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Original Article

Dual-Energy CT Enterography in Intestinal Tuberculosis: Role of Relative Enhancement Calculated on Iodine Maps in Assessing Disease Activity

Deeksha Bhalla[1] Tarvinder Singh[1] Anmol Bhatia[1] Naveen Kalra[1] Rakesh Kochhar[2] Vikas Gupta[3] Kim Vaiphei[4]

[1] Department of Radiodiagnosis and Imaging, Postgraduate Institute of Medical Education and Research, Chandigarh, India
[2] Department of Gastroenterology, Postgraduate Institute of Medical Education and Research, Chandigarh, India
[3] Department of General Surgery, Postgraduate Institute of Medical Education and Research, Chandigarh, India
[4] Department of Histopathology, Postgraduate Institute of Medical Education and Research, Chandigarh, India

Address for correspondence Naveen Kalra, MD, Department of Radio Diagnosis and Imaging, Post Graduate Institute of Medical Education and Research, Sector-12, Chandigarh 160012, India (e-mail: navkal2004@yahoo.com).

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Abstract

Objective This article studies the role of dual-energy computed tomography (DECT) enterography with iodine material decomposition images in activity assessment of tuberculosis of the bowel.

Materials and Methods Twenty-four patients with suspected tuberculous bowel involvement were enrolled in this prospective study. All patients underwent DECT enterography as well as endoscopy and biopsy. Quantitative assessment of iodine overlay images was done to map the absolute and relative iodine uptake in involved segments of the bowel and lymph nodes. Comparison of the iodine uptake was made with histopathological activity grading using Spearman's correlation. The temporal change in the iodine uptake on posttreatment versus pretreatment group was recorded and tested for significance using Student's *t*-test and Wilcoxon signed rank test.

Results Excellent correlation was found between grading of inflammatory activity on histopathology and relative bowel enhancement measured on iodine maps (Spearman's rho 0.895, $p < 0.001$). Attenuation values and absolute iodine uptake in the bowel showed no significant difference in the pre- and posttreatment groups ($p > 0.05$), while relative bowel as well as lymph nodal enhancement were significantly different ($p = 0.001$ and 0.008, respectively).

Conclusion Uptake on the iodine maps in DECT data set showed correlation with histopathology as well as posttreatment resolution, suggesting the role of DECT in disease activity assessment.

Keywords
- dual-energy CT
- intestine
- iodine maps
- lymph nodes
- tuberculosis

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Introduction

Extrapulmonary tuberculosis (TB) constitutes 10 to 15% of all TB cases, with bowel TB accounting for approximately 11 to 16%.[1,2] It is the sixth most common site of extrapulmonary TB.[1,3,4] Evaluating bowel TB poses numerous challenges, particularly due to inadequate bowel distension and the difficulty in quantifying disease activity during initial assessments and posttreatment follow-ups. Although computed tomography (CT) and magnetic resonance enterography, using large-volume neutral oral contrast, have proven superior to traditional small bowel follow-through for bowel distension,[5–8] imaging disease activity remains a largely unresolved issue.

The paucibacillary nature of bowel TB complicates diagnosis further, as acid-fast bacilli (AFB) are difficult to isolate, and mimics of TB can also present with granulomatous inflammation on histopathology.[9] As a result, diagnosis often relies on a "satisfactory response" to antitubercular therapy (ATT).[10] Some studies define this response as the healing of mucosal ulcers at follow-up colonoscopy,[11] but reliable noninvasive markers for response evaluation remain elusive. While C-reactive protein levels have been suggested as a potential marker, they are not elevated in all patients at baseline, limiting their utility.[12]

Dual-energy CT (DECT) that acquires images at both high and low voltage, may offer additional information over conventional CT enterography by quantifying iodine uptake.[13] Various techniques exist for acquiring DECT data sets, including rapid switching of X-ray tube potential and dual-source systems.[14] Regardless of the method, iodine uptake maps generated from DECT data can be valuable in assessing disease activity, as seen in inflammatory bowel disease.[15]

In this study, we evaluated the utility of DECT enterography in patients with intestinal TB, particularly the ileocolic segment, to determine its role in quantifying disease activity, correlating imaging findings with histopathological results, and monitoring the resolution of the disease following treatment.

Materials and Methods

Study Design

This was a prospective study performed after obtaining ethical clearance from the institutional review board. Written informed consent was taken from all patients.

