

Role of CT Enteroclysis in the Evaluation of Small Bowel Pathologies

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Abstract: ***Background:** The role of CT enteroclysis is gaining importance in the diagnosis of small bowel diseases. CT abdomen has become a frequently sought investigation to answer specific clinical questions and to localize the source of the abdominal complaints in undiagnosed cases. The aim of the study is to present our own experiences in CT enteroclysis application, with the use of a 64-detector CT unit. **Observations:** In our study, the most common pathology found was tuberculosis. 7 out of 34 patients were found to have tuberculous infection. We found 5 cases of inflammatory bowel disease, out of which 4 were Crohn's disease and 1 case of ulcerative colitis. There were total 8 cases of neoplastic diseases. 3 patients had small and/or large bowel polyps, 2 patients had GIST, and 2 had lymphoma with 1 suspected case of carcinoid syndrome. **Conclusion:** CT enteroclysis with the use of the 64-detector CT unit is a valuable tool in the diagnosis of small bowel diseases. It could supplement or precede capsule endoscopy.*

Keywords: CT enteroclysis, small bowel diseases, Tuberculosis, Crohns, Ulcerative Colitis.

1. Introduction

Various pathologies affecting small intestine range from congenital anomalies like malrotations, infections and parasitic infections, ischemia to malignancies. Perhaps the only group of pathologies exclusive to bowel is malabsorption syndromes.

Many diagnostic modalities have evolved over time for diagnosis of the small bowel pathologies. X-ray was the first of them in the armamentarium of the radiologist. Only some of the pathologies can be detected on plain X-rays and hence, owing to its limitations, it remains a screening investigation. The tubular nature of digestive system with a lumen, made it possible to use a contrast medium to opacity the lumen. Being a tubular organ, adequate distension is a must for proper evaluation of small bowel pathologies. With a nasojejun tube in place, controlled infusion of Barium could be performed leading to better control over bowel distension.

Ultrasonography being non-invasive and easily available is widely used to evaluate patients with abdominal complaints. Not all bowel loops can be evaluated with high accuracy, intraluminal pathologies are not well evaluated and it has a low sensitivity and specificity for bowel pathology.^[1]

CT has become the modality of choice in many clinical scenarios. To achieve the combination of cross sectional imaging with adequate distension of bowel, the procedure of CT enteroclysis was introduced. CT enteroclysis is a method of examination in which contrast material is infused through a nasoenteric tube and contiguous axial images are obtained after total opacification of a moderately distended small intestine.^[2]



Figure 1: BMFT and Barium Enteroclysis

With the nasojejun tube in place, adequate distension of bowel can be achieved by controlled infusion of fluids. The distension can be titrated according to the patient discomfort and diagnostic adequacy. Here, we describe a study of 34 patients evaluated with CT Enteroclysis.

2. Aims and Objectives

- 1) To evaluate the role of CT enteroclysis in various small bowel pathologies
- 2) To determine the exact nature of the pathology eg. Site and cause of obstruction in small bowel obstruction
- 3) To determine various patterns of mucosal enhancement seen in mucosal and inflammatory bowel diseases
- 4) To detect any associated extra-intestinal pathologies

3. Review of Literature

Some of the important and common pathologies affecting the small bowel include:

Celiac disease

It is an immune mediated enteropathy caused by exposure to gluten in genetically susceptible individuals. It is characterized by intestinal malabsorption associated with villous atrophy of the small intestinal mucosa, clinical and histological improvement after adherence to strict gluten free diet, and relapse when gluten is reintroduced. Imaging findings include – reversed jejunoileal fold pattern – ileal “jejunization” with a major loss of jejunal folds, jejunal and ileal fold and wall thickening, dilatation and fluid-filled distended intestinal loops, intussusceptions, mesenteric cavitating lymphadenopathy, mesenteric panniculitis, vascular engorgement, splenic atrophy and continuous peristalsis in the small bowel segments during fasting. [3]

Inflammatory Bowel Diseases (IBDs)

The hallmark of IBD is chronic, uncontrolled inflammation of the intestinal mucosa, which can affect any part of the gastrointestinal tract. [4]IBD comprises primarily 2 disorders: ulcerative colitis and Crohn’s disease. UC usually affects the colon, with disease spreading in a contiguous manner from the rectum proximally. Involvement of the small bowel in ulcerative colitis is mainly limited to backwash ileitis.

