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UTILITY OF MULTIDETECTOR COMPUTED TOMOGRAPHY FEATURES IN DIFFERENTIATING INFLAMMATORY AND MALIGNANT BOWEL WALL LESIONS.

Radiodiagnosis

Dr Pooja B P MBBS, MDRD, DNB, Ex Senior Resident PGI Chandigarh, Consultant Radiologist, Clumax Medall Jayanagar, Bangalore

Dr Pavankumar G Kale* Assistant professor, Department of Radiology, SVIMS, Allipiri road, Tirupati Andhra Pradesh 517507, INDIA *Corresponding Author

ABSTRACT

In our study 54% case were malignant and 46% were inflammatory/infectious. Large bowel was involved in 55% of cases , small bowel in 20% and 25% involving both small and large bowel. 77.7% of the small bowel lesions were seen to involve the ileum. In the large bowel, predominantly the cecum (42.5%), ascending colon (36.2%) and recto sigmoid colon (48.7%) were involved. Segmental or diffuse, symmetric, mild, circumferential thickening with target sign was sensitive and specific for inflammatory lesions. Tuberculosis presents as symmetric or asymmetric. Focal, asymmetric, mild- marked, circumferential, eccentric or exocentric thickening with loss of stratification and grey attenuation was sensitive and specific for malignant lesions.

KEYWORDS

Small Bowel, Large Bowel, Multidetector Row Computed Tomography, Tuberculosis, Malignant.

INTRODUCTION:

Pathologies of small and large bowel are frequently encountered in our day to day practice. It is important to differentiate a neoplastic lesion from an infectious/inflammatory lesion and benign from malignant lesion. Imaging the small bowel is challenging technically. A problem for imaging is motion, both the 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.[1] Recently, the role of wireless capsule endoscopy to assess small bowel diseases has been reported. However problems with technique include capsule obstruction by bowel strictures, battery failure, prolonged transit and also the false negative results if there is rapid peristalsis at the lesion site or if there is bowel angulation at a lesion that impairs the camera view.[2] Conventional colonoscopy potentially permits total colon evaluation but sometimes fails to show the entire colon in about 5% of cases owing to difficulties in reaching the right side; moreover, it does not allow evaluation of the liver and other organs outside the colon.[3] Improvements in CT technology have expanded the role of CT in small and large bowel.[4] The development of MDCT has allowed for thinner collimation, faster scanning and high resolution imaging of the whole abdomen in one breath hold obviating motion artifacts. Faster scanning speeds has all but eliminated motion artifact.[5] Using this volume data set for reconstruction allow concise display of the small and large bowel.[1] CT is becoming increasingly important in evaluating mural and extramural lesions and in assessing mesenteric involvement and ancillary intra-abdominal findings associated with [6] inflammatory or neoplastic small intestinal diseases. Multi-detector CT and 3D imaging have improved CT evaluation of the intestine and mesenteric vasculature. [7] Coronal reconstruction seems to be especially important for small bowel imaging because of the anatomic arrangement of the loops. The possibility of having all three planes available also helps to follow the bowel loops throughout the abdomen.[1] This study is an effort to evaluate the role of MDCT in detection and characterization of small and large bowel wall pathologies and to assist in deciding further course of management.

LITERATURE SURVEY:

