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Original Article

Accuracy of Transrectal Ultrasonography in Preoperative Staging of Rectal Cancer

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Abstract

Objective: To determine the diagnostic accuracy, sensitivity, specificity, positive predictive value and negative predictive value of transrectal ultrasound in the detection of the depth of tumor invasion, perirectal fat invasion and regional lymph node involvement in rectal cancer patients at Ramathibodi Hospital.

Materials and Methods: A total of 17 patients with biopsy proven rectal cancer, who had undergone transrectal ultrasound evaluation of the invasion of the rectal wall and the mesorectal lymph nodes status were retrospectively studied during a period of 5 years and 6 months. We compared the Transrectal Ultrasonography (TRUS) staging with pathology examination of the resected specimens according to TNM classification.

Results: 15 patients had a radical resection (11 abdominoperineal resection and 4 low anterior resection), and two patients had a local transanal excision. Eight among these 17 patients had preoperative chemoradiation. The overall accuracy in assessing the depth of tumor invasion was 47% and 56%, with 41% and 22% of the tumors overstaged and 12% and 22% understaged, in the all patients group and the other group with no neoadjuvant therapy, respectively. In determining the perirectal fat invasion, the diagnostic accuracy of TRUS was 52.9% with sensitivity 83.3% (95% CI 65.6-101.1), specificity 36.4% (95% CI 13.5-59.2), PPV 41.7% (95% CI 18.2-65.1) and NPV 80% (95% CI 60.9-99.0). The accuracy of TRUS in determining the perirectal fat invasion was higher in the group that excluded neoadjuvant therapy patients at 66.7%, with sensitivity of 66.7% (95% CI 35.9-94.5), specificity 66.7% (95% CI 35.9-97.5), PPV 50.0% (95% CI 17.3-82.7) and NPV 80% (95% CI 53.9-106.1). The accuracy in assessing nodal involvement in 15 patients treated with radical surgery was 60%, with sensitivity 33.3% (95% CI 9.48-57.2), specificity 66.7% (95% CI 42.8-90.5), PPV 20% (95% CI -0.24-40.2) and NPV 80% (95% CI 59.8-100.2).

Conclusion: Since the recent standard treatment for T3 and T4 tumors was to undergo preoperative chemoradiation, the lower accuracy occurred due to down-staging of the tumor from the neoadjuvant treatment. In addition, there was only a small number of included patients, which affected the statistical analysis of this study. The accurate results in the future study of transrectal ultrasound in preoperative staging of rectal cancer should be achieved by an increased sample size.

Keywords: Transrectal Ultrasonography, accuracy, rectal cancer

Introduction

The incidence rate of colorectal cancer in Thailand is the third in frequency in males after liver cancer and lung cancer, and the fifth after cancer of cervix, breast, liver and lung for females. The highest incidence for both sexes is in Bangkok. The estimated incidence rate in Thailand is 8.8 for males and 7.6 for females.[1]

Rectal cancer is highly treatable and often a curable disease when localized. Surgery is the primary treatment and results in a cure in approximately 45% of all patients. The prognosis of rectal cancer is clearly related to the degree of penetration of the tumor through the bowel wall and presence or absence of nodal involvement. These 2 characteristics form the basis for all staging systems developed for this disease.[2]

The preoperative evaluation of the rectal cancer is important in planning therapy and assessing prognosis. Precise knowledge of the depth of tumor invasion of a rectal cancer and the mesorectal nodal status is essential for the planning of optimal therapy. Local excision of early rectal cancer seems to be a good alternative to radical operations.[3] In more advanced rectal lesions, neoadjuvant chemoradiation succeeds in increasing sphincter saving operations and improves local control and survival in these patients.[4]

The currently available methods to evaluate the rectal cancer include digital examination, transrectal ultrasonography (TRUS), computed tomography (CT) and magnetic resonance imaging (MRI). TRUS is a diagnostic modality that has become useful in determining the depth of invasion preoperatively and the presence or absence of metastatic lymph nodes. The current literature suggests that staging with TRUS is equally accurate and often even superior to staging with other techniques.[5-9]

The aim of this study was to evaluate the accuracy of TRUS in accessing tumor infiltration depth and nodal involvement of rectal cancer, determine the sensitivity and specificity of any perirectal fat invaded lesion, as well as determine the sensitivity and specificity of any metastatic regional lymph node by using transrectal ultrasound.

