Association of CT features with TNM stage and pathology of patients with rectal cancer and their significance in evaluation of efficacy and prognosis

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Summary

Purpose: To explore the associations of computed tomography (CT) features with tumor-node-metastasis (TNM) stage and pathology of patients with rectal cancer and their significance in the evaluation of efficacy and prognosis.

Methods: A total of 83 rectal cancer patients who were operated in our hospital were collected. CT examination was performed before operation, and pathological examination was conducted after operation. The influence of CT stage on the prognosis of patients with rectal cancer was assessed.

Results: Postoperative pathological examination showed that there were 15 cases in T1-T2, 41 cases in T3 and 27 cases in T4. The results of CT examination showed that there were 15 cases in T1-T2, 40 cases in T3 and 28 cases in T4, and the sensitivity was 93.18%. It can be seen that the results in the two examinations were similar. The postoperative pathological examination revealed that lymph node metastasis occurred in 57 cases, and the main metastatic sites were the left

and right pelvic cavity, near the intestine and iliac vessels. CT also confirmed that 22 cases had no lymph node metastasis, 4 of which were pathologically diagnosed with lymph node hyperplasia after operation. The consistency of results in the two examinations was lower. The survival rate of patients with stage A, B, C and D rectal cancer was 85.33%, 63.44%, 36.12% and 11.14%, respectively.

Conclusions: CT scan plays an important role in the preoperative staging of rectal cancer, which is helpful for judging the tumor site and infiltration, and highly accurate for T1-T2 lesions, but has limitations for lymph node metastasis. CT scan also has great value for distant metastasis, and contributes to the development of clinical therapeutic regimens for patients with rectal cancer in different stages. CT stage has an influence on the prognosis and patient survival.

Key words: rectal cancer, TNM stage, prognosis

Introduction

Rectal cancer is a malignant disease of digestive system, with a high morbidity. Bad eating habits, such as excessive protein intake and insufficient intake of fruits and vegetables, will induce the rise of its morbidity [1,2]. According to statistics, patients with rectal cancer in China already account for 60-70% in all cases of large intestine diseases, and the patient quality of life cannot be guaranteed. The lesion site of rectal cancer is mainly at the junction of rectum and sigmoid colon, and the rectal tissues are damaged. There are no obvious clinical features in the early disease stage, and abdominal pain occurs in more advanced stages. Therefore, early prevention and timely treatment are extremely important [3].

At present, the commonly-used diagnostic methods for rectal cancer are rectal endoscopic examination, barium enema and computed to-

mography (CT). According to a large number of reports, CT examination can accurately assess the position of rectal cancer spread, and clearly observe whether there is infiltration of cancer cells into the surrounding tissues. CT examination, the most commonly-used method for rectal cancer before operation, offers effective help for preoperative evaluation and diagnosis. Operative treatment is a common therapeutic method for this disease. Excision can be performed in the early stage, and chemoradiotherapy is needed to improve the excision rate in the middle-late stages before operation, as well as for accurate diagnosis and treatment based on the degree of rectal wall lesions and presence or absence of lymph node metastasis [4,5]. Pathological staging based on CT plays an important role in the programming preoperative treatment of patients with rectal cancer, and also has a certain reference value for prognosis. In this paper, therefore, patients with rectal cancer were examined *via* CT, the association between tumor-node-metastasis (TNM) stage and pathology of patients was determined, and the significance of CT in the evaluation and patient prognosis was further evaluated.

Methods

General data

This study was approved by the Ethics Committee of Liaocheng People's Hospital. Signed informed consents were obtained from all participants before the study entry. A total 83 rectal cancer patients treated in our hospital from February 2012 to March 2014 were collected, including 51 males and 32 females with an average age of 56.52±7.39 years. In terms of the tumor differentiation, there were 12 cases of high differentiation, 47 cases of moderate differentiation and 24 cases of poor differentiation. According to the TNM staging system [6], there were 11 cases in stage I (well differentiated, tumor cells are similar to normal cells, with a low grade of malignancy), 39 cases in stage II (between stage I and stage III, with a moderate grade of malignancy), 26 cases in stage III (tumor cells are much different from normal cells, with lower differentiation and a higher grade of malignancy), and 7 cases in stage IV (no differentiation of malignant tumor cells, with a higher grade of malignancy). As for the Dukes stage, there were 14 cases in stage A (cancer confined to the intestinal wall), 35 cases in stage B (cancer penetrates the intestinal wall and invades the serosa or/and outside the serosa, without lymph node metastasis), 24 cases in stage C (cancer invades or does not invade the full-layer intestinal wall, but with lymph node metastasis) and 10 cases in stage D (distant metastasis or abdominal metastasis, or cancer involves the adjacent organs and is unresectable). Among the 83 patients, 70 cases had tenesmus and thin stool, 37 cases had blood-stained stool and slim body, 29 cases had abdominal distension and

pain, and 10 cases had urinary urgency and pain, and they all had various complications. The mean course of disease was 2.34±1.07 years, and the tumor diameter was ≤3 cm in 31 cases. The operation was performed in patients 7 days after examination.

