Multidetector Computed Tomography in Large Bowel Lesions—A Study of 100 Cases

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Abstract This study aims to evaluate the role of multidetector computed tomography (MDCT) in detecting and classifying the large bowel lesions. A prospective study of 100 adult patients was conducted from June 2007 to October 2009. Rectal and IV contrast were used for three dimensional reconstruction. Angiography was performed in cases of suspected ischemic pathology. CT colonography was done to evaluate adenomas. CT findings were correlated and confirmed by either colonoscopy, biopsy, postoperative findings or follow-up CT. The pathologies were common in 50–70 yrs (44%). M: F ratio was 2:1. Malignant lesions were seen in (55%) followed by inflammatory lesions in 26%, diverticulitis and ischemic colitis in 6% each. Miscellaneous conditions like polyps, volvulus and intussusceptions were seen in 7%. Adenocarcinoma was the common malignancy (81.2%). Present study showed that adenocarcinomas were associated with marked thickening of bowel wall (>1.5 cm) in 85.4% of patients, asymmetrical wall thickening (96.4%), focal involvement (length <10 cm) in 85.5% with heterogeneous post contrast enhancement (96.3%). Inflammatory lesions showed mild thickening (69%), segmental or diffuse involvement (77%), symmetrical wall thickening (89%) and homogenous post contrast enhancement (81%). Ischemic lesions showed marked thickening (83.4%), symmetrical thickening (100%) and homogenous enhancement (100%). Diverticulitis showed

marked thickening (100%), asymmetrical wall thickening (66.7%) with heterogeneous post contrast enhancement (100%), with pericolic fluid. Arterial/venous thrombosis was diagnosed in 66.66%. Three per cent had benign adenomatous polyps on CT colonographic studies. MDCT was accurate in 98.2% cases for differentiating between benign and malignant etiology and is the modality of choice.

Keywords MDCT (Multidetector computed tomography) · Wall thickening

Introduction

Imaging of large bowel has seen a quantum leap with multidetector computed tomography (MDCT) with its three dimensional reconstruction, angiography and CT colonographic applications. CT scanning has become a versatile tool in the assessing gastrointestinal tract and providing accurate information about lumen, its wall and surrounding structures. High resolution ultrasound can detect the pathology but cannot characterize the lesion. Areas like sigmoid colon are much more accessible with USG. MDCT has proved to be an effective modality in evaluating the bowel pathology.

Methods and Material

A prospective study of the role of MDCT in large bowel pathologies was conducted from June 2007 to October 2009. One hundred adult patients, presenting with clinical symptoms pertaining to large bowel pathologies were included. CT findings were confirmed by colonoscopy, biopsy report, postoperative study or follow-up CT and/or USG. Rectal and IV contrast were used for the study. Triple phase study was

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Table 1 Pathologies detected

Diagnosis	Percentage
Inflammation	26
Ischemic bowel	6
Diverticulitis	6
Malignancy	55
Miscellaneous	7
Total	100

performed for hepatic metastasis. Angiography was performed in cases of suspected ischemic pathology. Volumetric data were acquired in axial sections and reconstructed in coronal and sagittal planes. Criteria included in diagnosing the lesion were age of the patients, site of involvement, degree of wall thickening, length of the involved segment, symmetric or asymmetric thickening, homogeneous or heterogeneous enhancement and associated findings like soft tissue mass, lymph nodes, hepatic metastases, hepatic abscesses, surrounding fat stranding, ascites, collections and vascular involvement.

Results and Discussion

Age Group

Fig. 1 Normal bowel wall **Fig. 2** Mild diffuse thickening in ulcerative colitis

Discussion

Imaging of the large bowel has improved with introduction of MDCT with its 3-D reconstruction colonographic and angiographic applications. The common age group observed in our study is shown in pie chart which was between 40–70 years. Common bowel pathologies (Table 1) include colitis of different etiologies, diverticulitis, malignancy and other conditions like intussusceptions, polyps and volvulus. The latter three conditions are easy to diagnose but it is important to differentiate between colitis and malignancy as management is different. Other applications of MDCT include CT colonography which is non-invasive and virtual colonoscopy to detect adenomatous polyps. MDCT plays an important role in abdominal angina.

Fig. 3 Marked thickening of bowel wall in adenocarcinoma of caecum

Table 2 Degree of wall thickening

	Mild (<1.5 cm)	Marked (>1.5 cm)
Malignancy	8 (14.6%)	47 (85.4%)
Inflammatory colitis	18 (69%)	8 (31%)
Ischemic colitis	1 (16.6%)	5 (83.4%)
Diverticulitis	–	6(100%)
Total	27	66

With CT angiography it is easy to detect mesenteric vasculature to evaluate ischemic colitis.

Thickening of the bowel wall is the common finding in a majority of the diseases, hence, it is necessary to differentiate between benign and malignant thickening. Criteria for evaluation of bowel wall while differentiating benign from malignant lesions were divided into major and minor criteria.

