Diagnostic Value of Endoscopic Ultrasound in Staging Rectal Cancer

Linxia Liu[1], Ke Chen[2]*

[1]Nantong Tumor Hospital, Nantong 226300, Jiangsu Province, China
[2]Department of Endoscopy, Cancer Hospital Affiliated to Fudan University, Shanghai 200000, China

Corresponding author: Ke Chen, chenke_1990@126.com

Abstract: *Objective:* To explore the diagnostic value of endoscopic ultrasound (EUS) in the staging of rectal cancer. *Methods:* Fifty patients with rectal cancer, treated at the Department of Endoscopy, Cancer Hospital Affiliated to Fudan University, from March 2023 to June 2024, were selected. All patients underwent EUS and computed tomography (CT) examination within two weeks before surgery. The postoperative pathological staging was used as the standard to compare the accuracy of tumor TN staging using EUS and/or CT. *Results:* The accuracy rates of T and N staging by abdominal spiral CT were 72.00% and 76.00%, respectively, while those by EUS were 88.00% and 74%, respectively. There was a significant difference in the accuracy of T staging between the two methods (both $P < 0.05$). *Conclusion:* EUS has high diagnostic value in the staging of rectal cancer, providing important reference information for clinicians, aiding in the development of personalized treatment plans, and assessing patient prognosis.

Keywords: Endoscopic ultrasound; Rectal cancer; Diagnostic value

1. Introduction

Rectal cancer is a common malignant tumor, especially prevalent among middle-aged and elderly populations. Its incidence and mortality rates are second only to esophageal cancer, gastric cancer, and primary liver cancer, ranking fourth among digestive system malignancies [1-3]. Early-stage rectal cancer often lacks obvious symptoms but may primarily manifest as changes in bowel habits, occult abdominal pain, anemia, and progressive weight loss [4]. Like other malignant tumors, rectal cancer can metastasize to other organs and tissues through lymphatic, hematogenous, and direct spread, ultimately threatening the patient's life [5,6]. Currently, surgical treatment is the main approach for rectal cancer patients. Although surgery can effectively remove extensive lymph nodes, unclear preoperative pathological staging diagnosis may reduce clinical treatment efficacy [7]. Therefore, early clarification of pathological staging and formulation of individualized treatment plans are key to effectively controlling disease progression and improving patient prognosis [8]. The staging of rectal cancer mainly relies on imaging examinations, endoscopic examinations, and pathological examinations. Among these, endoscopic ultrasound (EUS), as a non-invasive, high-resolution examination

method, has unique advantages in rectal cancer staging. EUS can visually display the size of the tumor, the depth of infiltration, and the status of extramural lymph node metastasis, aiding in the accurate determination of the lesion's staging. However, despite the potential importance of EUS in rectal cancer staging diagnosis, its accuracy and clinical application in practice remain controversial. This study aims to systematically explore the accuracy of EUS in the staging diagnosis of rectal cancer, analyze its consistency with pathological staging results, and further evaluate its clinical application prospects, providing more reliable diagnostic evidence for clinicians.

2. Materials and methods

2.1. General information

This study included 50 subjects from the Department of Endoscopy, Cancer Hospital Affiliated to Fudan University, comprising 26 male and 24 female patients, with an average age of 52.8 years (age range 30 to 70 years). Inclusion criteria: (1) Patients pathologically confirmed to have rectal cancer; (2) Consent to participate in the study and sign informed consent; (3) Underwent both rectal endoscopic ultrasound (EUS) and computed tomography (CT) examinations; (4) No significant advanced metastases or other major diseases. Exclusion criteria: (1) Presence of other significant advanced tumors; (2) Presence of significant cardiovascular, renal, or other major diseases; (3) Refusal to participate in the study or failure to sign informed consent; (4) Poor quality of rectal EUS or CT examinations; (5) Lack of complete clinical data.

2.2. Methods

2.2.1. Normal bowel wall ultrasound endoscopic layering

Displayed as a five-layer structure from inside to outside.

(1) The innermost layer is a thin high-echo line representing the interface between the superficial mucosa and the intestinal lumen. It is very clear when the lumen contains fluid but can merge with the echo of gas when the lumen contains air.

