

Original Research Article

Role of CT enterography in evaluation of small bowel disorders

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ABSTRACT

Background: Small bowel pathologies are an enigma for clinicians and difficult to assess and evaluate for clinicians. In order to establish the efficacy of MDCT Enterography in diagnostic characterisation of small bowel lesions, the current study was undertaken.

Methods: A prospective observational cross-sectional study was carried out in a tertiary care hospital. 30 patients with clinically suspected small bowel disease underwent CT enterography using iso-osmotic mannitol as neutral enteral contrast. CT enterography diagnoses were compared with clinical, surgical and histopathological results.

Results: CT enterography showed a sensitivity (95.83%), specificity (100%), positive predictive value (100%), negative predictive value (85.71%), accuracy (96.66%) in diagnosis of small bowel diseases.

Conclusions: CTE is a non-invasive well tolerated and reliable imaging modality for the depiction of small-bowel diseases. It provides excellent visualization of luminal, mural and extraintestinal findings.

Keywords: CT Enterography, Enterography, Small Bowel Disorders

INTRODUCTION

The mesenteric small intestine remains the only gastrointestinal tract segment for which diagnostic study is not principally dependent on endoscopic viewing. Since radiologists assume primary responsibility in the diagnostic evaluation of the small bowel, it is essential that methods capable of accurately demonstrating small bowel morphology are appropriately applied. Jacob Gersham Cohem introduced combination of air and simple water suspension of barium sulphate through duodenal tube to produce double contrast effect that was termed enteroclysis barium contrast studies and enteroclysis, in particular, were the mainstay of small bowel imaging in the past.¹

Cross sectional imaging of the small bowel (CT and MRI) offer distinct advantages over fluoroscopic barium examination including depiction of the intraluminal pathologies, entire bowel wall and extra intestinal

manifestations coupled with the advantage of multiplanar imaging. Computed Tomographic Enterography (CTE) combines the improved spatial and temporal resolution of MDCT with neutral oral contrast and intravenously administered contrast material, thus permitting excellent assessment of the small bowel wall and lumen.

Luminal distension comparable to enteroclysis can be achieved with oral hyperhydration, thereby obviating nasoenteric intubation and making CT Enterography a useful, well tolerated study.² The present study aims to assess the feasibility and usefulness of CT enterography with orally administered iso-osmotic mannitol as neutral oral contrast in demonstrating small bowel diseases.

METHODS

The prospective study was carried out in the Department of Radiodiagnosis in collaboration with Department of Surgery, over a period of two years (2015-2017).

Inclusion criteria adult patients with clinically suspected small bowel disease were included in the study. A patient not consenting for imaging study as protocol, contraindication to contrast enhanced CT i.e. allergy to intravenous iodinated contrast media, pregnancy, hemodynamic instability, renal failure, inability for sufficient breath hold, acute high-grade intestinal obstruction/ perforation and acute intestinal infections are excluded.

Included 30 adults presenting with clinically suspected small bowel disease. They comprised of 14 male and 16 female patients of age ranged from 16-70years with a mean age of 31.03years. Most patients belonged to the 21-30years age group.

Procedure

Bowel preparation was done using low residue diet, ample fluids, laxative on the day prior to the examination and nothing by mouth on the day of the examination. Iso-osmotic mannitol at room temperature was used as neutral enteral contrast agent. 20% of 450ml mannitol diluted with enough plain water to make 1500ml. Patient was asked to drink solution every 5minutes to deliver continuous oral infusion over a period of 50minutes. An antispasmodic agent (Inj. buscopan 20mg IV) was given intravenously before CT acquisition. Thereafter, patient was taken up for CT scanning. 100-120ml of non-ionic iodinated contrast media was injected intravenously through a 20-gauge cannula at a rate of 4.5ml/sec.

Philips Brilliance™ 40-slice multidetector CT scanner was used. 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 50seconds. Images were obtained from the domes of the diaphragm to the lower margin of the symphysis pubis during a single breath hold. Reformatted images were obtained in the coronal plane. Both axial and multiplanar reformatted images were originally viewed with the standard window level (60HU) and width setting (360HU).

