ORIGINAL

PREOPERATIVE EVALUATION OF COLORECTAL CARCINOMA BY COMPUTED TOMOGRAPHY

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Abstract : *Colorectal cancer is a disease in which malignant cells form in the tissues of the colon and rectum. The incidence of the colorectal cancer (CRC) varies greatly throughout the world. Computed Tomography (CT) is a powerful technique for detecting and staging carcinoma of the colon and rectum. In general, the sensitivity, specificity and accuracy vary with the stage of the CRC. Positive findings are highly indicative of neoplastic spread. Thus an effort has been made through this study to evaluate the role of preoperative CT in the staging of CRC*

INTRODUCTION

Colorectal cancer is a malignant disease arising in the colon and rectum. The incidence of the colorectal cancer (CRC) varies greatly throughout the world. The lowest rates are found in the population of Africa, Asia, and Latin America. However, in northwestern Europe and North America, CRC ranks as one of the three most common fatal malignancies, along with lung and breast cancer, and members of these populations face a lifetime risk of developing the disease of 5% to 6%. [1,2] Moreover, because the survival statistics in patients who undergo surgical treatment for symptomatic CRC have improved marginally over the last four decades, [3] the calculated risk of dying of CRC is 2% to 3%. [4,5] Risk factors for CRC are many and include age above forty years, preexisting adenoma, cancer family syndromes, hereditary nonpolyposis colon cancer (Lynch syndrome), inherited polyposis syndromes, chronic ulcerative colitis, Crohn's enterocolitis, etc.

MATERIAL AND METHODS

A prospective study of fifty(50) biopsy proven cases of adenocarcinoma of colorectal region was undertaken. These patients were subjected to pre-operative computed tomographic examinations using the Siemens Somatom Series CT Scanner.

The patients were administered 500-600 ml of diluted water-soluble contrast media orally one hour prior to the CT examination followed by another 200-300 ml immediately before the examination to get the optimal opacification and distension of the bowel loops. Unless the contrast material is contraindicated, the patients were administered water-soluble contrast material through an intravenous route as well. Air insufflations of the colon through the per-rectal route were done to achieve optimal colonic and rectal distension, unless contraindicated.

CT examination was done in supine position. Decubitus and prone position were utilized whenever necessary. Scans were taken both prior and after the intravenous contrast administration. Trans-axial images 10X10 mm were taken covering the entire abdomen and pelvis in the cephalocaudad direction. Additional 5X5 mm trans-axial images were taken through the region of interest. Scanning was performed during suspended respiration. All scans were viewed at varying window widths and levels. CT staging was performed and the following parameters were established and evaluated:

- Tumor characteristics (intra-luminal / extra-luminal mass, thickness of the affected bowel segment & location)
- Local extramural invasion (irregular serrated / spiculated outer contour, tumor mass or strands of soft tissue extending out, and / or streakiness of the pericolic / perirectal fat)
- Regional nodes (a single adjacent node 1cm or larger or a cluster of three or more nodes, each less than 1cm in diameter, in their short axis)
- Distal and / or extensive disease (liver metastases, intraperitoneal and mesenteric tumor, distal retroperitoneal lymphadenopathy, and direct extension into adjacent solid or hollow organs).

The adjacent organs were considered involved, if a recognizable interface was not present between tumor and organ associated with irregular, spiculated or thickened apposing surfaces. Omentum was considered involved when it showed enhancing discrete nodules or omental cakes. Mesenteric involvement was considered with presence of disorganized, stellate or discrete tumor masses. Peritoneal involvement was considered with presence of enhancing small nodules or diffuse peritoneal thickening and enhancement. In distal retroperitoneum 8 mm diameter in short axis was taken as upper limit.

The patients who underwent CT examination were then followed up till surgery (palliative / curative). The CT findings were then compared with those of operative findings and wherever possible, with the histo-pathological evaluation of the resected tumor or other specimen. Finally, the CT staging was compared with the Surgico-pathologic staging of the disease.