(2) The second layer is low echo, representing the deep mucosa. This layer shows edema first in cases of bowel inflammation.

(3) The third layer is high echo, representing the submucosa, which becomes thinner when the bowel is dilated.

(4) The fourth layer is low echo, representing the muscularis propria.

(5) The fifth layer is a thin high-echo line, representing the serosa, generally indistinguishable from the surrounding mesentery and fat.

2.2.2. Rectal cancer staging

The TNM staging system (staging based on tumor size, lymph node involvement, and metastasis):

(1) T (Tumor): Describes the size and depth of the primary tumor, classified from T0 to T4.

(2) N (Node): Describes lymph node involvement, classified from N0 to N2.

(3) M (Metastasis): Describes the presence of distant metastasis, with M0 indicating no distant metastasis and M1 indicating the presence of distant metastasis.

2.2.3. Abdominal spiral CT and EUS examination methods

2.2.3.1. Abdominal spiral CT examination

(1) A Siemens 256-slice high-end dual-source CT (model Flash) was used.

(2) Patients were required to fast for 6–8 hours before the examination to maintain an empty stomach.

(3) Patients needed to drink 500–800 mL of water 30 minutes before the examination to help expand the abdominal organs and reduce artifacts.

(4) Laxatives were not administered to ensure the clarity of the intestines was not affected.

(5) The scan slice thickness was 3–4 mm, and the slice spacing was 3–4 mm, to obtain more detailed images.

(6) The examination involved a full abdominal scan to locate abdominal organs, followed by intravenous injection of iodixanol (62.5 g/100 mL) to acquire arterial enhancement and venous phase images.

2.2.3.2. EUS examination

(1) A Pentax ultrasound endoscope EG-3270UK was used for EUS.

(2) Laxatives were orally administered before the procedure to clean the bowel, ensuring clarity and stability in the digestive tract.

(3) The endoscopist inserted the Pentax ultrasound endoscope EG-3270UK into the rectum, removed air from the bowel, and injected degassed water while observing. The entire process involved positioning the endoscope centrally within the intestinal lumen, with the lesion at the 6 o'clock position on the ultrasound screen. The examination involved observing the lesion's infiltration into surrounding and deeper tissues, and checking for involvement of extramural lymph nodes, surrounding tissues, and organs to facilitate accurate assessment.

2.3. Observational indicators

At least two experienced radiologists and endoscopists independently assessed the images using a double-blind method to ensure consistent conclusions. The accuracy of different imaging techniques in staging rectal cancer was compared, using pathological evaluation as the reference standard. EUS T staging criteria:

(1) T1: If the mucosal layer shows disruption between the first and second echo bands, and the submucosal strong echo band is either fuzzy or disrupted, with the muscularis propria low echo band remaining intact.

(2) T2: If the lesion continues to invade, disrupting the muscularis propria low echo band without involving the serosa.

(3) T3: If the tumor breaches the serosa, causing disruption of the high echo band of the serosa, potentially connecting with surrounding tissues.

(4) T4: Presence of low echo masses in adjacent tissues.

EUS N staging: If lymph nodes change in size, with a diameter greater than 5 mm, abnormal internal echoes, and sharp edges, they are considered cancer-involved lymph nodes.

2.4. Statistical analysis

SPSS 23.0 software was used for statistical analysis of the data in this study. Data were expressed as either mean ± standard deviation (SD) or [n (%)], and comparisons between the two groups were made using two-sample t-tests or chi-squared tests, with $P < 0.05$ considered statistically significant.

3. Results

3.1. Comparison of staging accuracy for rectal cancer between two examination methods

As shown in **Table 1**, the accuracy of T and N staging by abdominal spiral CT was 72.00% and 76.00%, respectively. In contrast, the accuracy of T and N staging for colorectal cancer diagnosed via endoscopic ultrasound was 88.00% and 74%, respectively. The difference in T staging accuracy between the two

examination methods was statistically significant ($P < 0.05$).