Boudiaf M et al reported that the overall sensitivity was 100% for detecting small bowel disease with MDCT, specificity was 95%, and accuracy was 97%.37.[8] Balthazar EJ et al conducted a study on 11 patients with ileocecal tuberculosis. In their study, five cases showed mild circumferential wall thickening of the terminal ileum and cecum, thickening of the ileocecal valve [7] . Choi D et al reported four CT patterns of thickened bowel wall were divided into four types based on patterns of mural stratification and enhancement, They concluded that in patients with Crohn's disease, thickened bowel wall with layering enhancement is predictive of acute disease, and that of homogeneous enhancement suggests quiescence.[9] Wiesner W et al reported the prospective sensitivity, specificity, PPV and NPV of MDCT for the diagnosis of acute bowel ischemia in the daily routine were 79.17, 98.51, 90.48 and 98.15%.[10] Sandrasegaran K et al in a study of GIST showed that the tumors were of enteric, gastric, duodenal, and rectal origin. Primary tumors were typically exophytic, larger than 5cm , and inhomogeneously enhancing. Central necrosis in all tumors and aneurysmal dilation of enteric tumors were seen. Metastases were most commonly to mesentery or liver.[11] Burkill et al demonstrated that of 116 patients 49 tumours arose in the small bowel, 43 in the stomach and 13 in colon and rectum. In the 38 patients whose CT scans they were able to review, 23 showed metastases at presentation of which 13 involved the liver and eight were peritoneal.[12]Moschetta M et al in a study on bowel infarction, found arterial occlusion in 67% of patients and venous obstruction in 33%. Bowel-wall hyperdensity, loss of wall enhancement, and wall thickening were predictive of good outcome. They concluded that MDCT is able to detect the nature of bowel ischemia and provide important prognostic information.[13] Cervantes-Solís C et al concluded in their study that there was a statistically significant relationship between CT measured colonic thickening and colorectal cancer but no statistically significant association was found between thickening and sigmoid colon cancer.[14]Dighe S et al conducted a meta-analysis on nineteen studies. The pooled sensitivity, specificity, DOR for detection of tumour invasion was 86%; 78% and 22.4. Similarly, the values for nodal detection were 70%; 78% and 8.1. In the subgroup analysis, the best results were obtained in studies utilizing MDCT. They concluded that preoperative staging CT accurately distinguishes between tumours confined to the bowel wall and those invading beyond the muscularis propria; however, it is significantly poorer at identifying nodal status.[15]

MATERIAL AND METHODS :

Data for the study was collected from patients attending the department of radiodiagnosis of hospital attached to Bangalore Medical College, with clinically suspected bowel wall lesion. A prospective study was conducted over a period of two years on 100 patients. Patients were evaluated with MDCT on SIEMENS SOMATOM EMOTION 6. A provisional diagnosis was suggested after the CT examination and these findings were correlated with histopathology/surgical finding wherever applicable. Patients with history of trauma were excluded from the study. Patient preparation was done as per institute protocol. We administered 100–120 ml of iohexol at a rate of 2–3 ml/sec. Scanning was done 50 seconds after the start of contrast material injection, a delay that corresponds to the portal venous phase of liver imaging. The abdomen was imaged from the diaphragm to the symphysis pubis. 5-mm collimation was used, with a table speed of 8 mm/sec. Reconstruction of the data is typically performed at 5-mm intervals. Bowel segments were chosen for measurement where the bowel was well distended and wall was well delineated. Then the bowel wall thickness was determined by measuring the distance from the intraluminal contrast medium to the

outer layer of the bowel wall bordering the mesenteric fat. If, at the same location, the colonic wall showed different wall thicknesses, for example, at the mesenteric or antimesenteric side, the maximal wall thickness was measured. If there was doubt if the thicker part of the colonic wall could eventually result from a partial volume effect, according to the anatomic position of the colon, the thinner part of the colonic wall was measured. Thickening was considered symmetric when the involved segment shows the same degree of thickening throughout the circumference of the abnormal segment. Asymmetric thickening relates to different degrees of eccentric Thickening around the circumference of the involved segment. The extent and location of bowel wall involvement was evaluated. Thickening was classified as focal (<10 cm), segmental (10-30 cm), or diffuse (> 30cm). Attenuation patterns were assessed as "Water halo sign" indicating stratification within a thickened bowel wall that consists of either two or three continuous, symmetrically thickened layers. The "Gray pattern" was defined as a thickened bowel wall with limited enhancement whose homogeneous attenuation is comparable with that of enhanced muscle. The "fat halo sign" refers to a three-layered target sign of thickened bowel in which the middle or submucosal layer has a fatty attenuation. "White attenuation" pattern represents the bowel wall enhanced to a degree equal to or greater than that of venous opacification in the same scan. "Black attenuation" is the equivalent of pneumatosis [16,17]. All measurements were performed by the same reader. Data entry and analysis was done using Microsoft excel sheet.

OBSERVATION:

In our study, there was a male preponderance (61%) when compared to females who accounted for (39%) of cases. Out of 100 cases 54 were diagnosed to be malignant(54%) and 46 cases were diagnosed inflammatory/infectious (46%).The most common malignant bowel wall lesion was adenocarcinoma accounting for 39% of all the bowel lesions and 72.2% of the malignant bowel wall lesions. 16 out of 39 patients (41%) of adenocarcinomas were in the age range of 60-69 years. The age ranges for inflammatory lesions were between 20-69 years, the maximum number of cases in 50-59 year range (37.5%), with no lesions seen in <20 and >70 year age groups. Tuberculosis was seen to affect the entire range of age groups with the youngest patient with tuberculosis being a 17 year old female patient. Cases with lymphoma were seen in the age group of 30-69 years and those with GIST in the age group 20-79 years. Two out of 3 cases of metastases were in the age group of 60-69 years.