Inclusion and exclusion criteria

Inclusion criteria: 1) patients diagnosed with rectal cancer *via* pathological biopsy; 2) those undergoing the operation; and 3) those who and whose families signed the informed consent. Exclusion criteria: 1) patients complicated with other cancers; 2) those with coagulopathy; 3) those who quit the investigation for no reason or had incomplete clinical data; and 4) those receiving other anti-tumor therapies.

Examination methods

Before the examination, the intestinal tract was cleaned, and anisodamine was applied to reduce intestinal movement and avoid artifacts. 1000 mL of water was drunk to fill the bladder, and the anal tube was inserted in a supine position, followed by air inflation (1500 mL) until there was a feeling of abdominal fullness. After extubation, the patients held the breath quietly, and CT scan (GE, Little Chalfont, Buckinghamshire, UK, model: LightSpeed) was performed from the iliac crest to the ischium (120 kV, 250 mv, slice thickness: 0.125 cm, pitch: 0.938:1). If unsatisfactory, the air inflation continued until it was satisfactory. Then, a small amount of iohexol was intravenously injected, and enhancement scan was performed in the same range after 1 min.

CT staging

According to the TNM pathological staging criteria of rectal cancer CT of the International Union Against Cancer are [6]: T0 no tumors are found, T1: the thickness of the rectal wall increases by more than 6 mm, and there are obvious raised bumps in the intestinal wall; T2: the partial thickness of the rectal wall increases by more than 6 mm, and the peripheral adipose tissues are clearly visible; T3: the thickness of the rectal wall is more than 6 mm, with tumor invasion outside, and the peripheral adipose tissues are blurred, with intestinal lumen stenosis; and T4: the tumor protrudes outside the rectal wall, with obvious intestinal lumen stenosis, there are nodular changes on the intestinal outer wall, and the peripheral adipose tissues have increased density, involving surrounding organs. N (regional lymph nodes) staging: N0: no lymph node metastasis; N1: 1-3 regions of lymph node metastasis, with a diameter >3 mm; N2: 4 or more regions of lymph node metastasis, with a diameter >3 mm. M (distant metastasis) staging: M0: no distant metastasis; and M1: visible distant metastasis of surrounding tissues and organs.

Follow-up

After operation, the patients were followed-up through telephone and visits for 60 months once every 6 months, and the follow-up rate was 100%. Survival time: time from the end of operation to death or lost to follow-up.

SPSS 22.0 software (IBM, Armonk, NY, USA) was used for the analyses in this paper. Kaplan-Meier methods was used to plot survival curves and log-rank test to evaluate differences between groups. Measurement data were expressed as mean±standard deviation (SD), and t-test was performed for measurement data analysis. Enumeration data were expressed as [n (%)], and Kappa test was performed for their analysis. Kappa value >0.75 suggested high consistency, and p<0.05 suggested significant difference. Cox univariate and multivariate analyses were performed for more precise evaluation of the results.

Results

Comparisons of results of CT and pathological examinations

Postoperative pathological examination showed that there were 15 cases in T1-T2, 41 cases in T3 and 27 cases in T4. The results of CT examination showed that there were 15 cases in T1-T2, 40 cases in T3 and 28 cases in T4, and the sensitivity was 93.18%. It can be seen that the results in the two examinations were similar (Table 1). According to CT examination, there were intestinal wall

