RESEARCH ARTICLE

ROLE OF COMPUTED TOMOGRAPHY IN THE EVALUATION OF COLORECTAL LESIONS.

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Manuscript Info	*Abstract*
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Computed Tomography (CT) has become the most important imaging technique for evaluation of the abdomen and pelvis. CT is used to examine patients with acute abdominal complaints, intestinal obstruction, inflammatory conditions, known or suspected malignancy, abdominal and pelvic trauma. Recent technological advances and accumulated experience in image interpretation suggest that substantial information regarding colorectal lesions can be obtained by CT. This study aims at evaluating the accuracy of CT in characterizing large bowel lesions as benign/inflammatory or malignant conditions, and in suspected cases of malignancy its accuracy in tumor staging.

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Introduction:-

Technological advances in CT have changed the practice of gastrointestinal (GI) radiology. With the development of high resolution scanners, technical refinements in obtaining better quality studies and accuracy of CT of the gastrointestinal tract have Dr.amatically enlarged and improved. Today the indications for gastrointestinal examinations encompass a steadily expanding list of abnormalities based on CT's usefulness for (1) diagnosing or suggesting the presence of primary gut disease. (2) evaluating the nature and extent of disease in patients with known gastrointestinal lesions [1]

Thickening of the bowel wall is the commonly identified abnormality on CT in case of colorectal lesions. It is important to define the wall thickening as focal, segmental, or diffusely affecting an entire intestinal segment. In addition, wall abnormalities of the small and large bowel may be incidentally detected in asymptomatic patients or in patients with nonspecific complaints. CT features include degree of thickening of intestinal wall, symmetry of involvement, smooth versus irregular or lobulated inner or outer contour, and pattern of enhancement. Associated findings such as exophytic component, lymphadenopathy, distal metastases, adjacent mesenteric inflammatory response, phlegmon, or abscess are additional important features that are helpful in the differential diagnosis.[2]

Role of CT in Bowel Imaging:-

Computed tomography (CT) is almost universally accepted as the primary screening modality for the evaluation of patients suspected of having colonic disease.[3] Key benefits of CT over alternative modalities are that it not only accurately demonstrates the bowel wall but also outlines the peri-colonic soft tissues.[4] CT cannot demonstrate subtle superficial mucosal changes revealed on barium studies, but it is a highly sensitive method for the detection of intramural disease and extraluminal extension of colonic disease. Intravenous contrast enhancement together with distension of the intestinal lumen by water or positive contrast agents is very useful in the detection of inflammatory [5].

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860

Normal bowel wall:-
Acceptable bowel wall thickness values on CT strongly depend on the degree of bowel distension and vary widely in the literature. Some agreement, however, exists that the colonic wall can vary from 1 to 2 mm when the lumen is well distended to 5 mm when the wall is contracted or the lumen is collapsed [6]. The bowel wall normally enhances after the administration of intravenous contrast material. The mucosa is the most intensely enhancing layer of the bowel wall and the submucosa is less vascularised and is seldom seen as a separate structure on CT scans unless it is oedematous.[7]

Material and Methods:-
Study design: Hospital based prospective correlative study

Source of Data: 40 patients suspected to have large bowel lesions referred for CT Scan of the abdomen to the department of Radiodiagnosis at RajinDr.a Hospital, Patiala were included in the study.

CT protocol for bowel imaging:-
A 6 slice CT scanner, SOMATOM EMOTION was used for this study. Patient was given orally administered colon-cleaning preparation 12 hours prior to CT examination in elective cases. Oral, rectal and intravenous (IV) contrast was used to accurately demonstrate the inflammatory changes and malignant changes in the colonic wall and to assess the extent of the disease.

Initially 15-20 ml of oral contrast (TRAZOGRAPH® 76%) in 1.5-2 litres of water with added flavours to increase the palatability of the contrast for the patient was given. A delay of 1- 1.5 hrs will be recommended following the administration of oral contrast for adequate opacification of the colon.

Oral contrast protocol for colon and rectum:-
1st Dr.ink was given over 40 min,   2nd Dr.ink was given over 30 min 3rd Dr.ink was given over 20 min. Scan was done within 90-120 min of the 1st Dr.ink.

All patients were placed in the supine position on the CT table, A standard CT scout image was obtained to assess the degree of colonic distention and considered acceptable, when all colonic segments including caecum, ascending colon, transverse colon, descending colon, sigmoid colon and rectum were visualized and well distended. Rectal contrast (TRAZOGRAPH® 76%) was undertaken after assessing the patient for distension.