Major IBD affecting small bowel remains Crohn’s disease.

Crohn’s disease

CD can affect any part of the gastrointestinal tract, from the mouth to the anus. In 30-40% of patients, the small bowel is affected, whereas in 40-55% of patients, ileocolonic disease is present. Involvement of the terminal ileum is observed in 90% of patients with small intestinal CD. [5]

Imaging features on CT include : bowel wall thickening (1 – 2 cm) which is most frequently seen in the terminal ileum, bowel wall enhancement, mural stratification, strictures, fistulae, lymph node enlargement, mesenteric / intra-abdominal abscess or phlegmon formation, abscesses, pericolic or perienteric hypervascularity (comb sign) and fat halo sign (Thickened bowel wall demonstrating three layers: an inner and an outer layer of soft-tissue attenuation, between which lies a third layer of fatty attenuation). [6]

Small bowel neoplasms

Even though the small bowel corresponds to 75% of the entire length of the GI tract, only 5% of GI tract tumours involve the small bowel. Malignant tumours in the small intestine represent only 2 of GI cancers. The most frequent is adenocarcinoma (30-50%), followed by carcinoids (25-30%) and lymphoma (15-20%). Less frequent are mesenchymal tumours of the GI tract such as malignant GI stromal tumours and leiomyosarcomas. [7]

Benign neoplasms: [8]

Histology	Imaging finding
Adenoma	Sessile or pedunculated intraluminal polyps or small mural nodules, showing soft tissue density and mild post contrast enhancement
Heamangioma	Vascular malformations, which may project intraluminally if large and may have calcific foci representing phleboliths
Lipoma	A homogenous mass between -80 to -100 HU is considered diagnostic of lipoma.

Malignant neoplasms:[96]

Histology	Typical appearance
Adenocarcinoma	Concentric luminal narrowing with irregular edges. Complete bowel obstruction Heterogenous enhancement
Carcinoid	Small (<2c) single or multiple filling defects Desmoplastic reaction of the mesentery Hypervascular
Lymphoma	Coarse segmental wall thickening with ulceration and necrosis. Bulky lymphadenopathy Aneurysmal dilatation of bowel loops
GIST	Large regular mass with inhomogenous enhancement. Necrosis and/or ulceration
GIST	Large regular mass with inhomogenous enhancement. Necrosis and / or ulceration Ileal localization
Metastases	Intraluminal nodules developing from hematogenous spread to submucosal layers

Tuberculosis

The commonest site of involvement in the bowel is the terminal ileum and the ileocaecal region. There are two types of intestinal tuberculosis: ulcerative and ulcero-hypertrophic. [10]

Ulcerative type: The established lesion consists of an annular ulcer involving the entire circumference affecting a segment generally less than 3 cm in length. Cicatricial healing of these circumferential ‘girdle ulcers’ results in strictures. This type is usually seen in the small intestine.

Ultero-hypertrophic type: This variety commonly affects the ileocecal region, the patient presenting with a large mass in the right iliac fossa. The ileocaecal region, mesenteric fat, and their constituent lymph nodes are seen to constitute a large mass with extensive adhesions.

Materials (Inclusion and exclusion criteria) and Methodology

Place of study: Our institute (Tertiary care centre)

Duration of study: 2 years

Study Design: A prospective study of 34 patients was done in our department. Institutional ethics committee clearance was obtained prior to the study. Written informed consent was obtained from the subjects for inclusion of their images in the study, with the standard disclosures.

Inclusion criteria:

- Patient suspected or diagnosed of having small bowel pathologies on history and clinical examination / USG / CT scan / Barium Meal Follow Through / Barium Enteroclysis Study
- Patients with abdominal complaints with non-conclusive work-up
- Patients with suspected / proven systemic illnesses associated with small bowel pathologies.
- Follow up studies in a diagnosed case of small bowel pathologies.

Exclusion Criteria:

- Patients not consenting for the study.
- Pregnancy
- Known h/o allergy to intravenous contrast material.
- Patients requiring immediate surgical intervention such as acute obstruction, perforation etc.
- Hemodynamically unstable patients.
- Patients with fluid overload.
- Inability / refusal of patient for NJ tube placement.
- Pediatric patients.

Study protocol

Preparation: On referral for CT Enteroclysis, patient was explained about the procedure. Relevant history was noted.

Pre-procedure instructions:

- Keep NBM for at least 6 hours, preferably overnight.
- No need for fluid restriction.
- Medications, if any, should not be withheld.