Major	Minor
Site	Age
Degree of wall thickening	Adjacent mass
Symmetry of the thickening	Peribowel fat stranding
Enhancement pattern of the wall	Ascites
Length of involved segment	Lymph nodes
	Hepatic metastasis
	Hepatic abscess

Of the 93 patients with large bowel wall thickening, 98% were diagnosed correctly as benign or malignant using the above criteria. Thus, MDCT was accurate in 98% for differentiation between benign and malignant etiology.

Clinical diagnosis was accurate in 54 patients (45%) where ultrasound yield was (64%). Ultrasound sensitivity was high but specificity was low. With use of CT scan, it increased to 98%.

The normal thickness of the colonic wall depends on the degree of distention. When distended, the wall should measure <3 mm and it is often imperceptible [1] The normal bowel wall enhances after IV contrast material with enhancement greater on the mucosal aspect (Fig. 1).

Table 3 Type of wall thickening

	Symmetrical	Asymmetrical
Malignancy	2 (3.6%)	53 (96.4%)
Inflammatory colitis	23 (89%)	3 (11%)
Ischemic colitis	6 (100%)	–
Diverticulitis	2 (33.3%)	4 (66.7%)
Total	33	60

Table 4 Length of segment involved

	Focal (<10 cm)	Segmental (10–30 cm)	Diffuse
Malignancy	47 (85.5%)	8 (14.5%)	–
Inflammatory colitis	6 (23%)	16 (62%)	4 (15%)
Ischemic colitis	–	4 (66.7%)	2 (33.3%)
Diverticulitis	6 (100%)	–	–
Total	59	28	6

Degree of Wall Thickening

Mild thickening of the wall is considered when thickening is <15 mm as seen in non-neoplastic lesions e.g. inflammatory conditions. Early neoplasm may show mild thickening but associated findings may help. The common inflammatory conditions of the bowel are amoebic colitis, chronic granulomatous conditions like ulcerative colitis and Crohn's disease.

Fig. 4 a Wall thickening with homogenous enhancement in amoebiasis b Amoebic liver abscess

Because the disease process is limited to the mucosa in patients with ulcerative colitis and is often transmural in Crohn's disease, bowel wall thickening is usually greater in Crohn's disease. One study found that the mean thickness of the colon wall in Crohn's disease was 11 mm compared with 7.8 mm in patients with ulcerative colitis [2] (Fig. 2). Marked thickening with thickness >15–30 mm is seen in primary neoplasm e.g. adenocarcinomas, sarcoma, lymphoma (Fig. 3). In our study 69% of inflammatory lesions had mild wall thickening whereas 85.4% of adenocarcinomas were associated with marked thickening (>1.5 cm) (Table 2).

Type of Wall Thickening

Symmetrical wall thickening is seen in inflammatory conditions, bowel edema, ischemia and sub mucosal hemorrhage [3]. Irregular short asymmetric lesions with abrupt margins are the hallmark of adenocarcinomas and metastatic diseases [4]. In our study 89% of inflammatory lesion had symmetrical thickening and 96.4% of malignancy had asymmetrical thickening, considered to be specific for malignant lesions (Table 3).

Length of Involved Segment

Focal thickening is seen in both benign and malignant processes. Most neoplasms of the gastrointestinal tract

Fig. 5 Submucosal fatty infiltration in case of chronic colitis

Fig. 6 Heterogeneous enhancement in case of malignancy

present as a focal area of bowel wall thickening as seen in 85% of our patients. Inflammation mostly presents with diffuse or segmental involvement with length varying from 10–30 cm. Diverticular disease leads to focal involvement (<10 cm). Segmental involvement is also seen in Crohn's disease, radiation enteritis, ischemic colitis and intramural hemorrhage [5]. Diffuse involvement is seen in ulcerative colitis, infectious enteritis, edema from low-protein states, portal hypertension associated with cirrhosis, low-flow ischemia and edema [6, 7]. Our study showed that inflammatory lesion had segmental involvement in 62% with diffuse thickening seen in 15% (Table 4).

Enhancement Pattern

Homogenous attenuation after intravenous contrast is seen in inflammatory diseases (Fig. 4), sub mucosal hemorrhage or hematoma. In case of infarction, the wall is circumferentially thickened and may show a target or halo sign

Table 5 Post-contrast enhancement

	Homogenous	Heterogeneous
Malignancy	2(3.7%)	53 (96.3%)
Inflammatory colitis	21 (81%)	5 (19)
Ischemic colitis	6 (100%)	–
Diverticulitis	–	6 (100%)
Total	29	64

Fig. 7 a,b Transverse colon diverticulitis with adjacent abscess in axial and coronal plane respectively

[8]. Inflammatory lesions may show target or double halo sign and stratified enhancement pattern and is a sign of non malignant disease [9–11]. The fat halo sign seen on CT appears as a thickened bowel wall demonstrating three layers: an inner and an outer layer of soft-tissue attenuation, between which lies a third layer of fatty attenuation. The fat halo sign is seen in conditions in which fatty infiltration of the submucosa is present as seen in chronic inflammatory bowel disease (Crohn's disease and ulcerative colitis) [12] (Fig. 5). According to published data, the presence of the fat halo sign has been reported in 61% of patients with ulcerative colitis and in only 8% of patients with Crohn's disease [13].

