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RESEARCH ARTICLE

THE ROLE OF MUTIDETECTOR COMPUTED TOMOGRAPHY (MDCT) IN EVALUATION OF COLORECTAL PATHOLOGIES AT A TERTIARY CARE CENTER

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ABSTRACT

Introduction: Multidetector Computed tomography is an efficient modality for characterizing colorectal pathologies. As colorectal carcinoma is the second most common cancer and has the highest mortality rate, its early detection and preoperative staging help plan treatment and surgery to prolong survival. **Purpose:** The objective of the study is to evaluate the effectiveness of MDCT in diagnosis of benign and malignant pathologies as well as pre operative staging of colorectal cancer. **Method**:60 patients were referred to the Department of Radiodiagnosis of the Government Medical College, Akola, and were evaluated with appropriate CT protocol and multiplanar reconstruction performed.Data was collected and various benign and malignant bowel wall characteristics were studied. **Results:** The study showed that MDCT was efficient in characterizing bening and malignant colorectal pathologies.MDCT showed 100 % sensitivity and 92.5 % specificity in diagnosing malignant pathologies. **Conclusion**: The study showed that degree of bowel wall thickening with pattern of enhancement was most effective in characterizing benign and malignant pathologies. Multidetector computed tomography is the most cost-efficient , easy , faster method of imaging in colorectal pathologies and helps in early diagnosis of malignant colorectal lesions with pre-operative staging and planning surgery and management.

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INTRODUCTION

The introduction of computed tomography in the 1970s was a great triumph in medicine and technology. CT abdomen, a non-invasive imaging modality, gave us abundant knowledge regarding the bowel, retroperitoneal, and intraperitoneal pathologies and overcame the limitations of the less specific fluoroscopic barium studies. Recently, the availability of MDCT and the continuous processing of 3D images over helical CT is helpful for imaging bowel pathologies, tumors, appendicitis, diverticular, and ischaemic bowel disease by utilizing multiplanar imaging (axial, coronal, and sagittal images) and post-processing techniques like Maximum Intensity Projection (MIP), MPR, and 3D Volume Rendering (VR) for a detailed evaluation of the disease process and enhancing the diagnostic accuracy of initial diagnosis, management, follow-up, and detection of potential complications. [1,2] This study uses MDCT to characterize the benign and malignant wall thickening and preoperative staging of colorectal carcinoma, predominantly the T3 and T4 stages. Colorectal malignancies are the third most common cancer in males after prostate and lung cancer and the second most common cancer in females after breast cancer. [3,4] The various characteristics of the bowel wall include the severity of the thickening, whether it is symmetric or asymmetric, segmental or diffuse, enhancement patterns, and associated mesenteric lymphadenopathy.

The patient's prognosis depends on the disease's stage, lymph nodes' involvement, and other organs' metastasis. For metastasized colorectal cancer, it is appropriate to do a contrast-enhanced CT abdomen and chest to look for spread, which further helps with treatment planning. [5]

CT anatomy of the large bowel: The colon length in adults varies from 150 centimeters (cm) (5 ft) to 180 cm (6 ft) or up to 300 cm (10 ft).[6] It is divided into six segments: rectum, sigmoid colon, descending colon, transverse colon, ascending colon, and caecum. Average colon wall thickness is seen when the colon is distended with air or water and should be less than 3 mm [7].

In post-contrast images, there is regular mucous enhancement compared to the bowel wall [8, 9, 10]. The presence of surrounding inflammatory changes helps to differentiate wall enhancement in the normal bowel from other pathological conditions. [11]

CT APPEARANCE LARGE BOWEL LESIONS

BENIGN: Benign bowel pathologies on CT show symmetric, circumferential thickening with segmental or diffuse involvement of the bowel wall [12](Fig 1). On contrast study, it shows homogeneous enhancement. It can involve the colon or small bowel. Also, surrounding mesenteric Fat standing is a common finding. Thickening of the bowel wall depends on the cause and severity of the disease.

