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Transrectal Ultrasonography in Preoperative Staging of Rectal Cancer

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A precise knowledge of the depth of invasion of tumor is essential for the planning of treatment of rectal cancer. Transrectal ultrasonography is a new diagnostic modality that has become useful in determining the depth of invasion preoperatively and the presence or absence of metastatic lymph nodes. Transrectal ultrasonography was used in preoperative staging of 36 patients with rectal cancer. Thirty three patients had a radical resection (17 low anterior resection, 15 abdominoperineal resection and 1 pelvic exenteration), one patient had a local excision. Two among these thirty four patients had preoperative radiotherapy. Preoperative transrectal ultrasonographic staging was compared with pathologic findings. In staging depth of invasion, the overall accuracy was 88.8 percent, overstaged in 5.8 percent, understaged in 5.8 percent. Transrectal ultrasonography is the more accurate method than CT in staging of depth of tumor invasion (61.8% vs 88.8%). In staging of lymph nodes, the overall accuracy of transrectal ultrasonography was 85.3 percent, sensitivity was 71.7 percent and specificity was 88.8 percent. Transrectal ultrasonography is a safe, inexpensive and accurate staging method in the assessment of both depth of invasion and nodal status.

Key Words: Transrectal ultrasonography, accuracy rate, rectal cancer

The preoperative evaluation of a rectal cancer is important in planning therapy and assessing prognosis. Precise knowledge of the depth of invasion of a rectal cancer is essential for the planning of optimal therapy for patient with rectal cancer. The staging of a rectal cancer preoperatively is valuable in many instances in which it may influence the operative approach or prompt a decision to perform radiation therapy prior to operation. Clinical examination is not entirely reliable, even though, many information can be obtained. CT and MRI are also reliable for assessing advanced rectal cancers in evaluating the invasion of adjacent organs or complications.

The use of transrectal ultrasonography in the evaluation of carcinoma of prostate has been expanded in utilization. The capability of transrectal ultrasonography in predicting the depth of tumor invasion accurately is becoming increasingly evident. Early experiences of the authors with transrectal ultrasonography in the management of patient who have rectal cancer are presented in this report.

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MATERIALS AND METHODS

Thirty-six patients with primary rectal

cancer were studied from Nov. 1993 to Mar. 1994. Each patient underwent preoperative transrectal ultrasound examination and also had a CT scan. Mean age was 60 years old (range: 33-80) and male to female ratio was 2 to 1.

Distribution of a rectal cancer showed 4 cases (11.2%) at upper 1/3, 16 cases (44.4%) at lower 1/3 and 16 cases (44.4%) at middle 1/3 (Table 2).

Transrectal Ultrasonography was performed while the patient was in the lithotomy position. After cleansing enema with soap saline, a digital rectal examination and rectosigmoidoscopy with a rigid instrument were performed. The height of the tumor was measured and other characteristics of the tumor were checked.

Transrectal ultrasonography was performed with a Kretz ultrasound scanner (Combison® 310A°). A transversely oriented radial scanner with a 7.5 MHz transducer affixed to a 23 cm scanning probe was inserted into the rectum transanally after being coated with sonographic gel. A transducer was covered with a rubber sheath filled with 30 ml to 40 ml of degassed water, providing an optimal acoustic pathway. Images were obtained as the transducer rotates 360° at a rate of six cycles per second.

Table 1. Transrectal ultrasonographic staging system

Stage	Tumor features
	confined to mucosa or submucosa
	penetrating muscularis propria, but confined to rectal wall
UT3	invading perirectal fat
UT4	invading adjacent organ
N0	lymph node metastasis absent
N1	lymph node metastasis present

Table 2. Distribution of rectal cancer in patients (N=36)

Proctoscopic distance	No. (%)
Upper 1/3 (11.5 cm<)	
Middle 1/3 (7 cm~11.5 cm)	
Lower 1/3 (<7 cm)	