All images were specifically evaluated for the following parameters

- The degree of small-bowel luminal distension,
- The 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 3mm in at least two planes. Small-bowel stenosis was considered

to be present if segmental narrowing of the bowel lumen could be seen on at least two planes. A small bowel mass was considered to be present if a flat, sessile, pedunculated or polypoidal structure could be identified on at least two planes and could be differentiated from small bowel folds.

Visceral metastasis was considered to be present if nodules were identified within the peritoneal cavity or hypodense lesions were identified within the liver. Mesenteric stranding was considered to be present if an infiltration of the mesenteric fat was observed. An enlarged mesenteric lymph node was considered to be present when a lymph node was greater than 10mm in short-axis diameter. A lymph node was considered necrotic if there was peripheral enhancement associated with central hypodensity.

Enhancement pattern of bowel wall was characterized as hyperenhancement or mural stratification. Diagnosis was confirmed using clinical/surgical/ histopathological follow up findings as reference standard wherever relevant. Standardized statistical methods were used for the final analysis. The sensitivity, specificity, accuracy, positive and negative predictive value of CT enterography were calculated.

RESULTS

There were 14 male and 16 female patients in the study. Age ranged from 16-70years with a mean age of 31.03years. Most patients belonged to the 21-30years age group. Overall, abdominal pain was most common presentation (76.66%), followed by sub-acute intestinal obstruction (53.33%) and anorexia (53.33%). Optimal distension of the ileal loops was achieved in 28 patients (93.33%) and that for the jejunal loops was achieved in 22 patients (73.33%). The optimal distension of jejunioileal loops is shown in Figure 1.

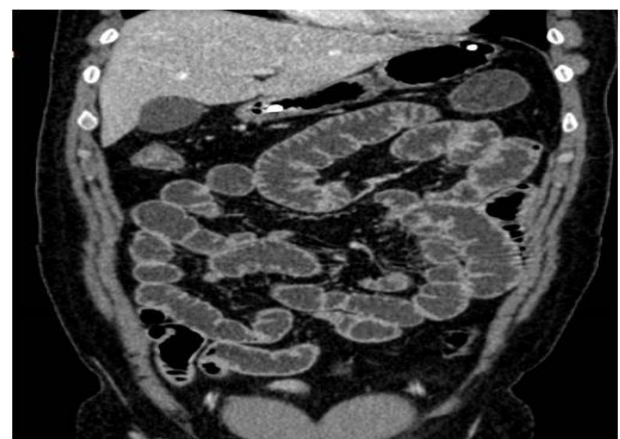


Figure 1: Optimal distension of the jejunio-ileal loops.

Multidetector CT enterography findings are shown in Table 1. CT enterography demonstrated findings suggestive of abdominal tuberculosis in 14 out of 30

patients (46.66%). Small bowel involvement was seen in all the patients (n=14). Additional large bowel involvement was seen in 4 patients. The involved segments of bowel showed circumferential wall

thickening (n=11), hyperenhancement (n=14), matting of bowel loops (n=1), strictures (n=12). A total of 28 strictures were demonstrated measuring 7-13mm in thickness with a mean thickness of 9.4mm.

Table 1: MDCT enterography findings: gastro-intestinal tract.