Fig. 1. Portal hypertensive colonopathy .Axial contrast enhanced CT scan showing diffuse reactive circumferential wall thickening of the ascending colon with submucosal edema. Minimal ascites seen in right paracolic gutter

MALIGNANT: Malignant bowel pathologies seen on CT scan images show eccentric or asymmetric wall thickening of the bowel, irregular and lobular outer and inner contour, and focalsoft-tissue density mass [13]. There is sudden luminal narrowing and can shows piculated margins(Fig .2). Regional lymphadenopathy and metastases when present, the lesion is malignant in nature(Fig.3). On post-contrast study, the soft-tissue lesion appears heterogeneous because of internal areas of the tumor necrosis and relatively less blood flow areas (Fig . 2).

Fig 2. Rectal cancer .Axial contrast enhanced CT scan showing heterogeneously enhancing (with a few non enhancing areas within) asymmetrical wall thickening involving the rectum causing significant luminal narrowing (black arrow). The wall shows nodular wall thickening involving the adjacent fat planes (white arrow). Rectal tube seen in situ

Fig 3. Rectal cancer. Coronal contrast enhanced CT scan in the same patient shows enlarged and heterogeneously enhancing left internal iliac lymph nodes suggestive of nodal metastasis. Rectal tube seen in situ

Characteristics of bowel wall on CT

The CT scan findings to assess bowel wall thickening:

- Bowel wall attenuation
- Grade of bowel wall thickening.
- Symmetric versus asymmetric thickening.
- length of bowel wall involvement
- Associated mesenteric pathologies

Bowel wall attenuation: A non-contrast study is essential in evaluating fat, calcification-containing lesions, and pneumatosis. However, it is not very useful in assessing bowel wall pathology. Contrast studies help in evaluating bowel wall characteristics [14].

It can be classified as follows:

White enhancement (avid contrast enhancement): When the bowel wall enhancement is homogeneous and more significant than the venous enhancement in the same scan, hyper-enhancing bowel walls may represent altered vascular permeability or perfusion problems like shock bowel or mesenteric ischemia [15, 16] (Fig .4 A, B). Another possibility of inflammatory bowel diseases presenting as white attenuation is likely due to hyperemic or hyper-vascular state [17,18 ,19].

Gray enhancement: Contrast enhancement is equal to muscle enhancement. It helps to differentiate between benign and malignant causes. However, this type of enhancement is seen in both benign and malignant bowel pathologies, predominantly in adenocarcinoma [20](Fig 5). This finding is specific when compared with the degree of wall thickening. According to a study conducted by Macari and Balthazar [11], bowel wall thickening of less than 2 cm was predominantly associated with benign disease, and wall thickening (> 3 cm) was associated with malignant disease.

Fig 4. Inflammatory bowel disease (A) Axial contrast enhanced CT shows hyperenhancing homogenous bowel wall thickening in the descending colon (white arrow) with loss of haustrations. (B) Axial contrast enhanced CT of the same patient shows similar hypreenhancing bowel wall thickneing of the sigmoid colon (white arrow) and rectum (blue arrow). Incidentally noted, posterior wall hypercellular intramural fibroid (asterisk)

Fig 5. Histopathology proven case of adenocarcinoma of descending and sigmoid colon showing marked asymmetrical wall thickening (> 3 cm) with complete loss of stratification of the bowel wall with homogeneous enhancement of the mass (gray enhancement). There is loss of surrounding fat planes with involvement of the left transversus abdominis muscle.

Water halo attenuation: It appears as stratification of the thickened bowel wall with a symmetrical thickened wall, where there is hyperenhancement of the outermost bowel wall and the mucosa with mid-sub mucosa edema[11,15, 21, 22] (Fig 6. A, B). It is found in inflammatory bowel disease, infection, vascular etiologies, and radiation damage.

