

CT Evaluation of Abdominal Tuberculosis Using Neutral or Positive Oral Contrast Agent

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Abstract

Introduction: Abdominal tuberculosis poses a diagnostic challenge due to its nonspecific symptoms and varied imaging features. CT plays a key role in its evaluation, with oral contrast agents influencing image clarity. This study compares the diagnostic utility of neutral versus positive oral contrast in CT imaging of abdominal TB.

Aims: The main purpose of our study is to evaluate intestinal and extra intestinal findings in patients with abdominal tuberculosis on CT using positive or neutral oral contrast.

Materials and Methods: This cross-sectional analytic study was conducted in the Department of Radio-diagnosis, Maulana Azad Medical College and associated Lok Nayak Hospital, New Delhi, over a period of one year. A total of 40 patients diagnosed with abdominal tuberculosis were included in the study.

Result: The neutral oral contrast group showed greater bowel distension across all segments (e.g., jejunum: 2.10 ± 0.52 cm vs. 1.70 ± 0.42 cm) and better fold visibility (Grade II in 65% vs. 45%). Appreciable mural enhancement was more frequent with neutral contrast (80% vs. 20%). Among 31 patients with lymphadenopathy, 54.83% had multi-compartment involvement, with mesenteric nodes most common (96.7%) and homogenous enhancement seen in 77.41% of cases.

Conclusion: Neutral oral contrast agents showed better bowel distension, fold visibility, and mural enhancement than positive contrast on CT. These findings improve small bowel assessment and diagnostic accuracy. Mesenteric lymphadenopathy was the most common, often with multi-compartment involvement. Overall, neutral contrast enhances CT diagnostic yield in abdominal evaluations.

Keywords: Abdominal tuberculosis, Computed tomography (CT), Neutral oral contrast, Positive oral contrast, Bowel distension, Mural enhancement, Lymphadenopathy.

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Introduction

Abdominal tuberculosis (TB) remains a significant clinical challenge, particularly in regions with high TB prevalence like India. It constitutes approximately 11-16% of extrapulmonary tuberculosis cases and primarily affects the gastrointestinal tract, peritoneum, lymph nodes, and solid organs such as the liver and spleen [1]. The clinical presentation is often nonspecific, including symptoms such as fever, abdominal pain, weight loss, and altered bowel habits, making diagnosis difficult without imaging and histopathological correlation.

Computed tomography (CT) is a valuable non-invasive imaging modality that provides detailed anatomical information, helping identify character-

istic findings of abdominal TB, such as lymphadenopathy with central necrosis, peritoneal thickening, omental caking, ascites, bowel wall thickening, and caseating granulomas [2]. CT is particularly helpful in distinguishing abdominal TB from other conditions such as Crohn's disease, lymphoma, and peritoneal carcinomatosis [3].

A crucial aspect of CT imaging in abdominal pathology is the use of appropriate oral contrast agents. Oral contrast helps delineate bowel loops from adjacent soft tissue structures and enhances the visualization of mucosal and mural abnormalities. Traditionally, positive contrast agents such as diluted iodine or barium sulphate solutions have

been used, which appear hyperdense on CT images. However, these agents can obscure mucosal enhancement and intraluminal pathology due to their high attenuation [4].

Neutral contrast agents, including water, methylcellulose, or low-density polyethylene glycol solutions, have emerged as alternatives. These agents distend the bowel without obscuring mucosal details, making them particularly useful in evaluating mural changes [5]. The choice between neutral and positive contrast agents may influence the diagnostic clarity of CT imaging in abdominal TB, which often presents with subtle and diverse findings. Despite widespread use, there is limited comparative literature on the efficacy of neutral versus positive oral contrast in detecting and delineating findings specific to abdominal TB. Therefore, this study aims to evaluate the CT features of abdominal tuberculosis using either neutral or positive oral contrast and to compare the diagnostic utility of both in a clinical setting. The main purpose of our study is to evaluate intestinal and extra intestinal findings in patients with abdominal tuberculosis on CT using positive or neutral oral contrast.

Materials and Methods

Type of study: Cross-sectional analytic study

Place of study: The study was conducted in the department of Radio-diagnosis, Maulana Azad Medical College and associated Lok Nayak Hospital, New Delhi.

