

The Clinical Significance of CT in the Preoperative Diagnosis of Colon and Rectal Cancer

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ABSTRACT

The clinical significance of CT in the preoperative diagnosis of colon and rectal cancer was studied. Thirty four patients were investigated in this series. The diagnostic criteria of the CT examination were previously established in a study of wall invasion (S factor), lymph node metastasis (N factor), liver metastasis (H factor) and peritoneal dissemination (P factor). The CT diagnosis was done prospectively according to these criteria, and the CT diagnosis was compared with the macroscopic and histological diagnosis.

The accuracy of the prospective diagnosis as to H, S, N and P factors was 79.4%, 55.9%, 41.2% and 20.6%, respectively. The diagnostic value of CT seemed to be acceptable as to the H factor, but limited to some extent to the S and N factors.

In the surgical treatment of colon and rectal cancer patients, there are problems such as the radical operation v.s. postoperative functional disorders. Therefore, an exact diagnosis before the operation is necessary in order to select the appropriate surgical method. Recently, ultrasonography and the CT scan have been utilized in the usual preoperative examinations for diagnosis of colon and rectal cancer. The role of the CT examination in the diagnosis of colon and rectum cancer is to get an exact evaluation of wall invasion, the relationship between the intestine and neighboring organs, lymph node metastasis, liver metastasis, the presence of ascites and peritoneal dissemination, which can not be evaluated by the usual examination methods such as the barium enema and endoscopic observation.

For the purpose of selecting the more appropriate surgical method, we previously reported on the value of CT in the preoperative and postoperative diagnosis of colon and rectal cancer⁹⁾. In this report, we show the clinical significance of CT in the preoperative diagnosis of colon and rectal cancer.

MATERIALS AND METHODS

From October 1982 to June 1984, 58 CT examinations were performed for preoperative diagnosis on 52 colon and rectal cancer patients. Out of the 52 patients, 34 patients were included in this series. The patients' macroscopic and histological findings were known.

All studies were performed using a Toshiba TCT-80A scanner (a third generation CT scanner) with a 9-second scanning time. All scans

were obtained using 1-cm collimation at 1-cm intervals from the anal level to the diaphragm level. After plain CT scanning, enhanced CT scanning was performed on all patients with the contrast medium, Conray® (60w/v%, 100–200 ml).

Wall invasion and the relationship between the intestine and neighboring organs (S factor), lymph node metastasis (N factor), liver metastasis (H factor) and peritoneal dissemination (P factor) were examined prospectively according to the CT diagnostic criteria (Table 1). These criteria were previously established in our hospital with reference to the general rules for clinical and pathological studies on cancer of the colon, rectum and anus¹¹.

The criteria for the S factor were decided based on the finding of the intestinal wall, the fatty tissue around the intestine and the relationship between the intestine and neighboring organs. Fig. 1 shows standard patterns of the

S factor of the rectum. Fig. 1a shows S₀: the same as the normal rectum. The S_I case (Fig. 1b) showed a slight thickening of the wall, although the external edge of the rectum was smooth and the fatty tissue around the rectum was normal. Fig. 1c shows S_{II}. The wall had clearly thickened, and a fluffy shadow, coronary shadow and the thread coiling phenomenon were observed at the external edge of the rectum. The fatty tissue between the rectum and the neighboring organs remained. Fig. 1d shows S_{III}; the wall had thickened and was shaped like a tumor. The fatty tissue between the neighboring organs (the uterus, the sacral bone and muscles) and the tumor had disappeared, and the tumor and the uterus were connected. When contrast enhancement was performed, they were enhanced in a same time.

The criteria for N and H factors were decided on the basis of the number and position of the metastatic lesions (metastatic lymph nodes

Table 1. Diagnostic Criteria of CT Examination (1984. Itano)

1. Diagnostic criteria for S factor

S_{0-I}: No or only slight thickening of the intestinal wall can be seen. The fatty tissue around the intestine ("the fatty layer") has remained in about the same condition as the normal and it is shown as a low-density shadow on CT film.

S_{II}: The lesion is found as a thickened intestinal wall or tumor in the intestinal wall and the CT number of the lesion has increased remarkably due to the contrast enhancement. Although the fatty layer around the lesion has remained, "the fluffy shadow", "the coronary shadow" and "the thread coiling phenomenon" is visible. Occasionally the irregularity of the external edge of the intestine can be seen.

