

Original Article**Comparison between endoluminal ultrasonography and spiral computerized tomography for the preoperative local staging of rectal carcinoma**Haixing Ju^{1,*}, Dong Xu², Dechuan Li¹, Guiping Chen¹, Guoliang Shao³¹ Colorectal Surgery Division, Zhejiang Cancer Hospital, Hangzhou, China;² Ultrasound Division, Zhejiang Cancer Hospital, Hangzhou, China;³ Radiology Division, Zhejiang Cancer Hospital, Hangzhou, China.**Summary**

The aim of this study is to compare the efficacy of endoluminal ultrasonography (EUS) and spiral computerized tomography (SCT) in preoperative local staging of rectal carcinoma. EUS and SCT were performed prior to surgery in 78 patients with rectal carcinoma. After radical surgery, the preoperative findings were compared with histologic findings on the surgical specimen, and we assessed the values of EUS and SCT in staging the tumor. For T staging, accuracy was 84.6% for EUS, 70.5% for SCT ($p < 0.05$). For N staging, accuracy was 64.1% for EUS, 61.5% for SCT ($p > 0.05$). EUS is superior to SCT in judging tumor infiltrate depth, but neither could provide satisfactory assessments of lymph node metastases.

Keywords: Rectal neoplasm, neoplasm staging, endo-luminal ultrasound, computed tomography

1. Introduction

Rectal cancer is a common form of digestive cancer and is responsible for significant morbidity and mortality rates. The decision about appropriate treatment for patients mainly depends on the knowledge of the exact stage. This has greatly increased the importance of accurate preoperative staging in providing information about tumor infiltration and lymph node metastasis. Recently, endoluminal ultrasound (EUS) and spiral computed tomography (SCT) have become one of the important methods for preoperative evaluation of rectal cancer as non-invasive instruments (1-3), but a comparison of EUS and SCT in patients with rectal cancer remains controversial (4). In this study, both EUS and SCT were performed in 78 patients with rectal cancer to compare the efficacy of EUS and SCT in preoperative local staging of rectal cancer.

2. Patients and Methods**2.1. Patient selection**

From October 2006 to June 2008, 78 patients with biopsy-proven rectal carcinoma underwent both SCT and EUS before their operation. There were 42 male and 36 female patients with a mean age of 61 years (range 32 to 78).

2.2. EUS and SCT examination**2.2.1. Participants and procedures**

Before EUS and SCT examinations, all patients were prepared with an enema. We used Technos MPX DU8 (Esaote, Genoa, Italy) with double transducers for EUS. The 10-MHz transducer was used to estimate the invasion of depth of cancers and the 8-MHz transducer was used to detect lymph nodes. Five minutes before the start of SCT, the patients received a rectal enema with 500 mL of air. All patients underwent the same CT protocol using a GE HiSpeed-CT/i scanner (GE Healthcare, Waukesha, WI, USA) with 10-mm slice thickness, 5-mm increment at a table feed of 6 mm/0.75-sec scanner rotation, table speed of 10 mm/sec.

*Address correspondence to:

Dr. Haixing Ju, Colorectal surgery Division, Zhejiang Cancer Hospital, 38 Guangji Road, Hangzhou 310022, China.

e-mail: juhaixing@126.com

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2.3. Image analysis

The depth of tumor infiltration and regional lymph nodes status were assessed as follows. As shown in Figure 1, tumors on SCT were classified by a modified TNM stage. Since SCT could not discriminate wall layers, tumors confined to the bowel wall were classified as T1 or T2. An indistinct or speculated border between the outer rectal wall and the surrounding fat at the level of the tumor was considered as evidence of perirectal invasion (T3). Tumor infiltration into adjacent organs was considered stage T4. Lymph nodes were considered to be positive for metastases if at least one perirectal lymph node with a short-axis diameter of more than 5 mm was found. For EUS, the invasion depth was classified into the following five tumor invasion categories: uT1, into the mucosa or submucosa; uT2, into the muscularis propria; uT3, into the serous membrane; uT4, through the muscularis propria into the adjacent organs. Metastatic lymph nodes were defined as mass lesions over 5 mm in diameter. Figure 2 shows EUS images of different stages according to our criteria.

