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ORIGINAL ARTICLE

The diagnostic role of MDCT enterography in small bowel lesions

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KEYWORDS

Multidetector computed tomography enterography (MDCTE);
Three dimensional volume-rendering (3D);
Multiplanar reformatted (MPR);
Maximum-intensity-projection (MIP)

Abstract *Purpose:* To evaluate the role of MDCT enterography in the diagnosis of small bowel diseases.
Patient and methods: Thirty nine patients suspected to have small bowel diseases were examined with 64 MDCT enterography.
Result: MDCT enterography easily diagnosed small intestinal diseases which confirmed with histopathological results, operative data and follow up.
Conclusions: MDCT can be used as a front-line imaging and one stop imaging modality for the detection of small bowel diseases. However, biopsy is still the confirmatory diagnostic method.

1. Introduction

There is a vast array of pathologic processes that occurs in the small bowel and mesenteric vasculature (1). Imaging of the small bowel is challenging technically, because the organ is long and serpentine, a large field of view and a large volume are needed to display in entirety. Another problem for imaging is motion, both intrinsic motion of peristalsis and the positional changes caused by breathing. These two motion patterns can be additive and lead to a complex movement of individual bowel loops, making their tracing very difficult. In addition, because small bowel diseases have a low incidence, their appearance is less well known and there is an increased risk of missing them. Ever most of the common diseases in the small bowel, early changes are subtle making their diagnosis difficult (2). Small bowel follow-through and enteroclysis are widely used for small bowel imaging; however, these examinations provide only indirect information about the bowel wall and prone to problems caused by overlapping bowel loops (3). Doppler ultrasonography allows direct evaluation of the mesenteric vessels; however, it is operator dependant and is often limited by overlying bowel gas (4). Enteroscopy shows promise for the study of the small bowel, but this technique is invasive and cannot explore the totality of the small bowel (5). Recent innovations, including capsule endoscopy and magnetic resonance imaging (MRI), have emerged as alternative small bowel imaging techniques that can be performed without ionizing radiation. However MRI appears less accurate and less sensitive than CT in detection of bowel wall

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thickening, abnormal bowel wall enhancement, and adenopathy. Also, capsule endoscopy has its drawbacks of capsule obstruction by bowel strictures. It may as well provide false-negative results if there is rapid peristalsis at a lesion site or if there is bowel angulations at a lesion that impairs the camera view, and equivocal results in the presence of excess luminal fluid (6). Currently, the availability of multidetector computed tomography (MDCT) has allowed improved depiction and characterization of small bowel pathology. It can also depict bowel and mesenteric injuries that require surgical repair in patients with blunt abdominal trauma (7).

The objective of this study is to evaluate the role of MDCT enterography in diagnosis of small bowel diseases.

2. Patient and methods

2.1. Patients

The study included 39 patients (25 males and 14 females); their age ranged from 3 to 75 years with a mean of 39 years; who suspected to have small bowel disease presented with abdominal pain, loss of weight, abdominal distention, melena and intestinal obstruction. Prior to MDCT examination, relevant clinical data and complete abdominal examination were obtained in every patient. This study was approved by institutional ethics committee during the period from September 2011 till December 2013.

2.2. Methods

2.2.1. Image acquisition and parameters

All patients were imaged with a 64-row MDCT scanner (Toshiba Acquillion-Japan) using the following scanning parameters: 64×0.75 mm detector configuration, 0.75 s rotation time, a rotation pitch of 0.8, and 0.625 mm reconstructed slice thickness, 120 kVp, reference mAs 250/700 mA. Automatic tube current modulation was used to minimize the radiation exposure. A standard reconstruction algorithm was used. Intra venous contrast enhancement is essential on performing CT enterography so that the bowel wall is well-visualized. A 20 – gauge cannula was inserted into an arm vein and a 1.5 ml/kg of iodinated contrast material (Ultravist 360 mg or Scanlux 300 mg) was injected at a rate of 4 ml/s using an automated power injector. The delay between the start of the IV contrast injection and the start of the helical scanning was approximately 25 s to achieve the arterial phase, and 60 s for the delayed phase (also named enterography phase where the small bowel wall enhancement was optimum). To evaluate mesenteric ischemia, three-phase CT (unenhanced, arterial and delayed phases) was performed. Images were obtained from the dome of the liver to the lower margin of the symphysis pubis during a single breath-hold. The technologist generated a set of axial 3 mm sections and a set of 3 mm thick coronal multiplanar reformatted images at 3 mm intervals encompassing the entire bowel using the suitable reconstruction parameters.

2.2.2. Peroral MDCT enterography technical considerations

Patients had a low-residue diet, ample fluids, laxative on the day prior to the examination, and they fasted for 4 h before the examination. This regimen did not apply to the emergency patients. Patients administered water as a neutral oral contrast agent so that the degree and pattern of small bowel enhancement can be well analyzed. At the imaging unit, patients ingested a volume of 1450 ml water over a 60 min period. On arrival at the imaging unit, patients ingested 500 ml, ten minutes later patients ingested another 500 ml. Twenty minutes later patients ingested 225 ml. Finally, on entering the scanning room, the patient drank 225 ml of water to distend the stomach and duodenum. The patients were monitored during water ingestion to ensure the accuracy of the procedure (8).