Contrast-enhanced CT scans was obtained from the diaphragmatic dome to the anal verge with the patient in the supine position after intravenous injection of 80-100 ml (1-1.5ml /kg body weight) of iodinated contrast agent (NIOSCAN) was administered at 3 ml/sec. CT acquisitions were performed in the arterial phase (start delay of 25-35 seconds) and in the portal venous phase (start delay of 50- 70 seconds) with a section width of 5 mm for both arterial and venous phase.

Inclusion criteria & exclusion criteria:-
1.   Patients with suspected large bowel lesions and those patients with equivocal findings on other imaging modalities.
2.   Patients with blunt trauma abdomen were excluded from the study.

Observations;-
Out of 40 patients studied, 32 were diagnosed as Malignant disease and 8 as benign on CT. CT diagnosis was then confirmed by tissue diagnosis (Histopathology) in patients undergoing surgery.31 patients out of 32 were confirmed to have malignant disease on histopathology .1 case was wrongly diagnosed as malignant on CT which turned out to be benign . Those patients with benign disease in whom surgery was not indicated like in inflammatory colitis and Typhilitis etc, diagnosis was confirmed by either FNAC, improvement in clinical symptoms or with follow up CT to analyse the benign nature of disease .

Distribution of patients according to age:-
In the present study out of 40 patients, maximum number of patients belonged to the age group 61-70 years (25%) followed by 41 to 60 years age group (Fig 1).
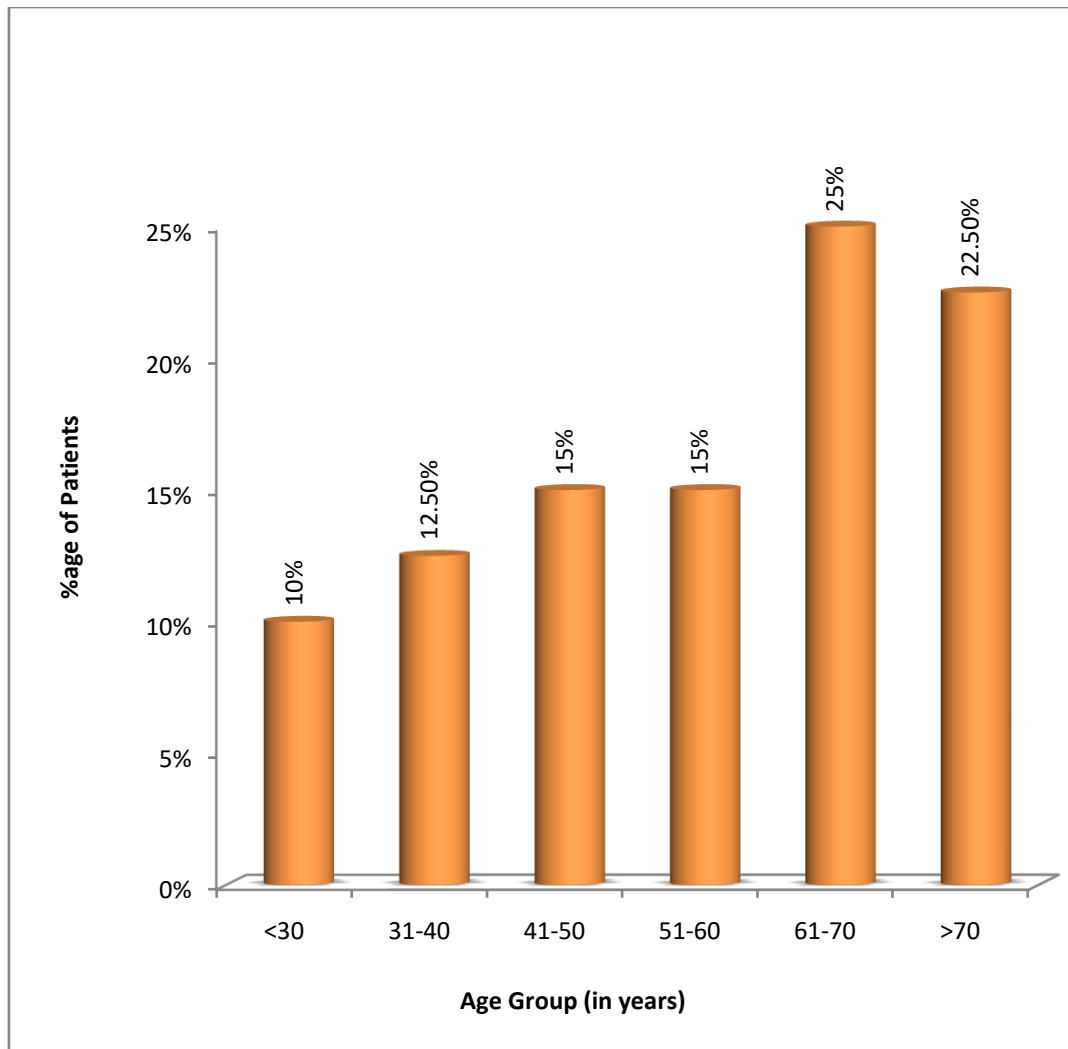
Fig 1:- Bar Diagram Showing Distribution Of Patients According to age.