EUS and SCT staging was compared with both surgical and histopathological results using UICC/AJCC 5th TNM stage (3). We defined the clinicopathological features of cancer, including depth of wall invasion and lymph node metastasis. The sensitivity, specificity and accuracy rates were calculated.

2.4. Statistical analysis

A chi-square test was performed to assess reliability. A *p* value of less than 0.05 was considered a statistically significant difference.

3. Results

3.1. Histopathological data

The histopathological examination showed stage pT1 tumors in 7 patients, pT2 tumors in 25 patients, stage pT3 tumors in 33 patients, and stage pT4 tumors in 13 patients. N staging showed 45 patients without lymph

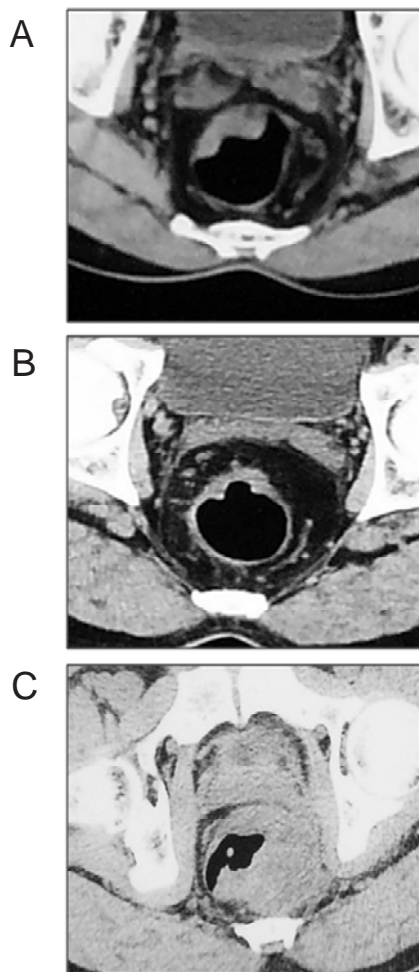


Figure 1. Different tumor stage by SCT. (A) Protrude type tumor in rectal area (T1-2). Tumors confined to the bowel wall. (B) Ulcer type tumor in rectal area (T3). Tumor infiltrates into the perirectal fat. (C) Rectal tumor classified as T4. Tumor infiltrates the left side of pelvic wall.

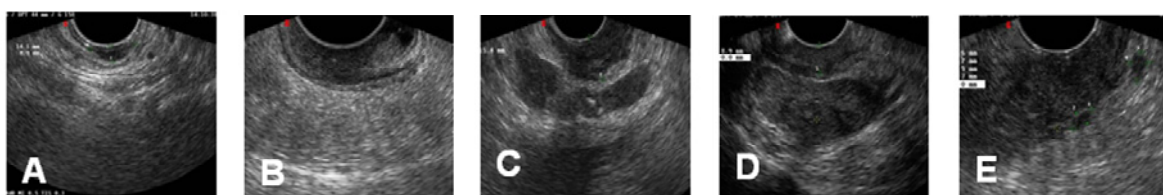


Figure 2. Different tumor stage by EUS. (A) Intramucosal carcinoma in rectal area (uT1). The high-echo band of submucosa was unbroken. (B) Tumor infiltrating into muscle (uT2). The low-echo band of proper muscle layer was broken. (C) Tumor infiltrating the whole rectal wall (uT3). (D) Tumor invading bladder (uT4). (E) Lymph node metastasis (uN1). Multiple low-echo nodules around the rectal wall.

node metastases, whereas 33 patients were classified as stage pN positive.

3.2. T staging

As shown in Table 1, the accuracy of EUS was 100% (7/7) for T1, 84.0% (21/25) for T2, 81.8% (27/33) for T3, and 84.6% (11/13) for T4. The accuracy of SCT was 71.9% (23/32) for T1-2, 66.7% (22/33) for T3, and 76.9% (10/13) for T4. The overall accuracy was 84.6% (66/78) and 70.5% (55/78) for EUS and SCT, respectively. There were statistically significant differences between EUS and SCT in diagnosing depth of tumor invasion ($p < 0.05$).