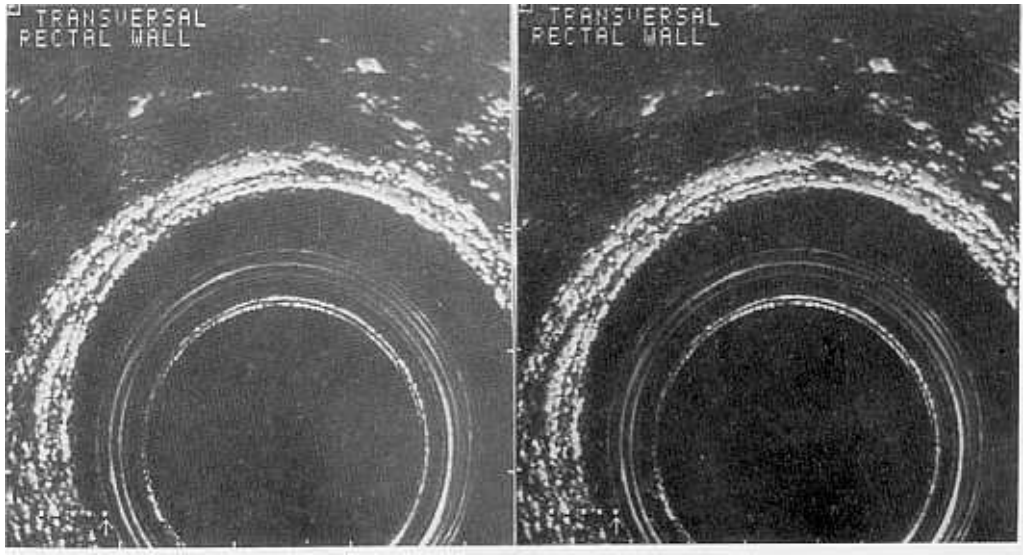

Fig. 1. Normal rectal wall. The five lines (three hyperechoic, white, and two hypoechoic, black) are clearly discernible in the ultrasonographic image of the rectal wall.

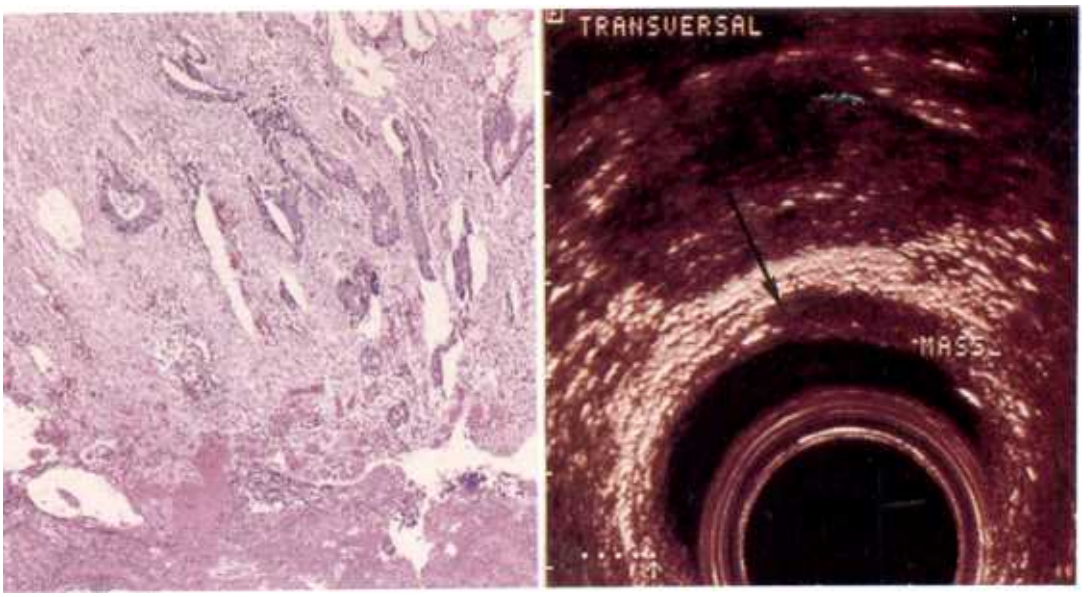

Fig. 2. *An uT_1 lesion. The middle white line is interrupted and irrgular (arrow), indicating invasion of submucosa. The outer black line (muscularis propria) is intact (Right). Adenocacinoma invade into the submucosa, confirming T1 lesion on pathologic examination (Left).*