Distribution of patients according to sex:-
In the present study, Out of 40 patients 22 (55%) patients were males and 18 (45%) were females.

Chief complaints in present study in benign and malignant diseases (as per histopathology):-
Out of 31 patients (as per histopathology) diagnosed as malignant, 16 (51.61%) had bleeding per rectum as the chief complaint followed by abdominal pain which was seen in 9 patients (29.03%).And among 9 patients diagnosed as benign disease, none of the patient presented with bleeeding per rectum (Fig 2).
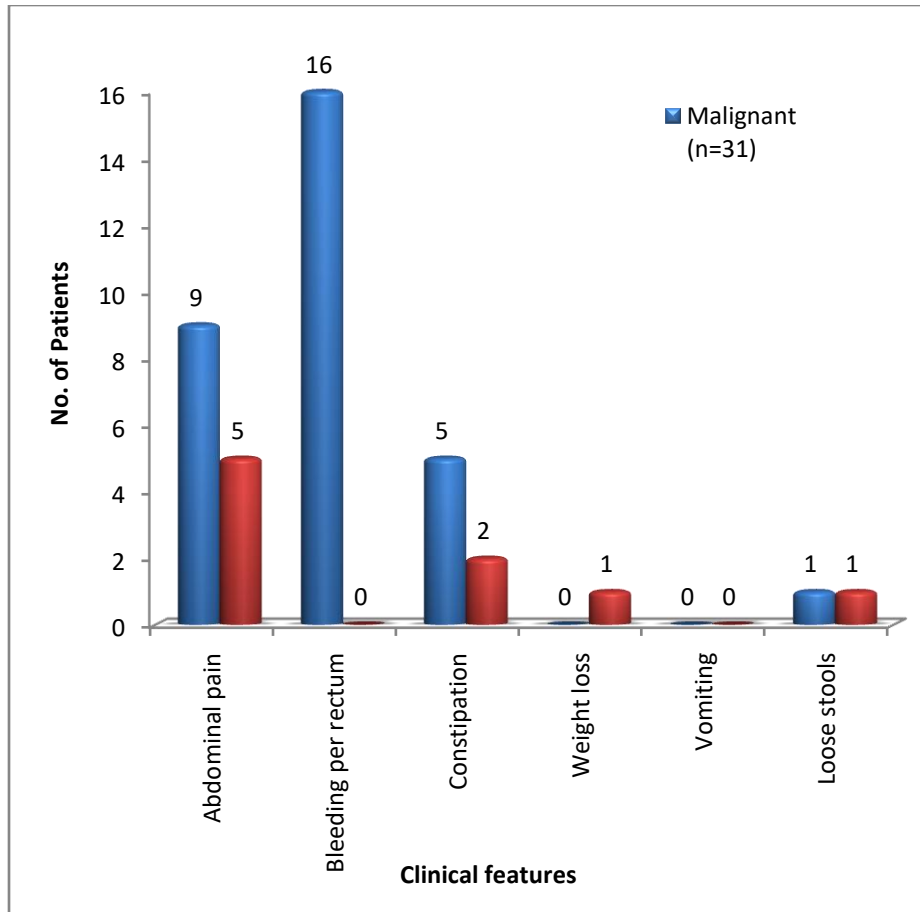
Fig 2:- Bar Diagram Showing Chief Complaints in present study in benign and malignant diseases (as per HPE)