3.3. N staging

The result of N staging is summarized in Table 2, the sensitivity of EUS was 54.5% (18/33) and specificity was 71.1% (32/45). For SCT, the sensitivity was 60.6% (20/33) and specificity was 62.2% (28/45). The overall accuracy was 64.1% (50/78) and 61.5% (48/78) for EUS and SCT, respectively. There were no statistically significant differences between EUS and SCT in diagnosing lymph node metastasis ($p > 0.05$).

4. Discussion

Accurate staging of rectal cancer is necessary to provide the optimal treatment strategy. Recently, the benefit of preoperative radiochemotherapy for advanced colorectal cancer had been proven (6,7), and local resection or laparoscopic surgery can be performed for early colorectal cancer. These advances have greatly increased the importance of accurate preoperative staging in providing information about tumor location, size, configuration, and local infiltration. At present, EUS and SCT as non-invasive instruments have been widely used to provide useful information in assessing

rectal wall invasion, infiltration of the mesorectum, and infiltration of the adjacent organs or vessels.

Initial studies have reported that accuracy rates of T staging were 53~92% for SCT and 81~93% for EUS (8-10). In our study, accuracy was 84.6% for EUS, while SCT had an accuracy rate of 70.5%, suggesting that EUS is superior to SCT in T staging as reported in previous studies. Due to the lack of detailed spatial and contrast resolution, SCT has some limitations for discriminating the rectal wall layers, leading to diminished accuracy for early-stage lesions confined to the rectal wall. Accuracy of SCT for T3 was 66.7%, where 7 patients were underestimated and results failed to reveal depth invasion. SCT showed an accuracy of 76.9% for T4, which suggest that SCT improves T staging accuracy in more localized advanced tumors. The accuracy of EUS was 100% for T1 and 84.0% for T2, indicating that EUS was superior to that of SCT for early stage rectal cancer. In EUS, two T2 patients with tumors of the ulcer type were overstaged as T3. The misinterpretation may be due to fibrosis caused by scarring and inflammation. Accuracy of EUS for T3 was 81.8%, in which peritumoral reaction, comprising fibrosis, inflammation, and congestive changes may have caused the overstaging. There is no significant difference in accuracy of EUS and SCT for T4 (84.6% vs. 76.9%), indicating that both can identify invasion into adjacent organs efficiently.

Lymph node involvement is also important for prognosis and treatment planning of rectal cancer. Pervious studies showed accuracy of EUS for N stage ranged from 58% to 83%, and accuracy of SCT ranged from 58% to 83% (8-10). In this study, there were no statistically significant differences between EUS and SCT in diagnosing lymph node metastasis (64.1% vs. 61.5%). The size and localization of the lymph nodes are important signs for the differentiation of lymph node metastases from reactive lymph nodes. Sensitivity for detecting lymph nodes was usually evaluated according to nodal size. When a lymph node is larger than 10 mm in diameter, the metastatic rate is thought to be higher. However, in some cases, the mean diameter of the metastatic nodes were under 5 mm (11), which indicates that dependence on size of the node only would reduce sensitivity for detection of lymph node metastasis. In EUS, a lymph node appears as a low-echo outside the rectal wall, but it is difficult to estimate whether or not it includes a metastatic locus. Morphologic characteristics suggestive of malignant involvement include a hypoechoic appearance, peritumoral location, and irregular shape or uneven echo levels (12), therefore, we should combine size with shape and density to estimate whether the lymph node is metastatic or not. Some studies have shown that endoscopic ultrasound-guided fine-needle aspiration demonstrated a trend toward more accurate nodal staging (13,14). Kim *et al.* found that 3D EUS showed greater accuracy than 2D

Table 1. A comparison of EUS and SCT in depth of tumor invasion

Histopathological staging (n)	EUS staging				SCT staging		
	T1	T2	T3	T4	T1-2	T3	T4
pT1 (7)	7	0	0	0	7	0	0
pT2 (25)	2	21	2	0	16	9	0
pT3 (33)	0	3	27	3	7	22	4
pT4 (13)	0	0	2	11	0	3	10

Table 2. A comparison of EUS and SCT in lymph node metastasis

Histopathological staging (n)	EUS staging		SCT staging	
	N(-)	N(+)	N(-)	N(+)
N(-) (45)	32	13	28	17
N(+) (33)	15	18	13	20

EUS or CT in rectal cancer staging and lymph node metastases (14,15). There is still a controversial issue in the preoperative staging of lymph node metastasis, and another new criterion should be clarified in a further study.

