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SPECTRUM OF COMPUTED TOMOGRAPHIC ENTEROGRAPHY FINDINGS IN SMALL BOWEL DISEASES

Radio-Diagnosis

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ABSTRACT

Small bowel pathologies are a major contributor of morbidity and mortality in India. Small bowel diseases consist of a variety of conditions like abdominal tuberculosis, inflammatory bowel diseases (IBDs), small bowel tumors, malabsorption syndromes (celiac disease and tropical sprue) and obscured gastrointestinal bleeding, however, in developing countries like India, diseases like abdominal tuberculosis has been a major cause of morbidity and mortality, while IBDs and malabsorption syndromes are less likely. In this study we aimed at describing Computed Tomographic (CT) Enterography findings in small bowel diseases and to correlate the imaging findings with operative findings / cytohistopathology / clinical findings. The study was a hospital-based cross-sectional observational study, which was conducted in the Department of Radio-diagnosis from November 2018 to March 2020.The study was approved by the institutional ethical committee and written informed consent was obtained from all 34 patients. Thereafter, the individual details, clinical history, and any significant past history, were recorded. Abdomen USG and routine lab work up were done for all these patients. Other radiological investigations such as, chest x-ray, plain abdominal x-ray and BMFT were carried out in the relevant cases. This was followed by CT Enterography and its analysis. In present study, majority of the patients (61.7%) had intestinal tuberculosis followed by small bowel malignancies (primary as well as secondary)in 14.6%. Parasitic enteritis was seen in 2.9%, while inflammatory bowel diseases (CD and UC) were seen in 5.8% cases. Intussusception and worms were seen in 5.8% cases each. CT Enterography examination offers the advantage of superior spatial and temporal resolution along with assessment of entire bowel loops, peritoneum and mesentery with multiplanar reformation in short scanning time as compared to USG which is mainly operator dependent and MRI which has longer acquisition time. Majority of patients belonged to 15-30 years of age group and mean age of presentation was 30.41 years. Majority of infective cases (intestinal TB, parasitic enteritis and worms) belonged <45 years of age groups while cases of small bowel malignancies were seen in elderly. Pain abdomen and weight loss were the most common presenting symptoms in small bowel pathologies.

KEYWORDS

Small bowel pathologies, Small bowel diseases, abdominal tuberculosis, inflammatory bowel diseases, small bowel tumors, malabsorption syndromes, celiac disease, tropical sprue, obscured gastrointestinal bleeding, computed tomographic enterography.

INTRODUCTION

Small bowel pathologies are a major contributor of morbidity and mortality in India. Small bowel diseases consist of a variety of conditions like abdominal tuberculosis, inflammatory bowel diseases (IBDs), small bowel tumors, malabsorption syndromes (celiac disease and tropical sprue) and obscured gastrointestinal bleeding, however, in developing countries like India, diseases like abdominal tuberculosis has been a major cause of morbidity and mortality, while IBDs and malabsorption syndromes are less likely. Some of the common small bowel diseases are follows :-

Abdominal tuberculosis is a common public health problem in India. It can occur in two forms, primary or secondary to pulmonary tuberculosis.

Inflammatory bowel diseases (IBDs) consist of chronic idiopathic inflammatory bowel conditions that usually include ulcerative colitis(UC) and Crohn's disease (CD).

There are various causes of gastrointestinal (GI) bleeding that includes ulcers, vascular lesions and GI tumors. The most common cause of occult GI bleeding is Angiodysplasia.

Celiac disease is a chronic autoimmune inflammatory condition, which occurs ingenetically susceptible individuals after ingestion of foods containing gluten like wheat, barley, rye, etc.

Tumors of small bowel are less common and have a non-specific clinical scenario. Benign tumors include leiomyoma, adenoma, hemangioma and polyposis syndromes{Peutz–Jeghers syndrome, familial adenomatous polyposis (FAP), Gardner's syndrome}.Malignant tumors of small bowel include adenocarcinoma, gastrointestinal stromal tumors(GISTs), lymphoma, and carcinoid.

Imaging Modalities For Evaluation Of Small Bowel Diseases

Plain Abdominal X-ray

It is the one of the first line imaging modality used for assessing abdominal pathologies, however, findings on plain x-ray are non-specific. Some of the specific indications include suspicion of perforated viscus, urinary tract stones, bowel obstruction, and ingested foreign body [1].

Barium Studies

Barium meal follow-through (BMFT) and barium enteroclysis are the radiological methods for investigating small-bowel obstruction (SBO), IBDs, malabsorption and small-bowel neoplasms. Single contrast BMFT study helps in assessing strictures, mucosal fold thickening, dilatation, ulcerations, bowel motility, demonstration of complex fistulas and differentiation of true obstruction from pseudo-obstruction [2,3,4]. The disadvantage with BMFT is that it is time consuming and provides no information about the extraintestinal findings[5].

Barium enteroclysis is a double contrast study and has superior sensitivity in the identification of mild strictures and mucosal abnormalities[6].However, it has disadvantages such as patient discomfort because of its invasive nature, non-evaluation of duodenum and inability to assess mural as well as extraintestinal pathologies [5].

Ultrasonography

Ultrasonography (USG)is a non-invasive, quick, and widely available imaging modality that lacks radiation hazards.It can be used in the evaluation of treatment response by assessing activity of disease which is dependent on colour flow in the wall[7].However, because of overlying gases, it has low tissue contrast resolution and gives non-specific findings in case of collapse bowel loops. Few other limitations of USG are its operator dependence and inadequate evaluation in obese patients.

Computed Tomography

Computed tomography(CT)is often used as initial imaging modality in the assessment of suspected bowel diseases. Conventional CT or CT Enterography can be used for imaging of bowel pathologies. Conventional CT can be helpful in patients presenting with non-specific symptoms but there is lack of adequate bowel distension [5].

