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CT ENTEROGRAPHY IN SMALL BOWEL DISORDERS -IS IT WORTH THE TROUBLE?

Radio-Diagnosis

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ABSTRACT

Computed tomographic (CT) enterography has emerged as useful diagnostic tool for evaluation of small bowel disease. It provides a superior evaluation of the bowel lumen, entire thickness of the bowel wall and also assesses extra-intestinal pathology, giving a more complete picture of the disease than standard contrast enhanced CT of the abdomen. This article explores the diagnostic utility and role of CT Enterography in detecting inflammatory, neoplastic, vascular, and infectious pathologies of the small intestine. Emphasis is placed on CTE's application in inflammatory bowel disease (IBD), particularly Crohn's disease, where it provides detailed assessment of mural and extramural disease, disease extent, activity, and complications such as strictures, fistulas, and abscesses. This study evaluated the role of CT enterography in detection of various small bowel pathologies and found that the correlation between CT enterography and final diagnosis was significant with p value< 0.001. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of CT Enterography were found to be 97.62%, 84.62%, 95.35%, 91.67% and 94.45% respectively. Despite concerns regarding ionizing radiation and the need for patient compliance with oral contrast intake, the benefits of CTE—such as its wide availability, speed, and ability to concurrently evaluate extraintestinal structures—make it a valuable tool in clinical practice. The article concludes that while CTE may not replace other diagnostic approaches in all settings, its comprehensive diagnostic capabilities justify its use in majority of patients suspected of having small bowel pathology.

KEYWORDS

CT Enterography, Small bowel, Crohn's, Carcinoid, Ileocaecal TB

INTRODUCTION

The small bowel is part of intestine between the stomach and the large bowel and includes the duodenum, jejunum, and ileum. The stomach and duodenum can be assessed by upper GI endoscopy and large bowel can be studied by colonoscopy, studying small bowel is technically challenging since the organ is long and winding. The conventional CECT abdomen does not provide enough information to study the small bowel adequately due to lack of small bowel distension. Recent advent of Capsule endoscopy has emerged as alternative small bowel imaging technique but is time consuming and not easily available. It has its own drawbacks such as capsule obstruction by bowel strictures, providing false-negative results due to rapid peristalsis at a lesion site or if there is bowel angulation at a lesion that impairs the camera view, and equivocal results in the presence of excess luminal fluid [1]. Computed tomographic (CT) enterography has emerged as useful diagnostic tool for evaluation of small bowel disease in recent times [2]. It provides a superior evaluation of the entire thickness of the bowel wall and also assesses extra-intestinal pathology, giving a more complete picture of the degree and severity of the disease [3]. The aim of this study was to evaluate the role of CT enterography in detection of various small bowel pathologies and to determine the sensitivity, specificity, and predictive value of CT enterography.

Subjects And Methods

- **Setting** - The study was conducted at the department of Radiodiagnosis and Imaging of a tertiary care hospital and teaching institution.
- **Study Design-** Prospective Observational Study
- **Study Population-** The study included all patients clinically suspected to have small bowel pathology who were referred for CT enterography.
- **Study Period-** This study was conducted for a period of 2 year, starting from Sep 2020 to Sep 2022.
- **Ethical Clearance**- Received from Institutional Ethical Committee of Base Hospital and Army College of Medial Sciences Delhi Cantt, letter no IEC/08/2020/12 dt 02 Sep 2020.
- **Inclusion Criteria**- Patients suspected to have small bowel disease based on detailed history, clinical examinations and relevant investigations.
- **Exclusion Criteria**
- Patients who were not willing to give consent to participate in the study
- Already diagnosed cases of small bowel disease on follow up
- Pregnant females
- Patients Allergic to contrast agent
- Patients with deranged Renal function.