BOWEL WALL TOPOGRAPHY OF LESIONS:

Large bowel was involved in 55% of cases , 20% cases involved the small bowel and 25% involved both small and large bowel. 77.7% of the small bowel lesions were seen to involve the ileum. In the large bowel, predominantly the cecum (42.5%), ascending colon (36.2%) and rectosigmoid colon (48.7%) were involved. In the small bowel, inflammatory/infectious and malignant lesions predominantly involved the ileum. 85.7% cases of tuberculosis involved ileum. 3 out of 4 cases of Crohn's were seen to involve small bowel predominantly jejunum and ileum. 2 out of 2 cases of ischemia were seen to involve jejunum and ileum. Adenocarcinoma and GIST were seen to involve duodenum, jejunum and ileum. 4 out of 4 cases of Crohn's were seen to involve large bowel. Adenocarcinoma predominantly involved rectosigmoid colon. No significant association between location of lesion and type of pathology was noted.

WALL THICKENING:

Of 14 cases of tuberculosis 11 were seen to have a maximum wall thickness of <20mm, with symmetrical thickening seen in 12 cases and circumferential thickening seen all cases. Equal distributions of focal and segmental lesions were seen. All cases of Crohn's, diverticulitis, ischemia and radiation enteritis showed maximum wall thickness of <20mm with symmetrical and circumferential thickening. All cases of inflammatory lesions showed circumferential thickening. Diffuse thickening was seen in 7 cases of inflammatory lesions. 25 out of 39 cases (64%) of adenocarcinoma were seen to have a maximum thickness of >20mm, 38 cases (97.4%) asymmetric thickening and 26 cases (66.6%) circumferential thickening where as 13 cases (33.3%) were seen to have eccentric thickening. All cases of lymphoma showed a maximum thickness of >20mm, asymmetric and circumferential thickening. All cases of GIST showed a maximum thickness of >20mm, asymmetric and eccentric and exocentric thickening. 61.2% malignant lesions showed circumferential thickening. The rest of the lesions showed eccentric (24%) and eccentric + exoenteric (14.8%) type of thickening. The wall thickness was segregated into two groups of less than or more than 20mm. There was a statistical significant association between circumferential /eccentric thickening of bowel and particular pathology in question (table 1) with a p value of 0.00010859.

TABLE 1: The distribution of type of thickening among different pathologies

Type Of Thickening	Pathologies			Grand Total
	Tuberculosis	Inflammatory	Malignancy	
Circumferential	14	31	34	79
Eccentric	0	1	20	21
Grand Total	14	32	54	100

BOWEL WALL STRATIFICATION:

All cases of tuberculosis showed loss of wall stratification with grey attenuation on post contrast study.3 cases of Crohn's showed mural stratification with 2 of the cases showing water halo attenuation and one case showing fat halo attenuation. 1 case of Crohn's showed loss of mural stratification with grey attenuation. 1 case of ischemia showed white attenuation and the other black attenuation. 15 cases of other inflammatory lesions (93.75%) showed mural stratification with water halo attenuation. All cases of appendicitis and diverticulitis showed mural stratification with water halo attenuation.37 cases of adenocarcinoma (94.8%) showed loss of mural stratification with grey attenuation. All cases of lymphoma, GIST and metastases showed loss of mural stratification with grey attenuation. In our study we found statistically significant association between stratification and different pathologies (table 2) with a p value of less than 0.001 (exact p value 5.185 x 10-16).

TABLE 2: The distribution of bowel wall stratification on CT among different pathologies

Stratification	Pathologies			Total
	Tuberculosis	Inflammatory	Malignancy	
Absent	14	4	51	69
Present	0	28	3	31
Total	14	32	54	100

In our study we found statistically significant association between bowel wall attenuation on CT and different pathologies (table 3) with a p value of less than 0.0001 (exact p value 2.95157 x10-15).