Computed tomography (CT) has the advantage that, apart from luminal pathology, it also displays extraintestinal manifestations of

small bowel diseases. CT enteroclysis is a method of examining the small bowel that combines the advantages of both CT and enteroclysis[8]. CT enteroclysis is an invasive procedure and is performed after administration of contrast through nasojejunal tube placement for bowel distension and hence is troublesome to the patients and needs extra fluoroscopic time[9, 10].According to recent studies, CT Enterography (CTE) is as effective as CT enteroclysis in achieving distension of bowel and has nearly replaced CT enteroclysis[11].Moreover, CTE is a non-invasive procedure which combines the improved spatial and temporal resolution of MDCT with large volumes of ingested neutral enteric contrast material to achieve luminal distension and permit visualization of the small bowel lumen as well as wall. It thereby obviates nasoenteric intubation and hence iswell- tolerated.It helps inthe evaluation of disease affecting mucosa and small bowel wall, in addition to luminal, extraluminal and mesenteric findings [12].

Magnetic Resonance Imaging

In conditions where CT has been contraindicated, Magnetic Resonance (MR) Enterography has been used as an accessory technique. MR is free from radiation but has disadvantages of higher cost, unavailability and long scan times.

AIMS & OBJECTIVES

1. To describe Computed Tomographic (CT) Enterography findings in small bowel diseases.
2. To correlate the imaging findings with operative findings / cytohistopathology / clinical findings.

MATERIALS AND METHOD

Study Place

The study'Spectrumof Computed Tomographic (CT) Enterography findings in small bowel diseases' was a hospital-based cross-sectional observational study, which was conducted in the Department of Radio-diagnosis from November 2018 to March 2020.The study was approved by the institutional ethical committee and informed consent was obtained from all patients.

Source Of Data

The Study population consisted of 34 patients (17 males, 17 females)

Inclusion Criteria

Patients with suspected small bowel pathology on the basis of clinical signs/symptoms and/or USG findings were referred for CT evaluation.

Exclusion Criteria

1. Patients with suspected bowel perforation.
2. Pregnancy.
3. Patients with known iodinated contrast allergy.
4. Patients with chronic kidney disease.
5. Patients who were unable to drink oral contrast material.
6. Patients in whom administration of intravenous iodinated contrast was contraindicated.

METHODOLOGY

1. All 34 patients with suspected small bowel pathology were referred to the department of Radio-Diagnosis for Computed Tomography Enterography. Patients were included in the study after taking an informed consent & henceforth were subjected to a detailed history and clinical examination.
2. The following clinical details were recorded for each patient:

- Demographic data i.e. age, sex with detailed clinical history with presenting symptoms like pain abdomen, weight loss, generalized weakness, altered bowel habit and abdominal lump were noted
- Relevant history regarding current illness, past history, personal and family history was taken.

3. A thorough general survey and detailed abdominal examination was carried out.
4. Routine hematological, biochemical and other relevant laboratory investigations were done.
5. Ultrasonography of the abdomen was done in all patients on Philips IU22 machine by using a curvilinear (2-5 MHz) transducer followed by linear (3-9MHz) transducer on the day of admission. USG was done to evaluate bowel (to look for normal/abnormal wall, lumen calibre, intraluminal abnormalities, peristalsis, or any intussusception), lymph node (location, size, presence/absence of fatty hilum, discrete/conglomeration and calcification), mesentery or omentum, peritoneum, solid organs and/or ascites. In case of any mass lesion, comment was made on its site, size, echotexture, vascularity and regional lymph nodes.
6. Other radiological investigations such as, chest x-ray, plain abdominal x-ray and BMFT were carried out in the relevant cases.

COMPUTED TOMOGRAPHY ENTEROGRAPHY

Technique

1. All patients were requested to come in fasting state. Informed consent was taken from the patient/relative prior to the contrast administration.
2. CT Enterography protocol – Ingestion of neutral entral contrast (mannitol 2.5%) was given over the period of 60 minutes.

3. For children

Neutral enteral contrast- 20ml/kg (maximum 1350 ml) was to be consumed over a period of 1 hour.

4. For Adults

Total 1350 ml neutral enteral contrast was given and was to be consumed as:
450 ml, 60 minutes before scanning
450 ml, 40 minutes before scanning
225ml, 20 minutes before scanning
225ml, 10 minutes before scanning

5. CT was done using PHILIPS BRILLIANCE 40 slice MDCT scanner. A CT tomogram including abdomen and pelvis was performed.
6. **Adult -** After ingestion of enteral neutral contrast agent, contrast enhanced CT was done using non-ionic, iodinated contrast and contrast material at a dose of 1.5 ml/kg was administered intravenously using pressure injector at the rate of approximately 3ml/sec followed by a saline chase of 30ml at the rate of approximately 2.5ml/sec.

Children – After ingestion of enteral neutral contrast agent, contrast enhanced CT was done using non-ionic, iodinated contrast and contrast was administered at a dose 1.5ml/kg (maximum dose-100ml) intravenously by using pressure injector at the rate of approximately 2ml/sec followed by a saline chase of 20ml at the rate of approximately 2ml/sec.

7. Post-contrast scanning was done in enteric phase (50sec) and the scans were obtained in the cranio-caudal direction from the domes of diaphragm to the level of pubic symphysis in supine position.

8. **Scan parameters used were as follows:**

Adults - 120 Kvp, 200 mAs / slice. Axial CT sections were taken at a pitch of 0.9 and were reconstructed at 3mm thickness. Window centering and windowing were kept at 60 & 360 HU respectively.
Children - 80 Kvp, 200 mAs / slice. Axial CT sections were taken pitch of 0.9 and were reconstructed at 3mm thickness. Window centering and window width were kept at 60 & 360 HU respectively

9. Images were reconstructed and in sagittal and coronal planes and maximum intensity projection (MIP) reformatting was done for analysis.