2.2.3. Image analysis

The thin slices were sent to the workstation (Vitrea workstation), where 3D volume-rendering, multiplanar reformatted (MPR), maximum-intensity-projection (MIP) and MDCT angiography display and volume rendering images. All small bowel abnormalities were based upon the seven criteria: Pattern of enhancement, length of involvement, degree of thickening, whether the thickening is symmetric or asymmetric, location of the lesion along the course of the small bowel, location of the lesion in the wall of the small bowel and associated abnormalities in the mesentery and vessels (9,10).

2.2.4. Verification of data

In twenty patients, results of upper endoscopy with biopsy or biopsy from a mass or enlarged abdominal lymphadenopathy were obtained.

2.3. Statistical analysis

Data were expressed as mean, range, number and percentage.

3. Results

They were divided into two groups according to their encountered MDCT findings and pathological entities. Seventeen patients (43.5%) were with neoplastic diseases and Twenty-two patients (56.4%) were with non-neoplastic diseases.

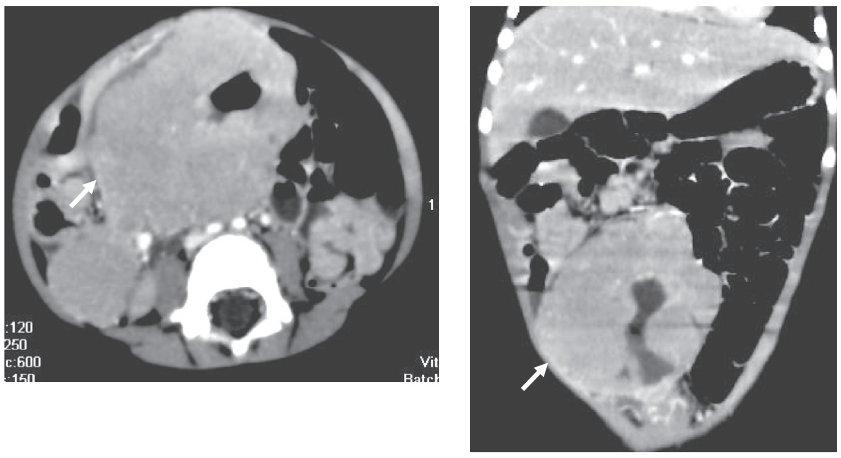
The neoplastic group included 17 patients (14 males and 3 females) with suspected small bowel neoplasms and proved to be malignant by histopathological results (Table 1).

3.1. MDCT criteria in the neoplastic group

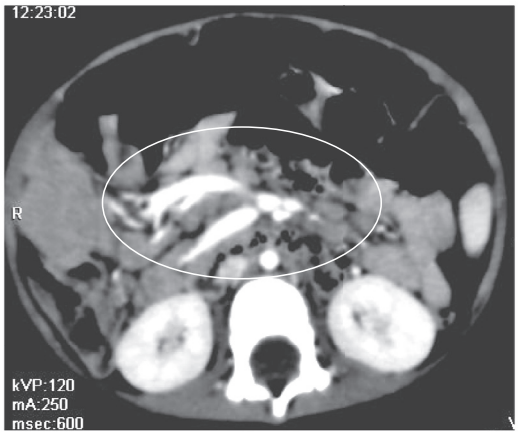
The common MDCT criteria found in the seventeen patients of the neoplastic group were segmental asymmetric marked wall thickening with homogenous wall enhancement, involving the mucosa and submucosa of the ileum associated with enlarged mesenteric lymph nodes. Segmental wall thickening was found in 14 patients (82.3%), asymmetric wall thickening

Table 1 Neoplastic group lesions versus number of patients.

MDCT diagnosis	No. of patients
Lymphoma	12
Malignant gastrointestinal stromal tumor(GIST)	3
Duodenal adenocarcinoma	1
Metastasis	1



(A) Axial and coronal images



(B) Axial image

Fig. 1 A 3 years old male patient with ileocecal junction lymphoma. MDCT showed segmental asymmetric marked wall thickening with heterogenous enhancement (white arrows) (A). The mucosa and submucosa were involved associated with multiple enlarged mesenteric lymph nodes showing the "sandwich sign" (white circle) (B).

was found in all patients (100%), marked wall thickening was found in 13 (76.5%) out of the seventeen patients, homogenous wall enhancement was found in 9 patients (53%). The submucosa of the small bowel was involved in all patients (100%). The ileum was involved in 7 patients (41.2%). Associated enlarged mesenteric lymph nodes were found in 11 patients (64.7%) (Figs. 1 and 2).

The non-neoplastic group included twenty-two patients (11 males and 11 females) with small bowel diseases of non-neoplastic pathology (Table 2).