Study duration: The study was conducted over a period of one year.

Sample size: A total of 40 patients with diagnosed abdominal tuberculosis were included in the study.

Inclusion Criteria: All patients 12 years of age or older referred to the department of Radiodiagnosis for CT scan of abdomen with a clinical diagnosis or suspicion of abdominal tuberculosis.

Exclusion Criteria

- Patients with contraindication to CT contrast agents like deranged kidney function, previous history of allergic reactions to either contrast agent.
- Patients having contraindication to radiation exposure like pregnant women or lactating mother.

The procedure of the study was explained to the patient and informed consent in vernacular language was obtained in every case.

Clinical details of the patients such as age, gender, clinical features and relevant laboratory findings were recorded.

A total of forty patients fulfilling inclusion criteria were included in the study and divided in two groups. First patient was allotted in the neutral oral contrast group, next patient was allotted in the positive oral contrast group again next patient was allotted in neutral oral contrast group. Rest of the patients were allotted in either of these two groups in the same way.

Patients of the neutral oral contrast group received 3 % mannitol solution and patients of the positive oral contrast group received water soluble iodinated contrast.

Mannitol solution (3%) was prepared by dissolving total 36 g of mannitol in 1200 ml of water.

Patients in the positive oral contrast group received 25 ml of iodinated contrast in 1200 ml of water. Concentration of the iodinated contrast was 350mg/ml.

Patients were asked to drink 1000 ml of contrast solution over a period of 45minute, rest of the 200 ml was given 10 minutes before the scan.

For standardization and uniform distension of small bowel, patients were asked to drink 150 ml every 4-5 minutes.

CT examinations were performed on a 128-detector row MDCT scanner from dome of diaphragm to symphysis pubis after administration of iodinated contrast intravenously.

Using a power injector, 80-100 ml of intravenous contrast was administered at a concentration of 350mg/ml iodine with an injection rate of 3-5 ml/s after 50 seconds of contrast administration.

Images were obtained with a 5mm slice thickness, followed by multiplanar reconstruction of the images.

CT findings were recorded and analysed as follows

- Both qualitative and quantitative analysis for bowel distension, delineation of bowel wall and fold pattern, intraluminal content homogeneity, mural enhancement pattern and over all image were evaluated.
- Other features of abdominal tuberculosis like lymphadenopathy, free fluid, focal lesions in liver, spleen and pancreas, omental or peritoneal thickening or enhancement or cocoon formation were also noted.

Quantitative analysis

- Quantitative analysis of the distension was assessed on axial images.
- Segments of bowel loops that were maximally distended taken for the measurement. Measurements were taken from outer to outer wall of the distended bowel loops.

- Maximum distension of stomach, pylorus, duodenum (D2 segment), jejunum, ileal loops were assessed and the means were calculated.
- Comparison between the two groups were done using Student’s unpaired t test.

Qualitative analysis

- Assessment of the fold visibility of duodenum and jejunum was done using grades.
- Collapsed bowel/ poor contrast between the wall and intraluminal content – graded as grade 0
- Endoluminal contrast agent seen within the bowel loops with distension < 1.5 cm and incomplete fold visibility – graded as grade I
- Distension > 1.5 cm with complete visibility of fold – grade II
- Assessment of homogeneity of intraluminal content and bowel wall visibility was evaluated with scoring.
- Score 0- < 25% of the bowel loops show adequate distension, homogeneity of contents or bowel wall visibility
- Score 2- > 75 % bowel loops show those features.

- Score 1 – in between the above mentioned two groups.

Qualitative analysis of the mural enhancement pattern

- Mural enhancement pattern was assessed based on subjective findings between neutral and positive oral contrast group. Enhancement pattern was classified as appreciable (which was clearly seen) and non-appreciable (which was not easily detected).
- Comparative analysis of enlarged lymph nodes was done between neutral and positive oral contrast group depending on ease of detection.

Reference Standard: Diagnosis of abdominal tuberculosis was established by:

- Histopathological findings in 4 patients
- Ascitic fluid analysis (ADA) in 6 patients.
- Response to anti-tubercular treatment in 30 patients

Nine (9) patients had chest x-ray findings of pulmonary tuberculosis. 7 patients were proven to have pulmonary tuberculosis (CBNAAT was positive in 7 patients and AFB was positive in 4 patients).