S_{III}: The fatty layer between the lesion and the neighboring organs has disappeared and the lesion is tightly connected to the neighboring organs. The increase of the CT number in the lesion and the neighboring organ is similar due to the contrast enhancement. In a much more advanced case, the neighboring organ itself shows deformity or enlargement.

2. Diagnostic criteria for N factor

N(+): When a lymph node shown as a nodular shadow is visible in the fatty tissue around the intestine, the N factor is evaluated as being positive.

N(-): When the nodular shadow is not visible, the N factor is negative (N₀).

The staging (N_I, N_{II}, N_{III}, N_{IV}) is diagnosed by the position and the relation between the nodular shadow and the primary lesion.

3. Diagnostic criteria for H factor

H(+): When the space occupied lesion (SOL), shown as a low-density shadow in almost all cases, is found in the liver and differentiated from benign lesions, the H factor is evaluated as being positive.

H(-): When the SOL is not found, the H factor is negative (H₀).

The staging (H_I, H_{II}, H_{III}) is diagnosed by the numbers and the position of the SOL.

4. Diagnostic criteria for P factor

P(+): When a long and narrow high-density shadow or nodular shadow is shown in the fatty tissue or on the peritoneum or the mesenterium, the P factor is evaluated as being positive.

P(-): When the clear positive finding is absent, the P factor is negative (P₀).

The staging (P_I, P_{II}, P_{III}) is diagnosed by the position and the relation between the high-density shadow and the primary tumor.

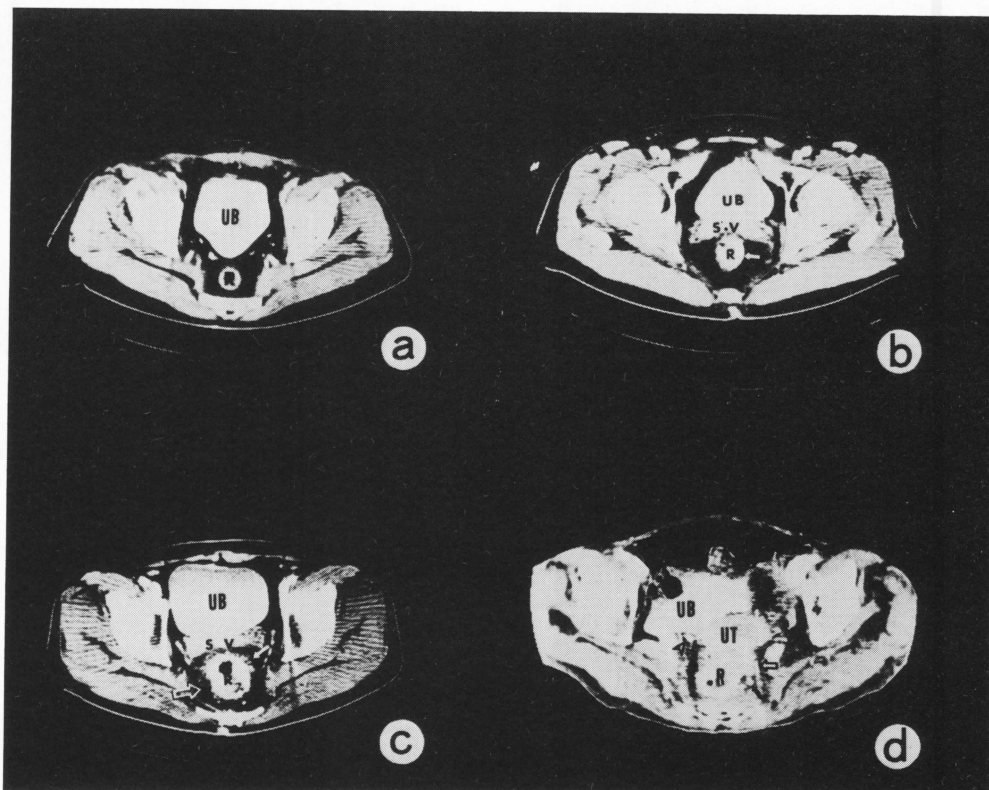


Fig. 1. Standard pattern of S factor (rectum)

1a: S₀; Same as the normal rectum. 1b: S_I; A slight thickening of the wall is visible and the fatty tissue around the rectum is normal. 1c: S_{II}; Thickening of the wall is clearly visible with a fluffy shadow (large arrow) and coronary shadow (small arrow). The fatty tissue between the rectum and the neighboring organ has remained in the same condition as normal. 1d: S_{III}; A lesion is visible as the tumor (large arrow) and the fatty tissue between the rectum and neighboring organs has disappeared. An arrowhead shows the right ureter and small arrow shows a metastatic lymph node.