3.2. MDCT criteria in the non-neoplastic group

The common MDCT criteria found were segmental symmetric mild or moderate wall thickening with homogenous wall enhancement seen involving the mucosa and/or the submucosa of the ileum and/or the jejunum associated with enlarged mesenteric lymph nodes and/or changes in the mesenteric vessels. Segmental wall thickening was found in 10 patients (45.5%), symmetric wall thickening was found in 18 patients (81.8%), mild and moderate wall thickening was found in 18 patients (81.8%), homogenous wall enhancement was found in 12 patients (54.5%). The submucosa of the small bowel was involved in 19 patients (86.4%). The ileum and the jejunum were involved in 20 patients (90.9%). Associated enlarged mesenteric lymph nodes were found in 7 patients (31.8%) and mesenteric vessels changes (vasa recta, superior mesenteric artery (SMA) or superior mesenteric vein (SMV) thrombosis) were found in 9 patients (40.9%) (Figs. 3–5).

4. Discussion

In this study, MDCT enterography was performed to determine the abnormal pattern of small intestinal disease relevant to patients' complaint. This is consistent with Eid et al. (11) who stated that the main advantage of CT enterography over the routine abdominal CT is its ability for detailed study of the bowel wall and mucosal pathology. This target is realized through two main factors: Bowel loop distention, and neutral luminal contrast. It is thus only used in clinical conditions aiming to diagnose primary small bowel pathologies, and not in every routine abdominal exam. The thinner collimation possible with MDCT along with oral administration of water and intravenous bolus of contrast material may improve the sensitivity of CT for depicting small-bowel tumors as it has

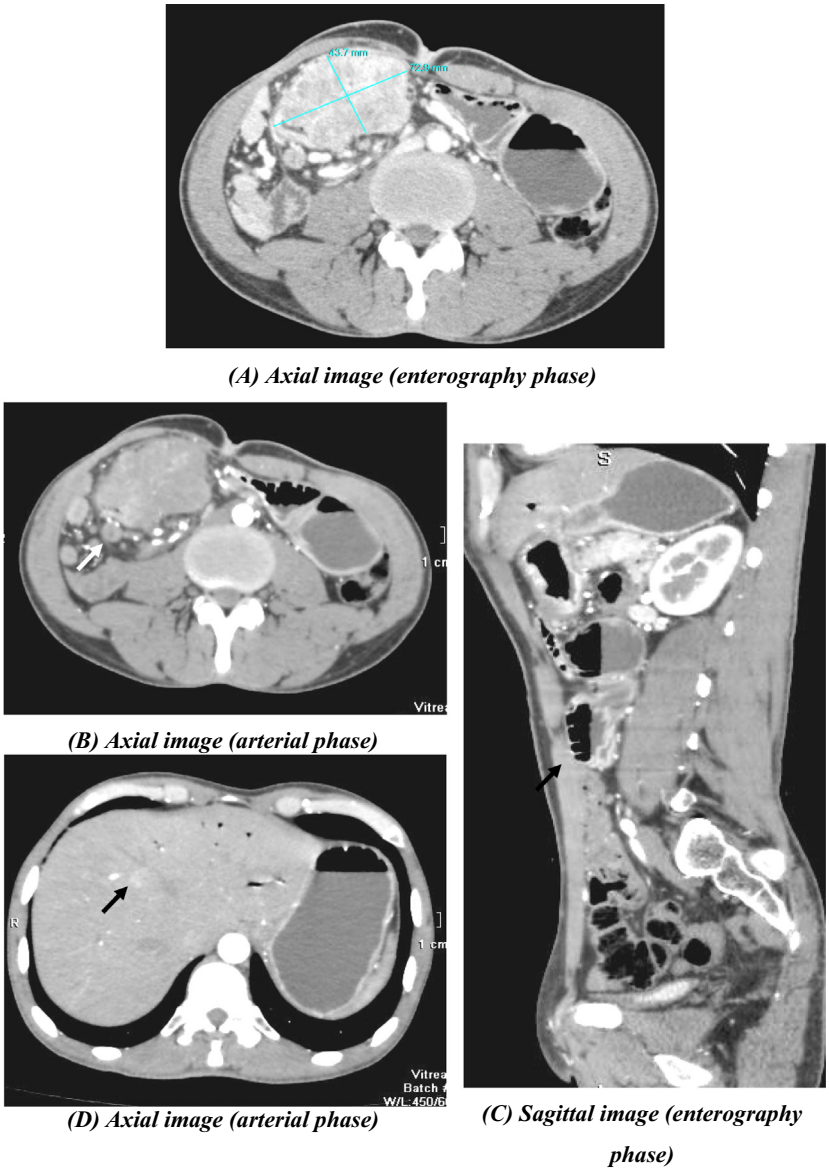


Fig. 2 A 34 years old male patient with Jejunal metastasis, lymphadenopathy and hepatic metastasis MDCT showed a focal asymmetric marked wall thickening with submucosal and serosal involvement and heterogenous enhancement (A). Associated enlarged mesenteric lymph nodes (white arrow) (B). Small intestinal obstruction (black arrow) (C). A single hepatic focal lesion (black arrow) (D).