Distribution of type of wall thickening seen on CT in benign and malignant diseases (as per histopathology):-
Among 32 cases with asymmetrical wall thickening on CT examination,31 patients had malignancy and 1 patient had benign inflammatory disease on tissue diagnosis. All 8 cases with symmetrical wall thickening on CT were proved to be benign on histopathology / FNAC (Fig 3).
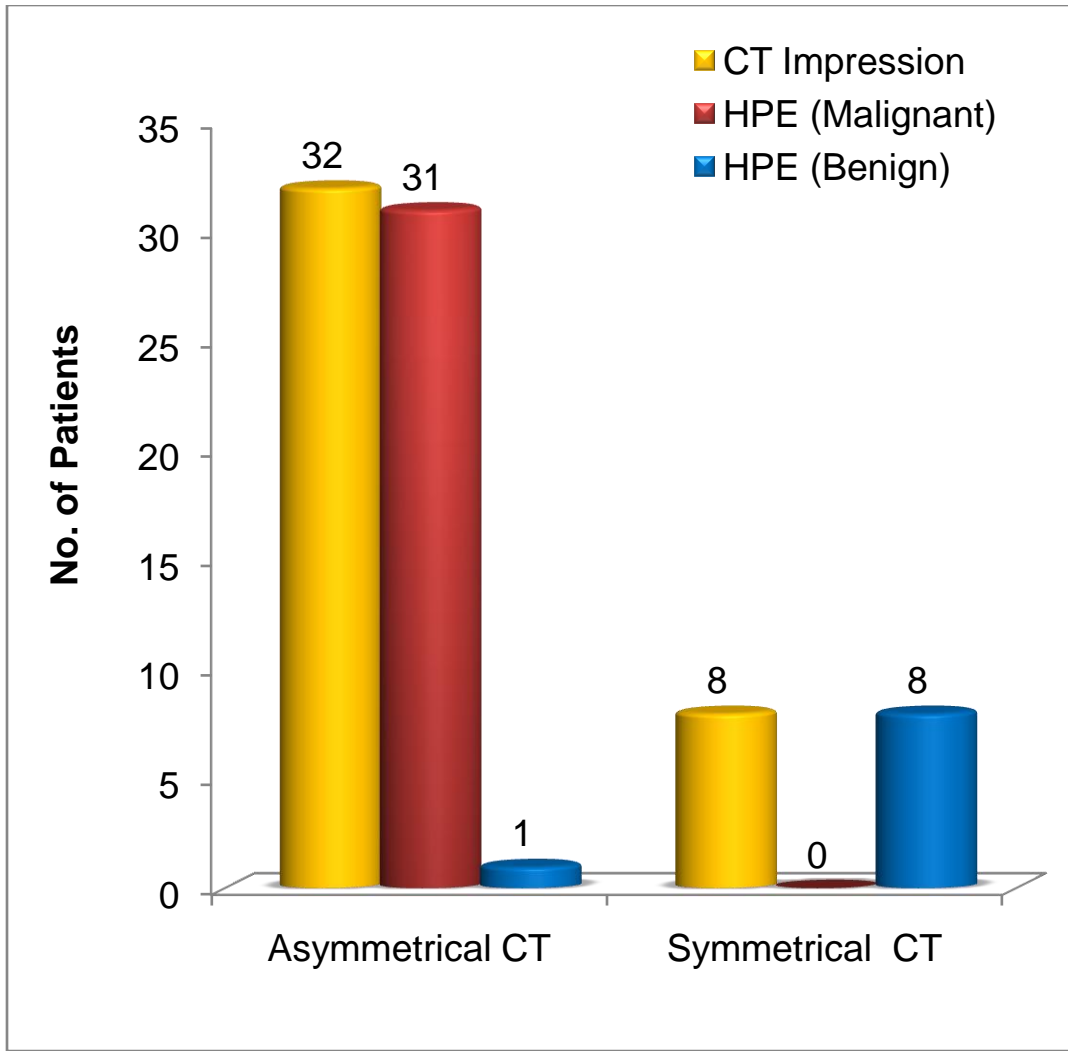
Fig 3:- Bar Diagram Showing Distribution Of Type Of wall thickening on CT with final diagnosis (as per HPE).

Table 1:- Diagnostic Accuracy Of CT In Diagnosing Malignant Bowel diseases based on type of wall thickening.

Statistical Parameters	Results
Sensitivity	100%
Specificity	88.89%
Positive predictive value	96.88%
Negative predictive value	100%

Table 2:- Diagnostic Accuracy Of CT In Diagnosing Benign Bowel Diseases Based On type of wall thickening

Statistical Parameters	Results
Sensitivity	88.89%
Specificity	100%
Positive predictive value	100%
Negative predictive value	96.88%

The results for the test are statistically significant for type of wall thickening and CT (P value 0.00 ,Chi square = 25.28).

Length of bowel wall thickening on CT in benign and malignant cases (as per histopathology):-
23 out of 31 patients had focal type of wall thickening,6 patients had segmental type and 2 patients had diffuse type of wall thickening among malignant group.

Similarly 5 patients had focal,3 had segmental and 1 had diffuse type of thickening in benign group.