Bowel thickening	Wall characterization	Stricture/ stenosis	No. of strictures	Level of involvement	Remarks
+	Hyper enhancing	+	1	Ileum	-
-	-	-	0	Jejunum and Ileum	Multiple small bowel polyps
+	-	-	0	Duodenum	Luminal and extraluminal mass
+	Hyper enhancing	+	3	Ileum, IC junction	-
-	-	-	0	-	-
+	Hyper enhancing mural stratification	+	3	Ileum, IC junction, caecum	Enteroliths also +
+	Hyper enhancing bowel within bowel +	+	2	Jejunum and Ileum	Intussusception also +
+	Hyper enhancing,	+	3	Ileum, IC junction, caecum	-
-	-	-	0	-	-
+	Hyper enhancing	+	3	Ileum, I-C	Dilated bowel loops
-	-	-	0	Ileum, I-C	Enteroliths +
+	Hyper enhancing mural stratification	+	2	Jejunum, Ileum IC Junction	Dilated bowel loops
+	Mass lesion from caecal wall	-	0	Caecum, terminal ileum	-
-	Intraluminal mass	-	0	Ileum	Intussusception also +
+	Hyper enhancing	+	2	Ileum, IC junction, caecum, Asc colon	Fistula, Enteroliths, dilated bowel loops with small bowel faeces sign.
+	Hyper enhancing	-	0	Ileum, IC junction	Localised form of sclerosing encapsulating peritonitis, dilated bowel loops
-	Intraluminal mass	-	0	Jejunum	Polyps
-	-	-	0	-	-
+	Hyper enhancing intraluminal mass	-	0	Ileum	-
+	Hyper enhancing	+	2	Ileum, IC junction, duodenum	-
+	Hyper enhancing	+	1	IC junction, caecum	Enteroliths
-	Intraluminal mass	-	-	Gastric	-
+	Hyper enhancing	+	1	Ileum, IC junction	-
-	Intraluminal mass	-	0	Jejunum	-
-	-	-	0	-	-
+	Hyper enhancing	+	1	Ileum, IC junction	Dilated bowel loops
-	-	-	0	-	-
-	-	-	0	-	-
-	-	-	0	Ileum	Dilated bowel loops, enterolith
+	Hyper enhancing stratification	+	2	Ileum	Mesenteric hypervascularity

Figure 2 depicts small wall enhancement and thickening in tubercular stricture. Strictures were seen in the Ileocaecal junction (n=12), ileum (n=13), jejunum (n=2), duodenum (n=1). Consequent small bowel dilatation was

seen in 8 patients. Lymphadenopathy was noted in 13 patients out of whom 8 patients showed necrotic changes. Ascites was evident in 8 patients. Other findings included hepatosplenomegaly (n=4), basal lung consolidation

(n=1), pleural effusion (n=1), tree-in bud opacities (n=1). Bilateral psoas abscesses were present in 1 patient. Seven patients with findings of abdominal tuberculosis underwent FNAC from lymph node, out of which 6 patients were confirmed to be tubercular. In one patient FNAC was inconclusive. In rest of the 7 patient's diagnosis of abdominal tuberculosis was made based on clinical response to anti-tubercular treatment. One patient with ileal perforation underwent diagnostic laparotomy with biopsy, histopathological findings confirmed tuberculosis. The sensitivity and specificity for diagnosing abdominal tuberculosis by CT enterography was 92.85% and 100% respectively.

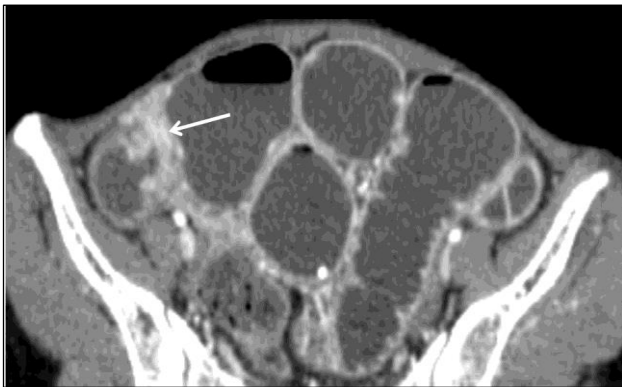


Figure 2: Focal ileal wall thickening with enhancement and luminal narrowing in a case of tubercular stricture.

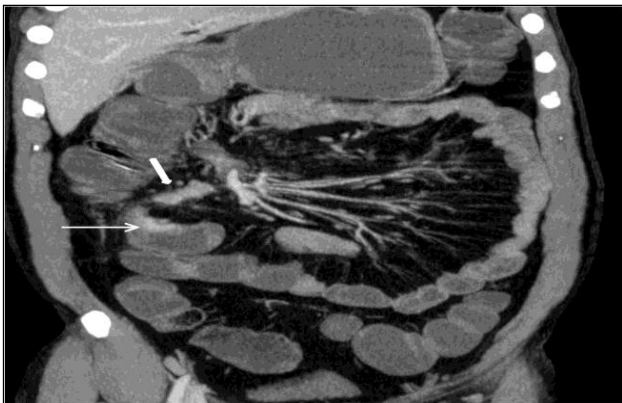


Figure 3: Small bowel carcinoid seen as focal enhancing mass in ileal wall (thin arrow) associated with adenopathy (thick arrow).