Materials and Methods

During a 5 years and 6 months interval from January 1, 2003 to June 30, 2008, 367 patients were diagnosed with rectal cancer. There were 34 out of 367 patients with biopsy proven rectal cancer who underwent pre-operative TRUS examination at the Radiology Department of Ramathibodi Hospital. Only 17 out of the 34 patients underwent open surgery with an available patho-logical report of the same lesion and were retro-spectively studied. The remaining 17 patients were excluded due to no available pathological report or did not perform further surgery. All TRUS examinations were performed and interpreted by the same radiologist, using a transrectal sonographic 7.5-MHz probe with a transversely oriented radial scan plane (Aloka transrectum mechanical radial scanner ASU-67; Tokyo, Japan, connected with a Prosound SSD-5000; Aloka ultrasound; Tokyo, Japan). The transducer produces transverse 360-degree scans in reference to the longitudinal axis of the rectum. The patients were examined in a left lateral decubitus position. The transducer was inserted into the rectum transanally after being coated with sonographic gel. The transducer was covered with a rubber sheath filled with 20 ml of degassed water, providing an optimal acoustic pathway.

The 5 basic layers seen on TRUS of the rectal wall compare directly with the anatomic layers present in the rectal wall. The 5 layers working out from the lumen of the rectum are:

1. Hyperechoic layer is the interface between the water/balloon and mucosal surface.
2. Hypoechoic layer is the combined layer produced by mucosa and muscularis mucosae.
3. Hyperechoic layer is the submucosa.
4. Hypoechoic layer is the muscularis propria.
5. Hyperechoic layer is the interface between the muscularis propria and perirectal fat or the serosa if present.

Ultrasonographic staging for the depth of tumor infiltration was made according to Kumar et al. (Table 1). The preoperative tumor staging was classified as uT1 when the tumor was limited to the mucosa-submucosa (fig 1), uT2 when the tumor invaded the muscularis propria (fig 2), uT3 when the tumor penetrated through the muscularis propria to involve the perirectal fat (fig 3) and uT4 when adjacent organs were invaded. The mesorectal lymph nodes were considered as malignantly invaded if they were hypoechoic with a smooth border[5]. The predicted tumor invasion depth (T) and nodal status (N) were compared with histopathologic findings, according to TNM classification designated by AJCC.[10]

The final diagnostic staging was established by means of operation with low anterior resection, abdominoperineal resection or transanal excision.

The pathological reports were reviewed by the same pathologist and categorized as:

- Depth of tumor invasion (T)
  - o T0: No evidence of primary tumor
  - o T1: Tumor invades submucosa
  - o T2: Tumor invades muscularis propria
  - o T3: Tumor invades through the muscularis propria into the subserosa, or into non-peritonealized pericolic or perirectal tissues
  - o T4: Tumor directly invades other organs or structures, and/or perforates the visceral peritoneum

(Note: Tumor that is adherent to other organs or structures, macroscopically, is classified as T4. However, if no tumor is present in the adhesion, microscopically, the classification should be pT3. The V and L substaging should be used to identify the presence of vascular or lymphatic invasion.)

The regional lymph node was categorized as

- Regional lymph node (N)
  - o N(-): No regional lymph node metastasis
  - o N(+): Presence of metastasis regional lymph nodes

Table 1 Transrectal ultrasonographic staging system

Stage	Tumor features
uT1	Tumor confined to mucosa or submucosa
uT2	Tumor penetrates muscularis propria, but confined to rectal wall
uT3	Tumor invades perirectal fat
uT4	Tumor invades adjacent structures
N(-)	No metastatic lymph node
N(+)	Metastatic lymph node