10. Image Analysis:

The Images Obtained Were Analyzed As Follows:

- Small bowel was assessed for wall thickness, focal/diffuse involvement, wall enhancement, mural stratification, lumen caliber, normal/altered position, stricture, intraluminal abnormalities and intussusception.
- Lymph nodes were analyzed for location, size, presence/absence of fatty hilum, presence or absence of conglomeration, enhancement and calcifications.
- Mesentery was assessed for vessel engorgement and fat stranding.
- Omentum and peritoneum were evaluated for thickening/ nodularity/enhancement.
- Ascites and pleural effusion were assessed
- Mass lesion were assessed for location, size, enhancement, calcification necrosis, regional lymph nodes involvement and any local/distant metastasis
- Solid organs were evaluated for size, location, enhancement and any focal lesion.

11. CT Enterography findings were correlated with operative findings/histopathological findings/clinical follow up.

Statistical Analysis

1. Data were entered in excel sheet.

2. Data were analyzed using standard statistical tests.
3. Qualitative data was expressed as proportion and percentages.
4. Quantitative data was expressed as mean, range and standard deviation.

OBSERVATIONS AND RESULTS

This study was conducted in the Department of Radio-Diagnosis, Lady Hardinge Medical College and associated hospitals, in collaboration with the Departments of Surgery and Pathology, Lady Hardinge Medical College and associated hospitals, New Delhi.

The study group included patients with suspected small bowel pathology referred to the Department of Radio-Diagnosis for CT Enterography from November 2018 to March 2020. A total of 34 patients were included in the study.Following is the data observed in the 34 patients included in the final analysis.

Table 01: Age Distribution Of Small Bowel Pathologies (n=34)

Age group (years)	Number of cases	Percentage (%)
<15	5	14.7%
15-30	16	47%
31-45	7	20.5%
46-60	3	8.8%
61-75	3	8.8%
Total	34	100%

- Among total 34 patients, youngest patientwas 11 year of age and oldest patients was 72 year of age.
- Mean age of study group is 30.41 years.
- Maximum number of patients were seen in age group of 15 to 30 year (47%).

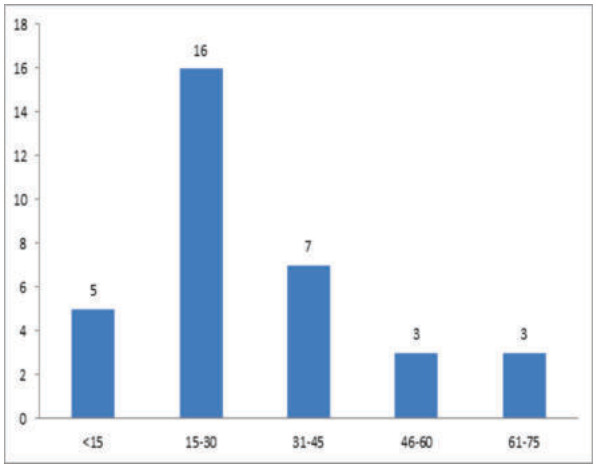

Figure 3: Age Distribution Of Small Bowel Pathologies (n=34)

Table 02: Etiological Distribution Of Small Bowel Pathologies (n=34)

ETIOLOGY		NO. OF CASES	PERCENTAGE (%)
Intestinal Malrotation		1	2.9
TB		21	61.7
Parasitic enteritis		1	2.9
Inflam-matory	UC	1	2.9
	CD	1	2.9
Bowel Tumors	primary small bowel	4	11.7
	secondary involvement	1	2.9
Others	intussusception	2	5.8
	worms	2	5.8
Total		34	100

- Intestinal TB was seen in 21 cases and parasitic enteritis was seen in1 case.
- Intestinal Malrotation, CD and UC each had 1 patient.
- Malignant bowel tumors cases had 5 in number out of which 4 were primary (1°) and 1 was secondary (2°)from adenocarcinoma of caecum.
- Intussusception and small bowel worms wereseen in 2 cases each.

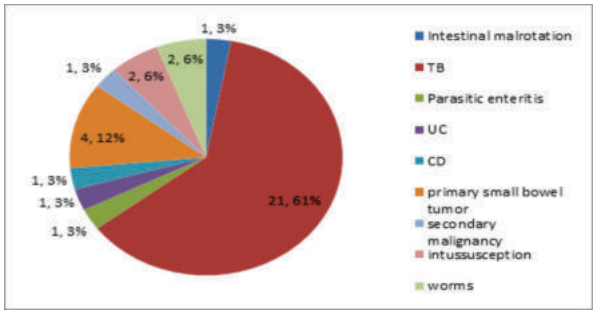

Figure 4: Etiological Distribution Of Small Bowel Pathologies (n=34)

Table 03: Age Distribution Of Cases According To Etiologies

Age group (years)	Mal rota tion	TB	Parasitic enteritis	IBD	Tumors	Others		Total
						intussusception	worms	
<15	-	4	1	-	-	-	-	5
15-30	1	13	-	1	-	-	1	16
31-45	-	3	-	1	1	1	1	7
46-60	-	-	-	-	2	1	-	3
61-75	-	1	-	-	2	-	-	3
Total	1	21	1	2	5	2	2	34

- Majority of the patients (16 cases) were seen in 15-30 years of age group followed by 7 patients in 31-45 years age group. There were 5 patients in <15-year group and 3 patients were in 46-60 years and 61-75 years age group.
- The mean age of presentation was 30.41 years ±15.91 (11-72)

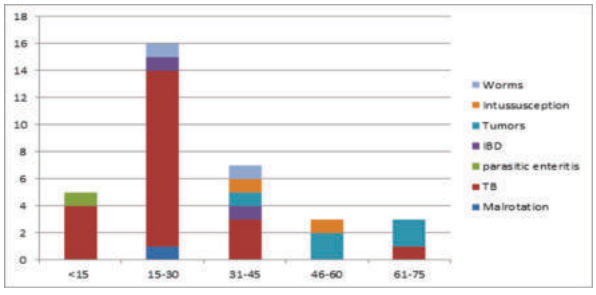

Figure 5: Age Distribution Of Cases According To Etiologies (n=34)

Table 04:sex Distribution Of Small Bowel Pathologies (n=34)

Small bowel pathologies		Male	Female	Total
Malrotation		1	-	1
TB		8	13	21
Parasitic enteritis		1	-	1
Inflammatory	UC	-	1	1
	CD	1	-	1
Tumors		4	1	5
Others	intussusception	1	1	2
	worms	1	1	2
Total		17	17	34

- Among 34 patients 17 patients were male and 17 patients were female
- Sex ratio was 1:1.