CT enterography enabled the diagnosis of small-bowel masses in 7 patients. Small bowel adenocarcinoma (n=1) presented as intraluminal enhancing mass of soft tissue attenuation in the ileum causing intussusception. Diagnosis was confirmed by surgery and histopathology. Small bowel gastrointestinal stromal tumours were seen in 2 patients arising from the duodenum and jejunum respectively. They presented as intraluminal and extraluminal lobulated enhancing masses. FNAC confirmed the diagnosis of GIST in the duodenum while

surgery and histopathology confirmed jejunal GIST in the other patient. Small bowel carcinoid was diagnosed in one patient and presented as small, intensely enhancing, nodular masses in the terminal ileum (Figure 3).

PET CT was positive for somatostatin receptors. The patient underwent surgery and histopathology was confirmatory for carcinoid. Polyposis was seen in three patients. In one known patient of Peutz Jegher's syndrome (post-operative status) who had come for evaluation of recurrence, multiple jejunal polyps were seen as moderately enhancing soft tissue masses. A combination of multiple small gastric mucosal polyps, abdominal wall desmoids and frontal osteomas was seen in one patient suspected with Gardner's syndrome (Figure 4 (A), (B)). Thus, CT enterography accurately depicted small bowel masses in six cases. Crohn's disease was diagnosed histo-pathologically in one patient. CT enterography depicted skip lesions in terminal ileum, mural thickening, stratification, strictures, fibrofatty proliferation, hyper enhancing mucosa and mesenteric hypervascularity (comb sign) suggestive of Crohn's disease (Figure 5).

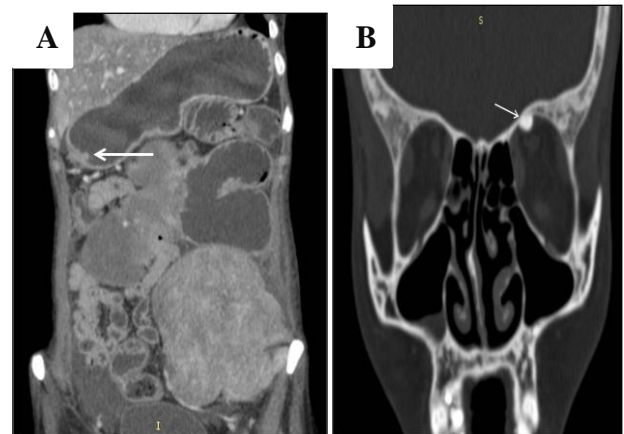


Figure 4 (A) and (B): A combination of multiple small gastric mucosal polyps, abdominal wall desmoids and frontal osteomas seen in Gardner's syndrome.



Figure 5: Ileocecal thickening with maintained wall stratification in a case of Crohn's disease: Surrounding fat proliferation and mesenteric hypervascularity is also seen.



Figure 6: Ileo-caecal low grade stricture (arrow) demonstrated by adequate luminal distension.

Negative findings from CT enterography were obtained in 6 patients who presented with recurrent episodes of abdominal pain, diarrhoea, vomiting and anaemia. Clinical course remained uneventful in all. Low grade obstruction (spontaneously resolving obstruction) was seen in 14 patients. CT enterography clearly depicted the site, level, and cause of the obstruction in clinically suspected patients of tuberculosis. Figure 6 shows mild luminal narrowing at the level of ileocecal junction demonstrated by the adequate luminal distension. In the present study sensitivity and specificity in evaluation of low-grade obstruction was 100%. The remaining two cases were of gall stone ileus and ileal perforation respectively. One patient presented with gastrointestinal bleeding in form of melena.

Table 2: Follow up and final diagnosis in patients undergoing CT Enterography.

