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Staging of rectal carcinoma: MDCT, MRI or EUS. Single center experience

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Original Article

ABSTRACT

Background/Aims: To retrospectively compare the efficacy of multidetector computed tomography (MDCT), magnetic resonance imaging (MRI) and endosonography (EUS) in the staging of rectal carcinoma.

Materials and Methods: A total of 50 patients (36 male, 14 female) were included in the study. The data from surgical staging were used as reference for comparing the yield of EUS, MRI, and MDCT in preoperative T and N staging of rectal carcinoma. Comparisons were based on the chi-square test.

Results: The mean age+SD of the patients were 60±12 years (range; 28-80). The distribution of rectal tumors according to the T and N staging in surgical pathology was as following: T1 (n:2), T2 (n:15), T3 (n:22), T4 (n:11); N0 (n:22), N1-2 (n:28). The accuracy rate of EUS was statistically higher than that of MDCT (92% vs 64%; p<0.01) and that of MRI (92% vs 72%; p<0.01) for T2 tumors. For T3 tumors, EUS had statistically better accuracy of staging compared to MDCT (90% vs 58%; p<0.01) and MRI (90% vs 60%; p<0.01). As for T4 tumors, the accuracy rate of EUS was higher compared to MRI (98% vs 80%; p<0.01). There was no statistical difference in accuracy rates for detection of lymph nodes across the modalities (EUS, 84%; MDCT 76%; MRI 70%; p=not significant).

Conclusion: EUS appears more accurate in T staging compared to MDCT and MRI in rectal carcinoma. Regarding nodal staging, performance of EUS, MDCT and MRI are similar.

Keywords: Endosonography, MDCT, MRI, staging of rectal carcinoma

INTRODUCTION

Colorectal cancer is the third most common cancer in women, and the fourth most common cancer in men worldwide (1). Around 30-40% of colorectal cancer is defined to arise from the rectum which is defined as the distal margin of tumor within 15 cm of the anal verge (2).

Traditional rectal cancer surgery is associated with 5-20% local recurrence. However, with the combination of high quality surgery using total mesorectal excision along with use of neoadjuvant and adjuvant treatment, there has been a significant reduction in local recurrence and improved survival. The surgeon aims to achieve a microscopic tumor free (R0) resection. However, even if it is achieved, local recurrence may still happen (2).

Accurate pre-operative staging of rectal carcinoma is paramount in tailoring the optimal surgical treatment and is the best predictor for recurrence (2). Local staging incorporates the assessment of tumor involvement of the rectal wall and adjacent structures, presence or absence of adjacent lymphadenopathy. Preoperative radiation therapy and total mesorectal excision (TME) are increasingly used in the treatment of locally advanced rectal cancer to reduce tumor recurrence. Recent data have shown that preoperative radiation therapy can reduce tumor recurrence from 27% to 11%. In addition, TME is a surgical technique in which the rectum and surrounding mesorectal fat and perirectal lymph nodes as well as surrounding mesorectal fascia are removed. It was shown to reduce postoperative recurrence to

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10% without radiation therapy. A randomized controlled trial has shown that the combination of TME with radiotherapy may reduce recurrence to 2.4% at 2 years compared with 8.2% with TME alone (3).

Endoscopic ultrasonography (EUS), magnetic resonance imaging (MRI), and multidetector computed tomography (MDCT) are the main modalities used for staging of rectal carcinoma. Neoadjuvant therapy (NAT) induced post-radiation edema, inflammation, fibrosis and necrosis jeopardize the accuracy of staging of rectal carcinoma (4). In this study, we aimed to investigate the comparative results of EUS, MRI and MDCT in staging of rectal carcinoma.

MATERIALS AND METHODS

The study was started after the local ethical committee approval (18.01.2011-6/12) and has been completed according to the principles of Helsinki Declaration. Written informed consent was obtained from all patients.

Study population

This study was designed as a retrospective and comparative study and performed between January 2011 and July 2012. Fifty patients with rectum cancer whose resected material and preoperative data of EUS, MRI, and MDCT were available were included in the study. While 18 patients directly underwent surgery, 32 patients had preoperative NAT.

Data collection

Hospital database was used for data gathering. Information about EUS results was collected from records of our endoscopy unit. MRI and MDCT findings, staging results of the surgical specimens were obtained from Radiology and Pathology Department, respectively.

Technical data

Surgery

For superficial tumors, the standard surgical techniques such as transanal endoscopic microsurgery and endoanal resection were used. For advanced tumors with surgical eligibility, the laparoscopic surgical technique included high vascular ligation of the inferior mesenteric vessels, radical lymphadenectomy, and total mesorectal excision were performed.