Table 2 Non-neoplastic group lesions versus number of patients.

MDCT diagnosis	No. of patients
Tuberculous enteritis	5
Crohn's disease	5
Small bowel obstruction	3
Mesenteric ischemia	8
Small bowel trauma	1

the potential to demonstrate intraluminal, mural, and extra intestinal abnormalities (12).

In the present study, circumferential and symmetric thickenings of the bowel wall are found in the non neoplastic group while irregular asymmetric thickening was found in the noeplastic group. This is in agreement with Fernandes et al. (13) and Macari et al. (14) studies who also stated that distinction should be made between (1) focal (less than 5 cm of extension) and (2) segmental (6–40 cm) or diffuse (> 40 cm) involvement of the small bowel.

In the current study, most bowel tumors present as a focal involvement and segmental and diffuse thickening of the bowel wall found in the non neoplastic group except small bowel lymphoma that shows segmental involvement that it is consistent with Macari et al. (14) and Wittenberg et al. (15).

The MDCT features of lymphoma which was the most common encountered tumor in our study were marked asymmetric segmental wall thickening with homogenous wall enhancement most commonly involving the mucosa and submucosa of the ileum, most commonly associated with enlarged mesenteric lymph nodes. All of these criteria were mentioned

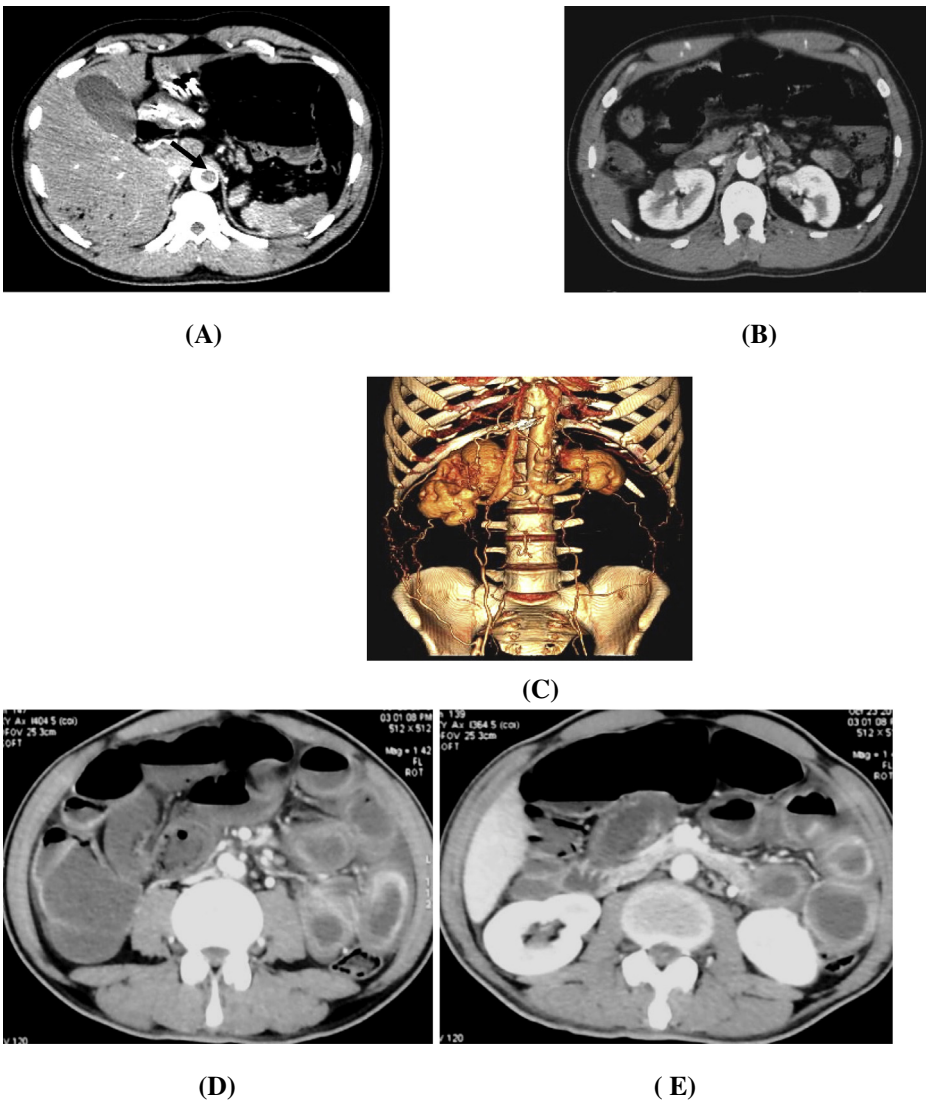


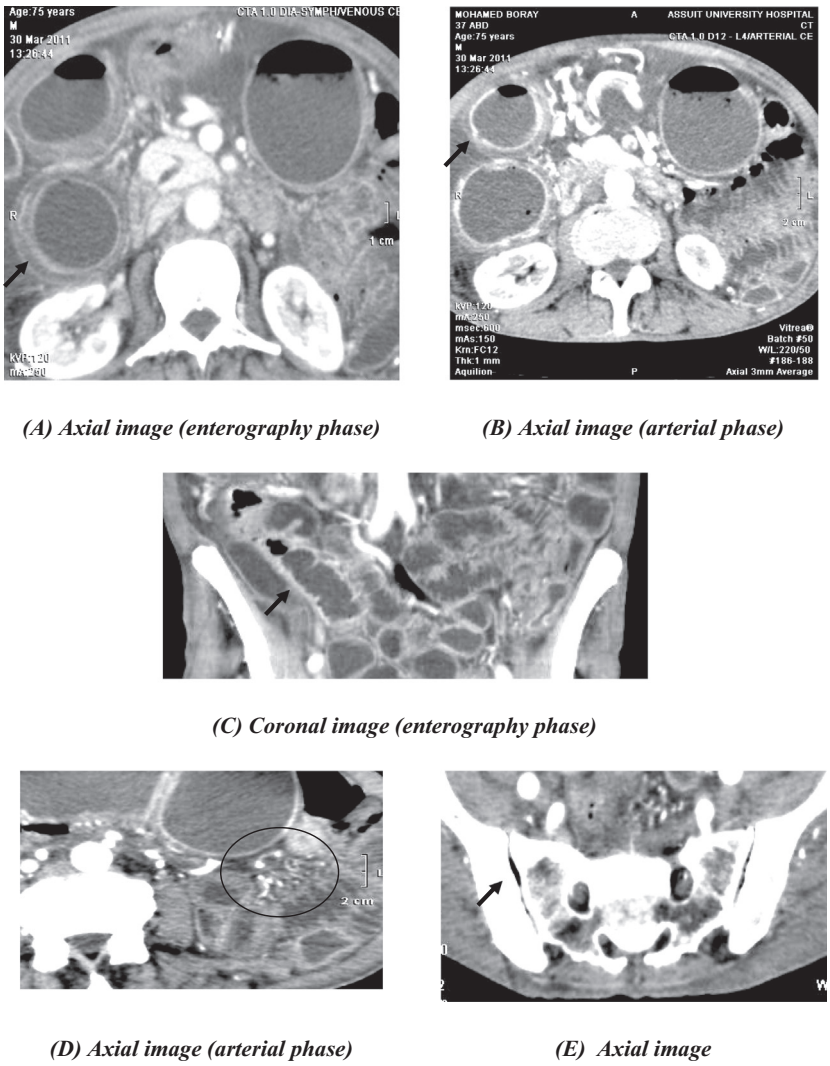
Fig. 3 A 50 year old male patient with Leriche Syndrome. MDCT showed hypodense thrombus filling defect within abdominal aorta (A). Extension of thrombus to the origin of the SMA (B). 3D CT angiography revealed infra renal aortic occlusion with multiple dilated collaterals (C). Small bowel showed segmental symmetric moderate wall thickening with target appearance of enhancement (D and E).