Forty-four patients who presented with symptoms suggestive of bowel TB (abdominal pain, weight loss, fever, diarrhea, constipation) over a period of 18 months (between January 2018 and July 2019) were enrolled. A composite gold standard was used for diagnosis of intestinal TB. This comprised of:

(1) Pathological evidence from surgical or biopsy specimens
(2) Microbiological evidence from extraintestinal sites including, but not limited to, the lymph node (LN), lung, solid abdominal organs, or vertebra
(3) Molecular evidence in the form of positive Xpert MTB/RIF assay from aspirates of the LNs, omentum, ascitic, or pleural fluid
(4) Response to ATT in the form of resolution of symptoms or reduction/resolution of lesions in case no pathological/microbiological evidence available

Patients underwent colonoscopy within 1 week of the DECT enterography; endoscopic biopsy of involved colonic and/or distal ileal segments detected at endoscopy was performed. After exclusion of patients with inadequate image quality, normal imaging, and alternative diagnosis, 24 patients were enrolled in the final analysis. ATT was initiated for all these patients, which varied between 6 and 12 months based on institutional protocol. At the end of therapy with clinical resolution of disease activity, repeat imaging was performed to document resolution of disease on radiology.

Histopathological Activity Assessment

The histopathological activity on biopsy specimens was classified as follows (adapted from reference [15]):

(1) Inactive: predominant patchy fibrosis in lamina propria and splaying of muscularis mucosa with replacement fibrosis
(2) Active: mucosal ulceration, epithelioid cell granulomas, colitis including crypt distortion, crypt abscess, and crypt loss
(3) Florid active: ill-formed granulomas with dense inflammatory infiltrate in the mucosa and submucosa, formation of lymphoid aggregates or follicles

DECT Enterography

All the patients were advised low residue diet and plenty of fluids on the day prior to the procedure. Minimum of 8 hours' fasting was required before examination. Polyethylene glycol was used as a neutral oral contrast agent for distension of the bowel. Two sachets (13–15 g each) of polyethylene glycol were diluted in 2 L of water. Patients were administered intravenous hyoscine butylbromide (20 mg) and ondansetron (8 mg) prior to solution intake. They were then asked to consume 1500 to 2000 mL of solution within 35 minutes prior to examination. The volume was divided in two parts, two-thirds of the volume, that is, 750 to 1000 mL was consumed in the initial 20 minutes, and one-third of the volume, that is, 500 to 1000 ml was consumed in the next 15 minutes.

Scan Acquisition and Postprocessing

Note that 1 to 2 mL/kg of nonionic iodinated contrast with iodine concentration of 300 mg/mL was used (Iohexol, CT vision). Rate of contrast administration was 2.5 to 3 mL/second using 18 to 22 G cannula. Scans were acquired on a dual-source dual-energy scanner (Somatom Definition Flash 128 slice scanner, Siemens) with detector configuration of 64×0.6. High kVp 140/120 and low kVp 80/100 data sets were acquired in portal venous phase (60 seconds after contrast administration) in a single breath hold covering the *Z*-axis from domes of diaphragm to pubic symphysis.

Postprocessing of the acquired data was done on the SyngoVia workstation, and the acquired dual-energy data set in venous phase was reconstructed on the CT console as a weighted average of the high and low kVp acquisitions. The weighting factor was 0.5 for the low kVp data set and 0.5 for the high kVp data set. The pure low kVp and high kVp data sets and the iodine maps were also generated on the workstation from the source data obtained in the venous phase.

Image Interpretation

Images were evaluated in a prospective manner by two radiologists (N.K. and A.B. with more than 12 and 6 years of experience in gastrointestinal radiology). Both radiologists were blinded to clinical and prior radiological details. Any discordance among the readings was settled by consensus approach. The parameters assessed are described below.

Image Quality Assessment

Bowel distension was assessed and graded as "good" (jejunum > 2.5 cm and ileum > 2 cm), "adequate" (only one segment, either jejunum or ileum having good distension), or "poor" (jejunum < 2.5 cm and ileum < 2 cm).

Gray Scale Images

The mixed kV images were used for recording gray scale findings. The number of involved segments was classified into "single," 2 to 3, or > 3. Mural thickening was measured in the thickest segments, and graded as mild (3–5 mm), moderate (6–10 mm), or severe (> 10 mm). Length of involvement was classified into focal (< 5 cm), segmental (5–40 cm), or diffuse (> 40 cm). The longest length of involvement was recorded in case of multisegmental disease.

The presence or absence of mesenteric, retroperitoneal, and periportal lymphadenopathy was independently recorded. A cutoff of 10 mm short-axis diameter was used to label the LNs as enlarged.

