e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2024; 14(12); 102-107

Original Research Article

A Study of Multi-Detector Computed Tomography (MDCT) in Assessment of Small Bowel Diseases

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Received: 11-10-2024 / Revised: 12-11-2024 / Accepted: 06-12-2024
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Conflict of interest: Nil

Abstract

Background: MDCT (Multi-Detector Computed Tomography) combined with enteroclysis or enterography has become a valuable tool in abdominal imaging. It provides detailed visualization of the small bowel wall and lumen through effective distension and allows assessment of the mesenteric vasculature. Additionally, it offers crucial insights into extraintestinal pathologies. The current study aimed to assess the role of MDCT in diagnosing and evaluating small bowel disorders.

Methods: A prospective study involving 40 patients was conducted at a tertiary care hospital over two years. These patients were diagnosed with small bowel pathologies on MDCT and subsequently underwent surgery with histopathological examination. Intraoperative findings and histopathological results served as the standard reference for diagnosis. Inclusion Criteria were patients with small bowel pathologies identified on MDCT who underwent surgery with histopathological correlation.

Results: This study evaluated MDCT in assessing small bowel diseases in 40 patients, comparing MDCT diagnoses with histopathology. Important findings include MDCT's accurate identification of adenocarcinoma, GIST, and small bowel TB, with strong concordance between imaging and pathology. MDCT also effectively identified various causes of small bowel obstruction and perforation. While MDCT provided valuable diagnostic clues, it could not always provide definitive tissue characterization, emphasizing the need for histopathological confirmation. This study highlights MDCT's clinical utility in detecting and characterizing a range of small bowel pathologies, guiding further investigations and treatment.

Conclusion: This study demonstrated MDCT's valuable role in assessing diverse small bowel pathologies. MDCT effectively identified neoplastic lesions like adenocarcinoma and GIST, inflammatory conditions such as small bowel TB and Crohn's disease, and various causes of small bowel obstruction. While MDCT findings often correlate with histopathological diagnoses, they cannot always provide definitive tissue characterization. Integrating MDCT findings with clinical and pathological data is crucial for accurate diagnosis and management.

Keywords: Multi-Detector Computed Tomography (MDCT), Small Bowel Pathologies, Histopathological correlation

Introduction

Small bowel diseases are a diagnostic enigma because of the length and intricate structural organization of this organ and inherent difficulties are encountered in the visualization of the lesions with traditional endoscopy. Even though capsule endoscopy (CE) and double-balloon enteroscopy (DBE) have provided the endoscopist with the ability to directly visualize the small bowel mucosa, they are not without their drawbacks. CE delivers images only and cannot sample the tissue while DBE is invasive in nature and more difficult in technique. These limitations highlight the importance of obtaining accurate and non-invasive cross-sectional imaging such as MDCT that can add to the Armamentarium of endoscopic procedures in assessing small bowel Pathology.

Recently, MDCT has been very useful for the evaluation of many diseases of the small bowel because of its greater spatial and temporal resolution, availability, and ability to display anatomic details. Quick acquisition of volumetric data can quickly produce multiparallel reformats