in the pattern approached by Sailer et al. (16) study as diagnostic MDCT criteria of Lymphoma. Anzidei et al. (17) also stated that satellite lymphadenopathies are usually bulky, larger than in other neoplasms and may be used as a differential sign and according to Lee et al. (18), lymphoma is more likely to involve multiple and longer segments of gut and is less likely to cause bowel obstruction. This was confirmed in our study as all lymphoma patient's MDCT showed a mass formation with aneurysmal dilatation without obstruction and most of them were associated with adjacent lymphadenopathy.

Gastrointestinal stromal tumor (GIST) is a common mesenchymal tumor of the gastrointestinal tract, primarily located in the stomach. MDCT features in the present study were marked asymmetric segmental wall thickening with heterogeneous wall enhancement (with necrosis) most commonly involving the submucosa of the jejunum in two patients and the ileum in only one patient with enlarged mesenteric lymph nodes in only one patient. A pedunculated or predominantly exocentric mass suggests a gastrointestinal stromal tumor as stated by Paulsen et al. (12).

Macari et al. (1) stated that adenocarcinoma of the small bowel was located in the proximal small intestine. Sailer et al. (16) also stated that the duodenum is the most frequently involved site and advanced stages of pancreatic, biliary, or colonic malignancies tend to infiltrate adjacent small bowel loops and MDCT criteria of metastatic tumors that coincided with the current study.