TABLE 3: The distribution of bowel wall attenuation on CT among different pathologies

Pathologies	Bowel wall attenuation					
	Fat halo	Grey attenuation	Water halo	Black attenuation	White attenuation	Total
Tuberculosis	0	14	0	0	0	14
Inflammatory	1	1	28	1	1	32
Malignancy	0	51	2	0	0	53
Total	1	66	30	1	1	99

LENGTH OF INVOLVEMENT:

Of the malignant lesions 88.8% were seen to have focal involvement. 45.6% of inflammatory/infectious lesions were seen to have focal involvement and 39.1% showing segmental involvement. All cases of diffuse involvement were inflammatory/infectious lesions. In our study we found statistically significant association between length of bowel wall involvement on CT and different pathologies (table 4) with a p value of less than 0.0001(exact p value 3.40042 x10-6 .

TABLE 4: The distribution of length of bowel wall involvement on CT among different pathologies.

Length of involvement	Diagnosis			
	Tuberculosis	Inflammatory	Malignancy	Total
Diffuse	0	7	0	7
Focal	7	14	48	69
Segmental	7	11	6	24
Total	14	32	54	100

DISCUSSION:

Minordi L.M et al in their study state that abdominal pain is the most common symptom, reported by 69% of patients with a histologically proven primary small-bowel malignancy. Gastrointestinal bleeding is seen in 52%, nausea and/or vomiting in 49%, weight loss in 45% and diarrhoea in 29% of cases.[18] Adenocarcinoma being the most common malignant bowel wall lesion in our study, pain abdomen was

seen in 46%, altered bowel habits in 30.7% and bleeding per rectum in 30.7% of cases. In our study 87% of cases with inflammatory/infectious lesions showed maximum thickness of <20mm with sensitivity of 87%, specificity of 70.4% and NPV of 86.4%. Of the malignant lesions 70.4% cases showed maximum thickness of >20mm with sensitivity of 70.4%, specificity of 87%. Maximum thickness of <20mm was more sensitive for inflammatory/infectious lesions while maximum thickness of >20mm was more specific for malignant lesions. In the study by James S et al 83% of patients with wall thickening or mesenteric masses >1.5 cm had a neoplastic process and 82% of patients with wall thickening <1.5 cm, or mesenteric masses <1.5 cm had inflammatory disease.[19] Macari and Balthazar, noted that bowel wall thickening of less than 2 cm was more characteristic of benign conditions, whereas thickening greater than 3 cm was usually present in neoplastic cases.[20] In our study maximum thickness of <20mm was more sensitive for inflammatory/infectious lesions while maximum thickness of >20mm was more specific for malignant lesions. Symmetric thickening was sensitive and specific for inflammatory/infectious lesions and asymmetric thickening was sensitive and specific for malignant lesions. of the inflammatory/infectious cases 95.6% showed symmetric thickening with sensitivity of 98.5%, specificity of 95.5% and NPV of 99.1%. Of the malignant cases 96.3% showed asymmetric thickening with sensitivity of 95.5%, specificity of 98.5% and NPV of 92.9%. Symmetric thickening was sensitive and specific for inflammatory/infectious lesions and asymmetric thickening was sensitive and specific for malignant lesions. Focal involvement in our study was seen in 88.8% of malignant lesions . 45.6% of inflammatory/infectious lesions were seen to have focal involvement with 39.1% segmental involvement. All cases of diffuse involvement were inflammatory/infectious lesions. In the study by Desai RK et al it was found that, asymmetric or focal wall thickening is most commonly associated with malignant processes, the presence of nodularity or thickening greater than 1 .5 cm suggests a malignant process and the presence of a target sign or multi- ringed appearance of abnormally thickened bowel wall is a sign of a non-malignant disease, often inflammatory or vascular in nature.[21] Focal thickening in our study was sensitive for malignant lesions. In our study 84.3% of inflammatory lesions showed water halo attenuation. 96.3%malignant lesions showed grey attenuation.100% cases of tuberculosis showed grey attenuation. In the study by Harisinghani M. G et al concluded that the halo sign is a moderately sensitive and highly specific sign for distinguishing benign from malignant bowel wall thickening.[22] In a study by Yeung KW et al showed that colonic wall thickening of soft tissue density with or without edema and pure bowel wall edema were the two statistically significant findings in differential diagnosis between infectious/ inflammatory diseases and neoplasms.[23] We found Water halo sign was highly specific with high NPV for inflammatory lesions. Grey attenuation was sensitive and specific for malignant lesions alone, however it was not specific (50%) in general because both inflammatory/infectious and malignant lesions show grey attenuation. Macari and Balthazar showed that ,the gray attenuation pattern is the least specific of the five attenuation categories for diagnosis, and it is common in both benign and malignant diseases.[20] Of the inflammatory lesions in our study 87.5% showed mural stratification with a sensitivity of 87.5%, specificity of 96.3% and NPV of 92.9%. 96.3%. whereas malignant lesions showed loss of mural stratification with a sensitivity of 96.3%, specificity of 87.5% and NPV of 93.3%. Mural stratification was more specific for inflammatory lesions and loss of mural stratification more sensitive for malignant lesions. Both inflammatory/infectious and malignant lesions showed mesenteric fat stranding and lymph node involvement. Heterogeneous enhancement was seen in malignant lesions predominantly adenocarcinoma. Necrosis was seen predominantly in GIST and adenocarcinoma. In the study by Buckley et al it was seen that CT is highly sensitive for the detection of mesenteric infiltration and regional lymphadenopathy.[24] But this finding was not specific for differentiating between lesion type which was similar finding in our study. Leite NP et al in their study concluded that CT has high accuracy for the non-invasive assessment of patients with suspected appendicitis, with reported sensitivities of 88–100%, specificities of 91–99%, positive predictive values of 92–98%, negative predictive values of 95–100%, and accuracies of 94–98%.[25] In our study, sensitivity, specificity, PPV, NPV and accuracy was 100%. Kircher MF et al conducted that overall CT interpretation of diverticulitis had a sensitivity of 99%, a specificity of 99%, a positive predictive value of 99%, a negative predictive value of 99%, and an overall accuracy of 99%.[26] In our study, sensitivity, specificity, PPV, NPV and accuracy was 100%.In a study by Mako EK et al sensitivity of CT for diagnosis of Crohn's was 94-100% and specificity 95%.[27] In our study, sensitivity, specificity, PPV, NPV and accuracy was 100% for advanced stages.