On arrival in the morning, NJ tube placement was done under fluoroscopic guidance using Seimens Fluorovision 3000; 5603(Seimens) at 50-60 kV and 0.8 mA. Contrast was not injected to check the placement of the tube and it was confirmed visually on fluoroscopy only.

In some patients, endoscopy guided NJ tube placement was done.

After placement of NJ tube, patient was taken for CT scan. Patient was told to empty the bladder before the CT scanning. 3 liters of 2 % mannitol solution in plain room temperature was prepared. On the CT table, approx. 1250-2000 ml of the solution was infused by hand injection at approx 100-150 ml / min. A non-contrast scan was taken. After plain scan, another 750-1000 ml of the same solution was injected through NJ tube. Patient was monitored for abdominal discomfort and vomiting during the infusion and the infusion was terminated if patient complained of these. After this final infusion, 20 mg of Buscopan was given intravenously, immediately followed by injection of 80 mL of non-ionic iso-osmolar iodinated contrast material intravenously through a 20 gauge cannula at a rate of 3.5 mL / sec by using an automated power injector.

The delay between the start of contrast material administration and the start of helical scanning for Enteric phase was 45 seconds covering from the dome of the liver to the upper margin of the symphysis pubis. This was followed by a Hepatic Venous phase at 70 seconds after contrast injection, covering from the dome of the diaphragm till scrotum in males and till perineum in females.

As per our institution's protocols for all CT abdomen and pelvis scans, a delayed phase was taken at 8 min after contrast injection.

After the study was complete, patient was observed for contrast reactions or any other complications of the procedure for half an hour. In uneventful procedure, the NJ tube and IV cannula were removed and the patient was advised to destarve.

The images were then viewed on a workstation for degree of distension, mucosal thickness and enhancement of the bowel loops, presence of any mass or leak in the bowel loops and any associated extra-bowel pathologies.

Results and Observations

Of the 34 patients included in our study, 19 were males and 15 were females. The most common age group in referred patients was 30-39 years followed by 20-29 years. The most common presenting symptom was abdominal pain (52.9%), with the others being chronic diarrhea, bleeding PR / melena, constitutional symptoms and constipation.

We found 22 positive cases (64%), Clinical presentations in our study

Complaints	Number of patients	Positive cases	Normal
Pain in abdomen	18	13	5
Chronic diarrhea	9	5	4
Constipation	3	3	0
Malena / bleeding PR	6	4	2
Constitutional symptoms	10	6	4

Diagnosis

Category	Number of patients	Diagnosis	Patients
Infective	7	TB	7
Inflammatory bowel disease	5	Crohn's disease	4
		Ulcerative colitis	1
Malabsorption syndrome	1	Celiac sprue	1
Ischemic	1	SMV thrombosis	1
Neoplastic	8	Polyp	3
		GIST	2
		Carcinoid	1
		Adenocarcinoma	0
		Lymphoma	2
Others	1	Post-op adhesions	1
Normal	12	Normal	12

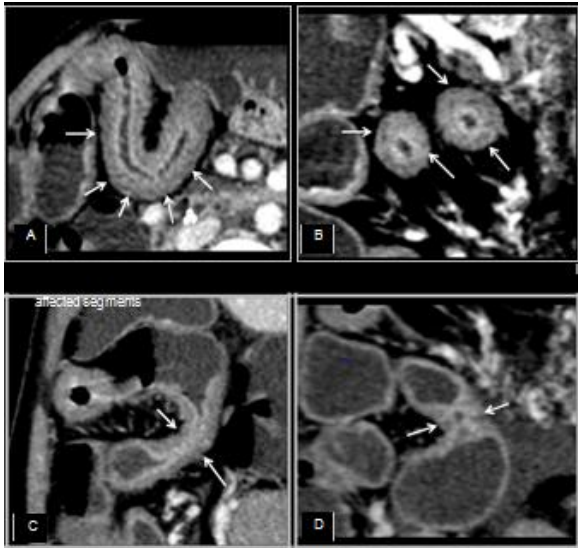


Figure 2: Crohn's disease A. Long segment ileal loop thickening (Arrows) B. Cross section – thickened bowel loop C and D. Skip lesions characteristic of Crohn's disease; with normal (arrowhead) and affected segments (Arrows)