Criterion standard

The resected specimen was used as a criterion standard. Regarding to the staging procedure of the patients with pre-surgical neoadjuvant therapy, the surgical pathology data were used only if positive lymph node or advanced T stage (T3 or T4) tumor was found in resected surgical specimen. The staging of surgical specimen was made according to the guidelines described by American Joint Committee on Cancer (5). A pathologist experienced in gastrointestinal cancers evaluated the samples and during evaluation, the pathologist was unaware of EUS, MRI, and MDCT findings.

EUS

Endosonographic examinations were performed with Hitachi (Hı-Vision Preırus, model E20-MT28-S1, New Jersey, USA radial echoendoscope. All examinations were performed in the left lateral decubitus position under conscious sedation. All procedures included thorough examination of rectum from the upper third to the anal channel. In order to improve the visualization of the rectal wall and perirectal area, the rectum was filled with water. EUS investigations were performed with the frequencies of 7.5-MHz or 10-MHz. The procedures were performed by two experienced endosonographers.

The staging of rectal tumor was made according to the criteria described by Hildebrandt et al (6): stage uT1 tumors were confined to the mucosa and submucosa, uT2 tumors were confined to the rectal wall, uT3 tumors penetrated the rectal wall and invaded perirectal fat, and uT4 tumors invaded surrounding organs.

The lymph nodes regardless of its size detected during radial sonographic examinations were accepted positive for malignant metastasis.

MRI imaging

Magnetic resonance imaging examination was performed at 1.5 T MR unit (Avanto, Siemens Medical Systems, Erlangen, Germany) using a four-channel phased array body coil. No specific bowel preparation or spasmolytics were given. The imaging protocol consisted of standard 2D T2-weighted (T2W) fast spin-echo sequences in three orthogonal directions (axial, coronal, and sagittal) (TR/TE 4290-5190/108 msec, field of view 30 cm, slice thickness 4 - 5 mm, matrix 154x256, NSA 1-2). Precontrast T1W axial (TR/TE 716/10 msec, field of view 30 cm, slice thickness 5 mm, matrix 179x256, NSA 1-2), and post-contrast fat saturated T1W axial, coronal and sagittal (TR/TE 716/10 msec, field of view 30 cm, slice thickness 5 mm, matrix 154x256, NSA 1-2) images were also obtained. Total imaging time was about 15 to 20 minutes.

Magnetic resonance imaging images were analyzed one of three abdominal radiologist. Each reader was blinded to EUS or MDCT results. Primary tumor and lymph nodes were assessed according to established imaging criteria.

MDCT imaging

Multidetector computed tomography examination was performed with a 128-slice CT scanner (Aquilion CX, Toshiba, Tokyo, Japan). One to 1.5 L of contrast agent solution composed of 750 to 1250 mL plane water and 250 mL of lactulose (667 mg/mL) was given one to one and half hour before examination (drink 200 - 250 mL every 10 minutes). Imaging was performed from the level of the diaphragma to the pelvic floor at the portal phase (about 65 sec after the initiation of IV contrast media administration) with 0.5 mm slice thickness. A total of 70 to 100 ml nonionic contrast medium was given intravenously with an automatic injector at a flow rate of 3-4 mL/sec.

Routinely 120 kV was used for exposure but mAs value was changed according to body weight due to automatic tube modulation technique.

Multidetector computed tomography images were analyzed by one of three abdominal radiologist. Each reader was blinded to EUS or MRI results. Primary tumor and lymph nodes were assessed according to established imaging criteria.

Statistical analysis

Continuous variables are expressed as mean±standard deviation. Student t-test was used for comparison of continuous variables, and chi-square test for comparison of qualitative variables.

Sensitivity, specificity, positive and negative predictive values, and accuracy for EUS, MRI and MDCT with their 95% confidence interval were calculated by using the standard formulas according to the criterion standard. Statistical analyses were conducted using the SPSS (Version 12.0) statistical software program (SPSS, Chicago, IL, USA). P<0.05 is considered statistically significant.

RESULTS

A total of 50 patients were included in the study between January 2011 and July 2012. Thirty-six male and fourteen female patients' records were analyzed. The mean age of the patients were 60±12 years with a range of 28-80 years. T and N stages are shown in Table 1.