and 3D images that give exquisite anatomic localization and characterization of the lesion. MDCT enterography or CTE is an improvement from conventional CT by the use of oral contrast agents to fill the small bowel loops and distend the bowel wall thus improving visualization and diagnosis [1]. The applications of MDCT in small bowel diseases are broad, encompassing a range of pathologies. In inflammatory bowel diseases (IBD), such as Crohn's disease, MDCT can detect mural thickening, strictures, fistulas, abscesses, and mesenteric changes, aiding in diagnosis, disease activity assessment, and treatment monitoring [2]. In cases of small bowel obstruction (SBO), MDCT can accurately identify the level and cause of obstruction, differentiating between mechanical obstruction and ileus, and guiding appropriate management [3]. Furthermore, MDCT is valuable in the detection and characterization of small bowel tumors, including both benign (e.g., adenomas, lipomas) and malignant (e.g., adenocarcinomas, lymphomas, carcinoids) lesions [4]. It can also assess the extent of tumor invasion and identify metastatic disease. MDCT is also useful in the assessment of other vascular diseases of the small bowel, for instance, angiodysplasia, and arteriovenous malformations, which are some of the most established causes of obscure gastrointestinal bleeding [5]. Other advantages of MDCT include: the identification of the tissue structures adjacent to the abnormal vessels, which may facilitate localization of the bleeding site and the planning of subsequent treatment. Furthermore, MDCT may also be employed to evaluate the small bowel in patients with abdominal trauma to detect perforation, hematoma, and mesenteric injury [6]. Compared with conventional X-rays, USG and MDCT have better diagnostic sensitivity and give more detailed information about the small bowel. However, other cross-sectional imaging modalities such as magnetic resonance enterography (MRE) are also useful, but MDCT is preferred in many clinical scenarios based on its shorter scan time, more availability, and less cost [7]. This study aims to evaluate the role of MDCT in the assessment of various small bowel diseases, focusing on its ability to detect, characterize, and stage different pathologies. By analyzing MDCT findings in a cohort of patients with suspected or confirmed small bowel disease, we seek to demonstrate the clinical utility of this imaging modality in improving diagnostic accuracy and guiding patient management.

Material and Methods

This prospective study was conducted in the Department of Radiology, Prathima Institute of Medical Sciences, Naganoor, Karimnagar, Institutional Ethical approval was obtained for the study after following the protocol for human research. Written consent was obtained from all the participants of the study after explaining the nature of the study in vernacular language.

A prospective study involving 40 patients was conducted at a tertiary care hospital over two years. These patients were diagnosed with small bowel pathologies on MDCT and subsequently underwent surgery with histopathological examination. Intraoperative findings and histopathological results served as the standard reference for diagnosis.

Inclusion Criteria: Patients with small bowel pathologies identified on MDCT who underwent surgery with histopathological correlation.

Exclusion Criteria: Patients with small bowel pathologies who did not undergo surgical intervention or lacked histopathological correlation.

CT Imaging Protocol: All cases were performed using a 64-slice GE LightSpeed VCT system. Scans were conducted with patients in the supine position, feet-first orientation, using the xiphisternum as an anatomical reference.

Plain CT Protocol:

- Scan Type: Helical
- Slice Thickness: 5 mm
- Detector Coverage: 40 mm
- Pitch: 1.375:1
- Rotation Time: 0.6 seconds/rotation
- Scan Field of View (SFOV): Large body
- kV/mA: 120 kV, Auto mA
- Display Field of View (DFOV): 38 cm
- Reconstruction Algorithm: 0.625 mm acquisition in a standard window
- Scan Time: 10 seconds
- Radiation Dose Metrics: DLP 2806.9, CTDI 74.8, Effective dose 4 mSv
- Window Parameters: Level 340-360, Width 40-60
- The scan covered the area from the dome of the diaphragm to the ischial tuberosities.

Enterography Protocol: Patients were instructed to fast for at least four hours before the examination. Neutral oral contrast (water) was administered in doses of 1000-1500 mL over one hour:

- 450 mL at the beginning
- 450 mL after 20 minutes
- 250 mL after 40 minutes

- A final table dose of 250 mL

Enteroclysis Protocol: Using a Bilbao-Dotter or Freka tube (120 cm, 22F), a nasojejunal tube was positioned just beyond the duodenojejunal flexure under fluoroscopic guidance. A total of 1000-1500 mL of water mixed with carboxymethyl cellulose was used as neutral oral contrast over 20-30 minutes. Intravenous contrast (non-ionic iodinated agents like Omnipaque or Visipaque) was administered at 1.5 mL/kg at a rate of 3.5-4 mL/s.

- Arterial Phase: Performed at 18-25 seconds
- Venous Phase: Performed at 70-90 seconds

For patients presenting with acute small bowel obstruction, oral contrast was omitted.

