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SPECTRUM OF IMAGING FINDINGS ON MDCT ENTEROGRAPHY IN PATIENTS WITH SMALL BOWEL TUBERCULOSIS

Radio-Diagnosis

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KEYWORDS

INTRODUCTION

Tuberculosis (TB) is a global disease, which is endemic in developing countries. Recently, it has shown increased incidence in endemic areas and resurgence in non-endemic regions due to human immuno-deficiency virus infection, drug resistance, increased use of immunosuppressive drugs, and increased migration.[1] The lungs and the mediastinum are the most frequently involved sites. However, TB may also involve many other organ systems (gastrointestinal, central nervous, genitourinary, cardiac, and musculoskeletal systems). The incidence of extrapulmonary TB is 15-20% affecting the abdomen including the small bowel. Abdominal TB is the sixth most common extrapulmonary site of involvement. [2] Only 15% of patients with abdominal TB have evidence of pulmonary disease and chest radiography may be normal in 50-65% of these patients.[3] Abdominal tuberculosis can develop from ingestion of the tubercle pathogen in infected sputum or milk. It can also develop from reactivation of a latent focus in the abdomen following haematogenous spread during an earlier primary infection, or haematogenous or lymphatic spread from current active tuberculosis, or by direct extension from adjacent involved tissues. The sites of involvement in abdominal tuberculosis, in descending order of frequency, are lymph nodes, genitourinary tract, peritoneal cavity, and gastrointestinal tract.[4] Tuberculous involvement of the solid organs in abdomen (liver, spleen, pancreas, and adrenals) is rare, but may be seen in cases with disseminated TB.[4] The radiological armamentarium for evaluating tuberculosis of the small bowel includes barium studies (small bowel follow-through, SBFT), multidetector computed tomography (MDCT; enterography and enteroclysis), ultrasound (sonoenteroclysis), and magnetic resonance imaging (MRI; enterography and enteroclysis). Endoscopic methods include ileoscopy, push enteroscopy, double-balloon endoscopy, and wireless-capsule endoscopy. In this study, we illustrate the abnormalities at MDCT enterography of 125 patients,of which 20 had proven TB of the small bowel and we also describe the extraluminal findings in these patients. The patients were referred from the Gastroenterology and Surgery Departments of Vydehi Institute of Medical Sciences and Research from January 2023 to January 2024 with a clinical suspicion of small bowel TB(SBTB). Symptoms and/or signs that raised suspicion were recurrent abdominal pain with episodes of vomiting and/or distension of the abdomen associated with fever, loss of weight, and appetite for more than 4 weeks duration. The diagnosis of TB was confirmed by histopathological findings from endoscopic biopsy, surgical findings in patients undergoing surgery, pathological findings from surgical specimens, cytological findings from fine-needle aspiration cytology (FNAC), or response to anti-tubercular treatment in the form of resolution of symptoms and/or radiological improvement at the end of 6months of treatment in certain cases in which no biopsy/ FNAC was possible.[5]

Pathology of SBTB

SBTB is characterized by inflammation and fibrosis of the bowel wall and involvement of the regional lymph nodes. Ileocaecal involvement is the commonest site of gastrointestinal tract TB, seen in approximately 90% of patients. There is inflammation of the submucosal lymphoid tissue with formation of epithelioid granulomas, cellular infiltration, and lymphoid hyperplasia resulting in intestinal mural thickening.[5] Two to 4 weeks after infection, caseous necrosis occurs in this inflammatory tissue leading to ulceration of the overlying mucosa. Further spread within the bowel wall and to regional nodes occurs via the lymphatic route.[6]

The bowel may adhere to adjacent lymph nodes forming an inflammatory mass. The gross appearance of these lesions is categorized into three forms: ulcerative form (60%), hypertrophic form (10%), and ulcero-hypertrophic form (30%).[7] The ulcerative form is characterized by presence of multiple small ulcers (3-6mm diameter) with their long axis perpendicular to the long axis of the bowel. Healing of deep and circumferential ulcers often results in fibrotic strictures. Thickening of the bowel wall with an extensive inflammatory response producing a rigid, mass-like appearance gives rise to the hypertrophic form. Combined features of both forms can lead to an ulcero hypertrophic form. The sites of involvement in descending order of frequency are the ileocaecal junction, followed by the ileum, caecum, ascending colon, jejunum, rest of the colon, rectum, duodenum, and stomach.[8]