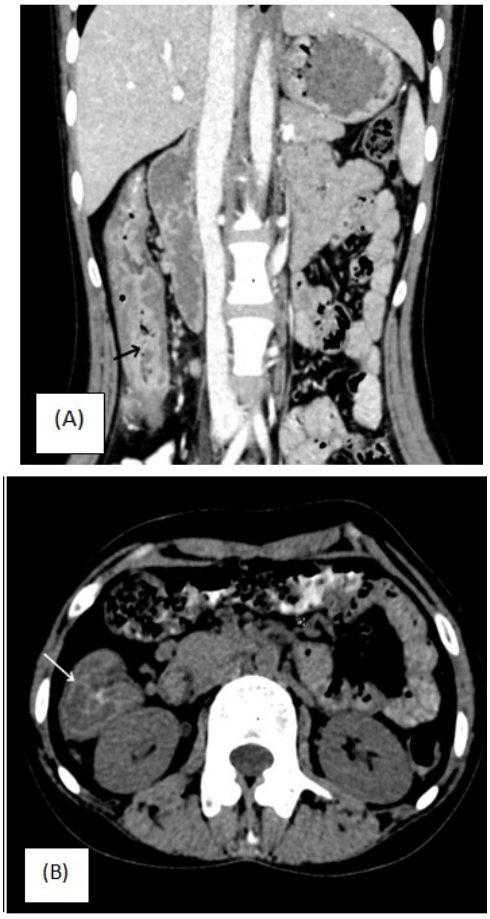

Fig. 6. (A) Typhlitis(Water halo attenuation). Coronal contrast enhanced CT scan shows marked symmetrical circumferential bowel wall thickening with hyperenhancing mucosa with ulcerations(black arrow) with relatively non enhancing submucosal (asterisk) - submucosal edema. (B) Axial contrast enhanced CT scan in the same patient shows peripheral hyperenhancing wall with submucosal edema

Fat halo: It is seen as fat attenuation in the submucosal plane within the bowel wall [11] (Fig. 7). It is seen in old inflammatory etiology, such as chrons.

Fig 7. Fat halo sign. Coronal contrast enhanced CT image shows diffuse submucosal hypoattenuating fat deposition

Black -the equivalent of pneumatosis, and this pattern is commonly seen in ischemia, infection, and trauma. e.g., infection, ischemia, and trauma (Fig. 8)

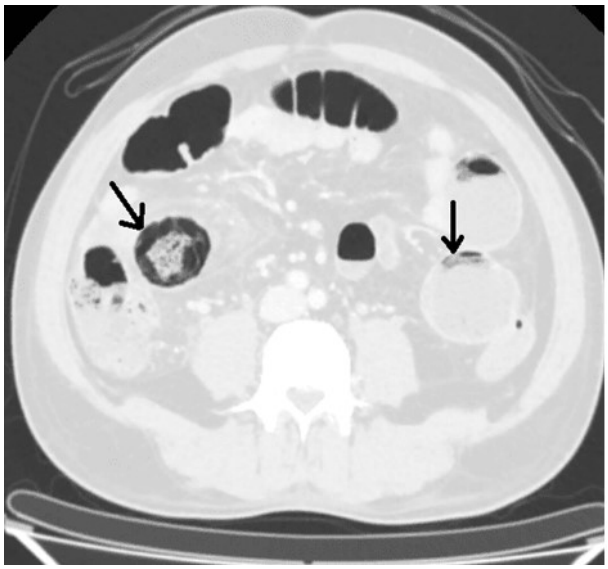

Fig 8. Blunt trauma - Pneumatosis intestinalis. Axial CT image shows circumferential pattern of pneumatosis intentinalis (Black arrows)

Symmetric vs nonsymmetric thickening

SYMMETRIC: It involves symmetrical bowel wall thickening. It is seen in inflammatory bowel diseases, submucosal hemorrhage, infective colitis, post-radiation injury, cirrhosis-related edema, lymphomas, and ischemic colitis [24, 25, 26](Fig . 9).