Table 1. Comparison of staging accuracy for rectal cancer between two examination methods [n (%)]

Examination methods	n	T	N
CT	50	36 (72.00%)	38 (76.00%)
EUS	50	44 (88.00%)	37 (74.00%)
χ^2	-	4.000	0.053
P	-	0.046	0.817

3.2. Image analysis

As shown in **Figure 1**, endoscopic ultrasound examination demonstrated higher accuracy and sensitivity in staging rectal cancer, clearly depicting tumor size, depth of invasion, and extramural lymph node metastasis.

Figure 1(c–f) are endoscopic ultrasound images showing tumor invasion into the serosa, with a sawtooth-like interruption in the fifth high-echo layer. Low-echo lymph nodes with sharp edges are visible outside the bowel wall.
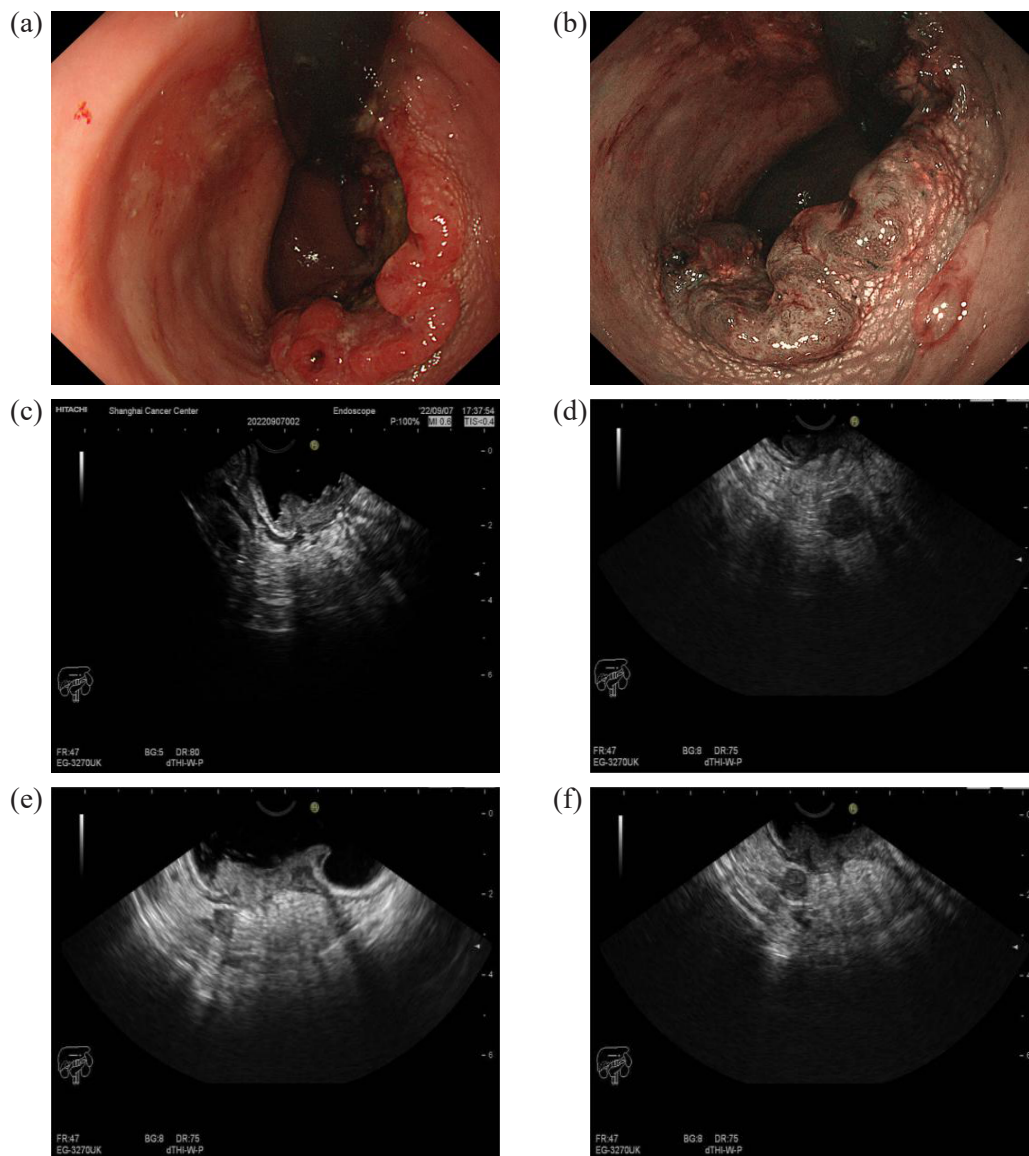