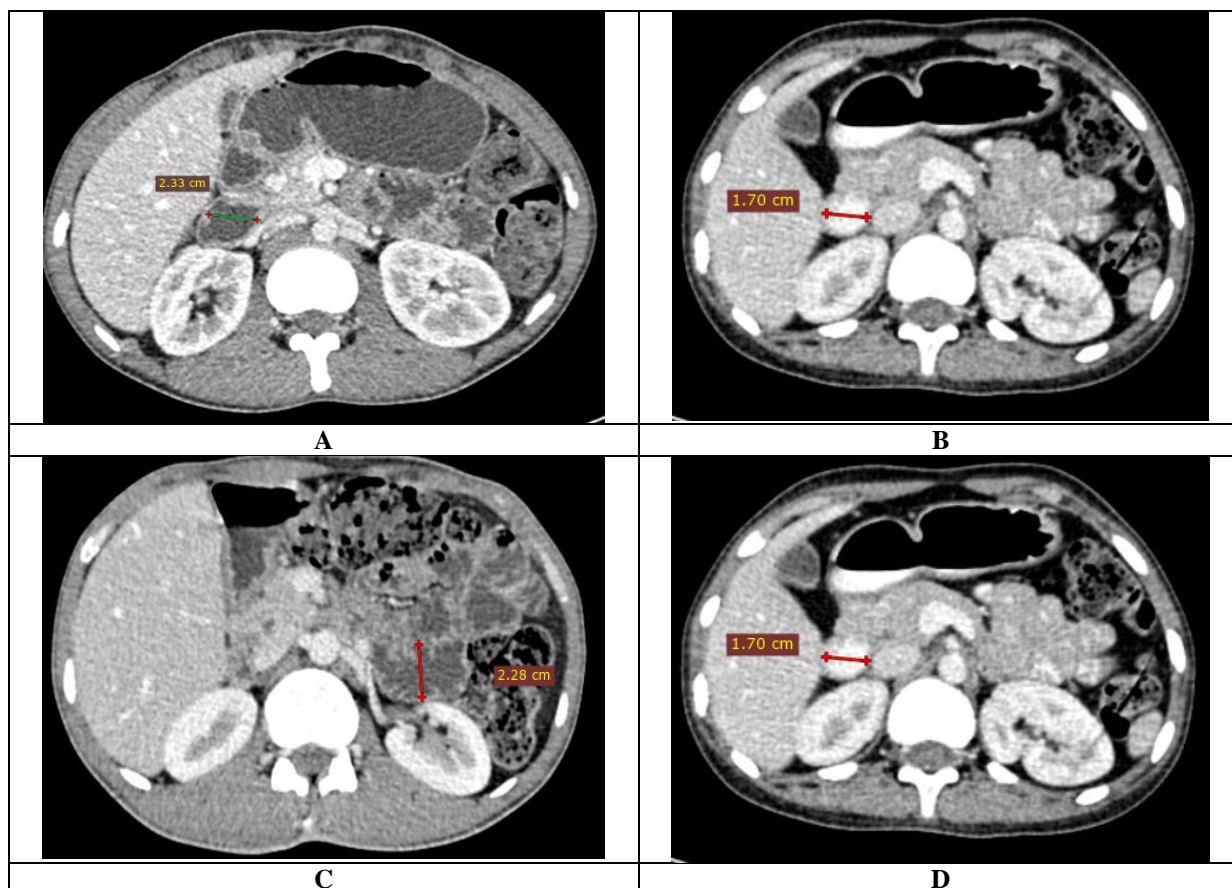


Figure 1: CECT abdomen images showing distension of bowel loops which is more with neutral contrast group (A, C) than positive oral contrast (B, D)