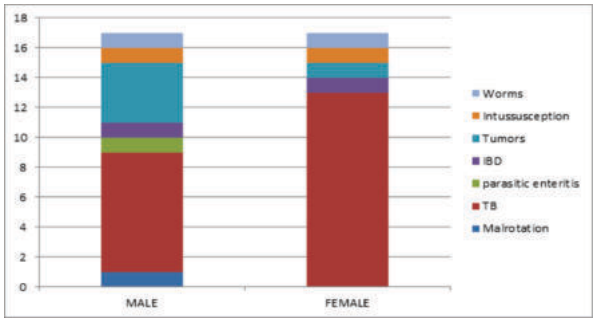

Figure 6: Sex Distribution Of Small Bowel Pathologies (n=34)

Table 05: Clinical Presentation Of Small Bowel Pathologies (n=34)

Symptoms	No of cases	Percentage (%)
Abdominal pain	28	82.3
Weight loss	16	47.1
Generalized weakness	13	38.2
Altered bowel habit	3	8.8
Abdominal lump	1	2.9

- Pain in abdomen was the most common presenting complaints seen in 28 patients(82.3%).
- Abdominal lump was least common presenting symptom seen in1 patients(2.9%)

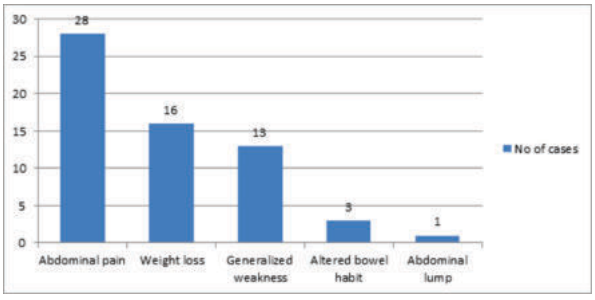

Figure 7: Clinical Presentation Of Small Bowel Pathologies (n=34)

Table 06: Etiological Work-up In Small Bowel Pathologies.

Etiology / Investigations	Mal-rotation (1)	TB (21)	Para-sitic enter-itis (1)	IBD UC (1)	IBD CD (1)	Tu-mors (5)	Others intussusception (2)	Others Worms (2)	Total (34)
TLC	1	21	1	1	1	5	2	2	34
DLC	1	21	1	1	1	5	2	2	34
Hb	1	21	1	1	1	5	2	2	34
ESR	1	21	1	1	1	5	2	2	34
Mantoux	-	11	-	-	-	-	-	-	11
Chest X-ray	-	21	-	-	-	5	-	-	26
Abdominal X-ray	1	21	1	1	1	5	2	-	34
BMFT	-	4	-	-	-	-	-	-	4
Sputum for AFB	-	7	-	-	-	-	-	-	7
Ascitic fluid analysis	-	2	-	-	-	-	-	-	2
Stool analysis	-	-	1	-	-	-	-	-	1
Colono-scopy	-	7	-	1	1	2	-	-	11
Endoscopy	-	-	-	-	-	1	-	-	1
IHC	-	-	-	-	-	3	-	-	3
Histo-pathology	-	1	1	1	1	5	1	-	10

Table 07: Evaluation Of Bowel In Intestinal Tb (n=21)

Bowel involved		No. of cases	Percentage (%)
IC junction		21	100
Ileum	Proximal ileum	4	19.04
	Distal ileum	20	95.2
Caecum		13	61.9
Ascending colon		6	28.6
Jejunum		3	14.3
Appendix		2	9.52

- IC junction was the most common site involved in intestinal TB and was involved in all 21 cases.
- Distal ileum was the 2nd most commonly involved site and was involved in 20 cases.
- Caecum was affected in 13 cases (61.9%) and jejunum involvement was seen in 3 cases.
- Ascending colon was involved in 6 cases (28.6%).
- Appendix was affected in 2 cases (9.52%).

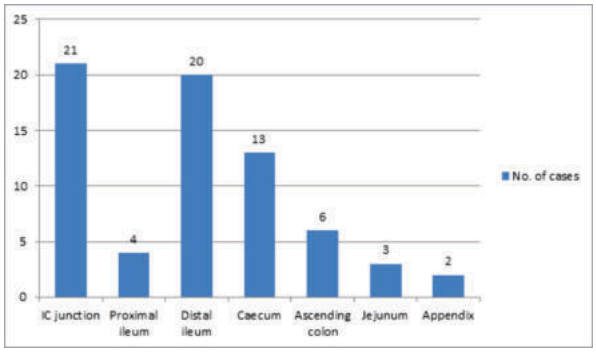

Figure 8: Evaluation Of Bowel In Intestinal Tb (n=21)

Table 08: Evaluation Of Ic Junction In 21 Cases Of Tb

IC junction characteristics	No. of cases	Percentage (%)
Wall thickening	21	100
Abnormal enhancement	21	100
Pulled up	1	4.8
Patulous IC junction	1	4.8

- Abnormal enhancement and wall thickening were seen in all the cases (100%). Pulled up IC junction was seen in 1 case and patulous IC junction was seen in 1 case

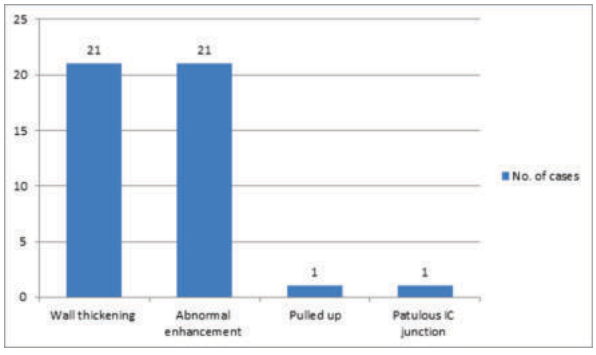

Figure 9: Evaluation Of Ic Junction In Cases Of Tb. (n=21)