Iodine Maps

All region of interests (ROIs) were drawn manually. ROIs were set in the wall of normal appearing bowel and the mean attenuation was recorded. ROIs were then set in the wall of the involved bowel over a fixed area of 0.1 cm^2 and the attenuation, iodine level, and the relative enhancement (expressed as a percentage of the enhancement of normal bowel wall) were recorded. Mean of three ROIs drawn in the involved bowel was taken.

To summarize:

Absolute enhancement of involved bowel segment = Attenuation value (in HU) obtained on iodine overlay map

Relative enhancement of involved bowel segment (in %) = Attenuation value (in HU) of involved bowel segment on iodine overlay map/Attenuation value (in HU) of normal appearing bowel segment on iodine overlay map × 100

For measurement of LN enhancement, ROIs were set in normal appearing inguinal LN in all patients and the mean attenuation and contrast enhancement were recorded. ROIs were then set in the enlarged LN, if any, or in locoregional or mesenteric LN in case no lymphadenopathy was identified. Necrotic LNs were excluded from the calculation. The mean of three ROIs drawn over an area of 0.1 cm^2 was recorded.

The relative enhancement was classified into low (≤ 100%), moderate (101–200%), and high (> 200% enhancement). The method of quantitative measurement on iodine maps is summarized in ►**Fig. 1**.

In the posttreatment scans of patients in case of no appreciable mural thickening, ROIs were applied over the segments of bowel, which were previously involved, to see the change in relative enhancement. Similarly, change in relative nodal enhancement was recorded. In case of no enlarged LN, values in previous involved or locoregional nodes were taken for analysis.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics (version 25.0). Wilcoxon signed rank test was used to compute significance of difference between ordinal data in pre- and postimaging data sets, which included length of involvement, number of bowel segments, degree of mural thickening, and relative enhancement. Pearson's chi-square test or Fisher's exact test, wherever applicable, was used to test significance of difference between means of categorical variables—mesenteric and retroperitoneal lymphadenopathy in the pretreatment versus posttreatment group, as well as between clinical symptoms of patients and parameters on gray scale as well as iodine maps. Paired Student's *t*-test was used for comparing normally distributed interval data such as attenuation and absolute iodine level. Spearman's rho was used for correlation between ordinal data obtained on two different modalities such as DECT and histopathology. All the statistical tests were two-sided and performed at a significance level of $\alpha = 0.05$.

Results

Twenty-four patients were included in the final statistical analysis (14 males, 10 females) with age range of 13 to 82 years (median 26 years).

Colonoscopy was performed in all patients. The evaluation extended from the rectum till the distal ileum. Nineteen of 24 patients underwent colonoscopic biopsy ($n = 17$) and surgical resection ($n = 2$); with pathological examination of surgical specimens.

Histopathological Activity Assessment

On disease activity assessment, active disease was most frequently encountered, seen in 14 of 19 patients (83.6%). Florid activity was seen in 3 of 19 patients (15.8%), while inactive disease was seen in 2 (10.5%) patients.

Image Analysis

Image Quality

Ten patients (41.8%) had adequate bowel distension, while 14 (58.3%) patients had good bowel distension. It was seen that all patients not showing "good" distension had collapsed jejunal loops, mostly those of the proximal half.

