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ROLE OF CT ENTEROGRAPHY FOR SMALL BOWEL PATHOLOGIES

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ABSTRACT

Objective: The purpose of this study was to demonstrate the role of CT enterography in detection and characterization of small bowel diseases.

Material and Methods: A total of 50 patients (16-70 years), including 30 males and 20 females who were suspected of having small bowel disorders on the basis of clinical examination underwent CT enterography examination on a 128-slice CT Scanner prospectively using neutral oral contrast (Polyethylene glycol).

Results: Out of 50 patients Grade 4 and grade 3 distension of the small intestine was seen in 28 and 20 cases respectively. Out of 50 patients, 36 patients presented with symmetrical small bowel thickening and 14 patient present with asymmetrical bowel thickening. Among the non-neoplastic pathologies Intestinal tuberculosis was the most common diagnosis in 28 cases, Crohns disease was diagnosed in 6 cases, stricture was diagnosed in 6 cases, duodenal diverticula in 2 cases, MBO and intussusception in 1-1 cases respectively. Among the neoplastic pathologies Small bowel tumors were seen in 6 cases with majority of them adenocarcinoma (3 cases), lymphoma was seen in 2 cases and GIST was seen in 1 case.

Conclusion: CT enterography is an effective modality to evaluate small bowel disorders. It can not only assess mural and intraluminal small bowel pathologies but also assess extraintestinal findings so as to make correct diagnosis.

INTRODUCTION

A vast array of pathologic processes occur in small bowel and mesenteric vasculature, which include inflammatory bowel disease and its complications for example abdominal tuberculosis, Crohn's disease and Ulcerative colitis, Small bowel tumors like hyperplastic polyps, adenocarcinoma, carcinoid, lymphoma, metastasis, GIST, Mesenteric ischemia and GI bleeding[1,2].

Imaging of small bowel is challenging technically as the organ is long and serpentine, therefore, a large field of view is needed to display the small bowel in its entirety. The bowel motion, both intrinsic motion of peristalsis and positional changes caused by breathing also make their tracing very difficult[1].

Small bowel barium meal follow-through and enteroclysis are used for small bowel imaging, however, these examinations provide indirect information about the bowel wall, provide no information about extraluminal pathologies and are prone to problems caused by overlapping bowel loops[1,2,3].

USG is a valuable technique in detecting wall thickening, lymphadenopathy, ascites and peristaltic movement. The major limitation is poor visualisation in a setting of increased bowel gas, obesity and less sensitivity in low grade small bowel obstruction[6].

Enteroscopy is invasive and cannot explore the entire length of small bowel.

Capsule endoscopy allows better mucosal visualisation but has its drawback of obstruction by bowel strictures and provides no information about extraluminal pathologies[1].

Currently, the availability of multidetector computed tomography (MDCT) allowed improved depiction and characterization of small bowel pathology[7]. It is non-invasive and easy to perform can also depict bowel and mesenteric injuries that require surgical repair in patients with blunt abdominal trauma[3].

CT enterography has several advantages over other modalities; it can demonstrate extraluminal pathology in addition to luminal disease the entire small bowel can be inspected unhindered by overlapping loops.

Multiplanar reconstructions increase diagnostic accuracy. Single CT enterography may eliminate need for multiple radiological tests, thus improving diagnostic (and cost) efficiency, patient compliance and ultimately reducing radiation dose[7].

Computed tomography has rapidly become the imaging modality of choice for small bowel pathologies. It combines the greatly improved spatial and temporal resolution provided by multidetector CT scanners, combined with the use of neutral or low-density oral contrast agents and non-ionic intravenous contrast agents for the optimal depiction of small bowel diseases.

This study is an effort to evaluate the role of MDCT in detection and characterization of small bowel pathologies and to assist in deciding further course of management.

AIMS AND OBJECTIVES

1. To evaluate and identify the etiology of various small bowel pathologies with CT enterography.
2. To identify the various specific and non specific features pertaining to small bowel pathologies.
3. To assess the performance of neutral oral contrast agents, comparing intestinal distension, distinction of intestinal wall, acceptance and side effects.

MATERIAL AND METHODS

Study Design: Observational prospective study.