A criteria[6] for CT staging of primary colorectal tumors is as follows

- **Stage I** – Intra-luminal mass without thickening of wall
- **Stage II** – Thickened wall (> 0.6 cm) or pelvic mass, no invasion or extension to sidewalls
- **Stage III a** – Thickened wall or pelvic mass with invasion of adjacent structures but not to pelvic sidewalls or abdominal wall
- **Stage III b** – Thickened wall or pelvic mass with extension to pelvic sidewalls and / or abdominal wall without distant metastases
- **Stage IV** – Distant metastases with or without local abnormality

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The above-mentioned criteria of CT staging correlates very well with the following surgico-pathologic staging system. A criterion of Surgico-pathologic staging is as follows [6]:

- **Stage A** – Limited to mucosa
- **Stage B1** – Extension into, but not through, the muscularis propria
- **Stage B2** – Extension through muscularis, no nodes
- **Stage C1** – Limited to bowel wall, positive nodes
- **Stage C2** – Extension through bowel wall, positive nodes
- **Stage D** – Distant metastases

(Note: This staging system represents the Astler-Coller version of the Dukes classification, as modified by Turnbull)

RESULTS

- **Age**: Patients in our series ranged from second to eighth decade. The youngest patient was 19 years old and the oldest being 75 years. In the study, the largest group is formed by patients in the range of 60-69 years (16) followed by 50-59 years (9), 40-49 years & 20-29 years (7 each), 70-79 years (6), 30-39 years (4) and 10-19 (1) years in the decreasing order of frequency.
- **Sex**: In our study of 50 patients, 34 were males and 16 were females. Among the 20 patients with rectal carcinoma, 11 were females and nine were males. Among the patients with colonic carcinoma, 22 were males and four were females.
- **Location of tumar**: Among all the patients with CRC in our series, the largest group were formed by those in which rectum was involved i.e. 20 out of 50 (40%). The smallest group was formed by those in which splenic flexure was involved i.e. one of 50 (2%). In four patients, sites of involvement were multiple. These included two patients with cecal & ascending colon involvement and one patient each with transverse colon & sigmoid colon and ascending colon & rectal involvement.
- **Relation to lumen & mural thickness (fig. 1, 2, 3, 4, 5, 6)**: All the patients in our series had intraluminal masses with associated increase in bowel wall thickness. None of the patients showed extraluminal masses or lack of mural thickening.
- **Local extramural invasion (fig. 2, 4, 5, 6):** In our study, CT revealed local extramural invasion in 35 out of 50 patients with a sensitivity of 91.43% and specificity of 80%. Positive and negative predictive values for the same finding were 91.43% and 80% respectively with an overall accuracy of 88%. The above results were obtained when CT finding was compared with surgical finding. Surgically, 35 of 50 cases showed extramural invasion. Comparison of the CT finding of local extramural invasion with histopathological data revealed a totally different scenario. On histopathology, only 11 of 33 patients who underwent surgical resection showed evidence of periserosal invasion. Thus when CT results were compared with that of histopathology, it yielded a sensitivity and specificity of 100% and 50% respectively. Positive and negative predictive values for the same finding were 50% and 100% respectively with an overall accuracy of 66.67%.
- **Nodal metastases (fig. 2,4)***:* In our study, CT detected lymphadenopathy in 20 of 50 patients & surgery in 30 of 50 patients. When of lymphadenopathy was assessed by CT and surgery, it yielded a sensitivity, specificity and accuracy of 66.67%, 100% and 80% respectively with positive & negative predictive values of 100% and 66.67%, respectively.
  Histopathologically, nodal metastases were detected in 15 out of 50 patients. When lymphadenopathy detected by CT was compared with histopathological metastatic involvement of lymph nodes; the sensitivity, specificity and accuracy was 83.3%, 58.3% and 73.3% respectively with positive & negative predictive values of 75% and 70% respectively.
- **Invasion into adjacent organs:** In our study, 14 of 50 patients were diagnosed to have invasion of adjacent organs as determined by CT. On surgery, all these 14 cases were confirmed; but additional 7 cases were identified that were missed by CT. Thus our study yielded a sensitivity & specificity of 66.67% and 100% respectively, when CT results were compared with surgery with positive & negative predictive values of 100% and 80.56% respectively. For this finding no histopathological data was available for comparison with CT.
- **Invasion into pelvic/abdominal wall (fig. 3 & 5):** In our study, 8 out of 50 patients were diagnosed to have invasion of pelvic/