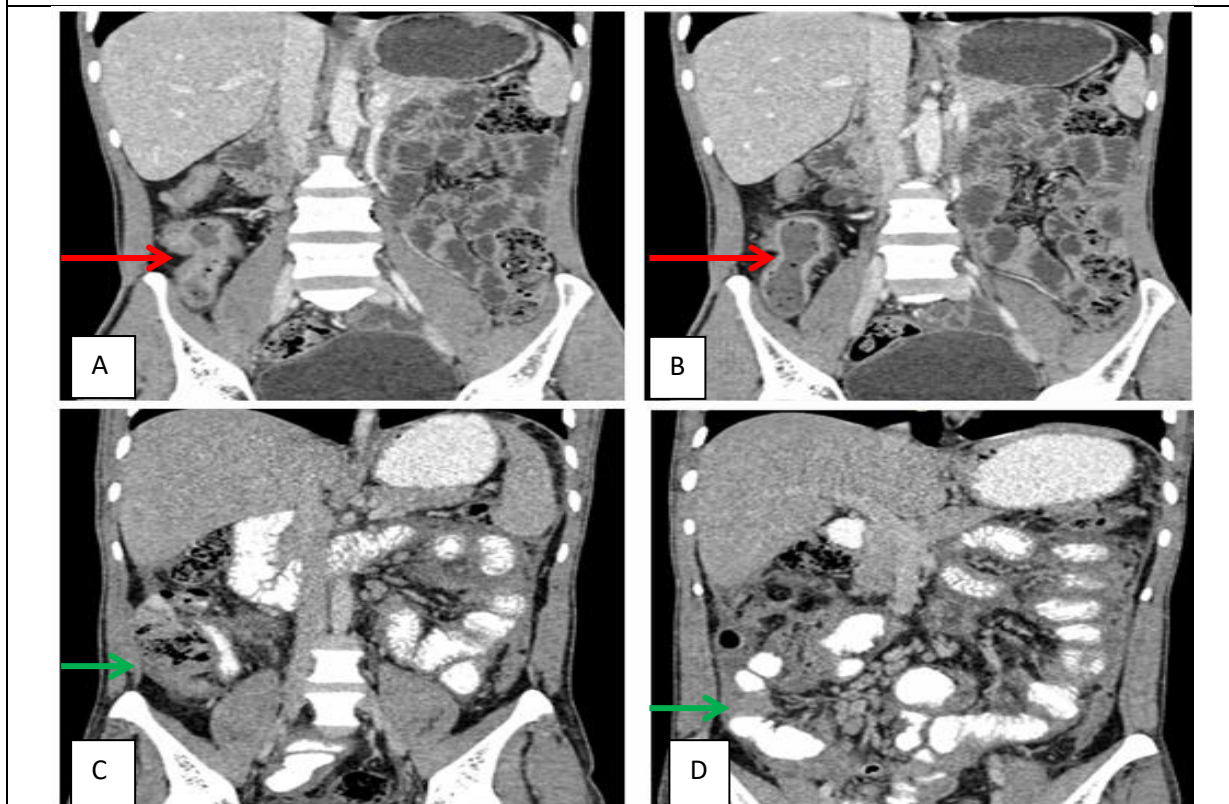


Figure 2: (A-D) CECT images showing better detection of mural enhancement and bowel wall with neutral contrast (A, B –red arrow) than positive contrast (C, D–green arrow)

Statistical Analysis: Data were entered into Excel and analyzed using SPSS and GraphPad Prism. Numerical variables were summarized using means and standard deviations, while categorical variables were described with counts and percentages. Two-sample t-tests were used to compare independent groups, while paired t-tests accounted for correla-

tions in paired data. Chi-square tests (including Fisher’s exact test for small sample sizes) were used for categorical data comparisons. P-values ≤ 0.05 were considered statistically significant.

Results

Table 1: Demographic, Clinical, and Radiological Profile of Patients

Parameter		Total no of patients	Percentage
Age in years	11-20	17	42.5
	21-30	14	35
	31-40	6	15
	>40	3	7.5
	Total	40	100
Gender	Male	16	40
	Female	24	60
	Total	40	100
Clinical features	Abdominal pain	29	72.5
	Abdominal distension	17	17
	Fever	20	20
	Loss of weight	15	15
	Vomiting	8	8
	Altered bowel habit	11	11
	Total	100	100
Site of involvement	Lymphadenopathy	31	77.5
	Gastro-intestinal tract involvement	19	47.5