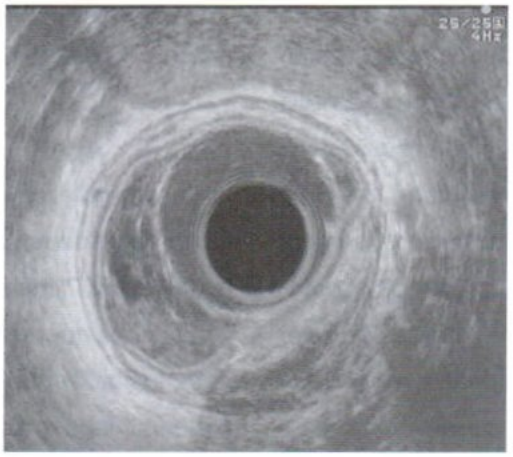


Fig.1 uT1 lesion- confined to mucosa and submucosa

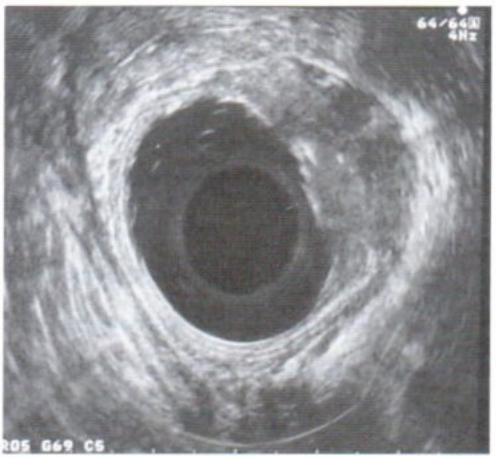


Fig.2 uT2 lesion- penetrates the muscularis propria but confined to the rectal wall

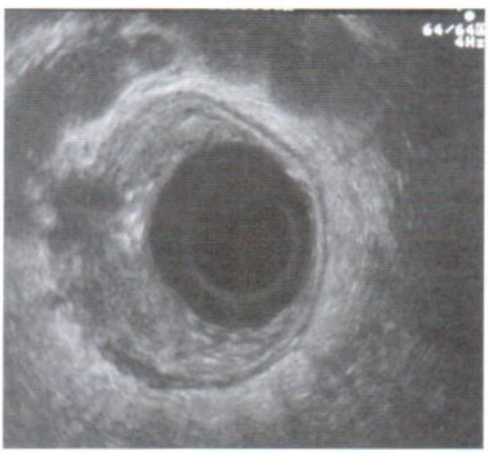


Fig.3 uT3 lesion- penetrates through entire thickness of bowel wall and invades perirectal tissue

Data of all patients were recorded as sex, age at initial TRUS examination, depth of tumor invasion (uT) and presence of regional lymph node metastasis (uN), which is according to the TRUS staging system.

All patients underwent surgery and the time between TRUS examination and surgery, type of surgery, cell type of the tumor, presence of neo-adjuvant therapy before surgery, depth of tumor invasion and presence of regional lymph node metastasis, according to TNM classification were recorded.

The depth of tumor invasion was also divided into two categories as perirectal fat invaded lesion and non-perirectal fat invaded lesion. Perirectal fat invasion was defined as a stage of T3 or T4, while stage T1 or T2 was referred to as non perirectal fat invasion.

Statistical analysis:

Continuous data (age at initial TRUS examination, time between TRUS and surgey) was summarized as mean (SD) and median (range) as appropriate. Categorical data (depth of tumor invasion, presence of regional lymph node metastasis, type of surgery, cell type of tumor) were summarized as counts and percentages. Results of the depth of tumor invasion were presented according to the four categories of tumor staging in a 4x4 contingency table to determine the overall accuracy (total number of correctly staged cases/total number of cases in the study). For each criterion of perirectal fat invaded lesions and presence of metastatic regional lymph node, a 2x2 contingency table was constructed and the sensitivity, specificity, positive and negative predictive value along with their 95% confidence interval (95% CI) were calculated.

All statistical analyses were performed by using STATA v.10 (Stata Corp, College Drive, Texas, USA).

Results

In a total of 34 patients with biopsy proven rectal cancer who underwent TRUS, 17 patients (10 females and 7 males) with a mean age of 55 (15.7) years who underwent tumor resection with available pathological report were enrolled (Table 2). All 17 patients were classified by the transrectal ultra-sonographic staging system. There were 2 cases of uT1 (12%), 3 cases of uT2 (18%), 12 cases of uT3 (70%) and no case of uT4 (0%). No evidence of regional lymph node metastasis (uN(-)) were 12 cases (71%) and presence of lymph node metastasis (uN(+)) in 5 cases (29%). The median time between biopsy and TRUS examination was 12 days (5-53), with a mean of 16.5 days (15.2).