Imaging of SBTB

As mentioned earlier many imaging methods are used in the diagnosis of SBTB. SBFT is the conventional imaging method used, which shows some of the characteristic features of TB. Early intestinal TB shows spasm, hypermotility, and oedema of the ileocaecal valve. Many characteristic signs of TB have also been described on SBFT, such as Fleishner's sign (narrowed terminal ileum with thickening of the ileocaecal valve lips and/or wide gaping of the ileo caecal valve) and Sterling's sign or the inverted umbrella sign (conical and shrunken caecum resulting in a widely open ileocaecal valve with fixed and narrowed terminal ileum due to fibrosis), which occurs in advanced disease. In advanced stages, the caecum becomes conical, shrunken, retracted, and fixed. [9] However, SBFT is a passive transit study of barium and has many disadvantages, such as poor luminal distensibility, overlap of bowel loops, and lack of extraluminal information. In barium enteroclysis, catheter intubation and luminal distension are undertaken, which results in better demonstration of mucosal details, ulcers, and multiple strictures. [10] It has the disadvantage of being invasive with extended examination times, high radiation doses, and lack of extraluminal information. CT can be used to evaluate the bowel lumen and wall, as well as extraluminal disease. Mucosal details demonstrated by the barium examination are not well seen at CT. How ever, it allows a comprehensive overview with direct imaging of the bowel, mesentery, and lymph nodes including bowel dilatation and bowel wall thickening. Also, in many patients there may be peritoneal and lymph nodal involvement, without significant changes in the bowel. The most common finding at CT is the hyperplastic form of TB involving ileocaecal region. In the early stages, there is mild symmetric circumferential mural thickening of the

terminal ileum and caecum. Later, there is focal asymmetric thickening of the ileocaecal valve and adjacent medial caecal wall.[11] In more advanced disease, there is gross bowel wall thickening, large regional nodes, mesenteric thickening, and adherent bowel loops forming a soft-tissue mass in the right iliac fossa. CT also assesses the complications that may occur such as obstruction, perforation, abscess formation, vascular complications such as ischaemia, fistulae, and intussusception.[8] However, it has the disadvantage of having poor distensibility of the bowel loops in many patients. Therefore, mild mural thickening, character of bowel wall thickening, and strictures may be missed when bowel loops are not well distended. CT enteroclysis is a hybrid method that combines the advantages of enteral volume challenge of enteroclysis and the cross-sectional imaging ability of CT. It provides luminal, mural, and extraluminal information. However, being invasive, due to catheter intubation, it is not well tolerated by most patients. It also has its disadvantages of extended examination times and high radiation doses. MRI of the small bowel may be performed with enterography or enteroclysis. It has recently emerged as an imaging method that can be used in the assessment of diseases of small bowel. Lack of ionizing radiation and high tissue contrast resolution are the advantages of MRI. MR enterography adds the advantage of higher tissue contrast than CT enterography with the same design of ingesting large volumes of oral contrast material to obtain good luminal distension. Limitations of MRI include the higher cost, lesser availability, and variability in image quality (related to patient cooperation and ability to breath-hold). It also has lower spatial and temporal resolution than CT. Studies have shown that CT enterography and MR enterography have similar sensitivities for detecting active small-bowel inflammation, but CT has better image quality. [13] However, no study has been published in the English literature citing the findings of MR enteroclysis or MR enterography in SBTB.

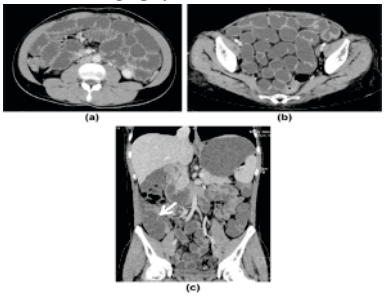

Figure 1: Normal small bowel. (a) Axial CT image shows normal jejunal loops. (b) Axial CT image shows normal ileal loops. (c) Coronal CT image shows normal ileocaecal junction (arrow).