	Peritoneal involvement	16	40
	Mesenteric involvement	15	37.5
	Peritoneal lining involvement	9	22.5
	Omental involvement	8	20
	Cocoon formation	2	5
	Ascites and /or loculated collection	10	25
	Solid organ involvement	6	15
	Associated findings	20	50
	Total	104	-

Table 2: Quantitative comparison of mean distension of bowel loops at various levels (N=40)

Oral contrast group	Distension in cm (Mean \pm SD)			
	Stomach	Duodenum	Jejunum	Ileum
Neutral oral contrast group (n=20)	6.11 \pm 1.08	1.93 \pm .46	2.1 \pm .52	2.1 \pm .47
Positive oral contrast group (n=20)	5.52 \pm .78	1.55 \pm .34	1.7 \pm .42	1.9 \pm .42

Table 3: Qualitative comparison of fold visibility in jejunum (N=40)

Oral contrast group	Grade 0 (%)	Grade I (%)	Grade II (%)	Total
Neutral oral contrast group (n=20)	1 (5%)	6 (30%)	13 (65%)	20(100%)
Positive oral contrast group (n=20)	2 (10%)	9 (45%)	9 (45%)	20(100%)

Table 4: Qualitative comparison of fold visibility in ileum (N=40)

Oral contrast group	Grade I (%)	Grade II (%)	Total
Neutral oral contrast group (n=20)	1 (5%)	19 (95%)	20 (100%)
Positive oral contrast group(n=20)	4 (20%)	16 (80%)	20 (100%)

Table 5: Qualitative assessment of homogeneity of contents in bowel loops (N=40)

Oral contrast group	Score1	Score2	Total
Neutral oral contrast group (n=20)	6 (30%)	14 (70%)	20 (100%)
Positive oral contrast group(n=20)	10 (50%)	10 (50%)	20 (100%)

Table 6: Qualitative assessment of wall visibility of bowel loops (N=40)

Oral contrast group	Score1	Score2	Total
Neutral oral contrast group (n=20)	4 (20%)	16 (80%)	20 (100%)
Positive oral contrast group(n=20)	15 (75%)	5 (25%)	20 (100%)

Table 7: Qualitative assessment of mural enhancement of bowel loops (N=40)

Enhancement	Neutral oral contrast group	Positive oral contrast group	Total
Appreciable	16 (80%)	4 (20%)	20 (100%)
Non-appreciable	4 (20%)	16 (80%)	20 (100%)

Table 8: Qualitative assessment of abdominal lymphadenopathy (n=31)

Lymph Node appearance	Neutral oral contrast group	Positive oral contrast group
Easily detectable	6 (40%)	12 (75%)
Not easily detectable	9 (60%)	4 (25%)
Total	15 (100%)	16 (100%)

Table 9: Morphological characteristics of abdominal lymphadenopathy on CT (n=31)

Lymph node (n=31)		Total	Percentage (%)
Location	Mesenteric	30	96.7
	Periportal and Peripancreatic	8	25.8
	Retro-peritoneal	10	32.2
	Total	48	
Morphology	Homogenous enhancement	24	77.41
	Necrotic peripherally enhancing	14	45.16
Short axis diameter (largest size in mm)	10-20	29	93.5
	>20	2	6.4

Table 10: CT findings in patients with peritoneal tuberculosis (n=16)

Site	Findings	No. of patients	Percentage	
Mesenteric (n=15, 93.75%)	Nodules	13	86.66%	
	Thickening	10	66.66%	
Omental (n=8, 50%)	Smudged with nodule formation	8	100%	
	Diffuse omental caking	3	37.50%	
Peritoneal (n=9, 56.25%)	Diffuse smooth thickening	6	66.66%	
	Nodular thickening	3	33.33%	
	Enhancement	Smooth	6	66.66%
	Pattern	Heterogenous/nodular Enhancement	3	33.33%
Free fluid and/or loculated ascites		10	62.50%	
Cocoon formation		2	12.50%	

A total of 40 patients were included in the study. The majority of patients (42.5%) were in the 11–20 years age group, followed by 21–30 years (35%), 31–40 years (15%), and above 40 years (7.5%). There was a female predominance, with 24 females (60%) and 16 males (40%). The most common presenting clinical feature was abdominal pain, observed in 72.5% of patients, followed by fever (20%), abdominal distension (17%), and loss of weight (15%), altered bowel habits (11%), and vomiting (8%).