Table 09:evaluation Of Mesentery And Peritoneum In Intestinal Tb (n=21)

FINDINGS			No. of cases	Percentage (%)
Mesentery	Lymph nodes	Enlarged	17	81
		Conglomerated	9	42.9
		Necrosis	12	57.1
		Calcification	1	4.8
	Fat stranding present		6	28.6
	Vessel engorgement		3	14.3
Peritoneum	Free fluid		6	28.6
	Deposits		4	19.04

- Most common feature was enlargement in the cases of involvement of lymph nodes followed by necrosis and least common feature was calcification.
- Enlarged lymph nodes were seen in 81% cases and necrosis was seen in 57.1% cases. Conglomerated lymph nodes were seen in 42.9% cases and 1 case (4.8%) showed calcified lymph nodes.
- Mesenteric fat stranding was seen in 6 cases (28.6%).
- Engorged mesenteric vessels was seen in 3 cases (14.3%).
- Peritoneal deposits were seen in 19.04% cases and ascites was seen in 6 cases (28.6%)

Table 10: Solid Organ Involvement In Intestinal Tb (n=21)

Solid organ		No. of cases	Percentage (%)
Liver	Enlarged	4	19.04
	Focal lesion	2	9.52
Spleen	Enlarged	2	9.52
	Focal lesion	1	4.8
Other organs		-	-

- Out of 21 patients 4 patients had enlarged liver with 2 had hepatic granulomas with 2 patients had splenomegaly and 1 had splenic

granulomas.

Evaluation Of 1 Case Of Parasitic Enteritis

- Out of 34 cases 1 case had parasitic enteritis (Trichuris trichura). Patient was presented with complaints of abdominal pain.
- Thickening of IC junction, caecum and ascending colon seen and caecum was pulled-up.Dilatation of ileal loops enlarged mesenteric lymph node, fat stranding and hepatospenomegalyalso seen.
- Microscopic examination of surgical specimen showed adult worm and egg of trichuris trichura.

Evaluation Of 1 Case Of Crohn's Disease

- A 38-year male patient wasdiagnosed with Crohn's disease. The patient had complaints of chronic abdominal pain.
- On CT, multifocal circumferential thickening with maintained mural stratification involving ileum, caecum and ascending colon with surrounding mesenteric fat stranding and intervening normal bowel loops. The mesenteric vessels appeared engorged (positive comb sign).
- Colonoscopic biopsy confirmed the diagnosis of CD.

Evaluation Of 1 Case Of Ulcerative Colitis

- One 22-year female was diagnosed with ulcerative colitis.
- On CT, the colon from anal canal till caecum continuously involved and appeared thick walled and increased enhancement with loss of haustral markings with increased peri-rectal fat space with fat stranding within. The terminal ileum was mildly dilated.
- Colonoscopic biopsy confirmed the diagnosis of ulcerative colitis.

Evaluation Of 1 Case Of Malrotation

- There was one incidental case of malrotation diagnosed in 25-year male who underwent CT examination for evaluation of GB polyp.
- On CT, entire small bowel loops were seen placed in right of midline with 3rd part of duodenum not crossing midline and duodeno-jejunal (DJ) flexure on the right side. Large bowel loops were predominantly seen on left side. Terminal ileum and IC junction were seen in midline. Normal SMA/ SMV relation was altered.

Table 11: Evaluation Of 5 Malignant Bowel Tumors

Site involved	GIST	Carcinoid	Adenocar-cinoma	Total	Percentage (%)
Duodenum	-	-	1	1	20
Jejunum	1	-	-	1	20
Ileum	1	1	-	2	40
IC junction+caecum	-	-	1	1	20
Total	2	1	2	5	100

- There were 5 cases of bowel tumors. 2 tumors were seen involving ileum and duodenum, jejunum and secondary involvement of IC junction in cecal adenocarcinoma were seen in one case each.
- Among these 5 cases, 2 were GIST, 1 was carcinoid and 2 were adenocarcinoma involving duodenum and caecum.

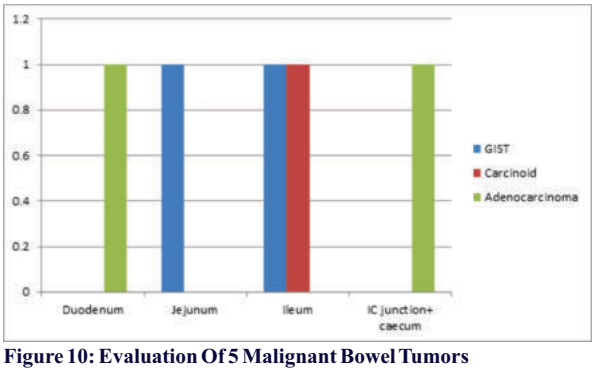

Figure 10: Evaluation Of 5 Malignant Bowel Tumors

Table12: CT Findings In Malignant Bowel Tumors (n=5)

CT findings		No. of cases	Percentage (%)
Wall thickening		5	100
Abnormal wall enhancement		5	100
Lymph nodes	Enlargement	3	60
	Necrosis	0	
Peritoneal deposits		1	20
Metastasis		1	20

- All the 5 cases of bowel tumors showed wall thickening and abnormal bowel wall enhancement in the affected bowel segment.
- Enlarged lymph nodes were seen in 3 cases. These included one case each of GIST, duodenal adenocarcinoma and carcinoid. Necrosis within lymph nodes was not seen in any case.
- Peritoneal deposits and metastasis were seen in one case on GIST.