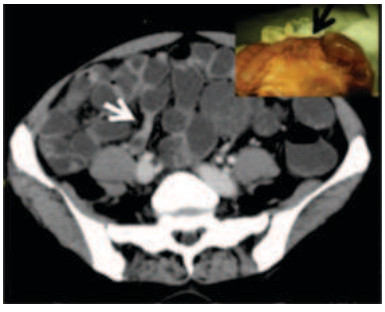

Figure 2: Axial CT image shows isolated short-segment ileal stricture (arrow). Inset shows the correlating intraoperative gross photograph of ileal stricture (black arrow).

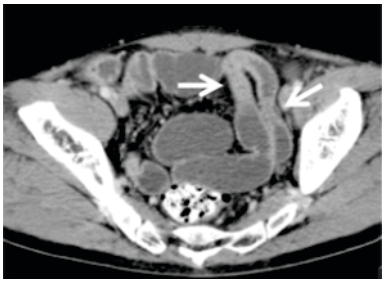

Figure 3: Axial CT image shows isolated short and long-segment ileal strictures (arrows)

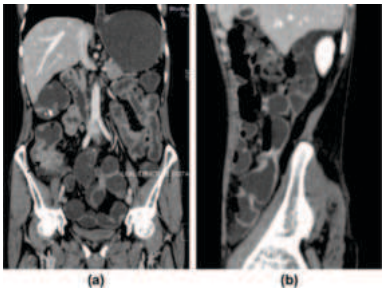

Figure 4: Multiple small bowel strictures with ileocaecal involvement. (a) Coronal CT image shows ileal stricture with mass-like configuration in ileocaecal region (arrow). (b) Sagittal CT image shows multiple ileal strictures with interstricture bowel dilatation.

MDCT Enterography

MDCT enterography overcomes many of the disadvantages of other imaging methods. It combines isotropic-voxel acquisition with the controlled oral intake of large volumes of neutral contrast agents and rapid intravenous administration of iodinated contrast medium to improve visualization of the small bowel wall and its mural features along with extra-intestinal manifestations, if any. [14] It allows non-invasive good-quality assessment of well-distended bowel loops and the adjacent soft tissues. It displays the entire bowel wall thickness and enhancement pattern in all the three planes and allows examination of all bowel loops, especially ileal loops, which are mostly superimposed. It allows better anatomical localization of the disease.

Methodology

For MDCT enterography, patients were kept on a low residue diet with intake of plenty of fluids on the day prior to the examination. Patients were asked to fast for 6 h before the procedure. Polyethylene glycol (PEG) was the electrolyte solution used as enteral volume challenge and as a negative contrast medium. PEG solution (1000-1500 ml) was given over 20 min followed by another 1000-1500 ml PEG solution over the following 15 min. Acquisition was performed 70 s after injection of 100 ml non-ionic intra venous contrast (300 mg iodine/ml) at rate of 3 ml/s on a Siemens Sensation CT machine.

Imaging Findings

The imaging findings that can be seen on MDCT enterography have been classified into various subgroups (Table 1). [15] The bowel was considered dilated when the luminal diameter of the jejunum was >3 cm and >2.5 cm for the ileum. Bowel wall thickness 3 mm is considered as abnormal mural thickening when luminal distension is adequate. Mural thickening can be stratified 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 cm). Jejunal folds measuring >2 mm are considered thickened.[15] The normal appearance of the small bowel loops and ileocaecal junction is depicted in Fig 1. In SBTB, skip areas of involvement may be seen in the small bowel loops. Focal involvement (65%) is more commonly seen than segmental or diffuse involvement. Multifocal involvement is more common than solitary focal involvement. Strictures are the commonest abnormality seen at MDCT enterography (90%; Figs 2 and 3). The terminal ileum and the ileocaecal region are the most common site of stricture (78%).