Menke (19) stated that CT has traditionally been used for two reasons in patients with suspected ischemia. First, it can help detect ischemic changes in the affected small bowel loops and mesentery. These changes include bowel wall thickening and edema, submucosal hemorrhage, increased or decreased enhancement of the bowel wall, mesenteric stranding or fluid, and pneumatosis. Second, CT can sometimes help determine the cause of the ischemia by allowing evaluation of the mesenteric vasculature for atherosclerosis, thrombus, occlu-



(A) Axial image (enterography phase)

(B) Axial image (arterial phase)

(C) Coronal image (enterography phase)

(D) Axial image (arterial phase)

(E) Axial image

Fig. 4 A 75 year old male patient with Crohn's disease. MDCT revealed segmental symmetric moderate wall thickening of the jejunum and ileum (the characteristic skip lesions with target appearance of enhancement) (arrow) (A). The mucosa and submucosa were involved. The mucosa was seen irregular in some regions (arrow) (B). Hyper-enhancement of the affected segments was noted and denoting activity (arrow) (C). Associated hyperemic mesenteric vessels (vasa recta) were found (black circle) (D). Bilateral sacroiliitis (arrow) (E).

sion, compression or invasion by tumor, and trauma. This was consistent with the current study, MDCT findings included filling defect within mesenteric veins and arteries in 6 out of 9 patients, showed moderate wall thickening with target appearance in early cases as Ahualli (20) stated that the target (stratified) pattern of attenuation may be an early finding of bowel ischemia results from edema of the submucosa and hyperaemia or hyperperfusion of the mucosa and/or muscularis propria, and those presented at later stage showed thinned wall with diminished enhancement. The characteristic small intestinal infarction feature "pneumatosis intestinalis" was seen in 2 of the 3 patients, with air seen in the portal radicles in one of these two in the current study. This is consistent with Chou et al. (21) and Rha et al. (22)studies that reported that intestinal pneumatosis and gas in the mesenteric or portal veins are indicatives of severe ischemia and are usually associated with thinning rather than thickening of the small bowel wall due to bowel wall necrosis.

Circumferential homogenous symmetrical bowel wall thickening was the commonest finding seen in all 3 patients in the current study presented with tuberculous enteritis. This was in concurrence to Zissin et al. (23) who reported that the typical concentric mural thickening was the commonest CT finding in gastrointestinal tuberculosis. The ileum (59%) was far more commonly involved than the jejunum (6%) as also described in the literature. This feature is attributed to the abundance of lymphoid tissue (Peyer patches) in the distal and terminal ileum (24). In the current study, thickening of jejunal and ileal loops was found. All the other associated extraintestinal manifestations of tuberculosis like psoas abscess, pleural effusion and mesenteric lymph nodal enlargement were useful imaging findings supporting the diagnosis of GI tuberculosis (25). This is consistent with the current study as psoas abscess was found in one patient and mesenteric lymphadenopathies in all tuberculous enteritis.

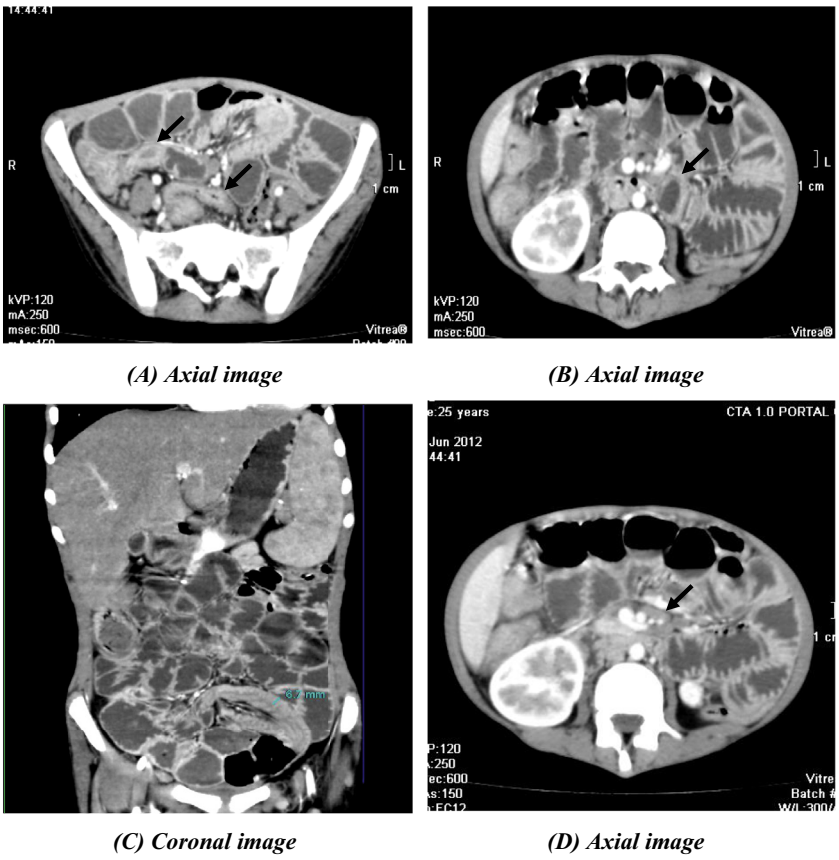


Fig. 5 A 25 year old female patient with small bowel tuberculosis. MDCT showed multiple areas of segmental symmetric moderate wall thickening of the jejunum and ileum (black arrows) (A) and (B). Homogenous enhancement and submucosal involvement (C). Associated multiple mesenteric lymph nodes (black arrow) (D).