Table 19: Sensitivity and Specificity of MDCT for bowel wall lesions

Diagnosis	Sensitivity	Specificity	PPV	NPV	Accuracy
Tuberculosis	100	100	100	100	100
Crohn's	100	100	100	100	100
Appendicitis	100	100	100	100	100
Diverticulitis	100	100	100	100	100
Ischemia	100	100	100	100	100
Radiation	100	100	100	100	100
Other inflammatory	81.3	99.4	96.3	96.6	97
Adenocarcinoma	93.8	99.2	98.7	96.1	98
Lymphoma	100	100	100	100	100
GIST	100	100	100	100	100
Metastases	100	100	100	100	100

Table 20: Correlation of MDCT with final diagnosis

Final diagnosis	Radiological diagnosis		Total
	Inflammatory/ infectious	Malignant	
Inflammatory/ infectious	43(93.47%)	3(6.52%)	46
Malignant	2(3.70%)	52(96.30%)	54
Total	45	55	100

CONCLUSION:

Segmental or diffuse, symmetric, mild, circumferential thickening with target sign was sensitive and specific for inflammatory lesions. We found that Tuberculosis can presents as symmetric or asymmetric, focal or segmental circumferential thickening with loss of stratification and grey attenuation with associated findings. Focal, asymmetric, mild- marked, circumferential, eccentric or exoenteric thickening with loss of stratification and grey attenuation is sensitive and specific for malignant lesions. All cases of Crohn's, diverticulitis, ischemia and radiation enteritis showed maximum wall thickness of <20mm with symmetrical and circumferential thickening. All cases of inflammatory lesions showed circumferential thickening. All cases of lymphoma showed a maximum thickness of >20mm, Focal involvement was predominantly seen in malignant lesions. Hence we conclude that MDCT of the bowel helps to identify and stage most of the common diseases of the bowel, such as tuberculosis, chrons disease, ischemia, obstruction, radiation enteritis, other inflammatory lesions and neoplasms.

FUTURE SCOPE:

With further increase in detector row number, faster scanning speed, MDCT will be a good tool for evaluation of bowel lesions. MDCT of the bowel helps to identify and stage most of the common diseases of the bowel, such as tuberculosis, ischemia, obstruction, radiation enteritis, other inflammatory lesions and neoplasms. This technique will change the paradigm for diagnosing bowel disease by setting MDCT in the first line of diagnostic tools for almost all bowel diseases.

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