Statistical Analysis: Data analysis was conducted using SPSS version 22. Tables and graphs were created with SPSS and Microsoft Excel. Descriptive statistics, including frequencies, standard deviations, and percentages, were calculated for all variables. Categorical data were analyzed using the Chi-square test for statistical significance. A two-tailed p-value of <0.05 was considered statistically significant.

Results

A total of 40 cases were included in the study based on the inclusion and exclusion criteria. Table 1 presents the distribution of diagnoses made by Computed Tomography (CT), MDCT, in a study focused on small bowel diseases. The most frequently diagnosed conditions were carcinoma of the duodenum (15%), small bowel tuberculosis (20%), and small bowel strictures (15%). This suggests that these were the most prevalent small bowel issues in the studied population. Several conditions, including Crohn's disease, GIST, lymphoma, carcinoid tumor, adhesive obstruction, and closed-loop obstruction, were less common, each representing 2.5% to 5% of the cases. This highlights that while MDCT can detect these conditions, they were less frequently encountered in this particular study group.

Table 1: Computed Tomography (CT) diagnosis in the cases of the study

CT Diagnosis	Frequency	Percentage
Carcinoma duodenum	6	15
Ileo-ileal intussusceptions	4	10
Small bowel TB	8	20
Small bowel perforation	4	10
Chron’s disease	1	2.5
GIST	2	5
Small bowel ischemia	5	12.5
Lymphoma small bowel	1	2.5
Carcinoid tumor	1	2.5
Stricture small bowel	6	15
Adhesive obstruction	1	2.5
Closed loop obstruction	1	2.5
Total	40	100

MDCT effectively identified various small bowel tumors, including carcinomas, GISTs, lymphomas, and carcinoid tumors. This underscores MDCT's role in tumor detection, localization, and staging, which is crucial for surgical planning and treatment decisions. The identification of duodenal carcinoma (15%) is particularly relevant, as this location can be challenging to assess with other imaging modalities. The relatively high prevalence of small bowel tuberculosis (20%) in this study is notable and may reflect the geographic location of the study population. MDCT can demonstrate characteristic features of small bowel TB, such as mural thickening, mesenteric lymphadenopathy, and ileocecal involvement. The identification of Crohn's disease, although at a lower frequency (2.5%), also highlights MDCT's utility in evaluating inflammatory bowel disease, and detecting complications like strictures, fistulas, and abscesses. MDCT proved valuable in diagnosing various causes of small bowel obstruction, including ileo-ileal intussusception (10%), strictures (15%), adhesive obstruction (2.5%), and closed-loop obstruction (2.5%). MDCT's ability to precisely locate the level and cause of obstruction is crucial for guiding appropriate management, which may range from conservative management to surgical intervention. The diagnosis of small bowel ischemia (12.5%) demonstrates MDCT's ability to assess mesenteric vasculature and detect signs of ischemia, which is a time-sensitive condition requiring prompt intervention. The identification of small bowel perforation (10%) further illustrates the role of MDCT in evaluating acute abdominal conditions.

Table 2: Final histopathological diagnosis in the cases of the study

Histopathology Diagnosis	Frequency	Percentage
Moderately differentiated adenocarcinoma	6	15
Lipoma	3	7.5
Non-Hodgkin lymphoma	2	5
Lymphangitis carcinomatosis	1	2.5
GIST	2	5.0
Inflammatory stricture	6	15
Small bowel perforation	4	10
Gangrene bowel	5	12.5
Granulomatous inflammation (TB)	5	12.5
Chronic inflammation	2	5
Peutzjegher Polyp	1	2.5
Meckel's diverticulitis	1	2.5
Crohn's disease	1	2.5
Carcinoid	1	1