Study Area: Department of Radiodiagnosis, GR Medical College and Attached JAH Hospitals, Gwalior, Madhya Pradesh. The study period will be conducted between February 2018 to August 2019.

Sample Source: Present study will be conducted in the Department of Radiodiagnosis, Gwalior.
Sample Size: 50 patients

Inclusion Criteria-

1. Inflammatory bowel disease

2. Occult GI bleeding
3. Suspected neoplasms
4. Known crohn's disease (not in the perioperative period)
5. Chronic diarrhoea and / or abdominal pain

Exclusion Criteria-

1. Pregnancy
2. Patient with a known , severe iodine contrast media allergy
3. Patient with chronic kidney disease, in whom iodinated contrast material or oral fluid volume is considered harmful
4. Patient in postoperative period (within 2-3 week) in whom abscess or anastomotic leak is considered more likely.

Technique

Patient should be instructed to minimum 6 hrs fasting prior to the study; Patient can take liquid food like juices at this time. No laxatives or enema administered prior to the study. Patient is asked to arrive one and half hour before the examination. Bowel is distended passively by ingesting neutral oral contrast agents, which include water, polyethylene glycol solution, or VoLumen (low-density barium in sorbitol), adding osmotic agents such as mannitol, sorbitol, or polyethylene glycol improves bowel distension[8,9]. We use polyethylene glycol solution is prepared by dissolving 9 mEQ of PEG with electrolytes and flavouring agents which is commercially available as PEG LEC 70 grams of powder in 2 liters of water.

This solution is ingested over 45 minutes, and the patient is scanned subsequently. The last 250 to 300 mL is ingested on table, just prior to scanning for gastric distension, and the patient is made to lie in right lateral decubitus for 3 to 5 minutes; 20 mg Buscopan is administered intravenously (IV) immediately prior to scanning to reduce bowel peristalsis[10]. Scanning was done in enteral phase acquired at 45 seconds, and bowel wall shows maximal enhancement in this phase[11] using 128 Slice MDCT scanner (SOMATOM Definition AS^{+}, Siemens, Erlangen, Germany) in supine position and 1.5 mL/kg of iohexol (Omnipaque 350 mg/mL 50 mL) is injected at the rate of 4 ml/sec using an automated power injector.

Postprocessing techniques include reformatting of axial image data for coronal, sagittal, and maximum intensity projections.

Multiplanar reformatting of axial image data allows excellent demonstration and characterization of enteric and extraenteric abnormalities[12]. Maximum intensity projection images are useful particularly for visualizing the mesenteric vasculature.

Image Interpretation

The images were assessed according to pattern approach suggested by Macari[13]. Seven criteria were used to aid in the evaluation of the abnormal small bowel on contrast-enhanced MDCT. They included the pattern of enhancement, the length of bowel involvement, degree of thickening, whether the thickening is symmetric or asymmetric, location of the lesion along the course of the small bowel (proximal or distal), location of the lesion in the wall of the small bowel (mucosal, submucosal, or serosal), and, finally, associated abnormalities in the mesentery and vessels. Optimal distension of small bowel loops was taken if luminal diameter was ≥ 1.8 cm, as it was sufficient to study the mucosal detail.

Bowel wall thickness above 3 mm was considered as abnormal mural thickening when luminal distension is adequate. Mural thickening was subdivided into three categories: mild (3- 4 mm), moderate (5- 9 mm), and marked (10 mm). Mural thickening can be symmetric or asymmetric and concentric or eccentric. Four patterns may be present during contrast-enhanced CT. These include a double-halo or target appearance, referred to as mural stratification; homogeneous or hyperenhancement; heterogeneous enhancement; and decreased or absent enhancement. The length of the affected small bowel can be focal (<5 cm), segmental (5-40 cm), or diffuse (>40).

OBSERVATION AND RESULT

Out of fifty patients, thirty (60.00%) patients were male and twenty (40.00%) patients were female with male to female ratio of 1.5:1. Majority of the patients were in the age group of 41 to 50 years, with a age ranged from 16-70years. The predominant symptom in small bowel disease was abdominal pain, which was seen in 86.00% of cases, vomiting (30.00%) was the second most common symptom. Other symptoms included abdominal distension, loss of appetite, weight loss, fever, vomiting, loose stole and blood in stool. Optimal distension of bowel loop was achieved in 48(96.00%) patients, out of which grade 4 distension was seen in 28(56%), grade 3 distension seen in 20(40%) and grade 2 in 2(4%) cases, no cases have found a grade 1 distension.