R: rectum, UB: urinary bladder, SV: seminal vesicle, UT: uterus

and metastatic tumors in the liver). Fig. 2 shows standard patient. Fig. 2a shows a solitary low-density shadow in the right lobe of the liver. After contrast enhancement, the lesion was enhanced circularly and designated as H_I. The arrowhead shows a stone in the gall bladder. A right lobectomy and cholecystectomy were performed, and the liver metastasis was confirmed by histological examination. Multiple nodular shadows are visible in Fig. 2b. Due to the position of the shadows around the inferior mesenteric artery, the staging of the N factor was established as N_{II}. The findings of the operation showed swelling of the mesenteric lymph nodes around the inferior mesenteric artery, as did the

CT scan and indicated N₂. As a result of a histological examination, the factor was finally set at n₃.

The criteria for the P factor were decided on the basis of the findings of the peritoneum or the mesentery. Fig. 3 shows the typical patterns of the P factor in a rectal cancer patient. Dissemination is clearly observed on the peritoneum as the semicircular tumor. These findings are very rare, because so much ascites is seldom observed in cancer patients. In this case, the P factor was set at P_{III} according to the CT diagnostic criteria. The operative diagnosis was P₃, and dissemination was confirmed by histological examination.

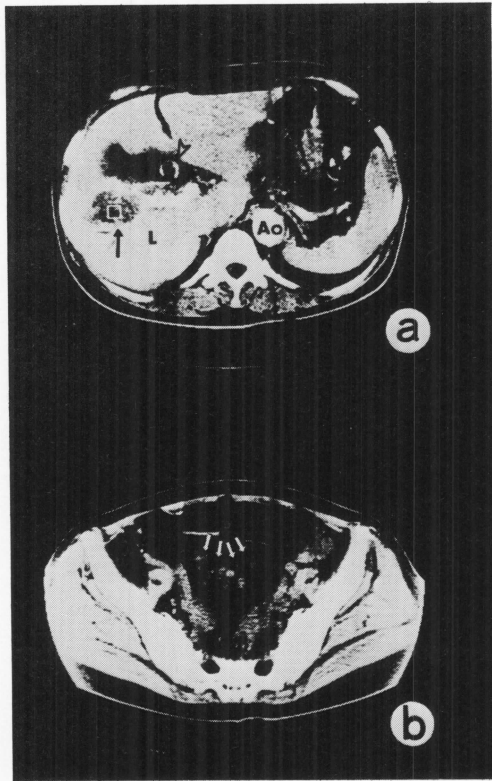


Fig. 2. H and N factors (case of the sigmoidal cancer)

2a: In the right lobe of the liver, a solitary low-density shadow is visible (small arrow). The edge was enhanced with contrast enhancement. Evaluated as H₁. The arrowhead shows a stone in the gallbladder. 2b: Multiple nodular shadows are visible (small arrow) around the inferior mesenteric artery. Evaluated as N_{II}, and found the same finding in the operation.

L: liver, Ao: aorta

RESULTS

Table 2 shows the results of the evaluation of each factor according to the CT diagnostic criteria. Since differentiation between S₀ and S_I was difficult, S₀ and S_I were discussed together. The accuracy in relation to the S factor at all levels was slightly low at 55.9%, but the S_{III} level the accuracy was high at 80.0%. The CT examination was significant in the evaluation of the invasion into neighboring organs. The accuracy in relation to the N factor was low at 41.2%. The incidence of false negatives was

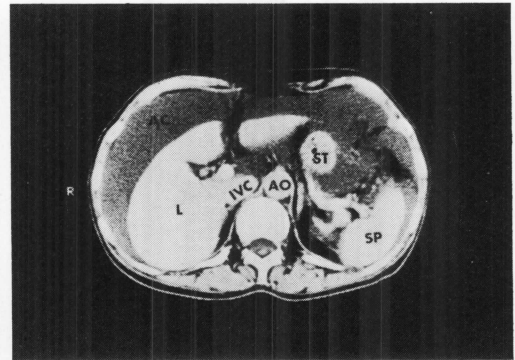


Fig. 3. P factor

The arrow shows the peritoneal disseminated tumor. This view is very rare. Only in the case such as this case, in which much ascites are shown, the tumor is clearly found.