Crohn's disease has predilection for the terminal ileum, it may affect any segment of the gastrointestinal tract (26), in our study, the jejunum and ileum were involved in all patients showing specific sign of skip lesions consistent with Tochetto et al. (27) who stated Small bowel involvement in Crohn's disease is typically transmural, with characteristic skip lesions. Typically, Crohn's disease results in segmental symmetric involvement of the affected small bowel in Macari et al. study (1) and this was found in all patients. Also Macari et al. (1) stated that segmental homogeneous mural hyperenhancement correlates significantly with histopathological findings of active Crohn's disease. This was confirmed in our study, as two patients showed hyperenhancement of the wall. LoRe et al. (28) concluded that the CT enterography finding of perienteric inflammation (increased fat density) and vascular engorgement of the vasa recta in Crohn's disease patients suggest that the disease is clinically active. This was found in our study in these two patients. Macari et al. (1) stated that Crohn's disease is associated with lymph node enlargement. In this study 3 patients showed multiple enlarged mesenteric lymph nodes. Paulsen et al. (12) stated that extraenteric manifestation of Crohn's disease including renal stones and sacroiliitis which were identified in two patients of our study.

Hong et al. (3) and Tye and Desser (29) stated that the diagnosis of bowel obstruction on MDCT depends on the identification of a transition zone with dilated proximal bowel loops. However, depiction of a definite transition zone is sometimes difficult because of overlapping dilated bowel loops when viewing only axial images. Thus 3D imaging can be helpful in evaluating indeterminate cases on the axial plane, such as volvulus or internal hernia. The additional use of positive oral contrast material can help to distinguish complete from incomplete bowel obstruction and allows performance of fluoroscopy during infusion. Subtle delays in the passage of contrast material are thus detected.

In our study, MDCT enterography detected the site, level and cause of the obstruction with neoplastic lesion in two of the patients, infectious enteritis (T.B.) in one patient, right-sided inguinal hernia in one patient, ileoileal intussusception in one patient, missed surgical clips in the last patient This finding was more evident and obvious after the analysis of the 3D images of the patients.

In the current study, a 19 year old male patient complained of acute abdominal pain and vomiting following a road traffic accident and MDCT showed diffuse dilatation of the duodenum, jejunum and ileum with homogenous enhancement and no abnormal pattern of wall thickening and mild amount of free intraperitoneal hemorrhagic fluid above the level of third sacral vertebra with no identifiable site of injury. This was supported by Yu et al. (30) study who found that the larger amount of free fluid identified in all 13 patients with surgically proved bowel and/or mesenteric injury was noted to extend above or at the level of the third sacral vertebral body. Also, Drasin et al. (31) who stated that it is well accepted that

unexplained hemoperitoneum raises the likelihood of an underlying small-bowel or mesenteric injury.

Limitation of the study, firstly, its small sample size, which precluded any finding of statistical significance. Secondly, CT enterography utilizes ionizing radiation. Recently published data on the risk of carcinogenesis in adult patients due to CT quote significantly lower-risk percentages of 0.02–0.04% (32) (average effective dose of abdomino pelvic CT examination is around 15 mSv). The authors believe that CT enterography is an appropriate technique when used judiciously in the right patient groups (33).

5. Conclusions

MDCT enterography has the potential to be used as one stop imaging modality for detection of small bowel diseases. However, biopsy is still the confirmatory diagnostic method. Also proved that the MDCT diagnostic pattern approach adopted by researchers to narrow the differential diagnosis of different small bowel diseases to a great extent and can be used as a wide world method of diagnosis.

Conflict of interest

We have no conflict of interest to declare.