Among 17 patients who were assessed for depth of invasion and regional lymph node metastasis by transrectal ultrasound, 6 patients were treated initially with neoadjuvant therapy (pre-operative chemoradiation) for down staging and underwent surgery later. All patients underwent an operation consisting of abdominoperineal resection (APR) in 11 cases (65%), low anterior resection (LAR) in 4 cases (23%) and transanal excision in 2 cases (12%).

The median time between TRUS and surgery was 60 days (6-577). There were 8 patients (47%) who received neoadjuvant therapy before surgery. All of them were initially treated with concurrent chemoradiation.

The pathological results were adenocarcinoma in 16 cases and 1 case of GIST. There were 2 cases of adenocarcinoma that had no evidence of tumor at the time of surgery due to pre-operative

chemoradiation for down staging (1 case of acute and chronic inflammation, 1 case of granulation tissue and fibrosis). The average size of the tumor was 3.5 (1.4) cm in the greatest diameter.

There were 2 patients who received neo-adjuvant therapy and showed no evidence of tumor at the time of operation. Therefore, the pathologic tumor staging in depth of tumor invasion were 2 cases (12%) of pT0 (no evidence tumor), 3 cases of pT1 (18%), 6 cases of pT2 (35%), 6 cases of pT3 (35%) and no case of pT4 (0%). The studies of regional lymph node metastasis were performed in only 15 patients (88%), because there were 2 patients who were treated with local resection and no information on lymph node status was available. There were 3 cases of pN(+) (20%) and 12 cases of pN(-) (80%). The characteristics and data of all included patients were shown in table 3 and table 4.

The histopathological staging of tumor, concerning the depth of invasion, correctly correlated with ultrasonographic staging in 8 of these 17 patients. Of those who were incorrectly staged, 7 were overstaged and 2 were understaged (Table 5). The overall accuracy in determination of the depth of invasion for all 17 patients was 47%. Overstaging and understaging of tumor appeared in 41% (7/17) and 12% (2/17), respectively (Table 7).

Since 8 (47%) out of 17 patients were treated initially with chemoradiation before surgery, we evaluated the remaining 9 patients (53%), who did not receive initial treatment, separately. There were correctly staged in 5 out of 9 patients, 2 were overstaged and 2 were understaged (Table 6). The overall accuracy of the depth of tumor invasion in this group was 56% (5/9), while the overstaging and understaging of tumor appeared in a similar percentage of 22% (2/9 and 2/9) (Table 7).

The regional lymph node status was correctly assessed by TRUS in 9 out of 15 patients, giving an accuracy of 60% (fig.4). Particularly TRUS diagnosed 8/12 N(-) patients (67%) and 1/3 N(+) patients (33%)

Table 2 TNM classification by AJCC 2002

Primary tumor (T)	
TX	Primary tumor cannot be assessed
T0	No evidence of primary tumor
Tis	Carcinoma in situ: intraepithelial or invasion of the lamina propria
T1	Tumor invades submucosa
T2	Tumor invades muscularis propria
T3	Tumor invades through the muscularis propria into the subserosa, or into nonperitonealized pericolic or perirectal tissues
T4	Tumor directly invades other organs or structures, and/or perforates the visceral peritoneum
Regional lymph nodes (N)	
NX	Regional lymph nodes cannot be assessed
N0	No regional lymph node metastasis
N1	Metastasis in 1 to 3 regional lymph nodes
N2	Metastasis in 4 or more regional lymph nodes