Table 1. Comparisons of results of CT and pathological examinations

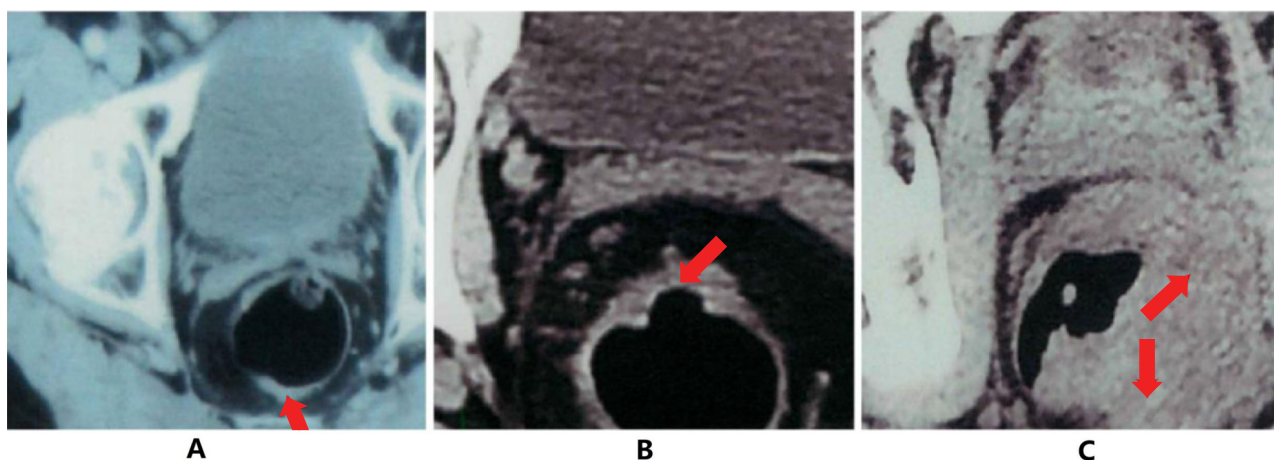| CT stage	Postoperative pathological stage			Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV (%)	Kappa	p
	T1-T2	T3	T4							
T1-T2	15	2	0	100	91.59	92.11	63.21	100	0.763	0.001
T3	0	39	0	96.42	87.43	90.45	85.39	96.27	0.822	0.000
T4	0	1	26	96.42	86.91	90.25	100	87.64	0.791	0.002

Figure 1. T1-T4 CT images. **A:** Tumor on the intestinal posterior wall and intestinal wall thickening (arrow). **B:** Ulcerative cancer and visible lymph nodes (arrow). **C:** Tumor infiltration into the pelvic wall (arrows).

Table 2. Lymph node metastasis of rectal cancer patients

CT stage	Postoperative pathological stage			Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV (%)	Kappa	p
	N0	N1	N2							
N0	19	2	1	84.62	75.79	73.87	80.43	85.37	0.664	0.003
N1	6	34	8	77.08	69.23	69.54	76.18	75.28	0.532	0.005
N2	1	1	11	65	91.18	56.12	56.39	91.38	0.449	0.004

thickening and smooth outer membrane in T1-T2 (Figure 1A), nodular shadows in intestinal membrane and unclear peripheral adipose tissue space in T3 (Figure 1B), and tumor involvement in adjacent organs and obvious lymph node metastasis in T4 (Figure 1C).

Lymph node metastasis

The postoperative pathological examination revealed that lymph node metastasis occurred in 57 cases, and the main metastatic sites were the left and right pelvic cavity, near the intestine and

iliac vessels. CT confirmed that 22 cases had no lymph node metastasis, 4 of which were pathologically diagnosed with lymph node hyperplasia after operation. The consistency of results in the two examinations was lower (p<0.05) (Table 2).

Distant metastasis

The postoperative pathological examination revealed that among the 83 cases of rectal cancer, there were 35 metastatic cases, including 20 cases of intrahepatic metastasis verified *via* postoperative pathological examination, 11 cases of pulmo-

Table 3. Distant metastasis of rectal cancer patients

CT stage	Postoperative pathological stage		Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV (%)	Kappa	p
	M0	M1							
M0	47	0	100.00	100.00	100.00	100.00	100.00	1.0	0.000
M1	0	36	100.00	100.00	100.00	100.00	100.00	1.0	0.000

Table 4. Rectal cancer pathology and univariate analysis of prognosis

Pathological feature	n	3-year survival (%)	5-year survival (%)	x^2	p
Diameter of tumor (cm)				2.253	0.133
<5	33	71.67	63.11		
≥5	50	61.37	36.01		
Grade of tumor differentiation				4.925	0.015
High	15	87.55	68.34		
Moderate	42	64.35	55.19		
Low	26	46.23	26.12		
TNM stage				6.215	0.001
Stage I	11	89.28	80.56		
Stage II	39	72.76	61.24		
Stage III	26	61.13	31.48		
Stage IV	7	40.47	10.02		
Intestinal wall invasion				4.338	0.032
Mucous layer	3	100	83.53		
Submucous layer	15	76.39	63.35		
Muscular layer	10	61.24	49.27		
Serosal layer	40	55.44	38.02		
Outside serosa	15	37.68	12.55		
Metastasis				6.992	<0.001
No lymph node metastasis	18	85.89	73.74		
Lymph node metastasis	40	74.52	56.09		
Distant metastasis	25	37.94	17.32		