In present study out of 50 patient, ileum is most common involved site noted in 30 (60%) of cases followed by ICJ 28 (56%), ceacum 14 (28%), jejunum 9 (16%) and duodenum 7 (14%) of cases.

Mild thickening was noted in 28(56%) cases and marked thickening was noted in 22(44%) cases in present study.

In present study out of 50 patient symmetrical bowel thickening was noted in 36(72%) patients and asymmetrical thickening was noted in 14(28%) patients.

Focal, segmental and diffused bowel involvement was noted in 32(64%), 16(32%) and 2(4%) cases respectively.

In present study out of 50 patient lymph node was present in 48(96%), out of which 36(72%) cases having a size >1 cm and lymph node necrosis was noted in 20(40%) cases.

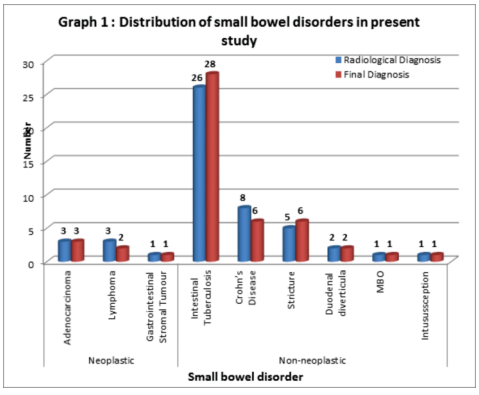

Table 1 : Diagnostic role of CT enterography for various small bowel disorders

Final diagnosis	Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
Adenocarcinoma	66.67	97.87	66.67	97.87	96.00
Lymphoma	100.00	97.92	66.67	100.00	98.00
Gastrointestinal stromal tumor	100.00	100.00	100.00	100.00	100.00
Intestinal Tuberculosis	89.29	94.45	96.15	87.50	92.00
Crohn's Disease	83.33	93.18	62.50	97.62	92.00
Stricture	66.67	97.73	80.00	95.56	94.00
Duodenal Diverticula	100.00	100.00	100.00	100.00	100.00

Intususception	100.00	100.00	100.00	100.00	100.00
MBO	100.00	100.00	100.00	100.00	100.00

DISCUSSION

Pathologies of small bowel are frequently encountered in our day to day practice. It is important to differentiate a neoplastic lesion from a infectious/inflammatory lesion and benign from malignant lesion. It is also important to define the location, extent and characterization of the lesion on contrast administration. Hence the imaging modality that we use should comprise high sensitivity and reasonable specificity for the lesion and should be able to distinguish between those lesions which require detailed evaluation from those which does not.

50 patients who fulfilled the selection criteria underwent CT Enterography. A provisional diagnosis was suggested after the CT examination and these findings were correlated with histopathological/fnac/operative findings wherever applicable.

Male predominance noted in present study also noted in studies done by Anshul Chamail et al[15].

Overall, abdominal pain was most common presentation noted in a study done by Misra RN et al[14] and Anshul Chamail et al[15] 76.66% and 69.23% respectively, so finding in our study is concordance to the mentioned studies.

The following parameters were used in the evaluation of abnormal small bowel including pattern of enhancement, length involved, degree of thickening, location of lesion in the course of bowel, associated abnormalities of mesentery and vessels.

The distension of the small bowel loops in our study using PEG LEC was optimal, Our study result was concordance with the mentioned studies of Ambika R et al (68) and D'Ippolito G et al[16].

The PEG LEC was remarkably well accepted by all the patients, similarly to a study done by Ambika R et al[17].

Mild diarrhea as a side effect of PEG LEC was found in 35(70%), this is concordance to the studies done by D'Ippolito G et al[18].

We performed the study at 52 seconds after intravenous contrast administration and achieved optimal enhancement in patients.

Schnidera et al[19] in their study have seen that the meantime to peak enhancement of the small-bowel wall on average about 50 seconds after intravenous administration of contrast material or 14 seconds after peak aortic enhancement. Findings in our study were in concordance with his findings.