Figure 1*: CT scan showing rectosigmoid carcinoma with mural thickening and intraluminal narrowing*

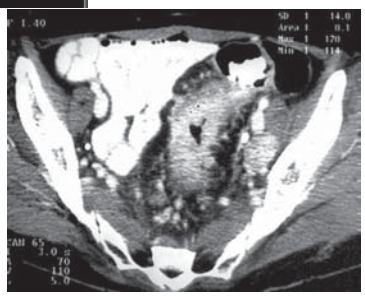

Figure 2*: CT scan showing rectosigmoid carcinoma with local extramural invasion and regional pelvic metastatic lymphadenopathy*

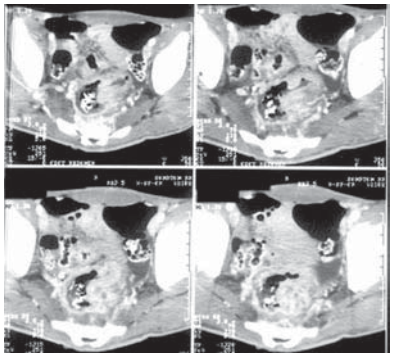

Figure 3*: CT scan showing rectosigmoid carcinoma with invasion of pelvic walls posteriorly and posterolaterally with minimal ascites*

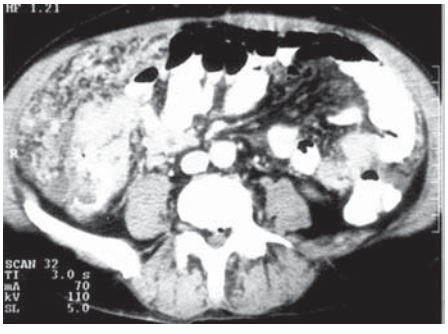

Figure 4*: CT scan showing carcinoma of ascending colon with pericolic metastatic lymphadenopathy, local extramural invasion and carcinoma peritonei*

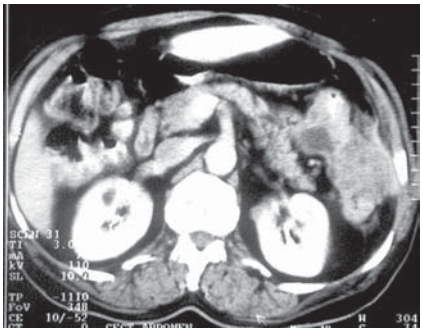

***Figure 5**: CT scan showing carcinoma of splenic flexure with local extramural and abdominal wall invasion*

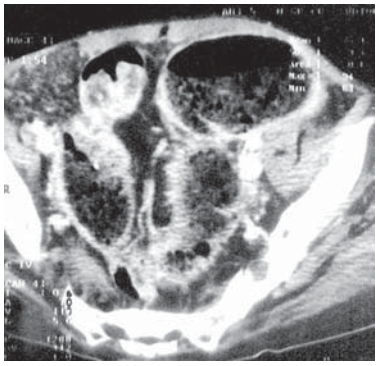

***Figure 6**: CT scan showing rectosigmoid carcinoma with local extramural invasion and proximal intestinal obstruction*

abdominal wall as determined by CT. On surgery, all these cases were confirmed; but additional one case was identified that was missed by CT. Thus our study yielded a sensitivity and specificity of 88.89% and 100% respectively when CT results were compared with surgery with positive predictive, negative predictive values and accuracy of 100%, 97.62% and 98% respectively. For this finding no histological data was available for CT comparison.