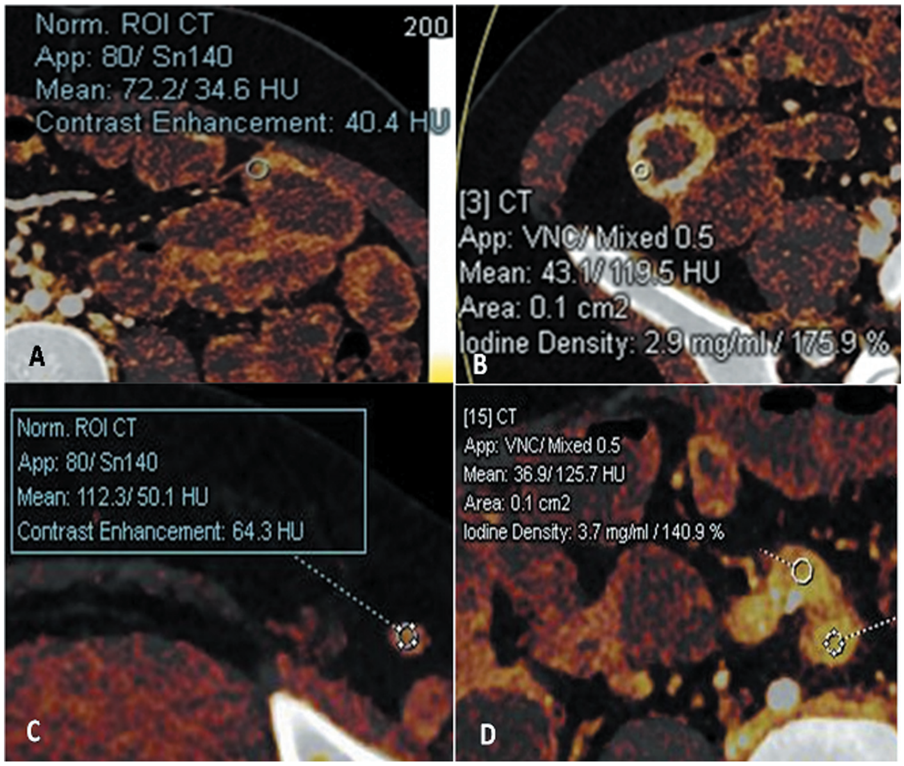

Fig. 1 Quantitative measurement of iodine uptake. (**A**) In the first step, a region of interest (ROI) was placed over a normal appearing bowel loop to set the reference standard for the scan. (**B**) Following this, an ROI of 0.1 cm^2 was placed over the most enhancing affected bowel segment. The mean attenuation (HU) and iodine density were recorded (mg/mL). The relative enhancement was recorded as a percentage of the normal bowel enhancement. (**C**) Similarly, for lymph nodes, inguinal lymph nodes were used as a reference standard. (**D**) The attenuation, iodine density, and relative nodal enhancement were also recorded. Mean of three ROIs was used as the final value.

Gray Scale Images

Eight (33.3%) patients had two to three involved segments, while another 8 (33.3%) patients had more than three segments involved. Single segment involvement was seen in 7 of 24 patients, while one patient had no discernible bowel pathology as previously mentioned. Thirteen patients had severe mural thickening (54.2%), followed by moderate thickening in 8 (33.3%). Two (8.4%) patients showed mild mural thickening. One patient (4.2%) showed no discernible bowel pathology on imaging. Ten patients (41.8%) had focal involvement while 13 (54.2%) patients had segmental bowel involvement.

The most common site of involvement was the ileocecal junction and terminal ileum, present in 21 of 24 patients (87.5%). The other bowel segments involved were the distal ileal loops (41.6%), colon (29.2%), and jejunum (16.5%). Ileocecal region involvement was present in 100% (7 of 8) patients with solitary lesions and in 87.5% (14 of 16) patients with multiple involved segments.

Mesenteric lymphadenopathy was seen in 15 patients (62.5%), while periportal/retroperitoneal lymphadenopathy was seen in 3 patients (12.5%).

Iodine Maps

On assessing the relative enhancement of bowel, it was seen that 3 patients (12.5%) had ≤ 100% enhancement, 15 patients (62.5%) had 101 to 200% enhancement, and 6 patients (25%) had > 200% enhancement. On assessment of relative LN enhancement, 11 patients (45.8%) had ≤ 100% lymph nodal enhancement, another 11 (45.8%) had 101 to 200% enhancement, while 2 (8.4%) had > 200% enhancement.

►**Table 1** shows the correlation between levels of bowel enhancement noted on the iodine maps and the inflammatory activity on histopathology in the 19 patients who underwent colonoscopic biopsy. The results of statistical tests testing difference between clinical features and gray scale as well as iodine map values are depicted in ►**Supplementary Table S1** (online only). Relative nodal enhancement showed a statistically significant result when related to systemic symptoms of inflammation such as fever and weight loss.

Table 1 Correlation between levels of bowel enhancement on the iodine maps and the inflammatory activity on histopathology ($n = 19$)

	Iodine overlay maps ($n = 19$)			Total
Biopsy ($n = 19$)	High (> 200%)	Moderate (100–200%)	Low (≤ 100%)	
Florid active	2 (10.5)	1 (5.2)	–	3 (15.7)
Active	–	14 (73.6)	–	14 (73.6)
Inactive	–	–	2 (10.5)	2 (10.5)
Total	2 (10.5)	15 (78.9)	2 (10.5)	Rho = 0.895[a]

[a]$p = 0.000$.