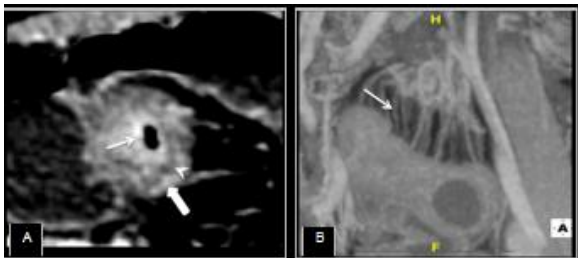


Figure 3: Crohn's disease
 A. Fat halo sign – Thin Arrow: Mucosa; Arrowhead: Submucosa; Thick Arrow: Muscularis & serosa B. Comb sign (Arrow)



Figure 4: Crohn's disease: Chronic with relapse
 A. Suspicious Entero-enteric fistula B. Site of entero-cutaneous Fistula – Arrow: Skin defect; Arrowhead: Post op fibrous tract

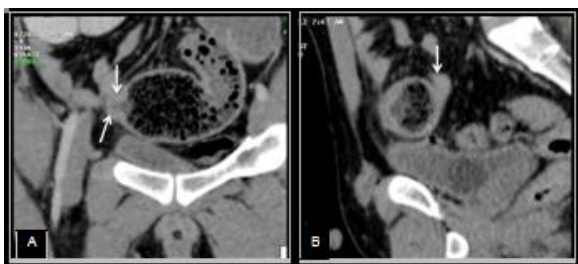


Figure 5: Tuberculosis
 A & B: Ileal Stricture (Arrows)

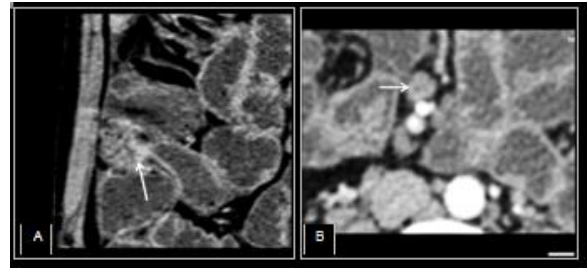


Figure 6: Tuberculosis
 A. IC junction (Arrow) B. Lymph node (Arrow)

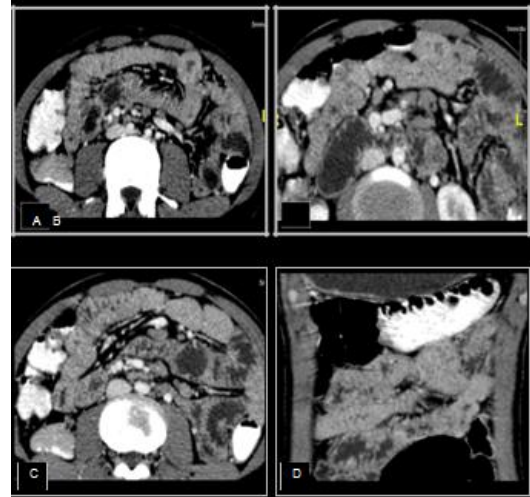


Figure 7: Tuberculosis
 A – D: Jejunal thickening

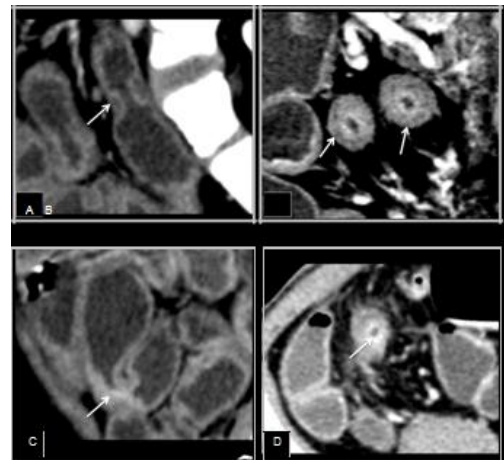


Figure 8: Tuberculosis Vs Crohn's Disease:
 A & B: Mural stratification (Arrows)
 A: Tuberculosis B: Crohn's disease
 C & D: Mucosal hyperenhancement (Arrows)
 C: Tuberculosis D: Crohn's disease