ASYMMETRIC: It involves asymmetrical bowel wall thickening seen in benign and malignant lesions. Neoplastic lesions are mostly asymmetrical, like adenocarcinoma, gastrointestinal stromal tumors, carcinoids, and metastases. Short segment and asymmetric bowel wall thickening are seen in colorectal adenocarcinoma [24](Fig. 10).

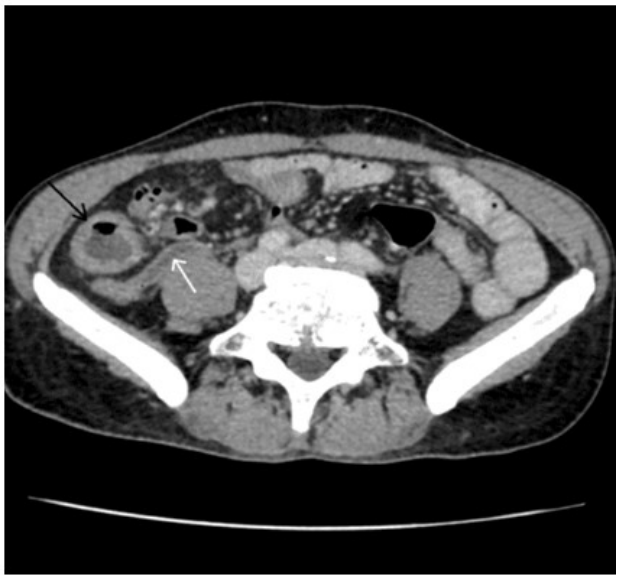

Fig 9. Acute appendicitis . Axial contrast enhnaced CT shows symmetrical wall thickening in the caecum (black arrow) with fluid filled dialted appendix resting over the right psoas muscle (white arrow)

Fig 10. Histopathology proven case of adenocarcinoma ceacum. Axial contrast enhnaced CT reveals asymmetrical ceacal thickening with gray enhancement

Length of bowel wall thickening:

FOCAL BOWEL WALL THICKENING (< 10 cm): Benign and malignant neoplasms can initially present as focal bowel wall thickening (Fig 11). A few inflammatory processes, like diverticulitis and appendicitis, can present similarly.

SEGMENTAL INVOLVEMENT (10 -30 cm): It is most commonly seen in inflammatory conditions. Other conditions with segmental involvement include infectious colitis, Crohn's disease, ischemia, and post-radiation enteritis [27](Fig 12).

DIFFUSE THICKENING (> 40cm): It is seen in inflammatory conditions like infective colitis, ulcerative colitis, portalhypertension, edema from low-protein states, and low-flow ischemia (Fig . 13).

Fig 11. Histopathology proven case of well differntiated sigmoid adenocarcinoma. Axial contrast enhanced CT sows stricturous short segment bowel wall thickening of the sigmoid colon

Fig 12. Acute appendicitis. Coronal contrast enhanced CT shows segmental wall thickening of the ceacum and the ascending colon

Fig 13.Portal gastropathy and colonopathy Coronal contrast enhanced CT shows diffuse involvement of the ascending colon (black arrow) and stomach (white arrow) resulting from portal hypertenion secondary to liver cirrhosis.Associated mild splenomegaly seen

Grade of thickening

Mild Thickening (1-2 cm)

There is always an overlap between inflammatory (infective enterocolitis, ulcerative colitis, Chron's disease, post-radiation injury, ischemic colitis) and neoplastic (adenocarcinoma, lymphomas) etiologies. However, benign lesions are primarily present as bowel wall thickening less than two cm [11,21, 28, 29](Fig 1).

Marked Thickening (>2CMS): It is seen most commonly with neoplastic etiologies [11, 21, 28, 29](Fig. 5). Infection and inflammation.- rarely with severe diseases (clostridium difficile colitis and cytomegalovirus infection in AIDS patients)

OTHER ASSOCIATED FINDINGS

Lymph Nodes: The morphology size, attenuation, and location of lymph nodes in mesentery are essential findings in patients with thickened bowel. There post-contrast enhancement

Hypodense lymph nodes with a peripheral rim of post-contrast enhancement and calcified hyperdense lymph nodes -tuberculosis. High attenuation lymph nodes AIDS patients - Kaposi's sarcoma.