Table 3 Characteristics of all included patients

Characteristics (n=17)	Summary: Number (%)
Age (years)	
Mean (SD)	55.5 (15.8)
Median (Range)	54 (30-85)
Sex	
Male	7 (41.2)
Female	10 (58.8)
Depth of tumor invasion by TRUS (uT)	
uT1	2 (11.8)
uT2	3 (17.6)
uT3	12 (70.6)
uT4	0 (0)
Presence of regional metastatic node (uN): n=15**	10 (66.7)
uN0	5 (33.3)
uN1	
Time between biopsy and TRUS	
Mean	16.5 (15.2)
Median	12 (5-53)
Time between TRUS and surgery (days)	60 (6-577)
Type of surgery	
Transanal excision	2 (11.8)
Low anterior resection (LAR)	4 (23.5)
Abdominoperineal resection (APR)	11 (64.7)
Size of tumor on pathology exam(cm)	
Mean (SD)	3.5 (1.4)
Median (range)	3.5 (1.2-6.5)
Histology of tumor	
Adenocarcinoma	16 (94.1)
GIST	1 (5.9)
Pathological results	
Depth of tumor invasion (pT)	
T0*	2 (11.8)
T1	3 (17.6)
T2	6 (35.3)
T3	6 (35.3)
T4	0 (0)
Regional lymph node metastasis (pN): n=15**	
N0	12 (80)
N1	3 (20)
Neoadjuvant therapy	
Yes	8 (47)
No	9 (53)

* T0 = *Other, compatible with no evidence of malignancy (1 case of acute and chronic inflammation and 1 case of granulation tissue and fibrosis)

** The remaining 2 cases had no data of lymph node pathological report due to transanal excision.

Table 4 The data of all 17 patients

Patient	Sex	Age	Time between biopsy & TRUS (days)	uT	uN	pT	pN	Time between TRUS & surgery (days)	Type of surgery	Neoadjuvant therapy
1	M	30	20	3	(-)	0	(-)	98	APR*	Yes
2	F	61	17	1	(-)	2	No data	21	Transanal excision	No
3	F	38	7	2	(-)	2	(-)	37	APR	No
4	M	63	53	3	(-)	2	(-)	47	APR	Yes
5	F	62	7	3	(-)	1	(-)	173	LAR	No
6	F	85	13	3	(-)	3	(-)	33	APR	No
7	M	54	No data	3	(-)	0	(-)	103	APR	Yes
8	M	53	6	3	(-)	3	(+)	95	APR	Yes
9	M	73	15	3	(-)	3	(-)	577	APR	Yes
10	F	57	5	2	(+)	2	(-)	26	LAR**	No
11	M	72	No data	3	(-)	2	(+)	89	LAR	Yes
12	F	51	12	3	(+)	2	(-)	6	LAR	No
13	F	54	45	3	(+)	3	(-)	60	APR	No
14	F	77	8	1	(-)	1	No data	17	Transanal excision	No
15	F	37	7	2	(-)	3	(-)	33	APR	No
16	F	34	No data	3	(+)	3	(+)	98	APR	Yes
17	M	43	No data	3	(-)	1	(-)	86	APR	Yes

* APR = Abdominoperineal resection

** LAR = Low anterior resection

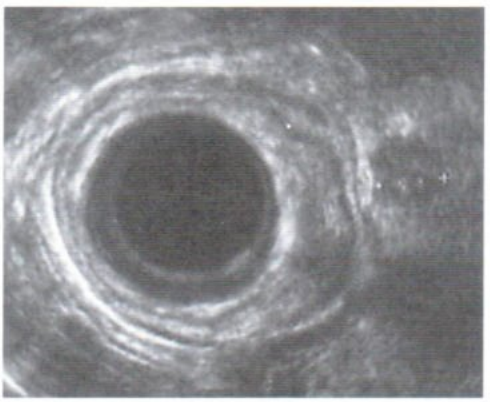


Fig.4 Metastatic node - hypoechoic, varying in size, round rather than oval and have discrete borders

Table 5 Results of transrectal ultrasound and pathologic staging of rectal cancer in determining of depth of invasion

Transrectal ultrasound (uT)		Pathologic findings (pT)				
Category	Number of patients n (%)	pT0	pT1	pT2	pT3	pT4
uT1	2 (11.8)	0(0.0)	1(33.3)	1(16.7)	0(0.0)	0(0.0)
uT2	3 (17.6)	0(0.0)	0(0.0)	2(33.3)	1(16.7)	0(0.0)
uT3	12 (70.6)	2(100)	2(66.7)	3(50.0)	5(83.3)	0(0.0)
uT4	0 (0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Total (N)	17 (100.0)	2(100)	3(100)	6(100)	6(100)	0(0.0)