Short-segment strictures(< 3 cm) are more common than long segment (>3 cm) strictures. Strictures can be multiple (66.7%) or solitary (33.3%). Fifty percent of patients with multiple strictures have concomitant ileocaecal involvement (Fig 4). The most common site of solitary stricture is the terminal ileum with contiguous ileocaecal involvement (Figs 5-7).

Symmetric concentric mural thickening is more commonly seen than asymmetric concentric mural thickening (Figs 8 and 9), although both forms of mural thickening can coexist in the same patient. However, eccentric mural thickening is not seen. Mural thickening without stricture formation is commonly present in the jejunum. Severe mural thickening is associated with long-segment strictures.

Homogeneous mural enhancement is seen in 91% of strictures (Fig 9). Strictures with mild or moderate mural thickening are associated with homogeneous contrast enhancement. Non-homogeneous mural enhancement is seen with severe mural thickening (Fig8) and long-segment strictures. Mural stratification is not seen with TB strictures.

Mesenteric lymphadenopathy is seen in 90% of patients. The enlarged lymph nodes may be necrotic, homogeneous, or may show calcification (Figs 7, 8 and 10). Necrotic lymphadenopathy is seen in 44% of patients. Discrete lymphadenopathy is more common than conglomerate lymph nodal mass. Calcified lymph nodes have to be distinguished from enteroliths. Enteroliths are small intestinal calculi seen proximal to intestinal stasis and are rare in Figure 14 Diagrams illustrating the salient features of tuberculosis (a) and Crohn's disease (b) on imaging. Adapted from Textbook of pathology by Harsh Mohan, 6th ed, Jaypee Brothers, New Delhi, 2010. SBTB (Fig 11). Although ascites is not a common finding (Fig 12), when seen it is usually of high density (radio density >10 HU). Peritoneal thickening and enhancement is seen in 15% of the patients (Figs 12 and 13). Mesenteric congestion and stranding is rarely seen. Crohn's disease should be considered in the differential diagnosis of SBTB. [16] Some findings on MDCT enterography may help in differentiating these two conditions (Table 2; Fig 14). In TB, the strictures are concentric, there is no mural stratification, and there is no mesenteric congestion. Lymph nodes with necrosis and high-density ascites, when seen, are characteristic of TB. In Crohn's disease, strictures are eccentric and there is mural stratification. The mesentery is hypervascular with fibro-fatty proliferation. Lymphadenopathy, when present, is mild and abscess and fistulae are more common with Crohn's disease.

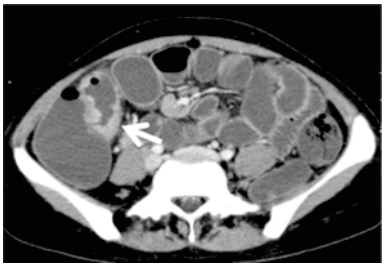

Figure 5: Axial CT image shows concentric mural thickening of ileum and ileocecal valve (arrow).

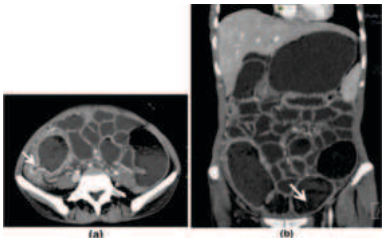

Figure 6: Ileocaecal tuberculosis. (a) Axial CT image shows gaping ileocaecal valve with mural thickening in this region (arrow). (b) Coronal CT image shows markedly dilated distal ileum with presence of small bowel faeces sign (arrow). Small bowel faeces sign is a CT sign seen in small bowel obstruction because of the intermixing of air with material that is static in obstructed small bowel proximal to transition zone

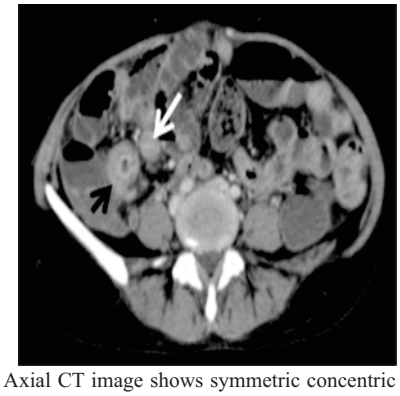

Figure 7: Axial CT image shows symmetric concentric mural thick ening of terminal ileum (black arrow). There is also presence of regional homogeneous lymphadenopathy (white arrow)