- **Metastases (fig. 4):** In our series, 12 patients had peritoneal/ mesenteric and hepatic metastases including one case that had metastases of both varieties. Out of above 12 patients, three had histologically proved peritoneal/mesenteric metastases, out of which two cases were correctly detected by CT. Similarly, out of 10 cases of histologically proved metastatic deposits in liver, CT could detect nine cases. This yielded sensitivity, specificity, positive predictive, negative predictive and accuracy values of 91.67%, 100%, 100%, 97.44% and 98% respectively.
- **Staging:** in our study, CT correctly staged 33 out of 50 cases (66%) when compared with surgicopathologic findings. CT understaged eight (16%) and overstaged nine (18%) cases. The distribution of cases is shown in the *table*.

  All stage patients were represented well in our series except stage A, which was insignificantly represented. In our study, 18 out of 27 (66.67%) stage II lesions; six out of 12 (50%) stage III lesions and nine out of 10 stage IV lesions were correctly staged by CT**.** Of the 24 patients with rectal and rectosigmoid carcinoma, CT correctly staged – none of one stage I; nine of 12, stage II; five of seven, stage III and four of four stage IV lesions.

DISCUSSION

Colorectal cancer is treated by surgical removal of the tumor, or with adjuvant therapy. Hepatic metastases are resected surgically or palliated by cytotoxic drugs, cryosurgery or laser therapy.[7] The chances of cure in patients with CRC depends upon the stage at which it is diagnosed. Treatment at an early stage allows 50% of patients to survive five years and 29% for 10 years, while, of those with advanced disease, 91% are dead within five years, and 97% of those patients who receive only symptomatic treatment die within five years.[8]

In our study, the percentage of patients in whom the rectum was involved formed the largest group i.e. 20 (40%), followed by cecum,

***Table**: Showing comparison between Computed Tomography and Surgico-Pathologic staging in fifty cases of colorectal carcinoma*

CT	SURGICOPATHOLOGIC				
	1	**2**	**3**	**4**	**TOTAL**
1	0	0	0	0	0
2	1	18	7	0	26
3	0	8	6	1	15
4	0	0	0	9	9
TOTAL	1	26	13	10	50

eight (16%); hepatic flexure, six (12%); ascending colon, five (10%); transverse colon, sigmoid colon & rectosigmoid region, four each (8% each); descending colon, two (4%) and splenic flexure, one (2%) in the decreasing order of frequency.

The percentage involvement of various sites from appendix to anus as per the trends is rectum 38%, sigmoid colon 21%, cecum 12%, rectosigmoid region 7%, transverse colon 5.5%, ascending colon 5%, descending colon 4%, splenic flexure 3%, hepatic flexure & anus 2% each and appendix 0.5%.[9]

Our study shows the higher incidence in the right-sided colon while maintaining its highest incidence in the rectum. This may reflect the changing trends or may be because of smaller sample volume & selection bias so that our results may not be accurately extrapolated over the entire population.

When the CT finding of local extramural invasion was compared with histopathological data (which was obtainable in 33 of 50), sensitivity, specificity and accuracy of 100%, 50% and 66.67% respectively was achieved with positive & negative predictive values of 50% & 100% respectively. Our study results of CT versus histopathological data *(table)* are quite different from those obtained by Emil J. Balthazar et al[10] and Patrick C. Freeny et al[11] in their studies. The use of thinner collimated slices in our series (5mm*5mm) than in other series (10mm*10mm) resulted in higher sensitivity at the cost of lowered specificity; however, the overall accuracy was comparable — 66.67% in ours, 57.9% in Emil's & 68.75% in Patrick's. Thus, it is clear that thinner scans do not significantly affect the overall CT accuracy of detecting local extramural invasion.