AC: ascites, L: liver, IVC: vena cava inferior, AO: aorta, ST: stomach, SP: spleen

high in N₀, and that of false positives was high in N_{II}, N_{III} and N_{IV}. When only the presence of lymph node metastasis was evaluated, the accuracy was high at 73.5%. The staging of the N factor was difficult. The CT examination was significant in the determination of the presence of lymph node metastasis. The accuracy in relation to the H factor was 79.4%, and the accuracy at the H₀ level was high at 88.0%. Three cases of false negative diagnosis at the H₀ level were examined during the early stage of the disease. These three lesions were less than 1 cm in diameter, and they were on the surface of the upper portion of the liver where the liver came in contact with the diaphragm. They were discovered during the operation and removed. The lesions could not be found retrospectively. In four cases of false positive diagnosis, a small low-density shadow was observed in the liver on the CT scan, and differentiation from a cyst was impossible.

Revealing the P factor, let alone evaluating it was difficult. The P factor was useful only in patients who had ascites or a great deal of abdominal fatty tissue. In one false negative case, the dissemination was diagnosed as lymph node metastasis.

DISCUSSION

In comparison with CT scanning of the whole body, CT scanning of the intestine has been on

Table 2. Results of Evaluation of each factor according to the CT Diagnostic criteria

	Accuracy	False Positive	False negative	Total
S factor				
0-I	4(57.1%)	0	3(42.9%)	7
II	11(50.0%)	5(22.7%)	6(27.3%)	22
III	4(80.0%)	1(20.0%)	0	5
Total	19(55.9%)	6(17.6%)	9(26.5%)	34
N factor				
0	3(42.8%)	0	4(57.2%)	7
I	6(75.0%)	1(12.5%)	1(12.5%)	8
II	3(30.0%)	6(60.0%)	1(10.0%)	10
III	1(16.7%)	4(66.6%)	1(16.7%)	6
IV	1(33.3%)	2(66.7%)	0	3
(+, -)*	25(73.5%)	4(11.8%)	5(14.7%)	34
Total	14(41.2%)	13(38.2%)	7(20.6%)	34
H factor				
0	22(88.0%)	0	3(12.0%)	25
I	2(50.0%)	2(50.0%)	0	4
II	1(33.3%)	2(66.7%)	0	3
III	2(100%)	0	0	2
Total	27(79.4%)	4(11.8%)	3(8.8%)	34
P factor				
(+, -)**	7(20.6%)	4(11.8%)	1(2.9%) 22(64.7%)#	34

*: Evaluated only as to the presence or absence of lymph nodes.

** : Only the presence or absence of the P factor was evaluated.

: The P factor could not be evaluated in 22 patients.

the increase, with many papers being presented on the subject^{1-8,10,14-16, 18-23}. In this series, the CT diagnosis in relation to S, N, H, and P factors was done prospectively, and the accuracy was discussed in comparison with the macroscopic and histological diagnosis.

The S factor was defined on the basis of the degree of wall thickening and the findings of the fatty tissue around the intestine. Fisher⁵ reported that if wall thickening was more 3-5 mm, an intestinal abnormality should be suspected. However, it is difficult to decide the standard thickness of an intestinal abnormality, because many factors, for example, care before a CT examination, premedication and the patient's age, must be taken into consideration. The degree of wall thickening should be evaluated in relation to the appearance of the neighboring intestinal wall¹⁰. For ease in observing the degree of wall thickening and the lesion itself, the olive-oil enema method⁹ or the warm-water enema method is occasionally used prior to the CT examination. Zaunbauer et al²³ clas-