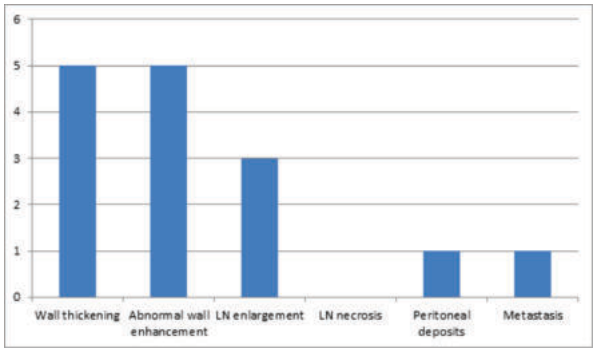

Figure 11: CT Findings In Malignant Bowel Tumors (n=5)

Table 13:evaluation Of 2 Cases Of Intussusception

CT finding	Case 1 (46Y female)	Case 2 (32Y male)
Site	Ilieo-ileal	Ileo-ileal
Segment involved	Long segment	Long segment
Lead point	Meckel's diverticulum	Not found
Proximal obstruction	No	No

- There were 2 cases of intussusception encountered in one 46-year female (case 1) and 32-year male (case 2). Both cases were presented with abdominal pain.
- Both the cases had long segment involvement and were ileo-ileal type.
- In case 1, Meckel's diverticulum was seen in the lead point in case 1 while lead point was not found in 2nd case.
- Featuresof bowel obstruction were not seen in both the cases.

Evaluation Of 2 Cases Of Worm Infestation

- There were 2 cases of worm infestation which were diagnosed incidentally in one patient underwent CT for complaints of pancreatitis and CT was performed in one suspected case of bowel obstruction.
- Both the cases showed multiple curvilinear hypodense tubular structures in small bowel.

DISCUSSION

The present study was conducted in LHMC and SSKH in thepatients with suspected case of small bowel disease and the study includedtotal 34 patients.

All patients undergone single enteric phase CT Enterography at 50 sec after administration of i.v. iodinated contrast using power injector.In our study we used iso-osmotic mannitol 20ml/kg in children and 1350 ml in adultas a neutral oral contrast over a period of 60 minutes. Ritu et al 2019used 1500 ml of iso-osmotic mannitol as a neutral enteral contrast in the detection of small bowel disorders[13].

Iso-osmotic mannitol is slightly sweet and acceptable and cannot absorbed by small intestine and can distend small bowel adequately when administered in large amount[8]. It is also cheap, well tolerated associated with minimal adverse effects[14]. According to a study peak mural enhancement of the normal small bowel occurs at about 50 seconds after intravenous administration of contrast material [15].

Padnabham et al in 2017 did a comparison of use of water, mannitol and positive contrast. They found that bowel distension, mucosal fold visibility and bowel homogeneity were highest with mannitolcompared to other two contrast agents. Obscuration of mucosal details, poor bowel wall demonstration were the drawbacks with positive oral contrast. They concluded that mannitol was proved best endoluminal agents as compared to these two agents[14].

Demographic Findings In Small Bowel Pathologies

Sex ratio in the present study was 1:1 (17 males and 17 females). Most

of the patients belonged to 15-30 years age group (47%). The mean age group was 30.41 years. This finding was in concordance with the previous prospective cross-sectional observational study by Ritu N. et al 2019 which included total of 30 patients. Among these 14 were males and 16 were females with maximum patients belonging to 21-30 years of age group and mean age of presentation was 31.03 years (range:16-70 years)[13].

Etiological Distribution Of Small Bowel Pathologies

In the present study, out of total 34 patients, abdominal TB was the most common pathology affecting 21 of 34 patients (61.7%) followed by 5 cases of small bowel malignancies (2-GIST, 1-carcinoid and 1-duodenal adenocarcinoma and 1-cecal adenocarcinoma with IC junction involvement). Intestinal malrotation, parasitic enteritis, CD, UC each had 1 case. Intussusception and worms were seen in 2 cases each.

Patients presented with variety of symptoms out of which abdominal pain was most common presenting complaint being present in 82.3% of cases followed by weight loss were seen in 47.1% of cases and least common was abdominal lump found in1 patient (2.9%).

Small bowel can be affected by several pathological conditions ranging from infective, inflammatory to malignant etiologies. In ourstudy most common etiology was intestinal tuberculosis which mainly affects young adults.

Intestinal Tuberculosis

Location

Out of 34 patients 21 patients had intestinal tuberculosis. In our study most frequent was ileocecal junction followed by ileum, caecum, ascending colon and jejunum.

According to a studyGulati et alin 1999, most frequent site was ileocecal region followed by ileum, caecum, ascending colon and jejunum[16].

Lymphadenopathy

In the present study, enlarged mesenteric lymph nodes was most commonly seen in cases of intestinal TB (81%), necrosis was seen in 57.1% cases, conglomerated LN were present in 42.9% and calcification was seen in 1 patient (4.8%).

In a study Kalra et al 2014, mesenteric lymphadenopathy was seen in 90% cases, and 44% showed necrosis. In their study discrete lymph nodes were more common than conglomerated lymph nodal mass[17].

In a studyZhao et al in 2015 lymphnodeswere most commonly found in the mesentery and necrosis was found in 67% and calcification was seen in 1 patient[18].

Peritoneal Involvement

In the present study, peritoneal deposits wasseen in 19% of intestine TB caseswhich is comparable with the previous study done by Karla et al in 2014 who found peritoneal involvement was seen in 15% cases[17].

Ascites was seen in 28.6% cases in the present study. Zhao et al 2015 found ascites in 20% of their Small Bowel TB cases[18].

Inflammatory Bowel Diseases

Crohn's Disease

In a studyBooya et al 2006 found that mural hyperenhancement and mural thickening weremost sensitive findings in patients with active CD patients, which was also seen in our study[19].

In another study Paulsen et al 2006, described the imaging findings in CD mural hyperenhancement with mural thickening, comb sign and soft tissue stranding in perienteric mesenteric fat which was also correlating our study[12].

In a study in Maria et al2012, (20) combination of mural thickening and increased attenuation of the perienteric fat are the most specific sign of active CD, which was also found in our study[61].

A study Al-Hawary et al 2013, described the similar findings i.e. mural thickening with muralhyperenhancement, haziness in the mesenteric fat and engorgement of mesenteric vessel [21].