Table 6 Results of transrectal ultrasound and pathological staging of rectal cancer in determining the depth of invasion, which excluded the neoadjuvant therapy group

Transrectal ultrasound (uT)		Pathologic findings (pT)			
Category	Number of patients (n)	pT1	pT2	pT3	pT4
uT1	2 (22.2)	1(50.0)	1(25.0)	0(0.0)	0(0.0)
uT2	3 (33.3)	0(0.0)	2(50.0)	1(33.3)	0(0.0)
uT3	4 (44.4)	1(50.0)	1(25.0)	2(66.7)	0(0.0)
uT4	0 (0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Total (N)	9 (100.0)	2(100.0)	4(100.0)	3(100.0)	0(0.0)

Table 7 Accuracy in determining depth of invasion by transrectal ultrasound in all patients compared to the neoadjuvant-excluded group.

	All patients	Without neoadjuvant
Accuracy	47% (8/17)	56% (5/9)
Overstaging	41% (7/17)	22% (2/9)
Understaging	12% (2/17)	22% (2/9)

(table 8). Overstaging and understaging in lymph node evaluation occurred in 13% (2/15) and 27% (4/15) of the patients respectively (2 and 4 out of 15 in each group). (Table 9). The sensitivity was 33.3% and specificity was 66.7% with PPV 20% and NPV 80% (Table 8). If we excluded the patients who received preoperative chemoradiation, there were 7 patients left. The TRUS diagnosed 4/7 N(-) patients and 3/4 N(+) patients. No evidence of lymph node metastasis was found in the pathological examination. Therefore, the accuracy and specificity in determining regional lymph node metastasis were similar at 54.2% (Table 10).

When perirectal fat invaded lesion was studied,

transrectal ultrasonographic diagnostic evaluation resulted in an overall accuracy of 52.9%, a sensitivity of 83.3% (95% CI: 65.6 to 101.1%) and a specificity of 36.4% (95% CI: 13.5 to 59.2%) (Table 11). The accuracy was also shown as area under the curve in Graph 1. However, if the neoadjuvant excluded group, were studied the overall accuracy was increased to 66.7% (area under the curve in graph 2), and sensitivity and specificity were similar at 66.7% (95% CI: 35.9% to 97.5%) (Table 12).

Table 8 Correlation of transrectal ultrasound and pathologic staging of rectal cancer in determining regional lymph node involvement

TRUS findings	**Pathologic findings**	
	No lymph node metastasis, n (%)	**Lymph node metastasis, n (%)**
No lymph node metastasis, n (%)	8 (69.2)	2 (66.7)
Lymph node metastasis, n (%)	4 (30.7)	1 (33.3)

TRUS	**Lymph node metastasis**
Sensitivity (%)	33.3% (9.48-57.2)
Specificity (%)	66.7% (42.8-90.5)
Positive predictive value (%)	20% (-0.24-40.2)
Negative predictive value (%)	80% (59.8-100.2)
Accuracy (%)	60%
LR +	1.0
LR -	1.0

Table 9 Accuracy in determining regional lymph node involvement by transrectal ultrasound

	All patients (n=15)
Accuracy	60% (9/15)
Overstaging	13% (2/15)
Understaging	27% (4/15)

Table 10 Correlation of transrectal ultrasound and pathological staging of rectal cancer in determination of regional lymph node involvement (excluded patients who received neoadjuvant therapy)

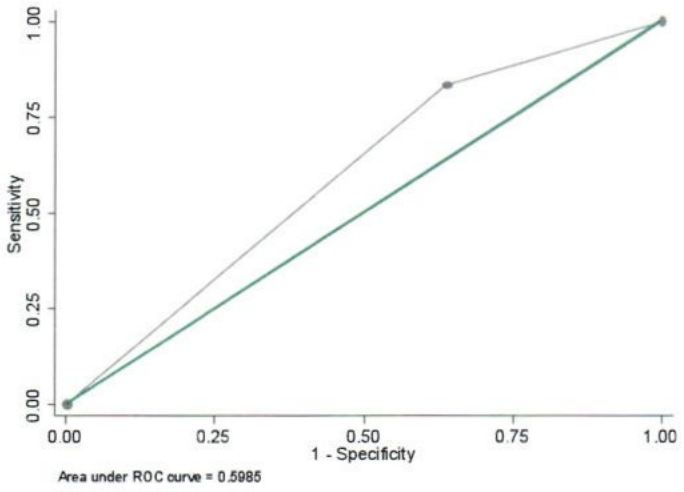
TRUS findings	**Pathologic findings**	
	Lymph node metastasis, n (%)	**No lymph node metastasis, n (%)**
Lymph node metastasis, n (%)	0	3
No lymph node metastasis, n (%)	0	4