Mesenteric fat Stranding: If present, it suggests the possibility of an inflammatory condition.

Abscess, Fistulas, and Sinus Tracts.

TECHNICAL CONSIDERATIONS IN IMAGING OF LARGE BOWEL

CT examinations result in adequate bowel lesion diagnosis if the proper technique is used to enhance their visualization. This technique includes empty and clean gastrointestinal track opacified and distended bowel lumen adequate and fast preparation of the colon Use of thin (5-mm) sections.

MATERIALS AND METHODS

This study aims to evaluate patients with colorectal lesions presenting at the GMC, Akola radiology department, to achieve the above aims and objectives Source of data. 60 patients were referred to the Department of Radiodiagnosis of the Government Medical College, Akola, and were evaluated with appropriate CT protocol and multiplanar reconstruction performed.

Examination technique

A purposive sampling method of study was carried out on 60 subjects using GE 128 SLICE CT machine with an automatic pressure injector.

Study Protocol

After signing an informed consent form, patients underwent MDCT abdomen contrast on 128 slice CT available at GMC. The findings were noted on a proforma.

Table 1. Effectiveness of MDCT in the diagnosis of benign and malignant lesions

			Final diagnosis		Total
			Malignant Lesions	Benign Lesions	
CT Impression	Malignancy	Count	20	3	23
			87	13	100.00%
			100%	7.5%	38.8 %
	Benign (Inflammatory/ Infective)	Count	0	37	37
			0.00%	100.00%	100.00%
			0.00%	92.5 %	61.6%
Total		Count	20	40	60
			33.3%	66.6 %	100.00%
			100.00%	100.00%	100.00%

All necessary precautions were taken to avoid any possible contrast-related complications.

Study Protocol

Contrast agent application: Contrast material on the basis of provisional diagnosis was adjusted. IV, oral and per-rectal contrast was given in this case.

MDCT Technique: The patient is instructed to lie with both arms raised above their head in a supine position, and the abdomen in the gantry is correctly centered. A Non-contrast CT (NCCT) is done from the diaphragm to the level of pubic symphysis for abdomen study with a single hold of breath. The kVp and mAs are set at 120kv and 200mAs; a section thickness of 5 mm or 3 mm is taken to acquire raw data. Images are first acquired in the unenhanced phase. Then, a non-ionic water soluble IV contrast medium with 275 to 370mg of iodine content, with 1-2ml/kg of contrast, was given at a - 4ml/sec rate with a power injector (100-120cc of omnipaque350). Then, postcontrast arterial, venous, and delayed phase images were obtained at 25 seconds, 45 seconds, and 70 seconds, respectively.

Processing images and their analysis: Volumetric reconstructions are performed after acquiring images from the source with raw data taken from the workstation. The raw data acquired for viewing images are then reconstructed into 1mm and 5mm thickness and then reconstructed. These included sagittal and coronal reformations. Thin MIP and 3D reconstructions can be done as and whenever needed.

Utility of reformation techniques: The MDCT axial images are then reconstructed in the multiplanar views in coronal and sagittal planes as needed. In a workstation, data can be used in any desired plane by multiplanar reconstruction techniques. MPR in the coronal plane and sagittal plane can be used along with the axial plane in the detection and confirmation of pathology in patients. These techniques of post-processing are performed on workstations for viewing.

Data collection

When bowel wall thickening was seen, the following characteristics were collected.

- Location
- Attenuation/enhancement
- Wall thickening- Marked (>2.0 cms)/ Mild (<2.0cms)
- Asymmetric /symmetric wall thickening
- Focal/diffuse/ segmental thickening
- Lymph nodes
- Peri-colonic fat stranding
- Adjacent visceral Infiltration
- Metastasis
- Staging in cases of suspected malignancy.

Data analysis: The data collected is analyzed with sensitivity and specificity. In non-surgical patients who planned for conservative management here, follow-up is taken, and their recovery is correlated with MDCT findings.