Table 2 summarizes the final MDCT-guided surgical resection or biopsy histopathological diagnosis of the extent and distribution of small bowel diseases assessed in one study. These are the gold standards by which the MDCT findings summarised in Table 1 can be compared. The table also shows neoplastic pathology including adenocarcinoma, lipoma, lymphoma, GIST, carcinoid, and others; inflammatory pathology including inflammatory stricture, granulomatous inflammation/TB, chronic inflammation, Meckel diverticulitis, Crohn disease; vascular pathology including gangrene bowel, often sequel of ischemia; congenital pathology including Peutz-Jeghers polyp. The most frequent diagnosis by histopathology was moderately differentiated adenocarcinoma constituting 15% and inflammatory stricture also occupying 15%. Gangrene bowel and Granulomatous inflammation (TB) were also detected with equal incidence (12.5%). Comparing the present table with Table 1 enables the evaluation of the diagnostic accuracy of MDCT. Table 1 revealed 6 patients with duodenal carcinoma which is seen here as moderately differentiated adenocarcinoma. Likewise, cases reported with CT features suggestive of small bowel TB are here proved to have granulomatous inflammation (TB). As for injuries described as small bowel perforation in Table 1, they are also specified in the same number of cases in this table. This correlation suggests good agreement between MDCT findings and the final histopathological diagnoses in these cases. However, Table 1 also included diagnoses like "ileo-ileal intussusceptions," "small bowel ischemia," "adhesive obstruction," and "closed loop obstruction" that do not have direct counterparts in Table 2. These are descriptive CT findings that suggest a disease process, not a specific histopathological diagnosis such as "gangrenous bowel" in Table 2 corresponds to some of the cases of "small bowel ischemia" in Table 1. Similarly, inflammatory strictures account for some cases previously classified as "stricture small bowel" in Table 1. However, the presence of a wide range of histopathologically confirmed diagnoses validates MDCT's role in identifying diverse small bowel pathologies. The correlation between MDCT findings and histopathology strengthens the evidence for MDCT's diagnostic accuracy. The comparison between Table 1 and Table 2 highlights the relationship between imaging findings and underlying pathology. MDCT can provide valuable information about the location, size, and characteristics of lesions, which can suggest specific diagnoses. However, histopathology remains the gold standard for definitive diagnosis. The discrepancies or lack of direct correspondence between some CT diagnoses and histopathological diagnoses emphasize the importance of integrating MDCT findings with clinical information, laboratory data, and other investigations for accurate diagnosis and patient management.

Discussion

The main aim of this research was to determine the effectiveness of MDCT in the evaluation of small bowel pathology in 40 patients. To assess the performance of MDCT in diagnosing the following small bowel abnormalities: We compared the accuracy of the MDCT diagnoses made on the study participants (Table 1) with the final histopathological diagnoses made for the study participants (Table 2). Altogether, the results of the present study provided evidence of the capability of MDCT to define a broad spectrum of small bowel pathologies including neoplastic, inflammatory, obstructive, vascular, and congenital diseases. The commonest diagnoses that were ascertained both on MDCT and histopathology were related to adenocarcinoma (15%) and, inflammation and structures (also 15%), implying that these were apparent in our study population. This prevalence could be related to referrals or characteristics of the patient inclusions. One of the major advantages of

the MDCT approach is its impressive performance in characterizing and detecting neoplastic ones. Of the six patients, who were diagnosed having duodenal carcinoma on MDCT, histopathology confirmed moderately differentiated adenocarcinoma, with high inter-observer agreement. This is important because correct staging and localization of small bowel tumors are critical in surgery planning and prognosis [8]. MDCT has great value in oncological practice due to its capability to assess the tumor extent, local invasion, and distant metastases. Likewise, the two cases of GIST identified by MDCT were additionally proven to be histopathological as are other mesenchymal tumors [9]. Lymphoma and carcinoid tumors which are detected though less commonly in our study also suggest the potential of MDCT in identifying these other uncommon but possible types of small bowel neoplasms.