Distribution of lymphadenopathy in benign and malignant diseases (as per histopathology):-
In the present study out of 9 patients diagnosed as benign disease based on final diagnosis , 7 (77.78%) patients were having adjacent lymphadenopathy and in 2 (22.22%) patient. CT did not reveal any lymphadenopathy . Out of 31 patients with malignant bowel wall thickening, 26 patients (83.88%) had lymphadenopathy and 5 patients (16.12%) had no evidence of lymphadenopathy. The results of the test was insignificant p value (0.567) (Fig 4).
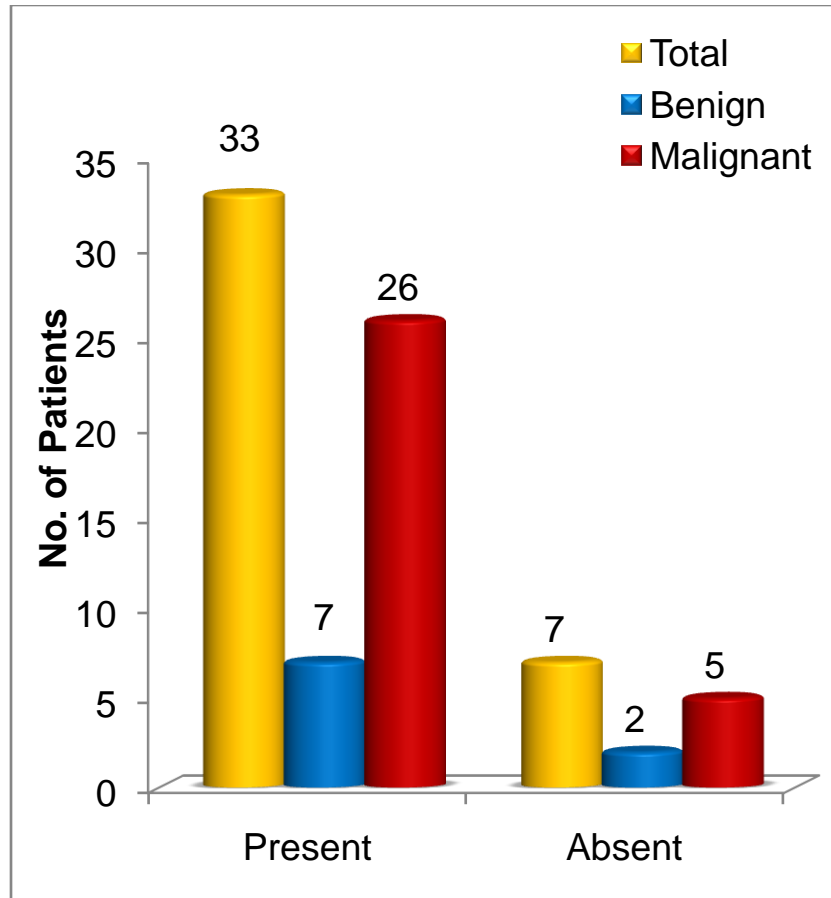

Fig 4:- Bar Diagram Showing Lymphadenoapthy On CT With Benign And malignant disease (as per histopathology)

Table 3:- Distribution Of Pericolic Fat Stranding Seen In Benign and malignant lesions on CT

Fat Stranding	Benign		Malignant	
	No. of Patients	%age	No. of Patients	%age
Present	9	100	20	64.5
Absent	0	0	11	35.5
Total	9	100	31	100

Among 40 patients studied for abnormal bowel wall thickening on CT, 29 including 9 benign and 20 malignant cases had evidence of pericolic fat stranding.The results of the test is statistically significant (p value 0.036).

Table 4:- Organ Involved In distant metastasis in HPE proven colorectal malignancies

Organ involved	No. of Patients	%age
Liver	4	44.45
Lung	2	22.22
Bone	1	11.11
Peritoneum	2	22.22
Total	9	100

4 out of 9 diagnosed as malignant colorectal diseae had distant metastasis.Liver was the most common organ involved.

Table 5:- CT Versus HPE Impression In Diagnosis Of Benign and malignant colorectal lesions

CT Impression		Histopathology		Total
		Malignant (Adenocarcinoma)	Benign (Inflammatory/ Infective)	
Malignancy (n=32)	Count	31	1	32
	%within CT	96.8	3.2	100
Benign (inflammatory/ infective) (n=8)	Count	0	8	8
	%within CT	0	100	100
Total	Count	31	9	40
	%within CT	77.5	22.5	100
Chi-square		34.444		
p value		0.000 (HS)		

Kappa value = 0.92 (Excellent Agreement):-
Out of 32 cases diagnosed as malignancy on the basis of CT were correlated with histopathology.31 cases were truly malignant on tissue diagnosis favoring CT impression.1 cases was falsely diagnosed as malignant which was reported as benign inflammatory etiology on Histopathology.8 cases were diagnosed as benign on CT based features. All were confirmed as benign etiology by histopathology / FNAC /Clinical grounds and Follow up CT.