In our study there was a one case of active Crohn's disease. Findings of CD included mural thickening with mural hyperenhancement, increased peri-enteric vascularity (comb sign) and mesenteric fat stranding with multifocal stricture involving caecum, transverse colon and descending colon and showed multiple ulcerative lesions however, mural stratification was not seen in this case.Distortion of crypt architecture with abscess formation on colonoscopic biopsy suggestingactiveCD.

Ulcerative Colitis

Ulcerative colitis along with Crohn's disease are the most common types of inflammatory bowel disease but in 6% cases the patient can have overlapping clinical, radiological and histological findings [22].

Classic rectal sparing disease is the main distinguishing imaging feature between UC and CD and is seen in CD [23, 24, 25] while UC has more perianal involvement [26]. Mural thickening is a common feature of both but is more commonly seen in cases CD.

Radiological features of UC may include widening of presacral space, rectal narrowing and stranding of peri-rectal fat [27]. On CTmural stratification and loss of haustration can also be seen in cases of UC [28].

In the present study, UC was seen in a female patient, On CT, the colon was involved from anal canal till caecum in continuous fashion and wallappeared thickenedwith increased enhancement with loss of haustral markings with increased peri-rectal fat space with fat stranding within. The terminal ileum appeared mildly dilated.

Malignant Lesions Affecting Small Bowel

In the present study there were 5 cases with malignant lesion affecting small bowel (2-GIST, 1-carcinoid and 1-duodenal adenocarcinoma and 1-cecal adenocarcinoma with IC junction involvement). All the cases were diagnosed on histopathology.

Cases Of Gastrointestinal Stromal Tumors (gist)

In the present study, there were two patients diagnosed with GIST. Both the cases had exophytic growth arising from the small bowel {one involving jejunum (case 1) and one involving ileum (case 2)}. Both the growth showed heterogenous enhancement post contrast. There were peritoneal deposits and liver metastasis along withnecrosis and calcification in case 1. While case 2 was devoid of such features.

GIST is the the most common non-epithelial small bowel tumor affecting small bowel most commonly besides stomach [29, 30]. According to Vasconcelos et al 2017GIST is seen predominantly as exophytic growth in their retrospective study of 111 GIST cases, 46 had exophytic growth, heterogenous enhancement was seen in 79 patients and internal necrosis was seen in 63 patients and 16 patients showed calcification. Peritoneal deposits were seen in 7 cases and hepatic metastasis were seen in 4 cases[31].

2 Cases Of Adenocarcinoma

There were 2 cases of adenocarcinoma involving the small bowel. One was 1° duodenal adenocarcinoma and other case was 2°involvement of IC junction in a case of adenocarcinoma of caecum. The case 1 was that of a 63-year male presenting with Gastric Outlet Obstruction (GGO) and weight loss. CT of the patient showed circumferential thickening of 2nd part of duodenum with over distended stomach. The mass was causing biliary obstruction leading to proximal IHBRD. Regional lymph nodes were involved. Case 2 was 55-year female presenting with RIF mass on CT showed a well-defined heterogenous enhancing proliferative endoluminal mass in ileocecal region and caecum, however no proximal obstruction was seen.

According to fernandes et al in 2012 adenocarcinoma was the most common small bowel tumor in 30-50% cases and patient typically presents with obstruction and weight loss. Duodenum is most commonly involved[32, 33, 34].

Evaluation Of 1 Case Of Carcinoid:

There was one case of carcinoid seen in 72-year male. The CT evaluation showed presence of soft tissue mass measuring 2.5x1.4 cm,arising fromterminal ileum.IC junction withcaecumwascontracted and pulled-up with peri-lesional mesenteric fatstranding. Regional lymph nodes were involved.

According to previous literature, most common location of carcinoid is

appendix followed by small bowel. In small bowel, ileum is the most common site [35, 36]. Nodal and liver metastasis in cases with carcinoid depends upon the size of the mass. For tumors >2 cm, 80% cases have metastasis to lymph nodes and 40%-50% cases show metastasis to liver[37].

Evaluaiton Of One Case Of Malrotation

On CT, the malrotation can be suspected when small bowel is seen predominantly on right-side, colon is left-sided, a normal SMA-SMV relationship is disturbed and aplasia of the uncinate process and many a times malrotation is can be identified on CT where it was performed for other unrelated reasons [38]. According to few authors, The CT whirl or whirlpool sign describes the swirling appearance of bowel and mesentery twisted around the SMA axis [39].

In present study, similar findings were found in one 25-year old male who underwent CT for evaluation of GB polyp and on CT showed small bowel placed in right and large bowel loops were predominantly on left and normal SMA/ SMV relation was lost.

Evaluation Of 2 Cases Of Intususceptions

In previous literature, intussusception is more common in children than adults. And in pediatric age group it is generally idiopathic while in adult intussusception often has secondary to an identifiable etiology such as Meckel's diverticulum, benign or malignant neoplasms, polyps and postoperative adhesions, may act as leading points by altering bowel peristalsis[40].

Few studies have described the CT imaging features which includeselongated structure extending into bowel lumen (in a central or eccentric position), normal caliber or only slight dilation of bowel loop, triangular or crescent-shaped fat density due to eccentrically placed mesentery (almost always detectable), normal caliber loop proximal to intussusception [41].

According to study, pathognomic imaging features of intussusceptions were bowel within bowel appearance with or without contained fat and mesenteric vessels[42].

In present study, both the cases showed bowel within bowel appearance. There was herniation of mesentery along with vessels in case1 and this patient also had Meckel's diverticulum as the lead point while it was idiopathic in second patient.

Case Of Parasitic Enteritis

In a case report by Tokmak et al 2006, [43] concluded that irregular and nodular bowel wall thickening of caecum and ascending colon to be a one of the CT finding of Trichuris trichuraand colonoscopy and biopsy were the gold standard investigations for parasitic enteritis.

In the present study, one patient showed bowel wall thickening involving caecum and ascending colon with enlarged mesenteric lymph node (18mm) in addition to this, involvement of IC junction was also seen.

Microscopic examination of the surgical specimen showed the eggs and adult worms of trichuris trichura.