CT criteria of metastatic lymphadenopathy when compared with histopathological data yielded a sensitivity, specificity and accuracy of 83.3%, 58.3% and 73.3% with a positive & negative predictive value of 75% & 70% respectively. Our results when compared with those obtained by Emil J. Balthazar et al and Patrick C. Freeny et al showed a comparable accuracy of 68.4% and 72.5% respectively. However, the sensitivity, specificity and positive & negative predictive value of only Emil's study correlated with ours, as the criteria used were same. But the sensitivity and specificity values are very different from Patrick's study viz. 25.9% and 96% respectively. This was because they used 1.5 cm as the upper limit of normal for labeling nodal metastases. Thus, it is clear that the lower cut-off criteria improve the CT sensitivity for detecting nodal metastases but lowers specificity significantly. But even this is advantageous as the CT detected lymph nodes can be subjected to FNAC before surgery for accurate preoperative staging and can also guide the surgeon to look for specific

lymph nodes so that they could be sent for biopsy for histopathological staging, thus allowing proper postoperative management and determining the prognosis of the patient.

When CT results for invasion into adjacent organs were compared with surgery findings in our study, it yielded sensitivity, specificity and accuracy of 66.67%, 100% and 86% respectively with a positive and negative predictive value of 100% and 80.56% respectively. No histopathological data was available related to this finding for comparison with CT data. A study by Emil J. Balthazar et al shows that CT detected nine out of 14 cases of tumor invasion into adjacent solid or hollow organs yielding a sensitivity of 64.29%. Our study results are comparable to that of Emil's study results.

In our series, CT detected pelvic / abdominal wall in eight out of nine cases confirmed on surgery. This yielded a sensitivity, specificity and accuracy of 88.89%, 100% and 98% respectively with a positive and negative predictive value of 100% and 97.62% respectively. No histopathological data were available for comparison with CT finding. This finding has not been separately considered and studied in previous reports. However, our study reveals that CT is quite an accurate method for determining the invasion into pelvic / abdominal wall.

In our series, CT could correctly identify 9 out of 10 cases of histopathologically proven hepatic metastases. The case missed on CT showed minute 2 - 5 mm hepatic nodulation. This may be because the size of nodules was beyond the resolution of the scanner or because of respiratory misregistration or partly because delayed hepatic scans were not taken. Our results are comparable to those obtained in Emil's and Patrick's series

Out of three cases of mesenteric / peritoneal metastases, CT could correctly diagnose two cases, thus yielding a sensitivity of 66.67%. The case missed on CT showed minute 2 - 5 mm mesenteric / peritoneal nodulation. This may be because the size of nodules was beyond the resolution of the scanner. The above result is similar to that of Emil J. Balthazar et al where four out of six cases were correctly diagnosed by CT, thus yielding a sensitivity of 66.67%.

In our study, 33 out of 50 cases (66%) were correctly staged by CT when compared with surgicopathologic findings. CT understaged eight (16%) and overstaged nine (18%) cases. Our study correlated well with the study conducted by Emil J. Balthazar et al i.e. 64% and G. Scott Gazelle et al[12] i.e. 76.67%.

The slightly higher staging accuracy achieved in Gazelle's study is due to the use of water-enema during CT scanning and use of dynamic sequential scans.

The higher staging accuracy achieved in our study as compared to some previous studies is due to good colonic preparation; good bowel opacification; improved CT scanning techniques and better resolution CT scanners. The accuracy may further increase with improvements in technology.

The staging accuracy in our study was much higher in patients with rectal and rectosigmoid carcinoma i.e. 79.2% which included an accuracy of 75% in stage II lesions, 71.4% in stage III lesions and 100% in stage IV lesions. This accuracy achieved in our study is higher than that achieved by B. Adalsteinsson et al[13] i.e. 60 - 70%. This may be due to use of thinner collimated scans, bowel preparation & larger amount of positive oral contrast for good bowel opacification and also because of improved resolution of CT scanners. However, the accuracy achieved was lower than that of Ruedi F. Theoni et al[14] i.e. 92%, as that study mainly included stage III and IV lesion where the CT accuracy is higher as 81.8% in our study.