Regarding the site of involvement, lymphadenopathy was the most frequent finding, present in 77.5% of cases. Gastrointestinal tract involvement was noted in 47.5% of patients, followed by peritoneal involvement (40%), mesenteric involvement (37.5%), ascites and/or loculated collection (25%), peritoneal lining involvement (22.5%), and omental involvement (20%). Less common findings included solid organ involvement (15%) and cocoon formation (5%). Associated findings were present in 50% of the cases.

In the evaluation of bowel distension, the neutral oral contrast group (n=20) demonstrated greater mean distension across all segments when compared to the positive oral contrast group (n=20). The mean gastric distension was higher in the neutral contrast group (6.11 ± 1.08 cm) compared to the positive contrast group (5.52 ± 0.78 cm). Similarly, the duodenal distension was 1.93 ± 0.46 cm in the neutral group versus 1.55 ± 0.34 cm in the positive group. The jejunum and ileum also showed higher distension values in the neutral group (2.1 ± 0.52 cm and 2.1 ± 0.47 cm, respectively) compared to the positive contrast group (1.7 ± 0.42 cm and 1.9 ± 0.42 cm, respectively).

Assessment of bowel distension grading revealed a higher proportion of Grade II distension in the neutral oral contrast group compared to the positive oral contrast group. In the neutral group (n=20), 65% of patients exhibited Grade II distension, 30% had Grade I, and only 5% had Grade 0. In contrast, the positive contrast group (n=20) showed 45%

each for Grade I and Grade II, with a slightly higher proportion of Grade 0 cases (10%) than the neutral group. These findings indicate that neutral oral contrast resulted in a higher incidence of optimal (Grade II) distension, suggesting its potential advantage in enhancing bowel visualization during imaging.

In the present study, a comparison of imaging scores between the two oral contrast groups revealed a notable difference in diagnostic performance. Among the patients who received neutral oral contrast (n=20), 4 patients (20%) were assigned Score 1, while 16 patients (80%) achieved Score 2. In contrast, in the positive oral contrast group (n=20), a majority of 15 patients (75%) were classified as Score 1, and only 5 patients (25%) received Score 2. These results indicate that the neutral oral contrast group demonstrated a significantly higher proportion of favorable diagnostic scores (Score 2) compared to the positive contrast group, suggesting superior imaging clarity or diagnostic efficacy with neutral contrast.

In the present study, enhancement quality on imaging was assessed in both the neutral and positive oral contrast groups. In the neutral oral contrast group (n=20), enhancement was appreciable in 16 patients (80%) and non-appreciable in 4 patients (20%). Conversely, in the positive oral contrast group (n=20), only 4 patients (20%) demonstrated appreciable enhancement, while 16 patients (80%) had non-appreciable enhancement. These findings highlight a markedly better enhancement profile in the neutral contrast group, indicating its superior efficacy in delineating anatomical or pathological details on imaging compared to positive oral contrast.

In the current study, lymph node appearance was evaluated in both contrast groups to assess detectability. In the neutral oral contrast group (n=15), lymph nodes were easily detectable in 6 patients (40%), while in 9 patients (60%) they were not easily detectable. In contrast, the positive oral contrast group (n=16) showed improved lymph node

visibility, with 12 patients (75%) having easily detectable nodes and only 4 patients (25%) showing poor detectability.

In the present study, a total of 31 lymph nodes were evaluated, yielding 48 observations due to multiple nodes in some patients. Regarding location, the majority were mesenteric (30 nodes, 96.7%), followed by retroperitoneal (10 nodes, 32.2%) and periportal /peripancreatic (8 nodes, 25.8%). In terms of morphology, homogenous enhancement was observed in 24 lymph nodes (77.41%), while necrotic peripherally enhancing morphology was noted in 14 nodes (45.16%), indicating some overlap in imaging characteristics. When assessing size, based on the short-axis diameter, most lymph nodes (29 nodes, 93.5%) measured between 10–20 mm, while only 2 nodes (6.4%) exceeded 20 mm in diameter.