Table 2 Comparison of the iodine map findings between pre- and posttreatment scans in 17 patients

	Pretreatment	Posttreatment	*t*	p^a
Attenuation normal bowel (HU) Mean	68.63	66.47	−0.532	0.603
SD	22.54	22.34		
Attenuation involved bowel (HU) Mean	33.20	25.48	0.848	0.414
SD	10.59	16.22		
Involved bowel iodine (g) Mean	2.48	1.80	1.609	0.134
SD	0.62	0.82		
Attenuation normal LN (HU) Mean	89.96	96.06	−1.236	0.240
SD	29.94	25.84		
Involved LN iodine (g) Mean	2.53	2.08	3.47	0.005
SD	0.55	0.62		
Relative bowel enhancement (%) ≤ 100	2	15		0.001
101–200	9	2		
> 200	6	0		
Relative LN enhancement (%) ≤ 100	7	15		0.008
101–200	8	2		
> 200	2	0		

Abbreviations: LN, lymph node; SD, standard deviation.
[a] $p < 0.05$ was considered significant.

►**Table 2** summarizes the iodine map findings (pre- and posttreatment) in the 17 patients who had follow-up imaging after the completion of the treatment. Significant difference was found among the two groups in relative bowel as well as LN enhancement, and also between the absolute iodine values in the involved LNs. In two patients, the relative bowel enhancement decreased from "high" to "moderate" level only.

On evaluating the correlation of the degree of mural thickening with relative mural enhancement, the difference was found to be statistically insignificant (chi-square 2.834, *p*-value 0.586). Thus, it was concluded that the two parameters are independent of each other.

Discussion

The current investigation of choice for response assessment in bowel TB is CT enterography, where we look for wall thickening of the terminal ileum, cecum, or Ileocecal (IC) valve along with necrotic LNs.[16] Bowel wall thickening and enhancement is assessed subjectively by the radiologist; however, no objective criteria is available to assess the response after ATT therapy. DECT has emerged as a good investigation tool in differentiating between intestinal pathologies such as Crohn's disease, ulcerative colitis, and intestinal TB, as reported by several studies.[14] In particular, DECT has been effective in assessing disease activity in patients with inflammatory bowel diseases like Crohn's disease, using iodine density values to distinguish between inflamed versus normal bowel segments.[15,17] For example, a study by Dane et al demonstrated that mean normalized iodine density significantly differed between uninflamed bowel and segments with active histologic inflammation ($p < 0.001$).[15] Building on this approach, we explored the use of DECT enterography to evaluate disease activity in patients with bowel TB.

Our study found a strong correlation between iodine uptake maps and the degree of inflammation seen in histopathology specimens (Spearman's rho = 0.895, $p < 0.001$). Iodine maps revealed varying levels of hyperenhancement in bowel segments, which corresponded closely with histopathological evidence of inflammation. Specifically, two patients with mural thickening and lower enhancement values were found to have "inactive disease" on pathology (►**Fig. 2**). These patients also showed no significant change in either mural thickness or enhancement on posttreatment iodine maps. Conversely, patients with very high enhancement values on pretreatment imaging were found to have "florid activity," and their follow-up scans at 6 months showed incomplete response (►**Fig. 3**).

In our posttreatment follow-up, while 47% of patients showed complete resolution of mural thickening, 53% exhibited persistent thickening, either unchanged or only marginally reduced. Although normal bowel and LNs showed similar attenuation values between pre- and posttreatment scans