The grossly thickened bowel wall in malignancies shows several irregular zones of lower attenuation haphazardly located adjacent to areas of higher attenuation. The findings are related to ischemia and necrosis and are seen in adenocarcinomas and stromal cell tumors. Larger tumors frequently undergo central necrosis and show heterogeneous enhancement [14] (Fig. 6). Diverticular disease in our study had focal asymmetrical wall thickening in (66%) and homogeneous post contrast enhancement in (100%) (Table 5), but all were associated with pericolic fluid collection, fat stranding and clinically, significant pain (Fig. 7). Many a times it is difficult to differentiate between malignancy and diverticular disease where associated findings help us. Peri bowel fat stranding with collection is more specific for the diverticular disease not seen in malignancy.

Table 6 Site of involvement in inflammation and malignancy

Bowel	Inflammation	Malignancy
Caecum & I. C. junction	14 (54%)	10 (18.2 %)
Appendix	4 (15.4%)	0
Colon	2 (7.7%)	10 (18.2 %)
Rectosigmoid	6 (23%)	35 (63.6%)
Total	26	55

Adenocarcinoma was the most common malignancy involving the large bowel in our study. Rectosigmoid region was common site of involvement seen in 64% (Table 6). 21.8% of malignancy presented with exophytic mass. Liver metastasis was seen in 45.5% of malignancies. 67.8% of patients with amoebic colitis had liver abscess as associated findings (Table 7). Lymphadenopathy was associated with both benign and malignant conditions.

Ischemic bowel disease results from acute or chronic insufficiency of blood flow termed as mesenteric ischemia. Bowel ischemia can threaten bowel viability with consequences like intestinal necrosis and gangrene. High index of clinical and radiological suspicion is required to make a timely diagnosis of ischemia and infarction of the gut. Dramatic improvement in cross-sectional imaging have potential to afford earlier and more precise diagnosis which is key to the reduction of morbidity and mortality of this fatal condition. MDCT helps in early and precise diagnosis. Most common locations include splenic flexure and rectosigmoid colon. Segmental wall thickening with layered appearance or target sign is seen on enhanced scan [15]. Pneumatosis may be seen in advanced disease. Complications include infarction, perforation and stricture. In first

Table 7 Associated findings

	Malignancy	Inflammatory	Ischemic	Diverticulitis
Adjacent soft tissue lesion	21.8%	23%	—	66.60%
Lymph nodes	10%	27%	—	—
Hepatic metastasis	45.50%	—	—	—
Hepatic abscess	—	67.8%	—	—
Fat stranding	47%	87%	—	100%
Ascites	—	25%	—	—
Vascular obstruction	—	—	66.66%	—

Fig. 8 **a** Superior mesenteric artery thrombosis in bowel ischemia **b** Intramural air in bowel ischemia

stage immediately after occlusion thrombus can be seen in superior mesenteric artery (SMA) or superior mesenteric vein (SMV) but wall changes are not developed. In second stage mild distension of bowel with paper thin wall and mural enhancement is seen. In case of SMV thrombosis mural thickening, mural hemorrhage and sub mucosal edema results in target appearance of the bowel wall. The damage at this stage is reversible and three outcomes can ensue: healing which may lead to stricture formation, chronic ischemia or progress to infarction.

Our study showed ischemic lesions had marked wall thickening (83.4%), symmetrical thickening (100%) and homogenous (target sign) pattern of enhancement (100%) with segmental involvement (66%). Angiography detected

arterial /venous occlusion in (66.6%) which helped to reach a specific diagnosis of ischemic colitis (Fig. 8)

Imaging findings of acute appendicitis include a dilated appendix thicker than 0.6 cm, circumferential wall thickening, and wall enhancement after contrast material administration, and periappendiceal fat stranding. A radiopaque appendicolith is occasionally seen, making the diagnosis more certain [16]. Other conditions like intussusceptions and volvulus are easy to diagnose. In adults mass can be the lead point of intussusceptions (Fig. 9).

CT Colonography

Colorectal malignancy is the second most commonly diagnosed cancer after lung malignancies. 65% of colorectal carcinomas are associated with the syndromes like peutz-jeghers, familial adenomatous polyposis, etc. 93% of

Fig. 9 Mass as a leading point of intussusception

Fig. 10 Virtual colonography showing pedunculated polyp

colorectal carcinoma arise from colonic polyps and there is reduction of cancer incidence following removal of polyps. CT colonography (CTC) has been extensively investigated over the past decade, with the ultimate goal of providing an accurate, minimally invasive screening test for detecting colonic polyps before they become frankly malignant. CT Colonography is indicated in patients who are contra-indicated for colonoscopy e.g. patients with cardiac or severe pulmonary disease, who have incomplete colonoscopy, patients who are high risk for development of colorectal carcinoma such as those who have ulcerative colitis or Crohn's disease or patients with hereditary polyposis [17] (Fig. 10).

Conclusion

MDCT proved to be “the imaging modality of choice” for bowel lesion.

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