CT Technique- Bowel preparation was done using low residue diet, fluids on the day prior to the examination and fasting for 6 hours before the CT study. Mannitol at room temperature was used as neutral enteral contrast agent. 300 ml mannitol was added to 1200 ml water to make 1500 ml solution. Patient was asked to drink 450 ml solution every 15 minutes to deliver continuous oral infusion over a period of 45 minutes. Remaining 150 ml of solution was given on CT table. 1ml/kg body weight of 300mg/ml of nonionic contrast medium (Iohexol) was be given IV @ 3ml/sec followed by saline chase of 20ml. All scans were performed on 16- Slice Siemens Somatom Emotion CT machine. Imaging was done in the enteric phase i.e the delay between the start of contrast material administration and the start of helical scanning was 60 seconds. Supine non contrast and single-phase images were obtained from the domes of the diaphragm to the lower margin of the symphysis pubis during a single breath hold. Arterial Phase images were obtained in a few cases where clinically indicated. Reformatted images were obtained in the coronal and sagittal plane.

- **Image Analysis**

All images were specifically evaluated for the following parameters

- Degree of small-bowel luminal distension
- Presence of focal or diffuse bowel wall thickening
- Small-bowel narrowing /stenosis
- Small-bowel masses
- Mesenteric stranding
- Mesenteric lymph nodes
- Peritoneal/visceral deposit
- Enhancement pattern

Small-bowel thickening was considered to be present if the thickness of the bowel wall was greater than 3 mm in at least two planes. Enhancement pattern of bowel wall was characterized as Target attenuation (water or fat), White and Grey attenuation. Diagnosis was confirmed using clinical/surgical/ histopathological examination findings and post treatment follow up findings as reference standard wherever relevant.

- **Statistical Analysis**

Statistical analysis was performed by the SPSS program for Windows, version 28.0. Continuous variables were presented as mean ± SD, minimum-maximum values and categorical variables were presented as absolute numbers and percentage. Categorical variables were analyzed using either the chi square test or Fisher's exact test. Sensitivity, specificity, PPV, NPV was calculated to analyze the diagnostic accuracy of CT Enterography. For all statistical tests, a p value less than 0.05 was taken to indicate a significant difference.

Informed Consent

Informed consent was taken from patients and permission from Institutional Ethical committee was obtained for the study. Identity of patients was kept confidential.

RESULTS

During the study period, 55 cases underwent CT enterography out of which 33 (60%) cases were males and 22 (40%) cases were females. Mean age of patients was 48.04 ± 16.887 with youngest patient 16 years old and oldest 81 years old. Small bowel wall thickening was absent in 19 (35%) cases and was either focal 14 (25%), diffuse 8 (15%), or segmental 14 (25%) in rest of the cases. Symmetrical wall thickening was seen in 27 (49%) cases and asymmetrical wall thickening was seen in 9 (16%) cases. Homogeneous enhancement (White attenuation) was seen in 17 (31%) cases, heterogeneous enhancement (Grey attenuation) was seen in 1 (2%) Case, target appearance with water attenuation was seen in 15 (27%) cases. Target appearance with fat attenuation was seen in 3 (5%) cases (Table 1). The extraluminal CT features seen were abdominal lymphadenopathy in 15 (27%) cases, prominent Vasa Recta in 13 (24 %) cases, Ascites in 4 (7%) cases, small bowel stricture in 3 (5%) cases and fistula in 2 (4%) cases (Table 2). Additional findings seen were right iliac fossa abscess in 01 case, active extravasation of contrast in the lumen of distal ileum in 01 case, clumping of bowel loops in 08 cases, deformed pulled up caecum in 01 case, wall thickening with aneurysmal dilatation of small bowel in 03 (5%) cases (Table 3). CT enterography diagnosed active bleed in Distal Ileum in 2% cases, Carcinoid in 5% cases, Crohn's disease in 24% of cases, Ulcerative Colitis in 9% of cases, small bowel gastrointestinal tumour (GIST) in 7% of cases, neoplastic small Bowel Thickening in 7% of cases, Ileal Lymphoma in 5% of cases, Ileocaecal TB in 13% of cases, Typhlitis in 2% of cases, regional Ileitis in 4% of cases (Table 4). The correlation between CT enterography and final diagnosis was found to be significant with p value <0.001. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) and accuracy of CT enterography was found to be 97.62%, 84.62%, 95.35%, 91.67%, and 944.55% respectively (Table 5).