CT enterography diagnosis	Type of follow up	Duration follow up	Final diagnosis	Result
Small bowel TB	Clinical	6 months	Small bowel TB	True +ve
Small bowel TB with polyposis	Clinical/surgical	6 months	Small bowel TB with polyposis	True +ve
Duodenal GIST	Surgical	2 months	Duodenal GIST	True +ve
Abdominal TB	Clinical	9 months	Abdominal TB	True +ve
Normal study	Clinical	3 months	Normal	True -ve
Abdominal TB	Clinical	9 months	Abdominal TB	True +ve
Small bowel TB with transient jejunal intussusception.	Clinical	9 months	Small bowel TB	True +ve
Abdominal TB	Clinical	9 months	Abdominal TB	True +ve
Normal study	Clinical	3 months	Normal	True -ve
Abdominal TB	Clinical	9 months	Abdominal TB	True +ve
Abdominal TB	Clinical	6 months	Abdominal TB	True +ve
Abdominal TB	Clinical/FNAC	9 months	Abdominal TB	True +ve
Caecal malignancy	Clinical/FNAC	3 months	Adenocarcinoma	True +ve
Adenocarcinoma	Surgical	3 months	Adenocarcinoma	True +ve
Ileal perforation	Surgical	2 months	Small bowel TB with ileal perforation.	True +ve
Abdominal TB	Clinical	6 months	Abdominal TB	True +ve
Small bowel polyposis	Surgical	2 months	Small bowel polyposis with Peutz Jeghers syndrome.	True +ve
Abdominal TB with Chiladiti`s syndrome	Clinical	6 months	Abdominal TB with Chiladiti`s syndrome	True +ve
Normal study	Clinical	3 months	Normal study	True -ve
Carcinoid	Surgical/biopsy	6 months	Carcinoid	True +ve
Abdominal TB	Clinical	6 months	Abdominal TB	True +ve
Abdominal TB	Clinical	6 months	Abdominal TB	True +ve
Desmoids with antral polyp	Clinical/histo	3 months	Gardeners syndrome	True +ve
Abdominal TB	Clinical	9 months	Abdominal TB	True +ve
Jejunal GIST	Surgical/histol	4 months	Jejunal GIST	True +ve
Normal	Clinical	4 months	Normal	True -ve
Normal	Clinical	3 months	Normal	True -ve
Normal	Clinical	3 months	Normal	True -ve
Crohn`s disease	Clinical	9 months	Crohn`s disease	True +ve
Gall stone ileus	Surgical	3 months	Gall stone ileus	True +ve

CT enterography showed caecal wall thickening. FNAC revealed adenocarcinoma. Comparison of CT enterographic diagnosis and final diagnosis is summarized in Table 2.

The overall results of this study regarding CT enterography in small bowel diseases were summarized as sensitivity (95.83%), specificity (100%), positive predictive value (100%), negative predictive value (85.71%), accuracy (96.66%).

DISCUSSION

The present MDCT study carried out on 30 patients using oral iso-osmotic mannitol was remarkably well tolerated by all the patients. The taste of mannitol was reported as sweet and was acceptable to all. Optimal distension of the ileal loops was achieved in 93.33% patients and that for the jejunal loops was achieved in 73.33% patients. It has been emphasized in a study by Paulsen SR et al, that there was no difference in the degree of small bowel loop distension between patients who underwent naso-jejunal intubation and those who ingested large volumes of water.² The current CT enterography study depicted a varied spectrum of pathologic processes that affected the small bowel in all the 24 patients in whom they were present and ruled out the presence of small bowel disease in 6 patients.

In 7 of these patients, CT enterography depicted small-bowel disease where the combination of clinical and ultrasonography examinations failed. CT, with its ability to provide a comprehensive overview of abdominal structures was the imaging modality of choice for evaluation of such patients.³ Till date, there was paucity of literature regarding the relevance of CT enterography in evaluation of small bowel tuberculosis. The present study showed 92.85% sensitivity and 100% specificity for diagnosis of abdominal tuberculosis.