Table 1. Patients' T and N stages

	T-stage (n)				N-stage (n)	
Modality	**T1**	**T2**	**T3**	**T4**	**NO**	**N1-2**
MDCT (n:50)	1	17	23	9	18	32
MRI (n:50)	4	17	20	9	17	33
EUS (n:50)	2	11	27	10	20	30
Pathology (n:50)	2	15	22	11	22	28

EUS: endosonography; MDCT: multidetector computed tomography; MRI: magnetic resonance imaging

As there were only 2 patients with T1 tumor, comparison between modalities was considered to be meaningless. EUS (92%) had significantly higher accuracy rates compared to MRI (72%) and MDCT (64%) in staging T2 tumors (p<0.05, p<0.05, respectively). Although MRI had higher accuracy rate compared to MDCT, it didn't reach statistical significance. Regarding accuracy rates for T3 tumors, EUS (90%) was also the best imaging modality compared to MRI (60%) and MDCT (58%) (p<0.05, p<0.05, respectively). In T4 tumors, EUS (98%) had statistically higher accuracy rate compared to MRI 80%. Comparative performances of EUS, MDCT and MRI in staging rectal tumors are depicted in Table 2 and 3.

The accuracy of EUS (86%) for N staging was higher compared to that of MRI (70%) and MDCT (76%), although the difference didn't reach statistical significance. The performances of EUS, MDCT and MRI in N staging of rectal tumors are shown in Table 4.

The issue of understaging and overstaging was prominent in T2 and T3 tumors for all three modalities in T staging of rectal tumors (Table 5).

DISCUSSION

The optimal surgical management of patients with rectal cancer is dependent upon accurate locoregional staging. Although T1-2 tumors are treated with surgical excision only, neoadjuvant therapy is used for T3 or T4 tumors and tumors with any stage with positive locoregional lymph nodes.

Although CT is the preferred diagnostic modality for investigation of metastatic disease of rectal cancer, its value in assessing local staging of rectal cancer is poor. A metaanalysis by Kwok et al revealed the accuracy of CT for T staging of 73% and for nodal staging of 22%-73% (7). MRI is the best radiologic modality for assessing the tumor and its surrounding mesorectal fascia. On the other hand, the performance of MRI identifying rectal wall layers and thus of tumor stages of 1-3 is poor and addition of endorectal coil provides an accuracy rate of 70%-90% in T staging of rectal cancer (8). EUS is becoming the preferred diagnostic modality in assessing the

Table 2. Statistics of T stagings of the EUS, MRI and MDCT

	Modality								
	EUS (n:50)			MRI (n:50)			MDCT (n:50)		
Statistics (%)	**T2**	**T3**	**T4**	**T2**	**T3**	**T4**	**T2**	**T3**	**T4**
Sensitivity	73	100	90	20	50	45	46	85	63
Specificity	100	82	100	51	67	89	94	66	94
PPV	100	81	100	15	55	55	77	50	77
NPV	89	100	97	60	63	85	80	92	90
Accuracy	92	90	98	72	60	80	64	58	88

EUS: endosonography; MDCT: multidetector computed tomography; MRI: magnetic resonance imaging; PPV: positive predictive value; NPV: negative predictive value

Table 3. Comparison of performance characteristics of EUS, MRI and MDCT for T staging

		STATISTICS				
T-STAGE	**Compared modalities**	**Sensitivity**	**Specificity**	**Positive predictive value**	**Negative predictive value**	**Accuracy**
T2	EUS-MRI	<0.05	<0.05	<0.05	<0.05	<0.05
	EUS-MDCT	NS	NS	NS	NS	<0.05
	MRI-MDCT	NS	<0.05	<0.05	NS	NS
T3	EUS-MRI	<0.05	NS	<0.05	<0.05	<0.05
	EUS-MDCT	NS	NS	<0.05	NS	<0.05
	MRI-MDCT	<0.05	NS	NS	<0.05	NS
T4	EUS-MRI	<0.05	<0.05	<0.05	<0.05	<0.05
	EUS-MDCT	NS	NS	NS	NS	NS
	MRI-MDCT	NS	NS	NS	NS	NS

EUS: endosonography; MDCT: multidetector Computed Tomography; MRI: magnetic resonance imaging

Table 4. Statistics of positive N Stagings of the EUS, MRI and MDCT

	Modality		
	EUS (n:50)	**MRI (n:50)**	**MDCT (n:50)**
Statistics (%)	**n (+)**	**n (+)**	**n (+)**
Sensitivity	92	82	75
Specificity	72	54	77
PPV	81	69	80
NPV	88	70	70
Accuracy	84	70	76

EUS: endosonography; MDCT: multidetector computed tomography; MRI: magnetic resonance imaging; PPV: positive predictive value; NPV: negative predictive value