Table 6:- Comparison of CT and HPE Impression in staging of malignant colorectal lesions

CT Impression		Histopathology Staging			Total
		T1 and T2	T3	T4	
T1 and T2	Count	7	2	0	9
	%within CT	88.8	22.22	0	100
	%within HPE	88.8	11.1	0	29.03
T3	Count	2	16	0	18
	%within CT	11.10	88.9	0	100
	%within HPE	22.2	88.9	0	58.06
7	Count	0	0	4	4
	%within CT	0	0	100	100
	%within HPE	0	0	100	19.35
Total	Count	9	18	4	31
	%within CT	29	58	13	100
	%within HPE	100	100	100	100

Of the 9 cases staged as T1 and T2 on histopathology, CT correctly staged 7 cases (88.8%). Overstaging was done in 2 cases (11.1%). Of the 18 cases staged as T3, CT correctly staged 16 cases (88.90%). Understaging was done in 2 cases (11.1%). All the 4 cases staged as T4 on histopathology were correctly staged on CT(Fig :5)
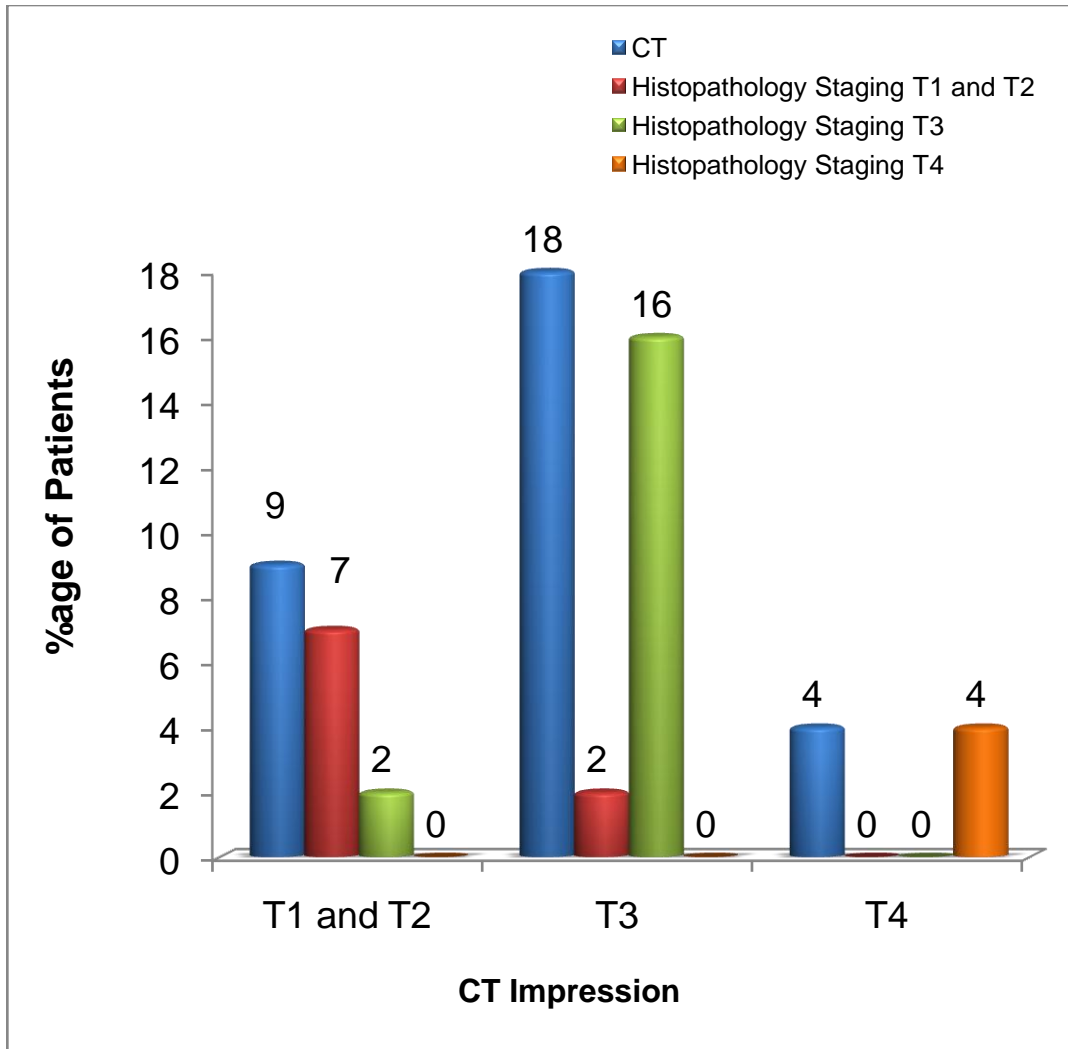
Fig 5:- Bar Diagram Showing Comparison Of CT And HPE impression in staging of malignant colorectal lesions.