sified rectal cancer into 4 stages according to the degree of wall thickening and the external invasion. Thoeni et al¹⁸ in the same way classified rectal cancer into 5 gradations. Tsujinaka et al^{19,20} classified the external invasion of rectal cancer into 3 gradations, and the accuracy of the diagnosis according to the degree of the wall invasion was 80-83.2%. Hisa et al^{6,7} classified colon and rectal cancer into 4 gradations, and the accuracy of the diagnosis according to the S factor was 65%. Discussing this series histologically, in the cases diagnosed as S0-1, the invasive depth in the wall was sm or pm and the serosal surface was smooth. In the SII cases, s or si and external invasion to the surrounding fatty tissue were observed. Since, inflammatory diseases, for example mesenteric panniculitis, occasionally show a similar shadow careful differentiation is necessary. In the SIII case, the invasion to the neighboring organs was confirmed histologically, and 80% of the SIII cases were diagnosed precisely by CT. Hisa et al^{6,20} reported similarly that the degree of the

invasion in SIII cases could be evaluated and the invaded organ identified precisely by CT scanning. Nevertheless, Hisa et al stated that a differential diagnosis between inflammatory adhesion and carcinomatous invasion was impossible. In this series, inflammatory adhesion with fibrosis was diagnosed similarly as invasion.

Regarding the N factor, Walsh et al²²⁾ reported that lymph node metastases could be found when they were more than 2 cm in diameter. However, a lymph node tightly connected to the intestine or tumor could not be identified in this series, even if it was of considerable size. Out of the 4 cases N₀ which produced a false negative diagnosis, the maximum size of the lymph node was 9 mm. The minimum size which could be detected with the recently developed CT scanner was 1 cm, so the 4 false negative cases diagnosed as N₀ in this series could not be observed in the CT examination. Zaunbauer et al²³⁾ stated that the possibility of a malignant metastasis was high when the size of the lymph node was more than 15 mm. However, in this series, the swollen lymph nodes were not always proven to be metastatic even if the size was more than 15 mm. Our experience has shown that metastatic lymph nodes have a tendency to have a ring-shaped shadow, just like an open circle, with contrast enhancement. Ozaki¹⁷⁾ reported that metastatic lymph nodes in gastric cancer patients were seen as a non-enhanced pattern with contrast enhancement, and Tsujinaka et al²⁰⁾ stated that the rate of metastasis was high in cases in which the lymph nodes were observed as a multi-spotted shadow. Ozaki and Tsujinaka et al. had results similar to ours. To evaluate the N factor, both the size and findings with contrast enhancement are necessary. In this series, the presence of lymph node metastasis was diagnosed exactly, but the staging was difficult. Nevertheless, we expect improvement in the evaluation of the N factor, with a more exact identification of the blood vessels using contrast enhancement and with a better understanding of CT anatomy.

Regarding the H factor, many reports and papers have been presented concerning CT examinations of liver carcinoma. Since many metastatic lesions in the liver are shown as low-density shadows, the diagnosis is easy. However, the differentiation of a small metastatic lesion

from a cystic lesion is difficult. Calcification of metastatic lesions is often seen in colon and rectal cancer patients¹²⁾, and metastases from colon or rectal cancer should be suspected if calcification is shown in a liver tumor¹⁶⁾. In this series, calcification was not seen in any of the metastatic cases. An exact evaluation of the H factor makes it possible to decide whether a liver resection is indicated, and which method is best if the resection is necessary. In this series, CT examinations were significant in showing that there was no liver metastasis in H₀ cases. Out of the 3 cases which had false negative diagnosis, all received CT examinations in the beginning of our CT series, and the metastatic lesions were on the surface of the liver touching the diaphragm. All had an average diameter of about 1 cm. Evaluation of the H factor in these 3 cases was impossible in the retrospective study of their CT films. Hisa et al⁷⁾ reported the same results as ours. The reason is thought to be due to an artifact of the CT examination, called the partial volume effect. So as to prevent these false negative diagnoses, scanning with a 5-cm collimation at 5 mm intervals or scanning with a 10-mm collimation at 5 mm intervals (called "overlap scanning") should be performed.

Regarding the P factor, Hisa et al^{6,7)} reported that the mesenterium was shown as being a long and narrow high-density shadow when dissemination occurred. However, the presence of dissemination (P(+)) was difficult to verify in this series, and an exact evaluation was possible only in the cases which had a lot of ascites or a great deal of fatty tissue in the abdomen. When the P factor was seen as a nodular shadow, it was viewed as the N factor. In such a case, the staging can not be evaluated exactly.

The stage of colon and rectal cancer was diagnosed using CT examinations before the operation. The CT examination was significant in deciding the indication for the operation and selecting the appropriate surgical method.

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