CONCLUSION

In conclusion, Computed Tomography (CT) is a powerful technique for detecting and staging carcinoma of the colon and rectum. The sensitivity, specificity and accuracy for staging primary colonic and rectal carcinomas range from 48 to 100% with a mean accuracy of 75%. In general, sensitivity, specificity and accuracy increase as disease progresses from mucosal to extramucosal stages and further especially in detecting hepatic metastases. Although negative findings on CT do not help staging colorectal carcinoma but positive findings are highly indicative of neoplastic spread. Following reasons thus justify the use of Computed Tomography in preoperative evaluation of colorectal carcinoma -

- CT is very accurate in establishing the cause of obstruction and detecting perforation in patients with colorectal carcinoma; the former being an independent prognostic factor in colorectal carcinoma and the latter determining the duration of disease free survival.
- Clinically unsuspected CT findings may lead to significant changes in either the preoperative management or type of surgery or may altogether preclude surgery; thus lessening the need for exploratory, noneffective, costly surgical procedures, reducing the hospital stay, directing FNAC / biopsy of suspected lesions, permitting application of chemotherapy & radiotherapy to be instituted promptly and effectively e.g. preoperative or intraoperative radiotherapy to control local tumor spread or to make previously inoperable lesions operable, resection of hepatic metastases, etc.
- CT is complementary to clinical assessment in high-located rectal tumors especially when preservation of rectal function is contemplated. It may provide the surgeon with additional information that can become essential during surgery as relationship between ureter and colon. CT is considered to be the best initial test for elderly frail patients with large bowel disease including colorectal carcinoma.
- Last but not the least, in patients with extensive local spread and in the absence of a specimen for pathological examination, the CT can give an objective and permanent record of the local extent in line with the pathological extent in most cases thus serving as the base-line for follow-up studies as in determining the response to therapy.

Finally, it would be apt to conclude that though CT findings cannot be solely relied upon but since the Computed Tomography delineates multiple abnormalities with a fair degree of accuracy than any other single diagnostic method, it should be considered as the investigation modality in preoperative assessment of colorectal carcinoma.

REFERENCES

1. ***Ransohoff DF, Lang CA**: Screening of colorectal cancer, N Engl J Med 325: 37, 1991 (current concepts).*
2. ***Fleischer DE, Goldberg SB, Browning TH et al**: Detection and surveillance of colorectal cancer, JAMA 261: 580, 1989.*
3. ***Bailar JC III, Smith EM**: Progress against cancer? N Engl J Med 324: 1226, 1986.*
4. *Schottenfeld D, Winawer SJ: Large intestine. In Schottenfeld D, Fraumeni JF, eds: Cancer epidemiology and prevention, Philadelphia, 1982, WB Saunders.*
5. ***Seidman H, Mushinski MH, Gelb SK et al**: Probabilities of eventually developing or dying of cancer—United States 1985, CA Cancer J Clin 35: 36, 1985.*
6. ***Ruedi F.Theoni**: Review Article, AJR 156:909-915, May 1991.*
7. ***Bailey and Love's**, Short Practice of Surgery, 22nd ed: 804-805.*
8. ***Berge T, Ekelund G, Mellner C et al**: Carcinoma of the colon and rectum in a defined population, Acta Chir Scand (Suppl) section A, 1977.*
9. ***Harrison's Principles Of Internal Medicine**, 13th ed., vol. II, page 1428*
10. ***Emil J Balthazar et al**. Carcinoma of the colon: Detection and preoperative staging by CT. AJR 1988, 150: 301-306*
11. ***Patrick C. Freeny et al**. Colorectal carcinoma evaluation with CT – Preoperative staging and detection of postoperative recurrence. Radiology 1986, 158: 347-353*
12. ***G. Scott Gazelle et al**. Staging of Colon carcinoma using water enema CT. Journal CAT 1995, 19: 87 – 91*
13. ***B. Adalsteinsson et al**. Computed tomography in staging of the rectal carcinoma. Acta Radiologica Diagnosis 26,1985, Fasc. 1.*
14. ***Ruedi F. Theoni et al.** Detection and staging of primary rectal and rectosigmoid cancer by computed tomography. Radiology 1981, 141: 135 -138*