TRUS	**Lymph node metastasis**
Accuracy (%)	57.14%
Specificity (%)	57.14%

Table 11 Correlation of transrectal ultrasound and pathological staging of rectal cancer in determining perirectal fat invasion

TRUS findings	Pathologic findings	
	Perirectal fat invasion (n)	Non-perirectal fat invasion (n)
Perirectal fat invasion (n)	5	7
Non-perirectal fat invasion (n)	1	4

TRUS	Perirectal fat invasion
Sensitivity (%)	83.3% (65.6-101.1)
Specificity (%)	36.4% (13.5-59.2)
Positive predictive value (%)	41.7% (18.2-65.1)
Negative predictive value (%)	80% (60.9-99.0)
Accuracy (%)	52.9%
LR +	1.3
LR -	0.5

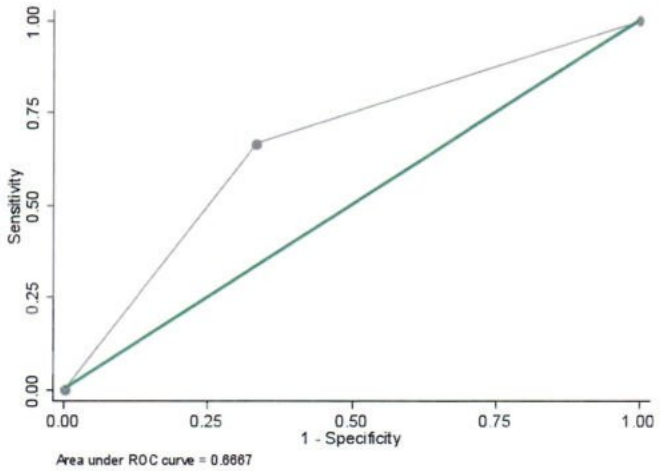


Graph 1. Accuracy of transrectal ultrasound in determining perirectal fat invasion, shown as area under the curve (all patients)

Table 12 Correlation of transrectal ultrasound and pathological staging of rectal cancer in determining perirectal fat invasion, in the neoadjuvant-excluded group

TRUS findings	Pathologic findings	
	Perirectal fat invasion (n)	Non-perirectal fat invasion (n)
Perirectal fat invasion (n)	2	2
Non-perirectal fat invasion (n)	1	4

TRUS	Perirectal fat invasion
Sensitivity (%)	66.7%(35.9-94.5)
Specificity (%)	66.7% (35.9-97.5)
Positive predictive value (%)	50.0% (17.3-82.7)
Negative predictive value (%)	80% (60.9-99.0)
Accuracy (%)	66.7%
LR +	2.0
LR -	0.5



Graph 2. Accuracy of transrectal ultrasound in determining perirectal fat invasion, shown as area under the curve (excluded patients who received neoadjuvant therapy)

Discussion

The preoperative staging of rectal cancer is an important factor in the treatment plan to achieve better prognosis. The precise knowledge of local staging (T, N) is essential for planning of the optimal therapy. Various methods have been used to evaluate the local staging of rectal cancer which include digital rectal examination, computed tomography (CT), and magnetic resonance imaging (MRI). TRUS (Transrectal ultrasound) is considered the diagnostic tool of choice in multicenter studies with a mean accuracy of 79-88%[5,6,8,9,11] in the assessment of depth

of tumor invasion. Metanalysis on the diagnostic accuracy of TRUS compared to CT and MRI found that TRUS provides equal or even superior characterization of the depth of tumor invasion (TRUS, median 89%; CT, median 79%; MRI 82%)[5]. Furthermore, TRUS is easily reproducible, safe, painless and much cheaper.