Study Design: observational study

Sample Size: 60

Duration Of Study: 6 months

SELECTION CRITERIA

INCLUSION CRITERIA

Only patients willing to participate in the study and give written informed consent will be included.· Patients referred to the radiology department for CT Scan and found to have positive findings will be included in this study. Patients coming for CT scans for diseases other than colorectal lesions and who are accidentally found to have colorectal lesions will be included in this study. Cases of above 18 age groups, irrespective of gender, will be included.

EXCLUSION CRITERIA:· Patients refusing written informed consent to participate in the study.

- Pregnant females.
- Allergic to contrast medium.

RESULTS

Sixty patients with bowel wall thickening were evaluated using the protocol described previously. The sole purpose of the study was to assess the effectiveness of multi-detector computed tomography in evaluating various colorectal pathologies. Various findings about benign and malignant bowel wall thickening were studied and tabulated. The CT findings were then correlated with intro-operative findings and histopathology to the maximum extent possible. The study included 37 males and 23 females. The age group less than 30 years was most commonly affected by benign pathologies and second most commonly seen in the age group 30-40 years. Most of the malignant bowel pathologies were seen in 60-70 years of age group. Most of the patients who presented to the OPD with complaints of abdominal pain (47.5 %) and loose stools (35 %) were found to have benign bowel pathologies on CT. At the same time, abdominal pain(

35%), bleeding per rectum(25%), and weight loss(25 %) were the presenting complaints in most of the malignant bowel pathologies. Benign pathologies most commonly showed contiguous involvement of the cecum, ascending colon, transverse colon, and descending colon (20%), whereas the rectum was most commonly involved in malignant pathologies (30 %).

BOWEL WALL ENHANCEMENT ON POST-CONTRAST STUDY: Out of 40 patients with benign bowel pathologies, white bowel wall enhancement was seen in 10 patients, gray enhancement in 12 patients, water enhancement in 9 patients, fat halo in 8 patients, and black attenuation in 1 patient with a history of trauma. Gray wall enhancement is seen in both malignant and benign diseases. Whereas out of 23 patients who were reported as malignant bowel wall pathologies on MDCT, 20 were found to be malignant on histopathology, whereas three were found benign. Of the 20 malignant cases, 18 had gray enhancement, whereas two had white enhancement.

DEGREE OF WALL THICKNESS: Thirty-six patients showed mild bowel wall thickening(< 1-2 mm), out of which 34 cases were reported as benign diseases, whereas 2 cases were reported as malignant diseases. MDCT was 85 % sensitive and 90 % specific in diagnosing mild wall thickness in benign disease. 24 patients showed marked bowel wall thickening (> 3 mm), 18 of which were reported as malignant disease, and 6 of which were reported as benign disease. MDCT was 90 % sensitive and 85 % specific in diagnosing marked bowel wall thickening in malignant disease. The degree of wall thickness is the most exact and sensitive finding in characterizing malignant and benign lesions. Other studies showed that marked bowel wall thickening is a characteristic characteristic of malignant lesions like colon adenocarcinoma [8]

WALL THICKENING- SYMMETRIC /ASYMMETRIC: MDCT was 82.5% sensitive and 100 % specific in diagnosing symmetric wall thickening in benign lesions, whereas 100 % sensitive and 82.5 % specific in asymmetrical wall thickening in malignant cases. Other studies showed that benign lesions have symmetric wall thickening features, and malignant lesions have asymmetric wall thickening [38]

LENGTH OF INVOLVEMENT OF BOWEL WALL THICKENING: Focal bowel wall thickening was seen in 19 patients, 15 of which were reported malignant and 4 of which were reported benign based on ancillary findings. Segmental bowel wall thickening was reported in 25 patients, 21 of which were benign and 5 of which were malignant. Diffuse bowel wall thickening was seen in 15 patients and was reported to be benign. Diffuse bowel wall thickening was most commonly seen in benign disease, whereas focal thickening was predominantly seen in malignant cases. Segmental bowel wall involvement was nonspecific for both benign and malignant diseases. Other studies showed similar findings [31]

