moreover, the study emphasized early detection, providing valuable data on the utility of IUS in newly suspected IBD cases, a relatively underexplored area in prior literature.

Despite its strengths, this study has certain **limitations**. **First**, it was conducted in a single tertiary care center, which may limit the generalizability of findings to community or rural settings. **Second**, the use of IUS remains operator-dependent, and performance may vary with examiner experience and equipment quality. **Third**, the sample size, although statistically adequate, may still be underpowered for subgroup analysis, particularly for rare complications like strictures and fistulas. Additionally, the lack of follow-up data limits our ability to assess the longitudinal utility of IUS in monitoring treatment response or disease progression.

Conclusion: This study highlights the high diagnostic performance of IUS in detection of IBD among patients with suspected symptoms. IUS showed excellent sensitivity (93.9%) and specificity (84.8%) when compared to histopathology, with substantial agreement with colonoscopy findings. These findings demonstrate the clinical utility of IUS as a non-invasive, readily accessible, and reliable tool in the early assessment of IBD.

Although colonoscopy remains the gold standard, our results suggest that IUS can be effectively used as a frontline diagnostic method, especially in resource-limited settings or when invasive procedures are contraindicated. The correlation between IUS, colonoscopy, and histopathology supports its integration into routine diagnostic pathways for IBD. Notably, the study's strength lies in its focus on suspected cases, providing real-world insight into IUS effectiveness in initial disease detection.

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