Figure 1. Images from endoscopic ultrasound examinations

4. Discussion

In rectal cancer, CT scans can provide valuable information regarding tumor size, depth of invasion, and distant metastasis, aiding in the accurate assessment of preoperative staging [9,10]. On the other hand, endoscopic ultrasound (EUS), as a method for precisely locating the depth of tumor invasion, has been widely used in this regard [11]. EUS can provide high-resolution images, clearly displaying the location of the rectal cancer lesion and the surrounding structures. Through EUS, doctors can evaluate characteristics such as the size, morphology, depth of invasion, and extramural lymph node status of the tumor, providing important evidence for TN staging of rectal cancer. Studies have shown that the accuracy of EUS in assessing the T stage of rectal cancer exceeds 80%, performing well in staging early rectal cancer. Although there is no statistical difference between the two methods in N stage, EUS can accurately evaluate lymph node metastasis in rectal cancer. EUS can assess whether surrounding lymph nodes are affected, determining the extent of lymph node involvement. Some studies indicate that EUS has a higher detection rate for extramural lymph node metastasis in rectal cancer, able to identify smaller lymph nodes and internal conditions that CT might miss, aiding in determining the extent of surgery and the selection of preoperative chemoradiotherapy regimens. However, due to the limited scanning depth of EUS, it is less accurate than CT in assessing distant organ metastasis and extramural lymph nodes. EUS can also guide precise needle biopsies to obtain tissue samples for definitive pathological diagnosis, further guiding treatment plan selection. Clinical manifestations of rectal cancer typically include weight loss, rectal bleeding, abdominal pain, and fatigue. If not treated promptly, the condition may progress, leading to serious complications such as rectal bleeding, abdominal masses, and even distant metastasis, which may ultimately result in patient death [12,13]. Related studies have shown that with changes in lifestyle and dietary structure, the incidence of colorectal cancer is rising annually, with a trend towards younger onset [14]. Therefore, early detection and accurate assessment of the disease can help develop more effective treatment plans, improving the survival rate and quality of life for rectal cancer patients.

This study suggests that the accuracy of EUS in the T staging of rectal cancer is significantly higher than that of abdominal spiral CT. This may be attributed to the fact that EUS, as a close-range endoscopic examination, avoids other confounding factors and provides more precise and clear details of the rectal wall and extramural lesions. It helps in accurately locating the lesion, assessing the depth of invasion, and detecting lymph node metastasis, with no statistical difference in N staging accuracy between the two methods. In contrast, abdominal spiral CT, as a systemic imaging method, can provide a comprehensive view of the lesion but is limited in displaying intracolonic structures and cannot distinguish the internal structure of lymph nodes. Therefore, it has a lower accuracy in determining the depth of invasion and lymph node involvement but can provide useful information on distant metastasis. Based on the study results, it can be concluded that for the T staging diagnosis of rectal cancer, EUS may be a more reliable and accurate choice, providing clinicians with more informative guidance for developing personalized treatment plans, improving treatment outcomes, and patient survival rates. Therefore, in clinical practice, EUS should be prioritized for staging diagnosis and evaluation of rectal cancer, supplemented by CT to achieve better clinical outcomes.

In summary, endoscopic ultrasound examination has significant diagnostic value in the staging of rectal cancer. Its accurate assessment of invasion depth and sensitivity in detecting extramural lymph nodes help clarify the staging and condition of rectal cancer, providing an important basis for developing individualized treatment plans for patients. In the clinical diagnosis and treatment of rectal cancer, EUS should be widely used to improve treatment outcomes and survival rates for rectal cancer patients.

Disclosure statement

The authors declare no conflict of interest.

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