Findings from our study of TRUS examination in the preoperative staging of rectal cancer showed that the accuracy is 47% in all 17 patients, which was lower than the recent multicenter studies. This was an important factor difference between our study and those in other studies. The patients in our study included the patients that also received pre-operative chemoradiation (8 in 17 patients; 47%) after they underwent TRUS examination, which caused downstaging of the tumor at the time of operation which lowered our accuracy. In another group in which we excluded the patients who received neoadjuvant therapy, we found that the accuracy increased from 47% to 56%, which corresponded with the decrease in overstaging from 41% to 22%. In this group, we correctly staged 56% (5 in 9 patients). Our overstaged and understaged rates for T staging were similar 22% (2 in 9 patients).

Of the understaged cases, there was one case (patient 2) that shown uT1 stage, while the pathological stage was T2 due to microscopically muscularis propria invasion. Another case of understage (patient 15) was staged as uT2, but the pathological report revealed pT3. The time between TRUS and surgery in this case was 33 days. According to the study of Hulsmans et al., they founded that, if patients with a therapy delay of 1 month or more were excluded, all incorrectly staged tumors were overstaged[12]. The explanation of this case could be due to the delayed time between TRUS and surgery (33 day), causing extra time for tumor growth before histopathological staging.

There were two overstaged cases. The first case (patient 12) was interpreted as uT3 but the pathological review show pT2. However, there is some error in this case due to inadequate resection that did not cover all the depth of tumor invasion in some part of the sampling. Therefore, the understaging in this case is still doubtful due to sampling error. Another explanation for overstaging is the time between biopsy and the TRUS study performed. Recent studies demonstrated the relation between the degree of inflammatory cell infiltration and the frequency of overstaging. Recently, it has been suggested that the inflammatory reaction responsible for the overstaging might be caused because the biopsy performed 1 week before TRUS examination[13,14]. In our two overstaged cases (patient 5 and patient 12), the time between biopsy and TRUS were 7 days and 12 days, respectively. Therefore, the inflammatory reaction from biopsy could be the reason for overstaging in our cases.

Although the accuracy was increased when we excluded the neoadjuvant group patient, the overall accuracy was still much lower than the other studies. We believe that the small number of examinations performed was the main reason for poor results.

The most important aim of the pre-therapeutic staging is the discrimination of tumor growth limited to the rectal wall (T1 & T2) and that invaded through this wall (T3 & T4). Related to this, TRUS examination in our study provided a sensitivity and specificity of 83.3% and 36.4%, respectively, with the accuracy of 52.9%. Similar to the above, the perirectal fat invasion detection in the non-neoadjuvant group was better with the accuracy of 66.7% and similar in

sensitivity and specificity of 66.7%, respectively. Data on these parameters from the other literature for the discrimination of T1-T2 VS T3-T4 were higher (accuracy 81-91%, sensitivity 90-94%, specificity 67-87%[6,15]. The reason for our lower results could be due to the small number of the enrolled patients. However, the high rate of prediction of growth beyond the rectal wall in the recent studies indicated that ultrasound can be of importance in the identification of those tumors with perirectal growth for which chemoradiation therapy could be suitable.

In the assessment of mesorectal nodes, the accuracy was 60%, which was lower than that reported in other studies, ranging from 70-86%[5,6,9,16]. Overstaging and understaging can occur during assessment of lymph node involvement[17]. Overstaging in node status is caused mostly by reactive lymph node swelling and understaging by the presence of small involved nodes and metastasis in extramesorectal nodes. The important factor that lowered the results in assessment of nodal involvement in our study was due to the small number of examinations performed.

Conclusion

The overall lower accuracy, sensitivity as well as specificity in this study as compared to the previous studies are probably due to the inclusion of the neoadjuvant therapy-patients group. However, when the neoadjuvant therapy group were excluded, the accuracy was improved, but still lower than others. The small number of included patients was believed to be the reason for the statistical analysis effect. As the recent standard treatment for T3 and T4 tumor was to undergo neoadjuvant therapy, therefore, there were only a small number of included patients left in this study. The accurate results in the future study of transrectal ultrasound in preoperative staging of rectal cancer should be achieved by increased sample size.

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