The current CT enterography study depicted a varied spectrum of pathologic processes that affected the small bowel in all the 50 patients.

Primary neoplasms of the small bowel, both benign and malignant, are rare. In the present study 06 patients were diagnosed to have neoplastic lesions, all of them are malignant among which adenocarcinoma (50%) was the commonest diagnosis followed by lymphoma (33.33%) and gastrointestinal stromal tumor (16.66%). The radiological findings were confirmed using post surgical histopathologic evaluation.

In the current study, 66.66% bowel tumors present as focal involvement and segmental and diffused thickening of bowel wall found predominantly in non-neoplastic group except small bowel lymphoma that shows segmental involvement that it is consistent with Macari et al.[2] and Wittenberg et al[20].

Macari et al.[1] stated that adenocarcinoma of the small bowel was located in the proximal small intestine. Sailer et al.[21] also stated that the duodenum is the most frequently involved site consistent with our study and it was the most common tumor in our study and was also associated with extraintestinal manifestation as mesenteric lymphadenopathy **(Fig. 1).**

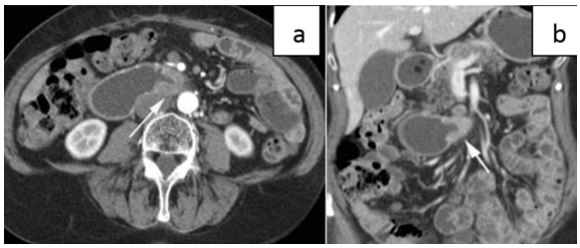

Figure 1 : (a) Axial and (b) coronal CT images show wall thickening of the horizontal part of the duodenum (arrow) causing stenosis proved to be Duodenal adenocarcinoma.

The MDCT features of lymphoma which was the 2nd most common encountered tumor in our study were marked segmental wall thickening with homogenous wall enhancement, aneurysmal dilatation most commonly involving the ileum, most commonly associated with enlarged mesenteric lymph nodes. All of these criteria were mentioned in the pattern approached by Sailer et al. according to Lee et al.[22] This was confirmed in our study as all lymphoma patient's , MDCT showed a mass formation with aneurysmal dilatation without obstruction and most of them were associated with adjacent lymphadenopathy.

Gastrointestinal stromal tumor (GIST) is a common mesenchymal tumor of the gastrointestinal tract, primarily located in the stomach. Only 1 case in our study as exophytic mass from duodenum heerogenous enhancement and central necrosis as stated by Paulsen et al. **(Fig.2)**

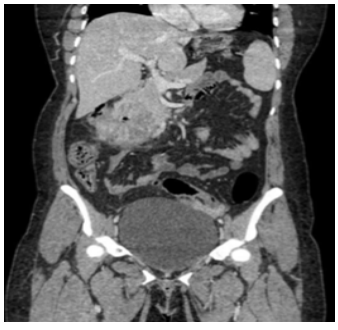

Figure 2 : CT Enterography (Coronal) image showing focal heterogeneously enhancing exophytic mass in relation to duodenum proved to be GIST

44 (88%) out of 50 cases in our study had non-neoplastic pathologies. 28 patients (63.63%) were diagnosed to have Gastrointestinal tuberculosis and 6(13.63%) with Crohn's disease.

ITB cases with gross thickening of caecum, Ileocaecal junction were approached via colonoscopy guided biopsy, cases with enlarged necrotic nodes without significant thickening of caecum, ileocaecal junction were approached via FNAC of enlarged nodes or histopathological evaluation.

Patients with Crohn's disease with inflammatory lesions involving terminal ileum, large gut underwent colonoscopic biopsy for histopathological evaluation.

Circumferential homogenous symmetrical bowel wall

thickening was seen in 22(78.57%) out of 28 patients in the current study presented with intestinal tuberculosis. This was in concurrence to Zissin et al.[23] who reported that the typical concentric mural thickening was the commonest CT finding in gastrointestinal tuberculosis. The ICJ was the commonest site of involvement seen in 26(92.85%) out of 28 patient followed by ileum seen in 19(67.85%) out 28 patients. This feature is attributed to the abundance of lymphoid tissue (Peyer patches) in the distal and terminal ileum[24] **(Fig 3)**. All the other associated extraintestinal manifestations of tuberculosis like pleural effusion and mesenteric lymph nodal enlargement were useful imaging findings supporting the diagnosis of GI tuberculosis[25]. This is consistent with the current study as mesenteric lymphadenopathy was the commonest feature was seen in all cases of intestinal tuberculosis. Enlarged mesenteric nodes >1cm were seen In 25(92.59%) out of 28 of ITB cases and central necrosis was seen in 19(70.37%) out of 28 cases.

