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Role of Contrast Enhanced Multidetector CT Enterography in Evaluation of Inflammatory Bowel Diseases

Mohammed Taha Abd-Elhak[1]; Ahmed Abdelsamie Mahmoud [2]; Fadila Mamdouh E Lsayed [3]; Zahraa Mahmoud Mohamed [4]

[1]Professor of Radiodiagnosis Radiodiagnosis Department, Alazhar University, Cairo, Egypt
[2]Assistantprofessor of Radiodiagnosis, Radiodiagnosis Department, Theodor Bilharz Institute, Cairo, Egypt.
[3]Assistant Professor of Radiodiagnosis Radiodiagnosis Department, Alazhar University, Cairo, Egypt
[4]Assistant Lecturer of Radiodiagnosis, Radiodiagnosis Department, Theodor Bilharz Institute, Cairo, Egypt.
Email: drzahraamahmoud@gmail.com

Abstract: Background: Computed tomography enterography (CTE) has become a main modality for the evaluation of inflammatory bowel disease (IBD). It non-invasively determines the extent of involvement, severity of disease, possible disease-related complications and extra-intestinal manifestations. Aim of the work: Was to highlight the role of contrast enhanced CT Enterography in evaluation of patient of patients of inflammatory bowel diseases. Materials and Methods: This study was done between July 2017 and June 2019 at Theodor Bilharz research institute & some private radiology centers in Cairo including 60 patients with inflammatory bowel diseases. Scan was performed on 256 Multislice CT scanners. Results: For Crohn's patients, 45 patients out of 50 (90%) showed signs of activity, while the other 5 patients (10%) were in the remission state (showed no signs of activity), 18 patients out of 50 (36%) showed complications and 15 patients (30%) showed extra-intestinal manifestations. For Ulcerative colitis, 9 patients out of 10 (90%) had active disease, 4 patients showed mild degree (44.4%), 3 patients with moderate degree (33.3%) and 2 patients showed severe form of the disease (22.2%). Conclusion: CT enterography can accurately assess the activity of inflammatory bowel disease, their activity, severity, possible complications perienteric & extra intestinal manifestations.

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Keywords: Computed tomography enterography, inflammatory bowel diseases, Crohn's disease, ulcerative colitis, activity, severity.

1. Introduction

Inflammatory bowel disease (IBD) is a group of idiopathic chronic inflammatory intestinal conditions. The two main disease categories are Crohn's disease (CD) and ulcerative colitis (UC), which have both overlapping and distinct clinical and pathological features. The pathogenesis of IBD is incompletely understood. Genetic and environmental factors play a role in the dysregulation of intestinal immunity, leading to gastrointestinal lesions [1]

Inflammatory bowel disease causes chronic inflammation and damage of GI tract leading to symptoms such as persistent diarrhea, abdominal pain, rectal bleeding, weight loss, fatigue and many other complications [2]

CT enterography is a well-established abdominal scan with a special protocol to assess the small bowel. It has become a valuable tool for evaluation of patients with bowel disorders [3]

It is based on the use of a combination of intra-venous contrast medium and large volumes of a neutral oral contrast in order to distend the intestinal lumen & allow imaging of the small bowel lumen, wall thickness and different patterns of enhancement [4]

CT enterography combine luminal imaging with an examination of extra-intestinal disease in a single study to detect associated pathology and complications [5]

Advantages of CT enterography include ease of performance, non- invasive and high resolution reconstructed images that surgeons and gastroenterologists are familiar with. Finally, the time of use of the CT room is less than 10 minutes, and the time from the moment the oral contrast is administered until the test is performed in less than two hours [4]

2. Materials and Methods:

This study was done between July 2017 and June 2019 at Theodor Bilharz research institute & private radiology centers in Cairo including 60 patients with inflammatory bowel diseases.

Inclusion criteria:

Patients diagnosed as inflammatory bowel disease.

Intestinal dilatation showed good results & did not affect assessment.

Patients with or without medical or surgical intervention.

Normal renal functions.