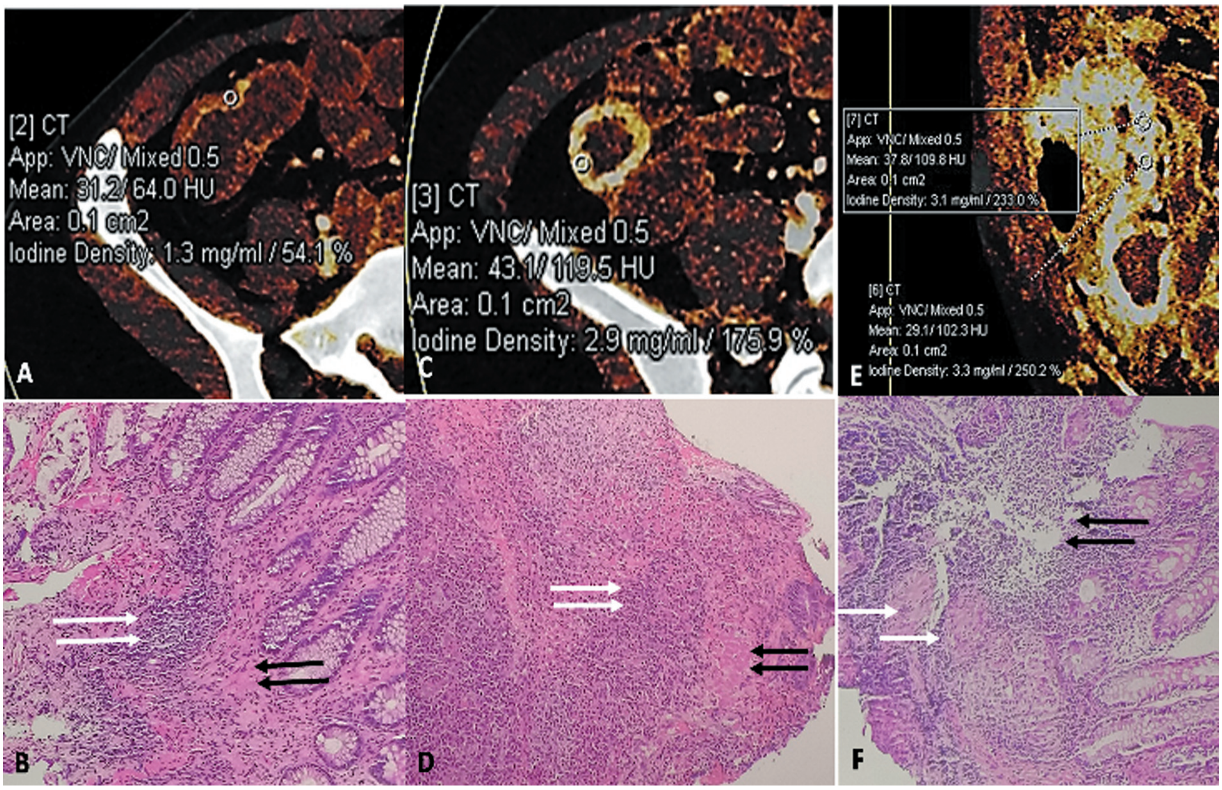

Fig. 2 Relative bowel enhancement on iodine overlay maps. (**A**) Axial iodine maps in a 23-year-old female with abdominal tuberculosis. The attenuation, iodine density, and relative bowel enhancement are reflected in the region of interest (ROI) drawn over the area of mural thickening. The bowel enhancement is 54%, classified as "low." (**B**) Medium power photomicrograph of colon shows patchy fibrosis of lamina propria and near total destruction of muscularis mucosae with replacement fibrosis (black arrows) and a lymphoid follicle (white arrows) (hematoxylin and eosin [H&E], ×300). (**C**) Axial iodine map in a 21-year-old female (same patient as B) shows the "high" (> 100%) enhancement of the thickened bowel wall. (**D**) Medium power photomicrograph of terminal ileal ulcer showing ill-formed epithelioid cell granuloma (black arrows) in the background of lymphoid cells of Peyer's patches (white arrows) (H&E, ×300). (**E**) A 13-year-old male with ileocecal tuberculosis. ROIs drawn in the affected ileocecal region show "very high" (> 200%) bowel enhancement. (**F**) Medium power photomicrograph of ileocecal valve biopsy showing multiple epithelioid cell granulomas (white arrows) involving the muscularis mucosae and overlying lamina propria. The overlying mucosa shows loss of crypts and disorganization (black arrows) (H&E, ×300).

($p = 0.603$ and $p = 0.240$, respectively), there was no statistically significant change in attenuation of the affected bowel segments ($p = 0.414$). The absolute iodine uptake in the involved bowel segments changed in posttreatment scans; however, they were not found to be statistically significant ($p = 0.134$), but the absolute iodine values of LNs showed statistically significant changes in the posttreatment scan during follow-up ($p = 0.005$).

Interestingly, when comparing relative enhancement on iodine maps before and after treatment, we observed statistically significantly lower enhancement values posttreatment ($p = 0.001$). This shift from pathological to normal enhancement values—or a decrease within the pathological range—was consistent in all patients who showed hyperenhancement in their initial scans and were rescanned after 6 months or more of treatment. A similar reduction in relative hyperenhancement was noted in mesenteric LNs ($p = 0.008$), independent of size reduction (►**Fig. 4**). The changes in LN enhancement with TB treatment response have tremendous treatment implications. LN involvement is a consistent feature of TB, and may involve cervical, mediastinal, or axillary groups in addition to abdominal nodes. Relative enhancement on iodine maps could serve as a marker for disease activity across all these forms, and thus help determine adequate or inadequate response. This hypothesis is further supported by the fact that relative nodal enhancement when compared with systemic symptoms of inflammation such as fever and weight loss also showed a statistically significant result. It must be considered, however, that a decrease in enhancement could also be seen due to spontaneous regression of disease activity, such as in patients with acute enteric infections or waxing and waning disease such as inflammatory bowel disease. These thresholds would require validation in further studies on this topic.