Table 5. The number of cases overstaged and understaged by EUS, MDCT and MRI

	All cases (n:50)	**T1 (n:2)**	**T2 (n:15)**	**T3 (n:22)**	**T4 (n:11)**
EUS					
Overstaging	6	-	5	1	-
Understaging	10	-	1	4	5
MDCT					
Overstaging	12	1	9	2	-
Understaging	12	-	-	8	4
MRI					
Overstaging	8	1	4	3	-
Understaging	14	-	1	8	5

EUS: endosonography; MDCT: multidetector compted tomography; MRI: magnetic resonance imaging

rectal wall involvement and gives the best results for T staging in early rectal tumors (T1 and T2). The accuracy of EUS in T staging varies from 62%-92% (2).

In our study, EUS was found to be highly accurate in all T stages of rectal tumors (T2 92%, T3 90%, T4 98%) compared to MDCT (T1 98%, T2 64%, T3 58%, T4 88%) and to MRI (T1 90%, T2 72%, T3 60%, T4 80%). The high accuracy rate of EUS was considered to be related to exclusion of stenotic tumors from the study and the presence of one highly experienced operator either performing or supervising procedures. Peritumoral inflammation is a confounding factor in the differentiation of T2 from T3 tumors (9) reflected as low accuracy rate of EUS in T2 and T3 tumors compared to T1 and T4 tumors in our study.

With regard to N staging, the accuracy of EUS (86%) was higher compared to MRI (70%) and MDCT (76%), although the difference didn't reach statistical significance. EUS overstaged 2 and understaged 2 patients. The possible factors for EUS in N understaging may be linked to difficulty in detecting very small involved nodes (<2 mm), micrometastases in normal-sized nodes, and the inability of endoscopic sonography to show lymph nodes outside the scanning range of the transducer (10).

Taking the potential presence of metastatis in lymph nodes <5 mm in size into consideration (11), we adopted the strategy of defining any visible lymph node as metastatic.

The majority of T overstaged and understaged patients in all imaging modalities were in T2 and T3 tumor groups. As the critical decision regarding whether or not the patient needs neoadjuvant therapy prior to surgery is the cornerstone of treatment in the management of T2 and T3 tumor groups, the issue of over- and understaging rectal cancer in the same group reveal the need for further improvement in all imaging modalities. Three D-image reconstruction, use of elastography, and using fine-needle aspiration for the lymph nodes detected during procedure can be used to increase the yield of EUS in staging rectal cancer.

The accuracy of EUS in T staging of rectal carcinoma generally ranges between 75-95% in published studies (12,13). In a retrospective study, T3 tumors were found to be most accu-

rately staged (86%), while the staging of T1 and T2 tumors were found suboptimal (14). The accuracy rate of EUS in T staging was found directly proportional to level of experience of the investigators and T stage of tumor (15,16). As the number of patients in T1 (n:2) and T4 (n:11) groups were small compared to T2 and T3 groups in our study, the yield of EUS for T staging in these groups should be interpreted cautiously.

Previous studies confirmed that EUS is not the optimal diagnostic modality for determining the nodal status of rectal tumors. The hypoechoic appearance, short axis length of lymph node over 5 mm and experience of operator were found to be most reliable parameters for differentiation of malignant lymph nodes from benign lymph nodes (17). However the proposed echogenicity and size characteristics of the lymph node (round, hypoechoic, size over 5 mm) are not suffice for the diagnosis of malignant lymph nodes. The differentiation of reactive lymph nodes from malignant lymph nodes still presents as a dilemma in clinical practice and underlines the low accuracy rate of EUS in N staging. In our study, only two cases with lymph nodes detected by EUS were confirmed as having reactive benign lymph nodes. The sonographic characteristics of these benign lymph nodes were similar to those of malignant lymph nodes. Although FNA-biopsy of lymph node may be tried to state the nodal status of the case for therapeutic decision, the low yield emerges as a major concern. As a result, the absence of optimal modality for N staging of rectal tumor urges the clinicians to use EUS and MDCT as the complementary imaging modalities.

In conclusion, EUS is superior in T and N staging of rectal tumors compared to MRI and MDCT in selected patients. Overstaging and understaging T2 and/orT3 rectal tumors are the most important issues to be solved in EUS investigation. The additional yield of 3D-reconstructed image, use of contrast and elastography, and using fine-needle aspiration from the lymph nodes detected during procedure should be further investigated for better results in staging rectal cancer.

Ethics Committee Approval: Ethics committee approval was received for this study.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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