CONCLUSION

Small bowel pathologies can have diverse etiologies. In present study, majority of the patients (61.7%) had intestinal tuberculosis followed by small bowel malignancies (primary as well as secondary)in 14.6%. Parasitic enteritis was seen in 2.9%, while inflammatory bowel diseases (CD and UC) were seen in 5.8% cases. Intussusception and worms were seen in 5.8% cases each.

CT Enterography examination offers the advantage of superior spatial and temporal resolution along with assessment of entire bowel loops, peritoneum and mesentery with multiplanar reformation in short scanning time as compared to USG which is mainly operator dependent and MRI which has longer acquisition time.

Adequate luminal distension of small bowel loops is required for picking up subtle changes which can be easily obtained by CTE, along with single enteric phase scanning can be helpful in diagnosing majority of small bowel disorders.

Majority of patients belonged to 15-30 years of age group and mean age of presentation was 30.41 years. Majority of infective cases (intestinal TB, parasitic enteritis and worms) belonged <45 years of age groups while cases of small bowel malignancies were seen in elderly. Pain abdomen and weight loss were the most common presenting symptoms in small bowel pathologies.

Small bowel pathologies most commonly involve IC junction and ileum.IC junction involvement was seen in all 21 cases of intestinal TB, 1 case of parasitic enteritis and one case of adenocarcinoma of caecum in the present study. Ileum was involved in 20 cases of intestinal TB, 2 cases each of worm infestation, intussusception and 2 small bowel malignancies (1-GIST and 1-carcinoid) and one case of Crohn's disease.

Presenceof abnormal enhancement and thickening of IC junction with enlarged mesenteric lymph nodes with conglomeration and central necrosis can help in diagnosing the cases of intestinal tuberculosis while findings like skip lesions, engorgement of mesenteric vessels and perilesional fat stranding were present in the case of Crohn's disease. Ulcerative colitis is characterised by involvement of large bowel in continuous fashionstarting from rectum alongwith increased peri-rectal fat space and peri-rectal fat stranding. .

Thickening of IC junction, caecum and ascending colon with enlarged lymphadenopathy can also be seen in case of parasitic enteritis while intraluminal curvilinear hypodense tubular structures are visualised patients with worm's infestation.

Exophytic growth from bowel wall with heterogenous enhancement can be seen in cases of small bowel malignancies like GIST.

CT Enterography can be helpful in the evaluation incidental findings such as malrotation and intussusception. The distribution of bowel loops and SMA/ SMV relation which can be helpful in the cases with malrotation. Intussusception can be identified by the presence of bowel in bowel appearance. CT can identify the lead point accurately.

The present prospective cross-sectional study was conducted in the Department of Radio-Diagnosis, Lady Hardinge Medical College and Associated Hospitals, New-Delhi from November 2018 till March 2020. A total 34 patients were included in the study. The study was undertaken to illustrate the Computed Tomographic (CT) Enterography findings in small bowel diseasesand tocorrelate the imaging findings with operative findings/cytohistopathological/ clinical findings.

Among total 34 patients, 47% were seen in 15-30 years age group.Mean age of study group is 30.41 years and ranged from 11-72 years. 17 were males and 17 were females. Pain abdomen (82.3%) and weight loss (47.1%) were the most common clinical symptoms in the patients with small bowel pathologies in the present study.

Among the 34 included cases, intestinal TB was the most common etiology and was seen in 21 cases (61.7%). Among these 21 cases, 13 cases were in the age group of 15-30 years.

IC junction involvement was seen in all 21 cases (100%) of intestinal tuberculosis. Among non- TB cases it was evident in 02 cases (1- parasitic enteritis and 1- adenocarcinoma caecum). Caecum and ascending colon involvement were seen in intestinal tuberculosis and 1 case of parasitic enteritis. In intestinal tuberculosis caecum and ascending colon were involved in 13 (61.9%) and 6 (28.6%) cases respectively.

In cases of intestinal TB, distal ileum was involved in 20 cases (95.2%). Enlarged lymph nodes were seen in 81% cases,central necrosis was seen in 57.1% and 42.9% cases of intestinal TB showed conglomeration. Ascites was present in 28.6% cases of intestinal TB and peritoneal deposits were seen in 19.04% cases. Liver granulomas were present in 2 cases (9.5%) while splenic granulomas could be seen in just one case (4.8%).In addition to involvement of caecum, ascending colon and IC junction, enlarged mesenteric lymphadenopathy and hepatosplenomegaly were the other findings in the case of parasitic enteritis.

Among findings like circumferential bowel wall thickening with maintained mural stratification involving ileum, caecum and ascending colon with surrounding mesenteric fat stranding and the

mesenteric vessels appeared engorged positive comb signwere evident on CT.In case of ulcerative colitis, entire large bowel from caecum till anal canal was involved with increased peri-rectal fat space and peri-rectal fat stranding. Terminal ileum appeared mildly dilated.

In one incidental case of malrotation, CT showed small bowel loops and Duodenojejunal (DJ) flexure on right and large bowel loops on left side of midline with 3rd part of duodenum not crossing midline and on the right side. Terminal ileum and IC junction were seen in midline with loss of normal SMA/ SMV relationship.

Among 5 cases of bowel malignancies (2-GIST, 2-adenocarcinomas and 1-carcinoid), 2 tumors were seen involving ileum while duodenum, jejunum and secondary involvement of IC junction in cecal adenocarcinoma were seen in one case each and wall thickening with abnormal bowel wall enhancement was seen in all the cases.Enlarged lymph nodes were seen in 3 cases. These included one case each of GIST, duodenal adenocarcinoma and carcinoid. Necrosis within lymph nodes was not seen in any case. Peritoneal deposits and metastasis were seen in one case on GIST.

There were 2 cases of intussusception of which both were involving long segments and were ileo-ileal type with Meckel's diverticulum as the lead point in one case while it could not be identified in other case while multiple curvilinear hypodense tubular structures within the small bowel loops could be identified in 2 cases of worm infestations.

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