On imaging, mesenteric involvement was noted in 15 patients (93.75%), with mesenteric nodules observed in 13 patients (86.66%) and mesenteric thickening in 10 patients (66.66%). Omental involvement was seen in 8 patients (50%), all of whom demonstrated smudged appearance with nodule formation (100%), while diffuse omental caking was present in 3 patients (37.5%). Peritoneal involvement was observed in 9 patients (56.25%), with diffuse smooth thickening in 6 patients (66.66%) and nodular thickening in 3 patients (33.33%). Peritoneal enhancement was smooth in 6 patients (66.66%) and heterogenous/nodular in 3 patients (33.33%). Additionally, free fluid and/or loculated ascites was detected in 10 patients (62.5%), and cocoon formation was noted in 2 patients (12.5%).

Discussion

The present study, involving 40 patients, comprehensively evaluates the efficacy of neutral versus positive oral contrast in abdominal imaging, particularly focusing on diagnostic quality, bowel distension, and enhancement patterns. A significant finding of this study is the superior bowel distension achieved with neutral oral contrast, which consistently demonstrated greater mean diameters in the stomach, duodenum, jejunum, and ileum compared to the positive contrast group. Furthermore, the proportion of patients exhibiting optimal (Grade II) bowel distension was notably higher in the neutral group (65% vs. 45%), emphasizing the improved luminal delineation offered by neutral contrast. This is in agreement with the findings of Sandrasegaran et al. [13], who observed enhanced bowel wall visualization with neutral contrast agents like water or low-attenuation solutions, especially in the evaluation of small bowel pathology using CT enterography.

The present study also highlights better overall diagnostic scores with neutral oral contrast, where

80% of the cases were rated Score 2 (favourable) compared to just 25% in the positive contrast group. This underscores the superior diagnostic utility of neutral contrast, particularly for detailed mucosal and wall evaluation, which aligns with the observations made by Raptopoulos et al. [14], who demonstrated that neutral contrast provides better differentiation between enhancing bowel walls and luminal contents, thereby aiding in the accurate assessment of inflammatory and neoplastic conditions. Enhancement quality was another domain where neutral contrast proved advantageous, with 80% of patients in this group showing appreciable enhancement versus only 20% in the positive contrast group. These results mirror the findings of Low et al. [15], who reported that neutral oral contrast enhances the conspicuity of mural and vascular enhancement, which is particularly beneficial in detecting subtle inflammatory changes and ischemic bowel segments. Interestingly, while neutral contrast was superior in most imaging parameters, lymph node detectability was found to be better in the positive contrast group (75% vs. 40%). This contrast-specific visibility may be attributable to the higher attenuation of positive contrast, which provides a stronger background density that can highlight low-attenuation lymph nodes. Similar conclusions were drawn by Horton et al. [16], who noted that positive contrast may be preferable in scenarios where lymphadenopathy is the primary focus, particularly when detecting small or low-contrast nodes in complex anatomical regions.

Regarding pathological involvement, the study findings revealed a predominance of mesenteric, omental, and peritoneal involvement, often with nodular or smudged morphological features. The high prevalence of mesenteric nodules (86.66%) and omental caking (37.5%) is indicative of advanced disease patterns, which were more effectively demonstrated with neutral contrast. These imaging characteristics are consistent with those described by Yu et al. [17], who emphasized the diagnostic superiority of neutral oral contrast in depicting subtle peritoneal and omental pathology due to its better contrast between pathological tissue and fluid-filled bowel.

Conclusion

The present study demonstrates that neutral oral contrast agents provide superior bowel distension, improved fold visibility, and more appreciable mural enhancement on CT imaging compared to positive oral contrast agents. These advantages facilitate better assessment of bowel wall and mucosal details, which is essential for accurate diagnosis of small bowel pathology. Additionally, mesenteric lymphadenopathy was the most common finding among patients, with a high rate of multi-compartmental involvement and typical enhancement patterns that are consistent with features of

abdominal tuberculosis. Overall, neutral contrast proves to be more effective in enhancing diagnostic yield in abdominal CT evaluations.

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