Exclusion criteria:

- Patients not proven pathologically & endoscopically as inflammatory bowel disease.
- Poor intestinal dilatation which affect assessment.
- Patients with renal impairment or patients with contraindication to iodinated contrast media.
- Patients having contraindication to exposure to ionizing radiation (pregnant females)

The CT machine:

Scan was performed on 256 Multislice CT scanners (Toshiba)

Patient position and preparation:

Patient was advised to consume liquid & semiliquid diet the day before the procedure. Patient must be fasting from food & drink at least 4 hours before exam. Theningested 5 % mannitol solution (about 1400 ml) orally for about 50- 70 minute (optimal terminal ileal distention time). Scanning was done from the top of the diaphragm to the lower edge of symphysis pubis using breath –hold technique. Tube voltage was 120 KV, Tube current 160-240 MA. CTE was done with patient supine, Images was acquired with a section thickness of 2.0–2.5 mm and a reconstruction interval of 1.0–1.5 mm displayed.

Injection of 100-150 cc of Iodinated IV low osmolar non-ionic contrast administration contrast media at rate 3-4 cc/sec by using high pressure syringe injection. CTE was performed during the enteric phase (45–50 s) after injection and the portal venous phase (70 s after injection). (Maximum peak small bowel wall enhancement occurs during the enteric phase (50 s post-contrast media injection)

Post processing was done by using a modern PACS and work station, usually we used axial and coronal reconstruction but sometimes we need sagittal reconstruction.

CTE interpretations:

Throughout all cases we checked.

The distribution and site of bowel involvement.

Disease activity (evident by mural thickening, hyper enhancement, mesenteric congestion (comb sign), and mesenteric lymphadenopathy)

Disease Severity.

Complications (e.g. strictures, fistulae, malignancy)

Extra intestinal manifestations. (Such as cholelithesis, hepaticsteatosis, nephrolithesis and sacroilitis)

Statistical analysis:

Data were statistically described in terms of mean, range, frequencies (number of cases) and percentages when appropriate.

3. Results

In our study we included 60 patients proven to have inflammatory bowel diseases (50 Crohn's disease & 10 ulcerative colitis) their age ranges from 15 to 74 years with the mean age 45 years (Disease duration from 1 month to 30 years). They were 34 females and 26males, all of them underwent CT enterography.

A: Crohn's disease:

Distribution according to site of bowel involvement: Table (1)

The lesions were located at different sites of the bowel and were more common at the distal ileum as well as ileo-cecal valve were involved in 36 patients (72%) as shown in **Table 1.**

Table (1): Frequency distribution of the studied Crohn's disease patients according to the area of bowel involvement:

Intestinal involvement	Studied Crohn's disease patients (n=50)	
	No.	%
Distal ileum with ilio-caecal valve involvement	36	72
Colon	10	20
Jejunum	6	12
Pylorus	2	4

Disease Activity:

In our study, 45 patients out of 50 (90%) showed signs of activity, while the other 5 patients (10%) were in the remission state (showed no signs of activity) as shown in **Figure (1)**

The Signs of activity in Crohn's disease are different including mucosal hyper enhancement, mucosal thickening, mesenteric congestion, and mesenteric lymphadenopathy. The distribution of the 45 Crohn's patients with signs of activity (according to the frequency and repetition of these signs) were as follow**: Table (2) and Figure (2)**

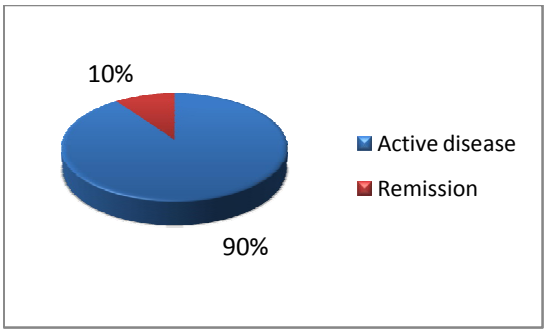

Figure (1) Pie chart shows frequency distribution of the studied Crohn's disease patients according to disease progression.