These findings suggest that while qualitative assessments of enhancement may offer insights, relying solely on absolute values can yield inconclusive results due to variations in vascular attenuation across scans. Therefore, to reduce the variability of results, an internal reference from the patient's own anatomy may be used to grade the relative enhancement. Different approaches have been proposed, from complex software algorithms to using muscle or aortic attenuation as reference standards.[15,18,19] In our study, we used normal bowel and LNs as a baseline, against which the enhancement of affected areas was graded. We believe that this approach reduces the likelihood of false positives.

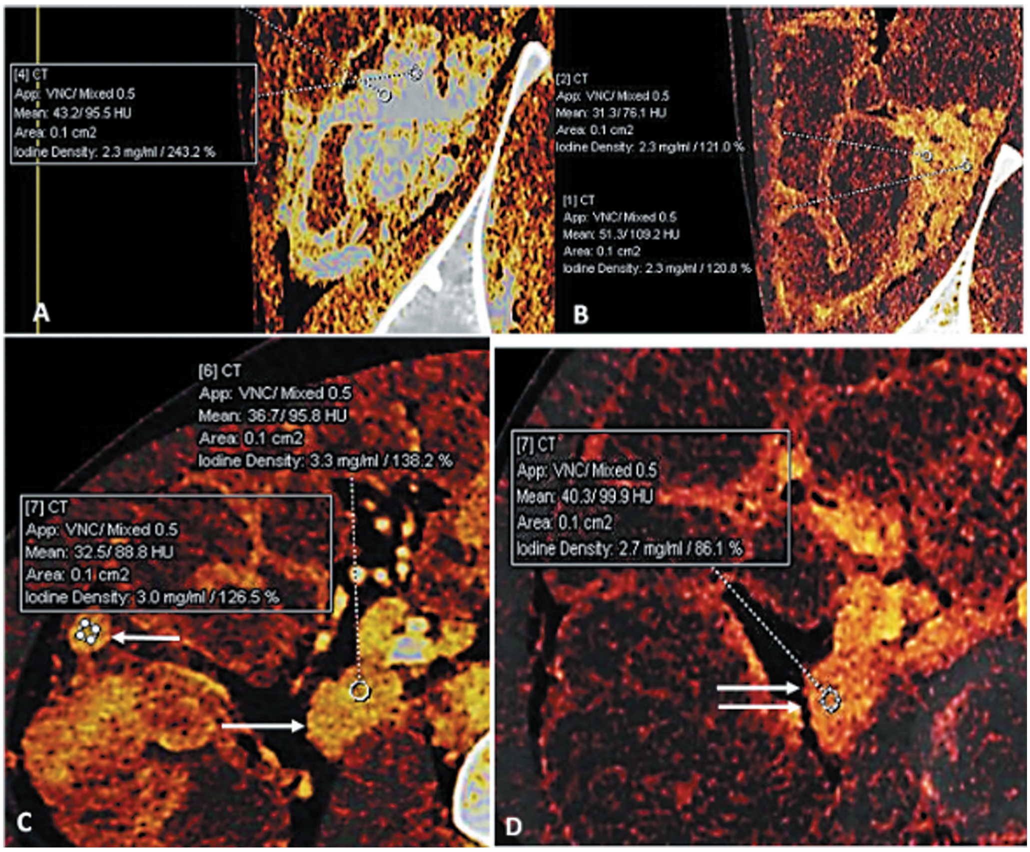

Fig. 3 Temporal evolution of relative bowel enhancement. (**A**) Pretreatment sagittal iodine map in a 23-year-old male with abdominal tuberculosis shows hypertrophic ileocecal junction involvement (arrow) with "very high" enhancement level. (**B**) Posttreatment image shows persistence of mural thickening (arrow), but reduction of relative enhancement to "high" level. (**C**) Pretreatment uptake in right iliac fossa (RIF) lymph nodes (solid arrow) also shows "high" relative enhancement. (**D**) Posttreatment image shows no reduction in size of lymphadenopathy (solid arrow), but decrease in enhancement to "low" level. Patient had significant relief in both bowel as well as systemic symptoms.