Helical CT study done by Leder RA et al, showed that in 90% of cases ileo-caecal involvement was present. The study revealed ileo-caecal involvement in all cases (100%) which are similar to previous study results. The most common radiological finding was the presence of strictures seen in 85.17% of this case of abdominal tuberculosis. A study by Nagi B et al, noted strictures in 62.7% of cases of abdominal tuberculosis.⁵ CT Enterography clearly demonstrated the site of bowel involvement, number and length of strictures, bowel dilatation, enterolithiasis, mural enhancement pattern and presence of a fistula in all the cases of abdominal tuberculosis. Extramural findings of lymphadenopathy, ascites and abscesses were clearly visualized.

In a study by Hara AK et al, CT enterography depicted more than twice as many cases of Crohn's disease than with small bowel follow through examination.⁶ In another study of 20 patients by Wold PB et al, CT enterography

correctly depicted more cases of Crohn's disease (10 of 13) than did SBFT (eight of 13).⁷ There are not enough studies that have evaluated the role of CTE for the detection of small bowel tumors. The overall sensitivity and specificity of study by Pilleul F et al, was 84.7% and 96.9%. The sensitivity of CT enterography for depiction of small bowel masses was seen to be 85.71% in the present study which was comparable.⁸ Anzidei M et al, reviewed MDCT and MRI protocols for the evaluation of small bowel tumours.⁹ They have stressed on the fact that since most carcinoids are small (2cm) at the time of the examination, optimal distension of the bowel lumen must be achieved in order to properly identify the nodules. Coulier B et al, reported analysis of the arterial phase of MDCT study appearing primordial to detect the sometimes very small but intensively enhancing primary tumor.¹⁰ In this study, nodular enhancing masses were present in the ileum. Mesenteric lymph nodes with a desmoplastic reaction in the retroperitoneum was also seen. Relationship of the masses to the adjoining mesenteric vessels was evident which was crucial for surgical planning.

Tumours of the small bowel are rare, accounting for about 3%-6% of all gastrointestinal neoplasm. The clinical symptoms are often nonspecific, and results of routine diagnostic tests are inconclusive. Traditionally, small-bowel follow through with enteroclysis has been used for imaging patients suspected of having small-bowel tumours.¹¹ In this study, 14 patients were suspected of having low-grade small-bowel obstruction. CT enterography was able to demonstrate the site, level, and cause of the obstruction in all the patients with a sensitivity and specificity of 100%. CT clearly depicts pathologic processes involving not only the bowel wall but also the mesentery, mesenteric vessels, and peritoneal cavity. Identification of dilated proximal bowel and collapsed distal bowel was diagnostic for bowel obstruction.¹²

CT criteria for SBO are the presence of dilated small bowel loops (diameter >2.5cm from outer wall to outer wall) proximally to normal-calibre or collapsed loops distally.¹³ If a transition zone between the dilated proximal and collapsed distal bowel was detected, the diagnosis was more certain. The reported sensitivity of CT in the detection of small bowel obstruction ranges from 78% to 100% for complete or high-grade obstruction.¹⁴ In a high-grade obstruction, there was a 50% difference in calibre between the proximal dilated bowel and the distal collapsed bowel.¹⁵ Also, a high-grade obstruction that has been present for several days leads to complete evacuation of the contents of the bowel segments distal to the obstruction point.¹⁶

In a study by Zhang LH et al, CT-E has been reported to have greater sensitivity (89%) and specificity (100%) than conventional CT (50% and 94%, respectively) in patients suspected of having a partial small bowel

obstruction.¹⁷ The overall sensitivity, specificity, positive predictive value, negative predictive value and accuracy were 95.83%, 100%, 100%, 85.71% and 96.66% respectively. This compares well with literature.¹⁸ The role of CT enterography continues to evolve within the milieu of traditional examinations and competing techniques. CT enterography has started to replace the small bowel follow-through examination and routine CT at the institution in the investigation of a gamut of small bowel disorders because of its superior performance. Furthermore, because of the good tolerability and high sensitivity of CT enterography and clinician's preference for this examination, author foresees it becoming the modality of choice in patients with a presumed diagnosis of small bowel disorder.

CONCLUSION

CTE should be routinely indicated for better localization of small bowel lesions, delineation of extent, and mural enhancement pattern for suggesting disease activity. It can replace routine CT for evaluation of small bowel tumors. It can be reliably recommended in cases of low-grade small bowel obstruction.

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