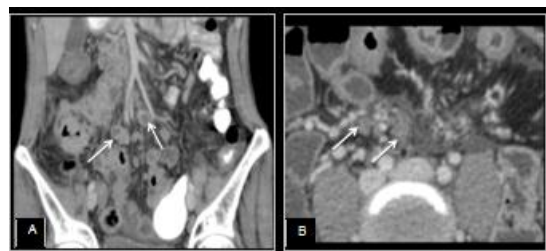


Figure 9: Tuberculosis Vs Crohn's disease:
 Lymphadenopathy (Arrows)
 A: Necrotic nodes in tuberculosis
 B: Non-necrotic nodes in Crohn's disease

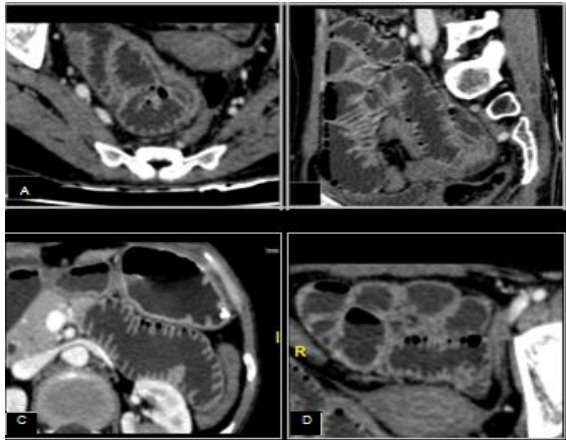


Figure 10: Celiac disease
 A, B & D: Prominent mucosal folds: Ileum
 C: Jejunal loop showing prominent mucosal folds

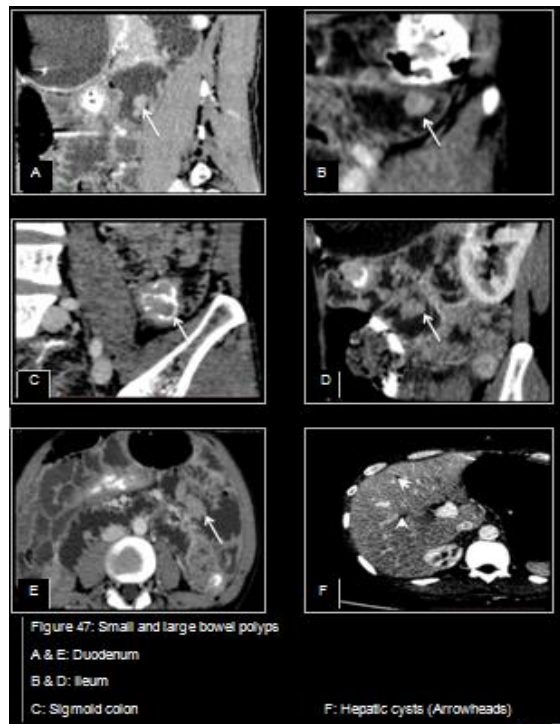


Figure 11: Small and large bowel polyps
 A & E: Duodenum
 B & D: Ileum
 C: Sigmoid colon
 F: Hepatic cysts (Arrowhead)

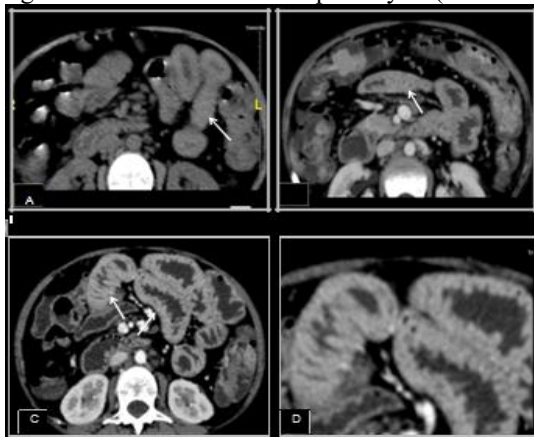


Figure 12: Small bowel ischemia; Thickened jejuna loops (Arrows)
 A: Non-contrast
 B: Venous
 C: Enteric
 D: Magnified image of C

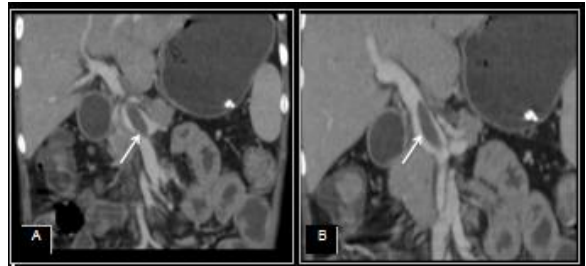


Figure 13: Small bowel ischemia: Thrombus (Arrows)
 A: Proximal SMV
 B: Portal vein