DISCUSSION

CT enterography is a non-invasive imaging technique for evaluation of small bowel that is fast, easy to perform, and accurate in detecting not only small bowel pathology but also providing information if its surroundings.

A total of 55 patients were enrolled in the study with mean age of the patients 48 years. M:F ratio was 1.5:1. Misra RN et al conducted a similar study where they found that mean age of the patients was 31 years as compared to 48 years in our study [4].

Small bowel wall thickening can be symmetrical or asymmetrical. Symmetrical wall thickening is usually attributed to benign conditions such as inflammatory, infections, bowel oedema and ischemia. Asymmetrical wall thickening is often seen in neoplastic etiology and sometimes in Crohn's disease. Symmetrical bowel wall thickening was present in 49% of cases whereas 16% cases had asymmetrical bowel wall thickening. In this study all cases of inflammatory bowel disease showed symmetrical wall thickening. The various patterns of enhancement include white attenuation, grey attenuation, water target and fat target appearance. White attenuation was seen in 17 (31%) of our cases, grey attenuation was seen in 1 (2%) case, water target appearance was seen in 15 (27%) cases and fat target appearance was seen in 3 (5%) of cases (Table 1). The White attenuation is seen in acute inflammatory bowel disease (Fig 1), shock bowel due to injury to intramural vessels, bowel wall hemorrhage in cases on anticoagulation (Fig 2). Water target appearance cab be seen in acute cases of Crohn's disease, ulcerative colitis, infections, portal hypertension and ischemia (Fig 3). Fat target sign appearance is due to submucosal fat deposition in bowel wall, the commonest cause of which is obesity but submucosal fat deposition is also seen in cases of chronic Crohn's disease and ulcerative colitis (Fig 4).

The extraluminal features were seen in vast majority of patients. Abdominal lymphadenopathy was seen in 15 (27%) cases. Prominent Vasa Recta was seen in 13 (24%) cases (Table 2). Abdominal lymphadenopathy was noted in 43% of the patients in a study by Misra RN et al [4]. In a recent study by Ali RMM et al, it was observed that engorgement of vasa recta was seen in 76% of the patients [5]. Ascites, Strictures (Single/Multiple) and fistula were present in smallest subset of patients i.e., 7%, 5% and 4% patients respectively (Table 2). Strictures are common in Crohn's disease and 25% of patients with Crohn's disease develop at least one small bowel stricture (Fig 5) which can lead to significant complication [6]. One of the major advantages of CT enterography over other imaging modalities such as Barium studies and capsule enterography, is its ability to show the extraluminal findings. Mesenteric blood vessels should be evaluated to exclude arterial or venous thrombosis. Mesenteric or retroperitoneal lymphadenopathy can give significant inkling to the presence of underlying diseases. It is well known that in intestinal tuberculosis the lymph nodes have a low attenuating centre due to caseation, while in neoplasia and Crohn's disease the nodes are usually of soft tissue density [7].

Multiple additional findings were also seen which aided in reaching specific diagnosis in a large number of patients. It was observed that 2% of the patients had abscess near terminal ileum, active extravasation of contrast in distal ileum suggestive of intestinal bleed and deformed pulled up caecum. Approximately 5 % of gastrointestinal bleeds come from small bowel (Fig 6). Arteriovenous malformation account for 30 % cases and is the commonest cause followed by ulcers, polyps, Crohn's disease and tumors. Clumping of jejunal loops with wall enhancement was seen in 8 (15%) cases (Table 3). 03 (5%) cases had wall thickening with aneurysmal dilatation of small bowel (Table 3).