The subject area of focus of this work was the application of MDCT in evaluating small bowel diseases in 40 patients. The outcomes of the study are presented in Tables 1 and 2 comparing MDCT diagnoses and final histopathological diagnoses to assess the feasibility of using MDCT for diagnosing various pathologies of the small bowel. Thus, our study evidence outlines the potential of MDCT in diagnosing or depicting various small bowel pathologies of neoplastic, inflammatory, obstructive, vascular, and congenital etiologies. The commonest diagnoses on MDCT and histopathological examination were adenocarcinoma (15%) and inflammatory strictures (15%) and these were probably common in our population. This prevalence may be due to referral bias or the type of patients treated within the practice.

The first strength of MDCT, which is the identification and characterization of neoplastic lesions is well achieved. All the six cases reported initially as duodenal carcinoma on MDCT were histopathologically proven as moderately differentiated adenocarcinoma indicating good agreement. This is important since the staging and localization of small bowel tumors are important both in the planning of surgery and in assessing prognosis [8]. Owing to its capacity to influence the characterization of tumor size, extent, proximity to involved organ margins, and presence of metastatic spread, MDCT is a crucial modality in oncological intervention. In the same way, two patients with GIST diagnosed with MDCT had histopathological evidence of the disease which establishes the utility of MDCT in the identification of these mesenchymal tumors [9]. Even if less common in the present work, the detection of lymphoma and carcinoid tumors demonstrates that MDCT is capable of detecting these uncommon small bowel tumors.

MDCT was also useful in the evaluation of inflammatory disorders as well The eight patients diagnosed as having mild bowel TB on MDCT correlated with granulomatous inflammation (TB) on histopathology. Though histopathology is considered the definitive test for TB, MDCT should be able to show features such as ileocecal disease, mural thickening, and mesenteric lymphadenopathy [10]. MDCT can help to give some clue of the diagnosis and lead to a subsequent investigation if endoscopy remains inconclusive or contraindicated. One Crohn's disease patient was confirmed by both MDCT and histopathology The fact that MDCT can successfully evaluate IBD, particularly with regard to complications such as strictures, fistulas, and abscess formation [11]. Small bowel obstruction was also evaluated and MDCT was revealed to be useful for identifying different etiology. While Table 1 enumerated findings such as ileo-ileal intussusception, stricture, adhesive obstruction, and closed loop obstruction these were frequently closely linked with histopathological diagnosis. For instance, the six patients diagnosed with "stricture small bowel" on CT may well have reflected six cases of "inflammatory stricture" on histopathology. Knowledge of the location and reasons for the obstruction helps in the decision-making process specifying surgical or non-surgical interventions [12]. MDCT establishment of the diagnosis of small bowel perforation by histopathology underscores the significance of the study in the diagnosis of acute abdomen with indications for urgent surgical interventions [13]. The cases they diagnosed as "small bowel ischemia" on MDCT perhaps included the cases of "gangrene bowel" on histopathology because ischemia is a major cause of gangrene. This shows that MDCT can be used to detect vascular compromise which gives better results when done in a time-sensitive manner.

However, our study also highlights the limitations of MDCT. While MDCT can suggest specific diagnoses based on imaging features, it cannot always provide a definitive histopathological diagnosis. For example, while MDCT can identify a stricture, it cannot always differentiate between inflammatory and neoplastic causes. Histopathological examination remains essential for confirming the diagnosis and guiding appropriate treatment. The small sample size of our study (40 patients) limits the generalizability of our findings and the statistical power of our analysis. Larger studies are needed to validate these findings and to assess the sensitivity, specificity, and accuracy of MDCT for specific small bowel pathologies.

Conclusion

This study demonstrated MDCT's valuable role in assessing diverse small bowel pathologies. MDCT

effectively identified neoplastic lesions like adenocarcinoma and GIST, inflammatory conditions such as small bowel TB and Crohn's disease, and various causes of small bowel obstruction. While MDCT findings often correlate with histopathological diagnoses, they cannot always provide definitive tissue characterization. Integrating MDCT findings with clinical and pathological data is crucial for accurate diagnosis and management. Despite limitations like small sample size, this study underscores MDCT's clinical utility in evaluating small bowel diseases, guiding further investigations and treatment strategies.

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