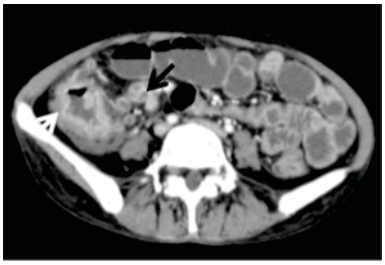

Figure 8: Axial CT image shows asymmetric concentric mural thickening of terminal ileum and caecum (white arrow) with non homogeneous enhancement. There is also presence of regional necrotic lymphadenopathy (black arrow) and mild fluid in pericecal region.

Figure 9: Axial CT image shows concentric mural thickening of distal ileum (arrow) with homogeneous enhancement.

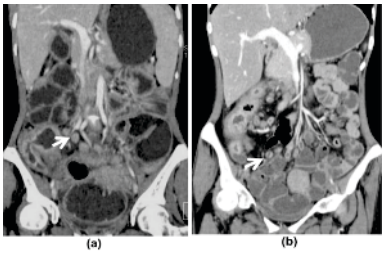

Figure 10: Regional lymphadenopathy in ileocaecal tuberculosis. (a) Coronal CT image shows discrete homogeneous lymph nodes in the mesentery (arrow). (b) Coronal CT image shows discrete necrotic lymph nodes in the mesentery (arrow) in another patient.

Figure 11: Enteroliths in ileocaecal tuberculosis. Sagittal CT image shows multiple enteroliths in distal ileum proximal to a stricture (arrow). Enteroliths are small intestinal calculi seen proximal to intestinal stasis and are rare in intestinal TB.

Figure 12: Axial CT image shows high-density ascites with enhancing peritoneum in the pelvis (arrow).

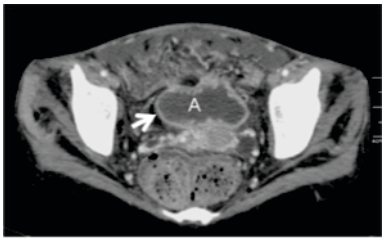

Figure 13: Axial CT image shows loculated ascites (A) with enhancing peritoneum in the pelvis (arrow)

Table 1: Classification Of Small Bowel Abnormalities Based On Multidetector Row Computed Tomography Findings.

Abnormality	Subgroups	Criteria
Dilated lumen	Jejunum	Calibre >3 cm
	Ileum	Calibre >2.5 cm
Increased wall thickness (≥3 mm)	Degree	Mild: 3–4 mm
		Moderate: 5–9 mm
		Marked: ≥10 mm
	Pattern of involvement	Symmetric
		Asymmetric
	Extent of circumference	Circumferential
		Eccentric
	Pattern of enhancement	Double halo/target (mural stratification)
		Homogeneous hyperenhancement
		Heterogeneous
		Decreased/absent
Length of diseased bowel	Focal	≤5 cm
	Segmental	5–40 cm
	Diffuse	>40 cm
Stricture	Short segment	<3 cm
	Long segment	≥3 cm

Table 2: Differentiating Features Between Tuberculosis And Crohn's Disease On Imaging.

Imaging abnormality	Tuberculosis	Crohn's disease
Strictures	Concentric and smooth	Eccentric and with sacculations
Mural thickening	Without stratification	With stratification
Mesenteric congestion	Absent	Present
Lymph nodes	With necrosis	Mild lymphadenopathy, without necrosis
High-density ascites	Present	Absent
Fibro-fatty proliferation	Absent	Present
Abscesses and fistulae	Absent	Present

Summary

The terminal ileum and ileocaecal junction are the most common sites of small bowel involvement in intestinal TB. The most common abnormality is short-segment strictures with symmetrical concentric mural thickening and homogeneous mural enhancement. Other findings include lymphadenopathy, ascites, enteroliths, peritoneal thickening, and enhancement. In conclusion, MDCT enterography is a comprehensive technique for the evaluation of SBTB.

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