Table (2) Frequency distribution of the studied Crohn's disease patients with active disease according to signs of activity.

signs of activity	Studied Crohn's disease patients with active disease (n=45)	
	No.	%
Hyper enhancement	42	93.3
Mucosal thickness >3 mm	41	91
Mesenteric congestion (comb sign)	29	64.4
Mesenteric lymphadenopathy (short axis > 10 mm)	15	33.3

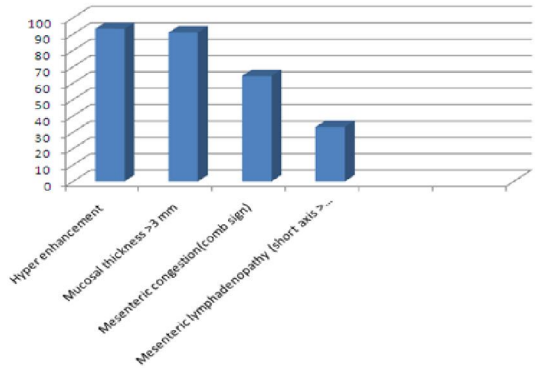

Figure (2); Column chart shows Frequency distribution of the studied Crohn's disease patients with active disease according to signs of activity.

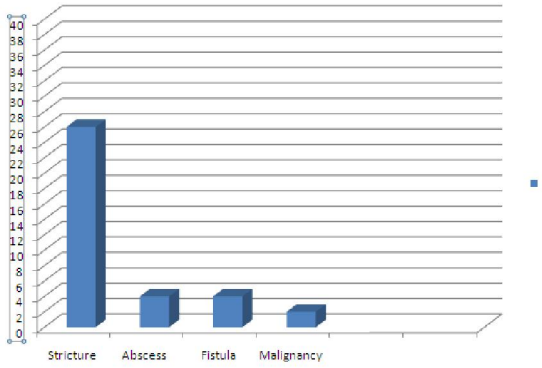

Figure (3): Frequency distribution of the studied Crohn's disease patients according to Complications

Disease complications:

Out of 50 Crohn's patients, 18 showed complications which were as showed in table (3) and figure (3)

Table (3) Frequency distribution of the studied Crohn's disease patients according to Complications:

Complications	Studied Crohn's disease patients (n=50)	
	No.	%
Stricture	13	26
Abscess	2	4
Fistula	2	4
Malignancy	1	2

Extra-intestinal involvement:

In our study 15 out of 50 (30 %) Crohn's patients showed extra-intestinal involvement. (6 with cholelithesis, 5 with hepatic steatosis, 3 with nephrolithesis and 1 with sacroilities)

B: Ulcerative colitis:

Distribution according to site of bowel involvement:

The lesions were located at different sites of the bowel and were more common at recto sigmoid in 6 patients (60%) as shown in **Table 4.**

Disease Activity:

9 patients out of 10 (90 %) had Active disease, while 1 patient (10 %) was operated with no post-operative recurrence **Figure (4)**

Table (4): Frequency distribution of the studied ulcerative colitispatients according to area of bowel involvement:

Intestinal involvement	Studied ulcerative colitis patients (n=10)	
	No.	%
Recto-sigmoid	6	60
Rectum only	2	20
Pancolitis	1	10
Small intestine	1	10

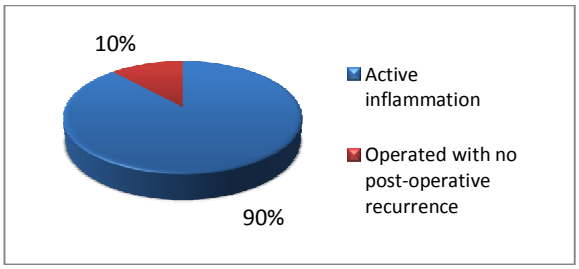

Figure (4): Pie chart shows frequency distribution of the UC patients according to disease progression

The Signs of activity in Ulcerative colitis include mucosal hyper enhancement, mucosal thickening, mesenteric lymphadenopathy and mesenteric hyperemia. The distribution of the 9 patients with signs of activity (according to the frequency and repetition of these signs) were as follow: **Table (5) and Figure (5)**

Table (5): Frequency distribution of the studied ulcerative colitis disease patients with active disease according to signs of activity:

Signs of activity	Studied ulcerative colitis disease patients with active disease (n=9)	
	No.	%
Mucosal hyper enhancement	9	100
Mucosal thickening	8	88.8
Mesenteric lymphadenopathy (short axis > 5 mm)	8	88.8
Mesenteric hyperaemia	4	44.4