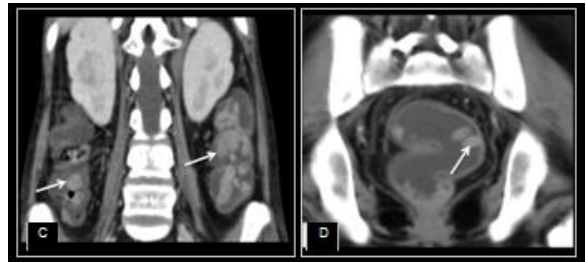


Figure 14: Large bowel polyps (Arrows)
 A: Ascending and descending colon
 B: Rectum

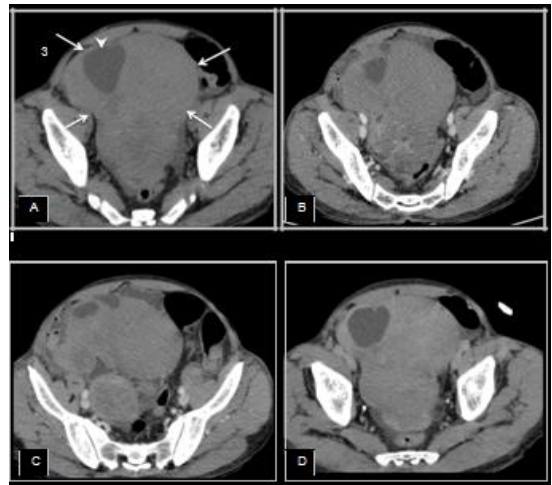


Figure 15: GIST (Arrows) with cystic component (Arrowhead)
 A: Non-contrast
 B: Enteric
 C: Venous
 D: Delayed
 Mild heterogenous post contrast enhancement is seen.

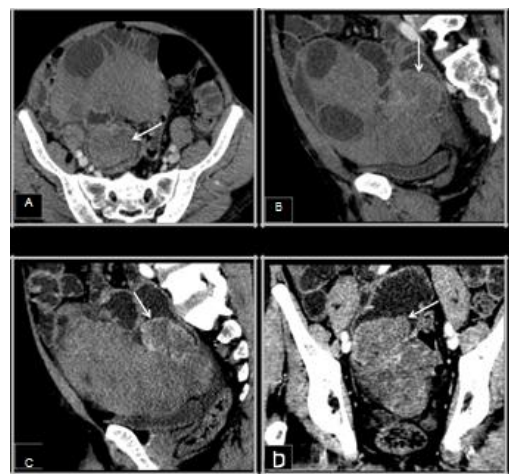


Figure 16: GIST with intraluminal component (Arrows) (A-D)

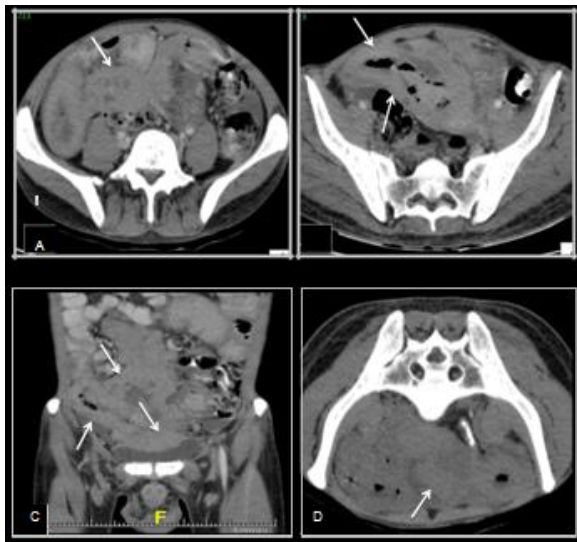


Figure 17: Lymphoma: Diffuse Small bowel thickening forming a mass (Arrows)