Table 5. Multivariate analysis of clinical pathology

Variable	Partial regression coefficient	Standard error	Relative risk coefficient	p
Grade of differentiation	0.229	0.112	1.254	0.045
TNM stage	0.906	0.115	2.458	<0.001
Grade of infiltration	0.223	0.198	1.233	0.048
Distant lymph node metastasis	0.265	0.105	1.317	0.032
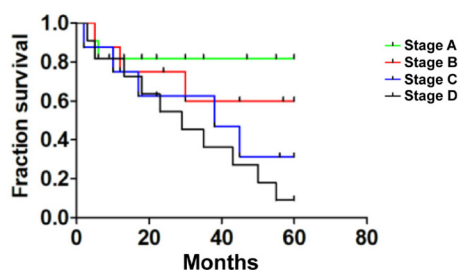
Figure 2. Dukes stage and 5-year survival rate of patients with rectal cancer (p<0.05).

nary metastasis and 4 cases of pleural metastasis, and the results of CT examination were consistent with those of pathological examination (Table 3).

Rectal cancer pathology and univariate analysis of prognosis

High, moderate and low differentiation, TNM stage, presence or absence of infiltration into surrounding tissues and nodal metastasis were major influencing factors for rectal cancer (p<0.05) (Table 4).

Multivariate analysis of clinical pathology

According to the multivariate analysis, among the above-mentioned influencing factors for prognosis, the grade of differentiation, tumor stage, grade of infiltration, and distant lymph node metastasis were independent risk factors for clinical pathology of patients with rectal cancer (Table 5).

Dukes stage and 5-year survival rate of patients with rectal cancer

The survival rate of patients with stage A, B, C and D rectal cancer was 85.33%, 63.44%, 36.12% and 11.14%, respectively (Figure 2).

Discussion

Patients with early rectal cancer can be cured by operative treatment. Currently, preoperative chemoradiotherapy can reduce the lesion in patients, which is helpful to improve the success rate of operation [7]. Therefore, the correct therapeutic

regimen made before operation is very important, and the TNM staging for rectal cancer patients through CT imaging based on the pathological grade before operation is conducive to the prognosis of patients [8]. A large number of clinical data indicate that the CT staging is highly accurate and widely used in clinical treatment, but some authors have also found that the specificity and accuracy of CT staging for lymph node metastasis should be improved. In this paper, therefore, the CT examination was performed in 83 rectal cancer patients for pathological staging, and its influence on prognosis was detected. The results are as follows.

It was found that the results of CT examination for rectal cancer patients in T1-T4 were highly consistent with postoperative pathological results. CT has always been an important tool for preoperative examination in rectal cancer patients. The abdominal image is clear, and the CT technique is constantly updated with time, in which the intestinal tract is cleaned, and anisodamine is injected to reduce intestinal movement and fully expand the intestine, so that the location, size and morphology of intestinal wall lesion are determined [9]. The results of CT examination for T1-T4 rectal cancer before operation are relatively reliable, similar to the research results obtained by Wang et al [10]. In this paper, the accuracy of CT N-staging over whether there was lymph node metastasis in patients was different from that of postoperative pathology. Lymph node metastasis is a common form of metastasis in rectal cancer, and CT imaging can help timely understand the size and shape of lymph nodes to determine whether lymph nodes are involved [11,12]. However, the diagnosis may also be missed. For example, smaller lymph nodes are easy to be ignored, and hyperplasia or metastasis cannot be identified in time for larger lymph nodes. Studies have shown that the accuracy and specificity of CT for N staging are 75% and 50%, respectively, similar to the research results of Liu et al [13,14]. In this paper, the results of CT for M staging were consistent with those of postoperative pathology. Kitz et al [15] studied and found that 16 out of 80 rectal cancer patients had distant metastasis, the

intrahepatic, bladder and para-intestinal tissues were common metastatic sites, and the accuracy of CT examination for lesions was 60-100%.

According to univariate and multivariate analyses, the grade of differentiation, tumor stage, grade of infiltration and distant lymph node metastasis were independent risk factors for clinical pathology of patients with rectal cancer. The 5-year survival of patients with rectal cancer in different stages was also different. Huang et al [16,17] found that the grade of differentiation of rectal cancer patients was positively correlated with stage, and lymphatic metastasis and distant metastasis had important significance for the prognosis of patients. A large number of studies demonstrate that there is a close relation between the clinical stage of rectal cancer and the disease prognosis.

Conclusions

In conclusion, CT scan plays an important role in the preoperative staging of rectal cancer, which is helpful for judging the tumor site and infiltration, and highly accurate for T1-T2 lesions, but has limitations for lymph node metastasis. CT scan has also great value for distant metastasis, and contributes to the development of clinical therapeutic regimens for patients with rectal cancer in different stages. CT stage has a significant influence on the prognosis and patient survival.

Conflict of interests

The authors declare no conflict of interests.

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