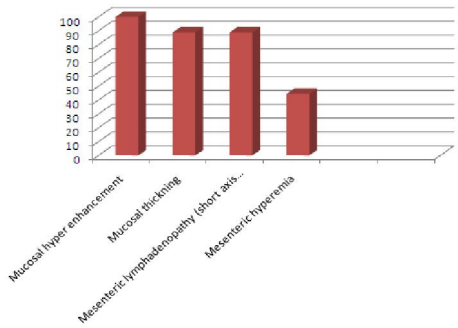

Figure (51): Column chart shows frequency distribution of the studied ulcerative colitis patients with active disease according to signs of activity

Case 1

Degree of severity of the disease:

The degree of severity in active nine patients were different based on cumulative CTE score described by **Jie et al.** [7] as shown in **Table (6)**

Table (6) Ulcerative colitis severity based on cumulative CTE score

Severity	Studied active ulcerative colitis patients (n=9)	
	No.	%
Mild	4	44.4
Moderate	3	33.3
Severe	2	22.2

Figure (6): CTE axial and coronal view showing Mural thickening and hyper enhancement of the distal ileal loops denoting active Crohn's ileitis

Case 2

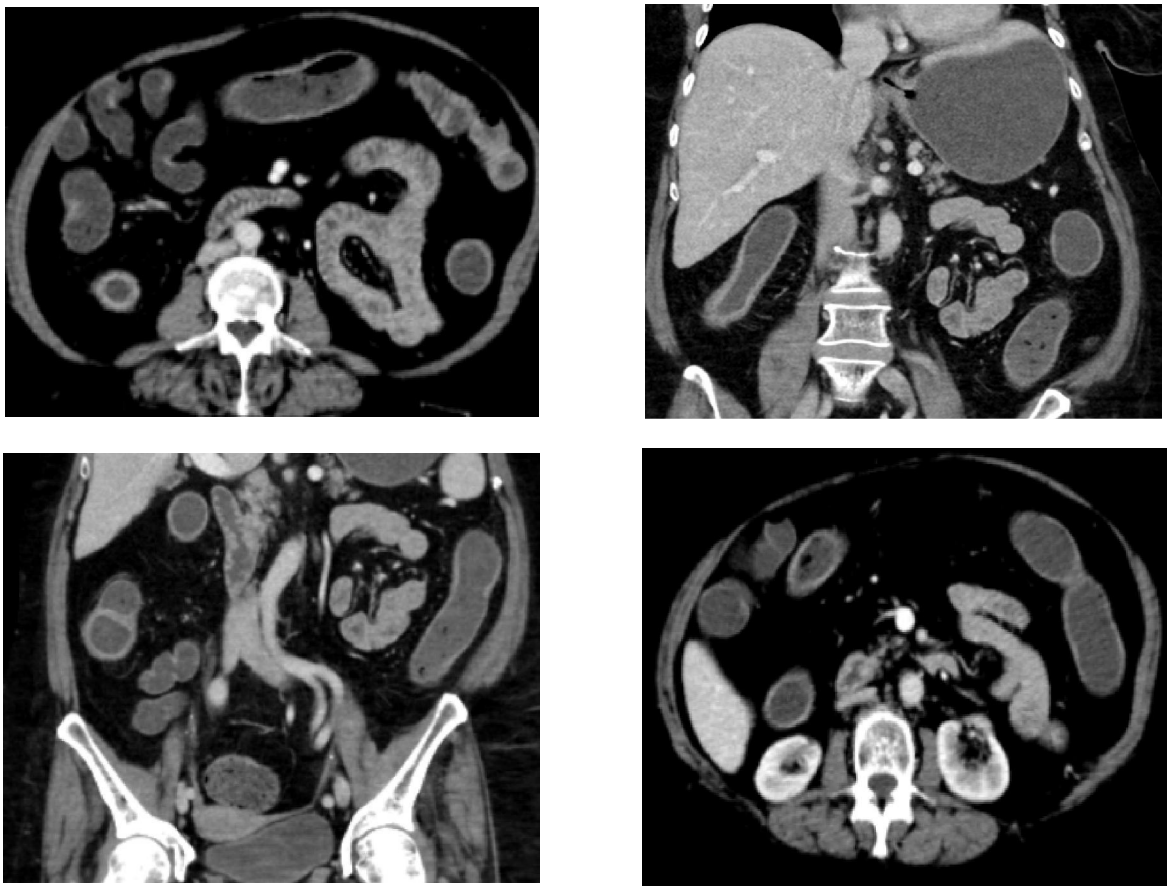

Figure (7): CTE axial & coronal views showing pan colic Ulcerative colitis with segments of mural thickening & segments of hyper enhancement