In conclusion, for the local staging of rectal cancer, our study shows EUS is superior to SCT in judgment for tumor infiltrate depth, but neither method could provide satisfactory assessment of lymph node metastases for rectal cancer.

References

1. Mackay SG, Pager CK, Joseph D, Stewart PJ, Solomon MJ. Assessment of the accuracy of transrectal ultrasonography in anorectal neoplasia. *Br J Surg.* 2003; 90:346-350.
2. Siddiqui AA, Fayiga Y, Huerta S. The role of endoscopic ultrasound in the evaluation of rectal cancer. *Int Semin Surg Oncol.* 2006; 3:36.
3. Chiesura-Corona M, Muzzio PC, Giust G, Zuliani M, Pucciarelli S, Toppan P. Rectal cancer: CT local staging with histopathologic correlation. *Abdom Imaging.* 2001; 26:134-138.
4. Low G, Tho LM, Leen E, Wiebe E, Kakumanu S, McDonald AC, Poon FW. The role of imaging in the preoperative staging and post-operative follow-up of rectal cancer. *Surgeon.* 2008; 6:222-231.
5. Sobin LH, Wittekind C. *TNM Classification of Malignant Tumours.* 5th ed. Wiley-Liss, New York, NY, USA, 1997.
6. Glimelius B, Holm T, Blomqvist L. Chemotherapy in addition to preoperative radiotherapy in locally advanced rectal cancer - a systematic overview. *Rev Recent Clin Trials.* 2008; 3:204-211.
7. Delaney CP, Lavery IC, Brenner A, Hammel J, Senagore AJ, Noone RB, Fazio VW. Preoperative radiotherapy improves survival for patients undergoing total mesorectal excision for stage T3 low rectal cancers. *Ann Surg.* 2002; 236:203-207.
8. Heriot AG, Grundy A, Kumar D. Preoperative staging of rectal carcinoma. *Br J Surg.* 1999; 86:17-28.
9. Matsuoka H, Nakamura A, Masakki T, Sugiyama M, Takahara T, Hachiya J, Atomi Y. Preoperative staging by multidetector-row computed tomography in patients with rectal carcinoma. *Am J Surg.* 2002; 184:131-135.
10. Adams DR, Blatchford GJ, Lin KM, Ternent CA, Thorson AG, Christensen MA. Use of preoperative ultrasound staging for treatment of rectal cancer. *Dis Colon Rectum.* 1999; 42:159-166.
11. Fukuya T, Honda H, Hayashi T, Kaneko K, Tateshi Y, Ro T, Maehara Y, Tanaka M, Tsuneyoshi M, Masuda K. Lymph-node metastases: efficacy with helical CT in patients with gastric cancer. *Radiology.* 1995; 197:705-711.
12. Bhutani MS. Recent developments in the role of endoscopic ultrasonography in diseases of the colon and rectum. *Curr Opin Gastroenterol.* 2007; 23:67-73.
13. Shami VM, Parmar KS, Waxman I. Clinical impact of endoscopic ultrasound and endoscopic ultrasound-guided fine-needle aspiration in the management of rectal carcinoma. *Dis Colon Rectum.* 2004; 47:59-64.
14. Miller L, Smith C, Canto MI. Endoscopic ultrasonography (EUS) and EUS-guided fine needle aspiration for accurate staging of rectal cancer: explanation of tumor staging and a case report. *Gastroenterol Nurs.* 2000; 23:97-101.
15. Kim JC, Cho YK, Kim SY, Park SK, Lee MG. Comparative study for three-dimensional and conventional ultrasonography used in rectal cancer staging. *Surg Endosc.* 2002; 16:1280-1285.
16. Kim JC, Kim HC, Yu CS, Han KR, Kim JR, Lee KH, Jang SJ, Lee SS, Ha HK. Efficacy of 3-dimensional endorectal ultrasonography compared with conventional ultrasonography and computed tomography in preoperative rectal cancer staging. *Am J Surg.* 2006; 192:89-97.

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