Reference

(1) Macari M, Megibow A, Balthazar E. A pattern approach to the abnormal small bowel: observations at MDCT and CT enterography. AJR 2007;188:1344–55.
(2) Patak MA, Mortele KJ, Ros PR, et al. Multidetector row CT of the small bowel. Radiol Clin N Am 2005;43:1063–77.
(3) Hong SS, Kim AY, Byun JW, et al. MDCT of small-bowel disease: value of 3D imaging. AJR 2006;187:1212–21.
(4) Bradbury MS, Kavanagh PV, Bechtold RE, et al. Mesenteric venous thrombosis: diagnosis and noninvasive imaging. Radiographics 2002;22:527–41.
(5) Boudiaf M, Jaff A, Soyer P, et al. Small-bowel diseases: prospective evaluation of multi-detector row helical CT enteroclysis in 107 consecutive patients. Radiology 2004;233:338–44.
(6) Maglinte DD, Sandrasegaran K, Lappas JC, et al. CT enteroclysis. Radiology 2007;245:661–71.
(7) Yu CW, Lee WJ, Tsai YH, et al. Demonstration of extensive mesenteric venous thrombosis and intestinal infarction with multidetector row CT: value of curved planar reformations. Abdom Imaging 2003;28:775–7.
(8) Jaeckle T, Stuber G, Hoffmann MH, et al. Acute gastrointestinal bleeding: value of MDCT. Abdom Imaging 2008;33:285–93.
(9) Liu YB, Liang CH, Zhang ZL, et al. Crohn disease of small bowel: multidetector row CT with CT enteroclysis, dynamic contrast enhancement, CT angiography, and 3D imaging. Abdom Imaging 2006;31:668–74.
(10) Elsayes KM, Al-Hawary MM, Jagdish J, Ganesh HS, Platt JF. CT enterography: principles, trends, and interpretation of findings. Radiographics 2010 Nov;30(7):1955–70. http://dx.doi.org/10.1148/rg.307105052.
(11) Eid M, Abougabal A, Zeid A. Celiac disease: do not miss that diagnosis! Egypt J Radiolo Nucl Med 2013;44:727–35.
(12) Paulsen SR, Huprich JE, Fletcher JG, et al. CT enterography as a diagnostic tool in evaluating small bowel disorders: review of clinical experience with over 700 cases. Radiographics 2006;26:641–57.
(13) Fernandes TC, Castro R, Pinto D, Oliveira MI, Carneiro A, Cunha R. Bowel wall thickening – a complex subject made simple. Electronic poster presented at 2011 ESGAR meeting. doi:10.5444/esgar2011/EE-063#_blank.
(14) Macari M, Balthazar EJ. CT of bowel wall thickening: significance and pitfalls of interpretation. AJR Am J Roentgenol 2001;176:1105–16.
(15) Wittenberg J, Harisinghani MG, Jhaveri K, Varghese J, Mueller PR. Algorithmic approach to CT diagnosis of the abnormal bowel wall. Radiographics 2002;22:1093–107.
(16) Sailer J, Zacherl J, Schima W. MDCT of small bowel tumours. Cancer Imaging 2007;7:224–33.
(17) Anzidei M, Napoli A, Zini C, et al. Malignant tumours of the small intestine: a review of histopathology, multidetector CT and MRI aspects. Br J Radiol 2011;84:677–90.
(18) Lee HJ, Im JG, Goo JM, et al. Peripheral T-cell lymphoma: spectrum of imaging findings with clinical and pathologic features. Radiographics 2003;23:7–26.
(19) Menke J. Diagnostic accuracy of multidetector CT in acute mesenteric ischemia: systematic review and meta-analysis. Radiology 2010;256:93–101.
(20) Ahualli J. The target sign: bowel wall. Radiology 2005;234:549–50.
(21) Chou CK, Wu RH, Mak CW, Lin MP. Clinical significance of poor CT enhancement of the thickened small-bowel wall in patients with acute abdominal pain. AJR Am J Roentgenol 2006;186(2):491–8.
(22) Rha SE, Ha HK, Lee SH, Kim JH, Kim JK, Kim JH, et al. Auh YH CT and MR imaging findings of bowel ischemia from various causes. Radiographics 2000;20(1):29–42.
(23) Zissin R, Gayer G, Chowers M, Shapiro-Feinberg M, Kots E, Hertz M. Computerized tomography findings of abdominal tuberculosis: report of 19 cases. Isr Med Assoc J 2001;3(6):414–8.
(24) Tripathi PB, Amarapurkar AD. Morphological spectrum of gastrointestinal tuberculosis. Trop Gastroenterol 2009 Jan–Mar;30(1):35–9.
(25) Bhatt S, Bhardwaj N, Tandon A, Jain BK, Bhargava SK. MDCT enterography a new diagnostic tool for gastrointestinal tuberculosis: an initial experience. Electronic poster presented at ECR; 2013. doi: 10.1594/ecr2013/C-1766.
(26) Karlinger K, Gyorke T, Mako E, Mester A, Tarjan Z. The epidemiology and the pathogenesis of inflammatory bowel disease. Eur J Radiol 2000;35:154–67.
(27) Tochetto S, Yaghmai V. CT enterography: concept, technique, and interpretation. Radiol Clin North Am 2009;47(1):117–32.
(28) Lo Re G, Cappello M, Tudisca C, Galia M, Randazzo C, Craxì A, et al. CT enterography as a powerful tool for the evaluation of inflammatory activity in Crohn's disease: relationship of CT findings with CDAI and acute-phase reactants. Radiol Med 2014;119(9):658–66.
(29) Tye GA, Desser TS. MDCT of the small bowel. Appl Radiol 2012;41(8).
(30) Yu J, Fulcher AS, Turner MA, et al. Blunt bowel and mesenteric injury: MDCT diagnosis. Abdom Imaging 2011;36(1):50.
(31) Drasin TE, Anderson SW, Asandra A, et al. MDCT evaluation of blunt abdominal trauma: clinical significance of free intraperitoneal fluid in males with absence of identifiable injury. AJR 2008;191:1821–6.
(32) Meer A, Basu P, Baker L, Atlas S. Exposure to ionizing radiation and estimate of secondary cancers in the era of high speed CT scanning. Scientific formal (paper) presentation: CODE: SSK08-04: RSNA; 1 December 2010.
(33) Sodickson A, Baeyens PF, Andriole KP, Prevedello LM, Nawfel RD, Hanson R, et al. Recurrent CT, cumulative radiation exposure, and associated radiation-induced cancer risks from CT of adults. Radiology 2009;251:175–84.