4. Discussion:

In our study we included 60 patients proven to have inflammatory bowel diseases (50 Crohn's disease & 10 ulcerative colitis) their age ranges from 15 to 74 years with the mean age 45 years (Disease duration from 1 month to 30 years). They were 34 females and 26males, all of them underwent CT enterography.

this disagree with **Chou et al**. [6] who made study on 190 patient with inflammatory bowel diseases and found that 80 (42%) were Crohn's & 110 (58 %) were ulcerative colitis and this disagreement may referred to our study had less number of patients & ulcerative colitis is mainly colonic disease so clinicians usually ask patients for endoscopy.

Crohn's disease:

Regarding the site of bowel involvement.

In our study which included 50 patients with Crohn's disease, there were:

36 patients with distal ileum as well as ileo-cecal valve involvement (72%). This relatively agree with **Mark et al.** [7] who revealed that approximately 80 % of patients have distal ileal involvement & disagree **Sherine et al**. [8] with who described ileal involvement percentage 44%, 10 patients with colonic involvement (20%). This agrees with **Mark et al**. [7] who revealed that approximately 20 percent have colonic involvement & also agrees with **Kim et al.** [9] who revealed that percentage of patient with colonic involvement was 19.2 % & also agrees with **Sherine et al.** [8] who described percentage of colonic involvement 20%, 6 patients with jejunal involvement (12%). This disagree with **Kim et al**. [9] who revealed that the patients with jejunal involvement were 2.7%, also disagreed with **Sherine et al**. [8] who described jejunal involvement 28 %, 2 patients with pyloric involvement (4%). This relatively agrees with **Kefalas** [10] who said that gastro duodenal disease occurs in 0.5% to 4% of all patients with Crohn's disease.

Regarding Disease Activity:

In our study, 45 patients out of 50 (90%) showed signs of disease activity (mural thickening, hyper-enhancement, congested mesenteric vessels 'comb sign' & mesenteric lymphadenopathy), while the other 5 patients (10%) were in the remission state (showed no signs of activity). This relatively agrees with **Jingyun et al.** [11] who reveals that (96 %) of the

patients included have active disease.

The distribution of the patients with signs of activity (according to the frequency and repetition of these signs) were as follow:

42 patients showed mucosal hyper enhancement (93.3%). This agrees with **Mona & Rasha** [12] who informed that 21 patients out of 23 shows mucosal hyper enhancement (91%).

41 patients showed mucosal thickness more than 3 mm (91%), this relatively agrees with **Mona & Rasha** [12] who informed that mucosal thickening seen in 86 % of patients.

29 patients with mesenteric congestion (64.4%). this agree with **Jingyun et al**. [11] who found 32 patient from 49 shows mesenteric hypervascularity (65 %).

15 patients with mesenteric lymphadenopathy (33.3%). which is relatively agreed with **Jingyun et al.** [11] who described that from 25 patients only 7 cases shows lymphadenopathy short diameter were beyond 10 mm (28%) & agreed with **Mona & Rasha** [12] who informed that 7 patients out of 23 shows nodal enlargement (30%).

Regarding Disease complications:

Out of 50 Crohn's patients, 18 showed complications which were as follow.

13 patients with strictures (26 %) which agrees with **Rieder et al.** [13] who informed that incidence of stricture in patient with Crohn's disease (11 - 50 %) which increases with prolonged disease duration.

2 patients with Abscesses (4%), this agrees with **Jingyun et al. [**11] who found that 1 patient out of 49 complicated with abscess (2%)

2 patients with Fistulae (4%), this agree with **Jingyun et al**. [11] who revealed that 2 patients out of 49 complicated with fistulae (4.8%), disagree with **Gecse et al**. [14] who revealed than 17% of patients have fistulae, disagree with **Rieder et al**. [13] who informed that incidence of fistula occurrence 16%.