Based on the findings of CT Enterography, it was observed that nearly one-fifth of the patients were found to be normal (22%). In one-fourth of the patients (24%), Crohn's disease was diagnosed. A lowest percentage (2%) of the patients had active bleed distal ileum. A diagnosis of Small Bowel Thickening-of Neoplastic etiology and GIST was given in 7% patients. 13% patients were diagnosed with Ileocecal TB, 4% of the patients had Regional Ileitis, 9% of the patients were diagnosed as Ulcerative Colitis (Table 4). Ileocecal tuberculosis is the most common site of gastrointestinal tuberculosis the CT features of which include circumferential wall thickening of terminal ileum and caecum, thickening of ileocecal valve, and mesenteric adenopathy (Fig 7). In 5% of the patients, Carcinoid and Ileal Lymphoma was given as diagnosis.

After follow up, final diagnosis was reached and it was observed that the sensitivity and specificity of CT enterography was 97.62% & 84.62%. Positive predictive value, negative predictive value, and accuracy of CT enterography in this study was 95.35%, 91.67%, and 94.55% respectively. Husam HM et al in their study found sensitivity and specificity to be 93.88% and 85.71%, and positive predictive and negative predictive value to be 95.83% and 80 % respectively [8] which is nearly similar to the findings in this study.

CONCLUSION

Computed tomographic Enterography has established itself as a useful diagnostic tool for accurate and efficient evaluation of pathology arising from the small bowel wall due to its ability to not only delineate the lumen and wall of the bowel but also its surrounding areas which at times may hold clue to the diagnosis. CT is widely available, fast, relatively cheaper, and fairly accurate as was demonstrated in this study. Therefore, it is suggested that CT enterography may be routinely used for work up of small bowel diseases where cross section imaging is warranted.

Tables

Table 1: Small bowel wall Enhancement pattern (original)

Enhancement Pattern	Cases	%
Homogeneous (White attenuation)	17	31%
Heterogeneous (Grey attenuation)	1	2 %
Target Appearance, Fat Attenuation	3	5%
Target Appearance, Water Attenuation	15	27%
Absent Bowel wall thickening	19	35%
Total	55	100%

Table 2: Extraluminal Features seen in CT Enterography cases (original)

Extraluminal Features	Cases	%
Abdominal Lymphadenopathy (Mesenteric/ retroperitoneal/ perirectal)	15	27%
Prominent vasa recta	13	24%
Ascites	4	7%
Strictures	3	5%
Fistula	2	4%

Table 3 : Additional findings seen in CT Enterography (original)

Additional findings	Cases	%
Right Iliac fossa abscess	01	2%
Active extravasation of contrast in distal ileum	01	2%
Deformed pulled up caecum	01	2%
Clumping of jejunal loops with wall enhancement	08	15%
Wall thickening with aneurysmal dilatation of small bowel	03	5%

Table 4: Diagnosis on CT Enterography (original)

CT Enterography Diagnosis	Frequency	%
Active Bleed Distal Ileum	1	2%
Carcinoid	3	5%
Crohn's disease	13	24%
Ulcerative Colitis	5	9%
GIST	4	7%
Neoplastic small Bowel Thickening	4	7%
Ileal Lymphoma	3	5%
Ileocaecal TB	7	13%
Typhlitis	1	2%
Regional Ileitis	2	4%
Normal	12	22%
Total	55	100%

Table 5: Correlation between CT Enterography Diagnosis and Final Diagnosis (original)

CT Enterography	Final diagnosis			P value
	Positive	Negative	Total	
Positive	41 (74.5%)	2 (3.6%)	43(78.2%)	<0.001
Negative	1 (1.8%)	11(20%)	12(21.8%)	
		Total	55 (100%)	
Sensitivity	97.62%			
Specificity	84.62%			
Positive Predictive Value	95.35%			
Negative Predictive Value	91.67%			
Accuracy	94.55%			

Figure Legends

Fig 1 – Showing noncontiguous symmetrical white attenuation bowel wall thickening in ileal loops (arrow) (1a & b) and in ascending and descending colon (1c & d) (bold arrows) in a case of Crohn's disease.