A: Axial B: Axial
 C: Coronal D: Prone

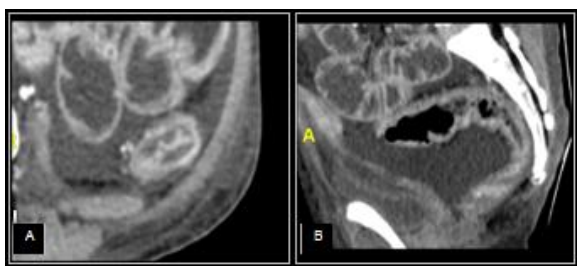


Figure 18: Ulcerative colitis – wall thickening
 A: Descending colon B: Rectum

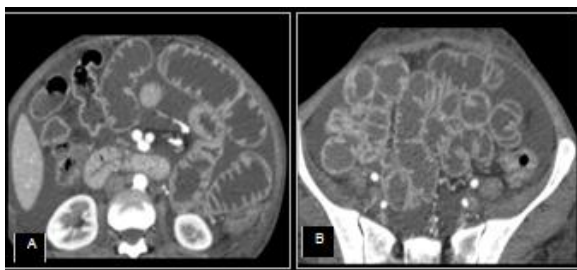


Figure 19: Ulcerative colitis – Gross ascites
 A: Normal jejunal loops B: Ileal loops

4. Discussion

The number of CT enteroclysis procedures being performed has increased considerably over the past few years. Small bowel barium studies, which many a times, do not provide the answers of specific clinical questions important for management have decreased over the years. Capsule endoscopy and MR enteroclysis are not widely available and are relatively costly investigations. These factors, along with comparatively easy availability, low cost and ease of performance of CT scan, have resulted in preference given to CT enteroclysis.

Patient characteristics:

Gender:

Out of the total 34 patients included in the study, 19 were male and 15 females. Out of 12 normal cases, there was

equal distribution in males and females. In patients suffering from infective diseases (7), 5 were male and 2 females. In inflammatory diseases, there was slight female preponderance (F:M :: 3:2). In neoplastic diseases, there was slight male preponderance with 5 males and 3 females out of 8 patients. Only one case of celiac disease was found, which was a female patient.

Age:

Most common age group was 30 to 38 years with 9 patients and 20 to 29 years with 7 patients. In these 16 patients, most common diagnosis was tuberculosis in 5 and normal study in 5 patients followed by inflammatory bowel disease in 4 patients. 1 patient had subacute obstruction while 1 had lymphoma.

In <20 years, most common diagnosis was polyp (2/5 patients) or normal study (2/5 patients) with 1 patient suffering from tuberculosis.

In >40 years, most common pathology was neoplastic diseases affecting 5 out of 13 patients with 5 patients having normal study.

Presentation:

Most common presenting symptom in our study was abdominal pain (18) followed by constitutional symptoms like loss of weight, loss of appetite, mild fever etc.

Pathology characteristics:

In our study, the most common pathology was tuberculosis. 7 out of 34 patients (nearly 20%) were found to have tuberculous infection. Our findings were consistent with the high burden of tuberculosis in India.

We found 5 cases of inflammatory bowel disease, out of which 4 were Crohn's disease and 1 case of ulcerative colitis. This is consistent with observation that 'In the past few years there has been a growing realization that, despite the high prevalence of intestinal tuberculosis, CD does occur in India'.

There were total 8 cases of neoplastic diseases, 3 patients had small and/or large bowel polyps, 2 patients had GIST, and 2 had lymphoma with 1 suspected case of carcinoid syndrome. The pathology prominent by its absence was adenocarcinoma. It is consistent with the low prevalence of small bowel adenocarcinoma.

Celiac disease remains undiagnosed in most affected people. Consistent with this, we have found only 1 case of celiac disease.

Tuberculosis

Most common age group was 20-40 years. Most common finding was wall thickening involving terminal ileum and IC junction (4 / 7 patients). One patient had jejunal wall thickening and one patient had ileal thickening. These features are consistent with the existing literature establishing ileocaecal region to be the most common site involved in the GI tract. Two of the patients had involvement of other systems in the form of pleural effusion in one and spinal TB in other patient.

3 patients had necrotic lymph nodes, while rest of them had non-necrotic lymph nodes. Most common presentation amongst TB patients was pain in abdomen.

Inflammatory bowel disease

We had 4 patients of Crohn's disease. 3 of the 4 patients had thickened bowel loops, with terminal ileal involvement seen in 2 patients. Skip lesions characteristic of CD were seen in two patients. All the patients with bowel wall thickening had mural stratification and mucosal hyper-enhancement. One patient had suspicion of entero-enteric fistula.

In our study, we found only 1 case of ulcerative colitis, which too was a diagnosed case with CT Enteroclysis done to rule out complications and other pathologies.