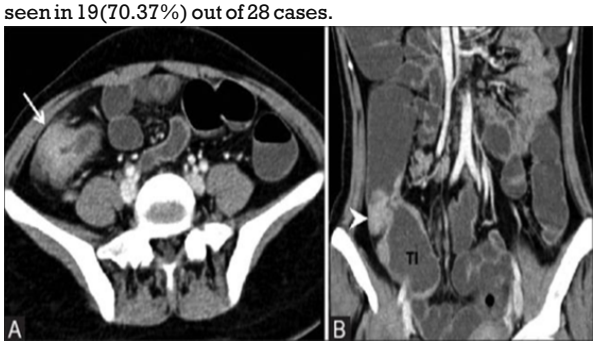

Figure 3 : Axial (A) and coronal (B) CT enterography images show gross thickening of ileocecal valve (arrow) and contracted cecum (arrow head) with pericecal fat stranding. Terminal ileum (TI) is dilated proved to be Ileocecal tuberculosis.

Crohn's disease has predilection for the terminal ileum, it may affect any segment of the gastrointestinal tract[26], in our study, ileum was the commonest site of involvement seen in all patient followed by jejunum seen in 3(50%) out of 6 patient, the jejunum and ileum showing specific sign of skip lesions consistent with Tochetto et al.[27] who stated Small bowel involvement in Crohn's disease is typically transmural, with characteristic skip lesions.

Typically, Crohn's disease results in segmental asymmetric involvement of the affected small bowel in Macari et al.[1] study. Findings in our study were in concordance with his findings. Macari et al.[1] also stated that segmental homogeneous mural hyperenhancement correlates significantly with histopathological findings of active Crohn's disease. This was confirmed in our study, as 5(83.33%) patients showed hyperenhancement of the wall. LoRe et al.[28] concluded that the CT enterography finding of perienteric Inflammation (increased fat density) **(Fig 4)** and vascular engorgement of the vasa recta in Crohn's disease patients suggest that the disease is clinically active. This was found in our study in 5 patients. Macari et al.[1] stated that Crohn's disease is associated with lymph node enlargement. In this study all patients showed mesenteric lymph nodes however only 2(33.33%) out of 6 patients had size>1cm.

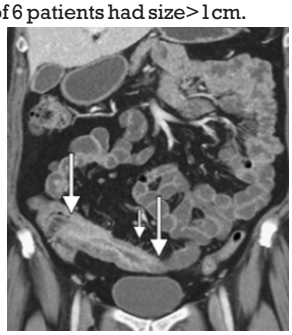

Figure 4 : CT enterography coronal image shows mural thickening with target appearance due to Crohn's disease in terminal ileum (long arrows). Additional findings supporting diagnosis of Crohn's disease include fibrofatty proliferation and prominent vasa recta (short arrow)

Hong et al.[3] and Tye and Desser[29] stated that the diagnosis of bowel obstruction on MDCT depends on the identification of a transition zone with dilated proximal bowel loops. However, depiction of a definite transition zone is sometimes difficult because of overlapping dilated bowel loops when viewing only axial images. Thus 3D imaging can be helpful in evaluating indeterminate cases on the axial plane, such as volvulus or internal hernia

In our study, MDCT enterography detected the site, level and cause of the obstruction with inflammatory strictures in 6 patients (out of which 4 patient is having a previous history of TB), intussusception in one patient, postoperative adhesions in 1 patients. These findings were more evident and obvious after the analysis of the 3D images of the patients.

Among the other entities, duodenal diverticula was seen in 2 cases. Inflammatory strictures was confirmed by post-surgical histopathological evaluation.

CT enterography helps to diagnose all major small bowel pathologies evaluate bowel lumen and also assess extra enteric manifestations of disease.

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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