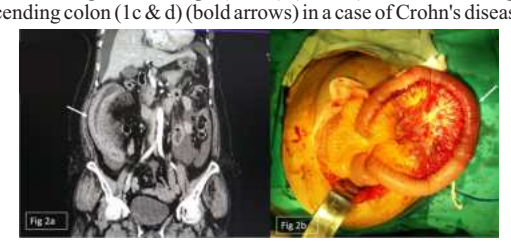

Fig 2 (a & b)- White attenuating bowel wall thickening (arrow) in a 62-year-old lady on anticoagulants, also note hyper attenuation of adjacent mesentery (Fig 2a). Per Op image showing hemorrhage in the long segment of jejunal loop and the adjacent mesentery (arrow) (Fig 2b).

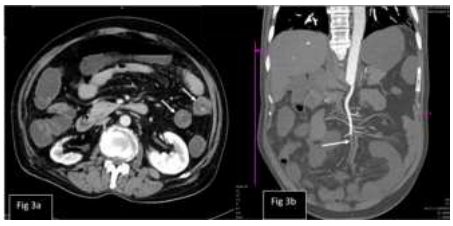

Fig 3 (a &b) Axial & Coronal images- Arterial and portal phase CT enterography shows water target sign in small bowel (arrows) (Fig 3a) due to thrombosis of distal superior mesenteric artery (arrow) (Fig 3b).

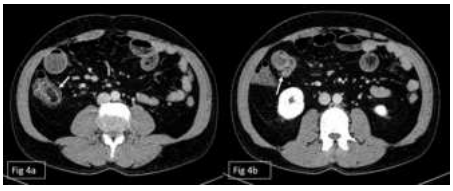

Fig 4 (a &b)- Axial CT images showing submucosal deposition of fat in small bowel loops giving fat target appearance (arrows) in a case of chronic Crohn's disease.

Fig 5 – Axial CT shows short segment narrowing of small bowel loop (arrow) consistent with stricture in a case of Crohn's disease.

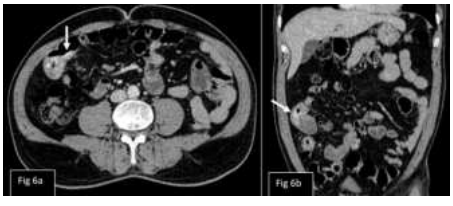

Fig 6- Axial & Cor CT images- showing leakage of contrast in the lumen of ileum (arrow) in a case of GI bleed.

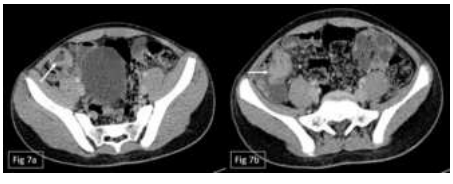

Fig 7a &b- Axial CT image – Showing circumferential enhancing wall thickening of terminal ileum (Fig 7a) and ileocaecal valve (Fig 7b) (arrows) in case of ileocaecal tuberculosis.

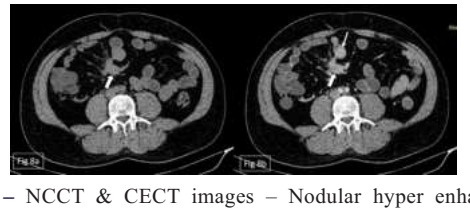

Fig 8 – NCCT & CECT images – Nodular hyper enhancing intraluminal lesion seen (Fig 8b) (arrow) in small bowel lumen with stellate shaped enhancing mesenteric scar (Bold arrow) in case of Carcinoid.

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