Ancillary findings

LYMPH NODE INVOLVEMENT

Lymph nodal involvement was seen in 62.3 % of benign pathologies, whereas 37.7 % in malignant bowel pathologies. Lymph node enlargement was again nonspecific in differentiating malignant from benign pathologies on imaging alone. However, some studies showed that hypoattenuating with rim-enhancing lymph nodes is seen in tuberculosis, and bulky hypodense lymph nodes are seen in colon lymphoma.

FAT STRANDING

All the benign cases showed varying degrees of pericolic fat stranding depending upon the severity of the disease. At the same time, 11 out of 20 malignant cases showed pericolic or mesorectal fat stranding.

DISTANT METASTASES: Out of 20 cases of malignancy, 2 showed metastasis to the liver, and one showed metastasis to the omentum and peritoneum.

EFFECTIVENESS OF MDCT IN DIFFERENTIATING BENIGN FROM MALIGNANT DISEASE: Of 23 cases reported as malignant on MDCT abdomen and pelvis, 20 were correctly diagnosed as malignant on histopathology and intra-operatively. MDCT showed 100 % sensitivity and 92.5 % specificity in diagnosing malignant pathologies. However, out of 37 cases reported to be benign on MDCT, all the cases were found to be benign intra-operatively and on follow-up. MDCT was 92.5 % specific and 100 % sensitive in diagnosing benign bowel pathologies. Therefore, for differentiating malignant lesions from benign lesions MDCT is an excellent modality.

CT IN MALIGNANT LESIONS STAGING:MDCT played a crucial role in differentiating the T2 stage from T3 (TNM cancer staging 8th edition). T3-stage cancer was found to involve the subserosa as well as nonperitonalized areas like pericolic fat and mesorectal fat. CT staging of all the 20 malignant cases that were staged as T2 when compared with histopathology or intraoperative findings, 7 out of 8 cases were correctly diagnosed. Out of 7 cases that were staged as T3, five were diagnosed correctly. All the cases (5) with T4 staging were diagnosed correctly.

DISCUSSION

Multidetector computed tomography is the most cost-efficient , easy , faster method of imaging in colorectal pathologies . It not only provides with thinner sections but also multi planar image reformation which helps with early diagnosis of malignant colorectal lesions and further helps with pre-operative staging and planning surgery and management. It was observerd that most of the malignant colorectal pathologies were seen in older age groups.The benign pathologies showed long segment involvement of the bowel loops, whereas malignant pathologies showed segmental involvement. Similar findings were reported in other studies with abdominal pain being the most common presenting complaint in our study.[30] Gray enhancement is a nonspecific finding seen in both malignant and benign diseases. However, it has high sensitivity in detecting malignant bowel pathologies when other findings, such as degree of wall thickness, local invasion, lymphadenopathy, or distant metastasis, are considered. Similar findings were confirmed in different studies. [21, 30] Our study showed strong association of pericolic fat stranding with inflammatory and infective bowel pathologies.According to

some studies, inflammatory conditions commonly show surrounding pericolic fat standing. [32, 33, 34, 35]. The colorectal carcinomas mostly metastasize to liver, lungs , omentuma and peritoneum. 2 cases showed metasatis to the liver. Other studies also showed that the liver is the most common site of colon and rectum malignancy metastasis[36]. In our study , MDCT showed 100 % sensitivity and 92.5 % specificity in diagnosing malignant pathologies as well as effective in diagnosis of T3 and T4 stages of colorectal carcinomas.

CONCLUSION

Over all MDCT is a useful modality in evaluating benign as well as malignant colorectal pathologies. It is also provides information about various infective as well as inflammatory pathologies and their severity and further helps in management. It also helps to identify pericolic fat stranding surrounding the lesion, lymph nodal involvement and distant metastases as well as aids in pre-operative and post operative treatment.

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