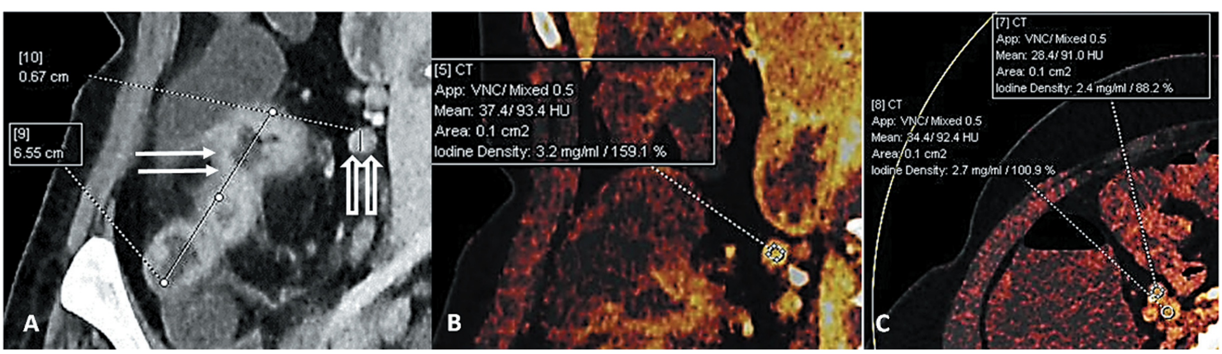

Fig. 4 Temporal evolution of relative lymph nodal enhancement. (**A**). Coronal computed tomography enterography (CT-E) in a 40-year-old female with ileocecal tuberculosis shows a lymph node in the right iliac fossa (RIF) measuring < 10 mm in size (solid arrow). Segmental thickening of the ileocecal junction is seen (solid arrow). (**B**) There is high (101–200%) relative enhancement of the lymph node. (**C**) Posttreatment with 6 months of antitubercular therapy, there is reduction in relative enhancement to low (< 100%) level.

The posttreatment reduction in relative enhancement on iodine maps shows promise as a biomarker for a "satisfactory response" in patients with bowel TB. This is especially relevant in cases where AFB are not isolated, and the diagnosis remains uncertain. The suggested threshold for "response" would be a *change* in enhancement category, that is from "high" (> 200%) to "moderate" (101–200%), or "moderate" (101–200%) to "low" (≤ 100%). However, the criteria for "complete response" would be fall of enhancement into the "low" category (≤ 100%), that is, not exceeding that of normal bowel. We suggest discontinuing therapy when complete response criteria is met. Conversely, in confirmed cases where a reduction in enhancement is not observed, or even where there is incomplete resolution, such as where relative enhancement levels fall from "high" to "moderate," but not within the normal range, clinicians should consider extending the treatment duration or investigate potential drug-resistant strains. This was seen in two patients in our study. However, they did respond clinically, and so did not entirely meet the criteria for drug resistance. Long-term follow-up would be desirable in future studies on the topic to better understand the evolution of findings in such patients, whether they are really drug resistant or a complete response was not elicited due to high initial disease burden.

Few other studies in literature have also attempted to quantify disease activity using newer imaging modalities. The primary objective in these was to differentiate causes of terminal ileal thickening, that is, Crohn's disease or TB, and also separate these from nonspecific or clinically insignificant thickening. In a study by Xu et al, DECT-derived normalized iodine concentration measured on iodine density images was used as a marker to differentiate TB from Crohn's disease, and also nonspecific ileitis.[20] Similarly, Singh et al[21] used positron emission tomography-CT to differentiate clinically significant from insignificant thickening and found that a maximum standardized uptake value cutoff of 4.5 yielded 70% sensitivity and 100% specificity. The question of disease activity posttherapy, however, remains largely unaddressed.

Our study has certain limitations. Our results reflect preliminary findings, and the small sample size—along with attrition during follow-up—limits the generalizability of our conclusions. Due to the relative novelty of DECT and radiation concerns, we could not recruit a control group to test the specificity of iodine map-derived parameters. A larger study population is necessary to validate the potential of DECT in replacing conventional imaging and histopathology in the diagnostic workup of intestinal TB. Additionally, histopathological correlation was not possible for all affected bowel segments, particularly those in regions inaccessible by endoscopy. In some patients with low initial relative enhancement values, DECT provided little clarity on whether persistent thickening and enhancement posttreatment necessitated further intervention or could simply be monitored due to symptomatic relief.

Conclusion

DECT enterography offers clear diagnostic advantages over conventional enterography by utilizing iodine material decomposition images. Of the parameters measured—attenuation values, absolute iodine levels, and relative enhancement —relative enhancement proved to be the most useful. This technique provides a measure of disease activity that is independent of gray scale markers such as mural thickening, enhancement, and LN size. Moreover, relative enhancement correlates well with histopathological activity and demonstrates clear posttreatment evolution.

Ethical Approval

The Institutional Review Board of Post Graduate Institute of Medical Education and Research approved this prospective study and Ethical approval number is INT/IEC/2017/1178.

Patients' Consent

Written informed consent has been taken from all the patients.

Funding

None.

Conflict of Interest

None declared.

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