Celiac disease:

We have 1 patient in our study which was diagnosed as celiac disease on the basis of histopathology. CT enteroclysis was reported as prominence of ileal folds, however, definitive diagnosis was not made.

Reversed jejuno-ileal fold pattern is highly indicative of Crohn disease. This feature associates an ileal "jejunitization" with a major loss of jejunal folds. Thus prominence of ileal folds seen in our patient is consistent with this.

Neoplastic disease: Polyps

We had 3 patients with polyposis, 2 of them had small bowel polyps whereas 1 patient had only colonic polyps. None of these patients had any e/o malignant transformation at present scan. All patients were counseled for the risk of development of GI tract carcinomas and other tumours elsewhere and were advised family screening.

Neoplastic disease: GIST

We found 2 patients with GIST in our study. Both were males > 50 years.

Neoplastic disease: Lymphoma

In our series, we found two cases of lymphoma. The patients were a 30 year old male and a 40 years old female. One of the patients had aneurysmal dilatation of a bowel loop segment. This is quite characteristic feature of lymphoma.

Neoplastic disease: Carcinoid tumour

We had one case of a patient with chronic alcoholic liver disease with distension of abdomen. On CT Enteroclysis study, the patient had kinking of bowel loops in ileocaecal region which could have been attributed to the desmoplastic reaction caused by carcinoid tumour. There was no visible mass noted.

Others: Post-operative adhesions (following appendicectomy – with no significant abnormality in bowel loops in CT enteroclysis), Small bowel ischemia.

5. Conclusion

CT enteroclysis is a one stop shop for evaluating small bowel diseases with excellent depiction of the intraluminal, mural and extraluminal pathologies. Extra-intestinal pathologies were easily detected due to coverage of the

complete abdomen and pelvis. Our study highlights the importance and contribution of CT Enteroclysis in imaging a broad spectrum of bowel pathologies like tuberculosis, Crohn's disease, and multiple neoplastic etiologies like lymphoma and carcinoid. The diagnostic yield of CT as regards Crohn's disease, definitely improves with the use of Enteroclysis. Along with being an excellent radiological investigation, it also is a safe procedure. CT enteroclysis has a high negative predictive value and hence a negative scan helps to avoid unnecessary interventions. CT Enteroclysis is an excellent modality, which can thus be utilized for a broad spectrum of diseases.

References

- [1] Rondonotti E, Villa F, Mulder CJJ, Jacobs MAJM, de Franchis R. *Small bowel capsule endoscopy in 2007: Indications, risks and limitations*. World J Gastroenterol 2007; 13(46): 6140-6149
- [2] G N Bender, D D Maglinte, V R Klöppel, and J H Timmons *CT enteroclysis: a superfluous diagnostic procedure or valuable when investigating small-bowel disease?* American Journal of Roentgenology 1999 172:2, 373-378
- [3] Bartusek, D. et al. *Small bowel ultrasound in patients with celiac disease* European Journal of Radiology, 2007 Volume 63, Issue 2, 302 – 306
- [4] Hanauer SB *Inflammatory bowel disease: epidemiology, pathogenesis, and therapeutic opportunities*. Inflammatory Bowel Diseases. 2006 12(5): p S3-S9.
- [5] Kumar, V., et al., *Robbins and Cotran Pathologic Basis of Disease*. 2009: Elsevier Health Sciences.
- [6] Furukawa A., et al, *Cross-sectional Imaging in Crohn Disease* RadioGraphics 2004 24:3, 689-702
- [7] DiSario, J. A., Burt, R. W., Vargas, H., & McWhorter, W. P. *Small bowel cancer: Epidemiological and clinical characteristics from a population-based registry*. American Journal of Gastroenterology, 89(5), 699-701.
- [8] Gore R. M. and M. S. Levine, *Textbook of gastrointestinal radiology*. 3rd ed. [edited by] Richard M. Gore, Marc S. Levine, ed. 2008, Philadelphia, Pa. : [Edinburgh]: Saunders
- [9] M Anzidei et al., *Malignant tumours of the small intestine: a review of histopathology, multidetector CT and MRI aspects* The British Journal of Radiology, 84 (2011), 677–690
- [10] Tandon, H.D. and A. Prakash, *Pathology of intestinal tuberculosis and its distinction from Crohn's disease*. Gut, 1972. 13 (4): p. 260-9.