Diagnostic accuracy of CT in detecting benign and malignant lesions:-
The statistical parameters are as mentioned in Fig 7 .K= 0.92 (Excellent agreement). Hence CT is an excellent modality in differentiating benign and malignant lesions of the colon and rectum (Fig 6).
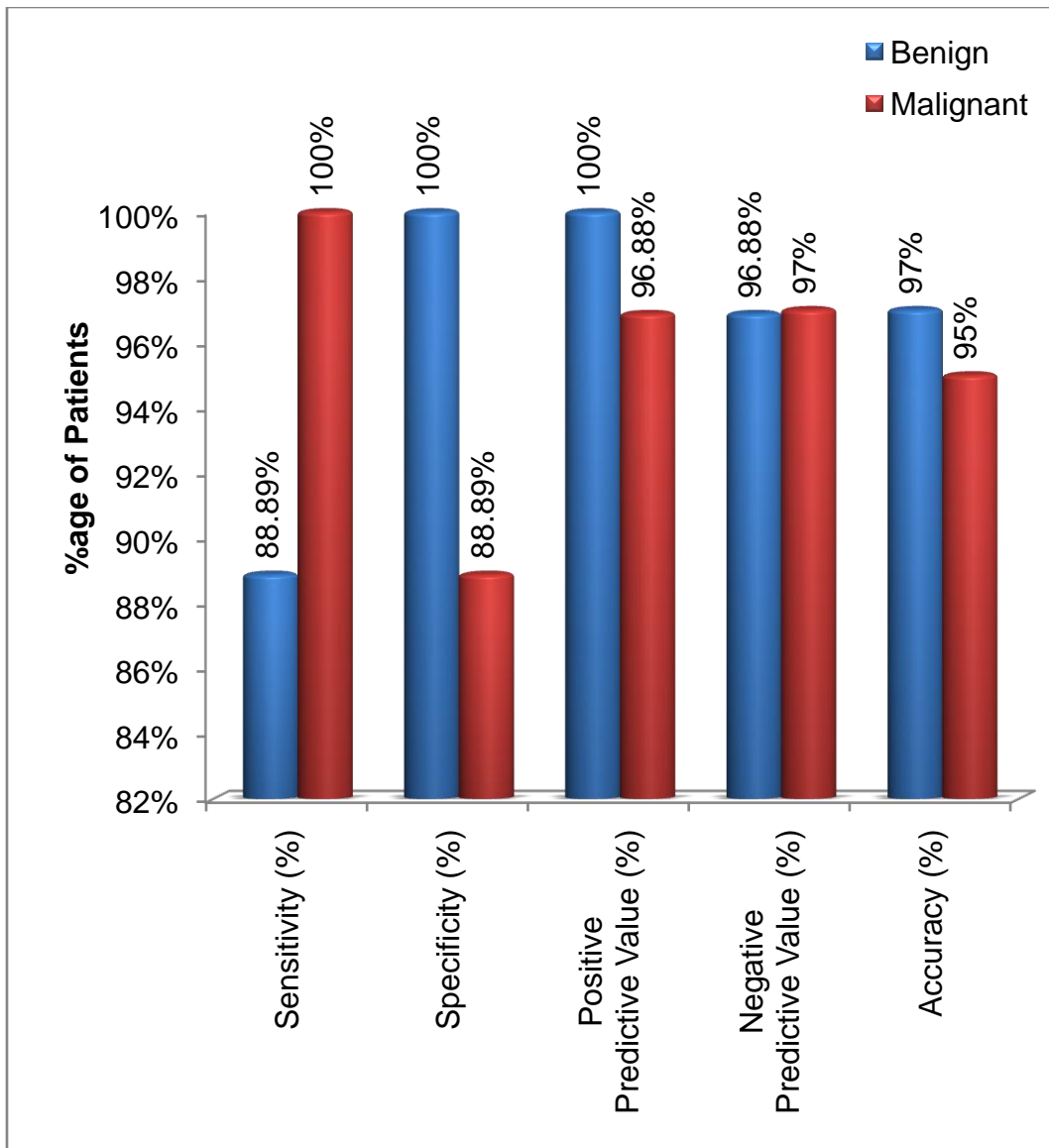
Fig 6:- Bar Diagrams Showing Diagnostic Accuracy Of CT in detecting benign and malignant lesions