1 patient with malignant transformation (2%). this relatively agrees with **Freeman** [15] who reported bowel cancer in 8 of 449 patients with Crohn's disease, or about (1.2%) & disagreed with **Kappelman et al**. [16] who did study on 13756 Crohn's patient out of them only 772 cases have cancer (5.6%) this may be referred to our study has less number of patients.

Regarding extra-intestinal involvement:

Out of 50 patient, 15 patients (30%) have extra intestinal involvement (6 with cholelithesis, 5 with hepatic steatosis,3 with nephrolithesis and 1 with sacroilities) this agrees with **Rothfuss et al.** [17] who reported that frequency of Extra intestinal involvement in patients with IBD varies from 6%-47%, this disagree with **Jingyun et al.** [11] who experienced 25 out of 49 extraintestinal involvement (50%)

Ulcerative colitis:

Radiological testing in UC can be used as an alternative to endoscopic assessments, when tissue acquisition is not needed, providing data on disease activity, extent and severity.

In patients with UC, an exhaustive evaluation of disease extent and activity is crucial for therapeutic decision-making.

In our study we had 10 patients with ulcerative colitis.

Regarding the site of bowel involved by the disease:

The patients were divided according to the site of bowel involved as follow.

- 6 patients with descending & sigmoid colon involvement (60%).
- 2 patients with rectal involvement (20%).
- 1 showed Pancolitis (10%).
- 1 patient with Small intestine involvement (10%).

Regarding the disease activity:

9 patients out of 10 (90 %) had Active disease, while 1 patient (10 %) was operated with no post-operative recurrence, this relatively agrees with **Mona & Rasha** [12] who informed that 3 out of 3 patients shows active disease. (100%)

The signs of activity were as follow.

- 9 patients showed mucosal hyper enhancement (100%)
- 8 patients showed mucosal thickness more than 3 mm (88.8%)
- 8 patients with mesenteric lymphadenopathy (88.8%)
- 1 patient with mesenteric hyperemia (44.4%)

Our results in signs of activity percentage agree to a great extent with **Jie et al.** [18] who made study on 46 patients found that 93 % of their patients have mucosal hyper enhancement, and 93%, mural thickening, and 50% had mesenteric hyperaemia.

But we disagreed with him regarding the percentage of patients with lymphadenopathy, as their study demonstrated that 41 % only of their patients found have mesenteric adenopathy but ours were 88.8%.

****Regarding the Degree of disease severity:**

The degree of severity in active nine patients was different based on cumulative CTE score described by **Jie et al**. [18] as follow:

- 4 patients showed mild degree (44.4%).
- 3 patients with moderate degree (33.3%).
- 2 patients showed severe form of the disease (22.2%).

Cumulative CTE score is a new potential predictor for severity of active ulcerative colitis patients.

A cumulative CTE severity score (0–15 points) was calculated as the sum of all individual criteria scores. The cumulative CTE scores for mild, moderate and severe groups were 4.9 ± 2.3, 7.6 ± 2.6, and 10.9 ± 2.0.

In our study we have 9 patients with active disease with the following cumulative CT score 3 patients with score 5, 1 patient with score 3, (4 patients within mild zone) (44.4 %) this disagree with **Jie et al.** [18] who described that 17% of cases were mild cases (10 patients out of 46) this may be caused by the difference in sample size., 2 patient with score 8, 1 patient within score 10 (3 patients within moderate zone) (33.3 %) this agree with **Jie et al.** [18] who made study on 46 patients and found that 17 patient is seen within moderate zone (36%) & 2 patients within score 11 (2 patient within sever zone) (22.2%) this disagree with **Jie et al**. [18] who described that 41% of cases were sever cases this may be caused by the difference in sample size.

His study is agreed with our study in the percentage of moderate disease but disagreed in the mild & sever disease forms, this may be caused be the smaller sample we used (we had 9 patients with active disease while he had 46 patients)

Conclusion:

CTE is readily available and easy to perform. It makes it possible to determine the extent and stage of progression of inflammatory bowel disease, extra-intestinal involvement and potential complications. The combination of a short examination time, a single breath hold, accessibility, good imaging quality, and multidirectional display of lesions and mesenteric vascular conditions.

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