Discussion:-

Out of the 40 cases of abnormal large bowel wall thickening of colorectal region which were studied, 31 resulted from a malignant cause (adenocarcinoma, n = 31) and 9 resulted from benign disease (n=9) *(as per HPE).*

Tissue diagnosis was present in all malignant cases. Among 9 benign cases, 5 had undergone surgery and 4 patients were managed conservatively.

Age and sex wise Distribution:-
Table 7:-

Author and year of study	Age groups (%age)	Males affected
Laishram et al [8] (2010)	60-69years (24.07%)	53.71%
Richie et al [9] (2016)	61-70years (22.2%)	55.56%
Bhatt et al [10] (2011)	50-70years (44%)	75%
Present Study (2016)	61-70 years (25%)	55%

The age group predominantly affected was 61-70 yrs (25%). Our results are in comparison with the study as metioned in above table.

Chief complaints and bowel wall thickening:
Table 8:-

Author and year of study	Rectal bleed in colorectal malignancy	Pain abdomen in colorectal malignancy
Majumdar et al[11] (1999)	58%	52%
Richie et al [9] (2016)	22.2%	44.4%
Sauter et al [10] (2016)	78%	-
Present Study (2016)	51.6%	29.03%

This is similar to studies done by Majumdar et al[11] (1999) and Sauter et al[10] (2016) in which rectal bleeding was the predominant complaint.

Anatomical location and malignant bowel wall thickening:-
Table 9:-

Author and year of study	Most common site of involvement in colorectal malignancy
Majumdar et al[11] (1999)	Distal to splenic flexure (58%)
Laishram et al [8] (2010)	Rectum (53.71%)
Bhatt et al[10](2011)	Recto-sigmoid (63.6%)
Richie et al[9] (2016)	Rectum (50%)
Present Study (2016)	Rectum (38.7%)

Results of the present study are in good comparison to others as described above.

Type of wall thickening and colorectal diseases:-
Table 10:-

Author and year of study	Colorectal Malignancy	Benign/Inflammatory
Bhatt et al[10] (2011)	96.4% asymmetrical	89% symmetrical
Tapasvi et al[12] (2014)	83% asymmetrical	67% symmetrical
Present Study (2016)	100% asymmetrical	88.89% symmetrical

Our study is in good comparsion with the studies conducted by Bhatt et al[10](2011) and Tapasvi et al[12] (2014) .

Statistical Analysis:-
Table 11:- Diagnostic Accuracy Of CT For Malignant Lesions.

Author and year of study	Sensitivity	Specificity	PPV	NPV
Richie et al[9] (2012)	100	88.9	97.3	100
Chaudhary et al[13] (2016)	100	87.5	97	100
Present Study (2016)	100	88.89	96	100

The results of our study are similar to previous studies by Richie et al[9] (2012) and Chaudhary et al[13] (2016).

Table 12:- Diagnostic Accuracy Of CT For Benign Lesions.

Author and year of study	Sensitivity	Specificity	PPV	NPV
Richie et al[9] (2012)	88.90	100	100	97.3
Chaudhary et al[13] (2016)	87.5	100	100	97
Present Study (2016)	88.89	100	100	96.88

Our result are comparable to previous studies by Richie et al.(2012) and Chaudhary et al[13] (2016).**For present study, K= 0.92** (Excellent agreement).

Conclusion:-
Due to its high sensitivity and specificity, CT is an ideal imaging modality for differentiating between benign and malignant etiology of abnormal bowel wall thickening. The combination of focal ,segmental and diffuse bowel wall involvement, symmetrical and asymmetrical type characterization, presence or absence of fat stranding and pericolonic heterogenous lymph nodes will help in lesion characterization on imaging. Preoperative CT staging in malignant cases is one such another parameter which has its own significant role in management of patient.

Radiologists should be aware of some specific CT criteria of bowel wall thickening for better differentiation of benign lesions from malignant or potentially malignant lesions that warrant further diagnostic evaluation like colonoscopy and biopsy. Further correlation and confirmation by tissue diagnosis and histopathology will help in deciding the treatment plan in different cases.

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