Fig. 3. *An $_0T_2$ lesion. The submucosal white line is interrupted with expansion of the outer echo-poor layer (muscularis propria), indicating invasion of the muscle (white arrow). The outer white line is intact (black arrows)(Right). Adenocarcinoma invade into the outer muscle layer, confirming T_2 lesion on pathologic examination (Left).*

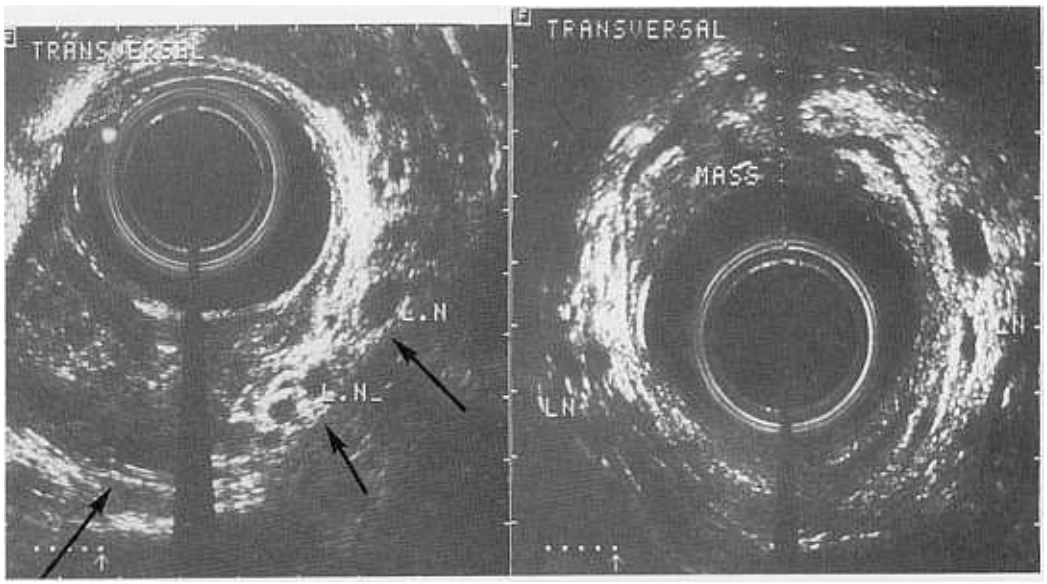

Fig. 4. A large tumor is seen, invading well beyond the rectal wall (arrow). Hypoechoic structure are seen in the mesorectum (arrows), which were confirmed as a metastatic lymph node (left). The tumor was a $_{U}T_{3}$ lesion and outer white line is irregular and interrupted, indicating extension into perirectal fat (right).

Ultrasonographic staging for depth of tumor invasion was evaluated in all patient by Hildebrandt and Feifel formula (Table 1).

The rectal wall was ultrasonically splitted into five layers. Three hyperechoic and two hypoechoic lines were shown (Fig. 1).

An $_{U}T_{1}$ lesion is an invasive malignancy confined to the mucosa and submucosa (Fig. 2). An $_{U}T_{2}$ lesion penetrates the muscularis propria but is confined to the rectal wall (Fig. 3). An $_{U}T_{3}$ lesion invades perirectal tissue and $_{U}T_{4}$ lesion penetrates into surrounding organs (Fig. 4). All identified lymph nodes are determined as positive for tumor involvement if its internal echo is hypoecoic (Fig. 4). Ultrasound assessment were compared with permanent histologic slides and the accuracy of the examination was determined.

CT: Thirty-six patient were taken abdominopelvic CT scanning used by Siemen's Somatom Plus-S or GE-9800 machines. Precontrast pictures were taken initially as whole scanning field. Thereafter, contrast medium (Optiray®, 100 ml) was introduced into the rectum without any prior bowel preparation. Pictures were taken at 1 cm intervals and three degrees of infiltration were defined as 1) tumor limited to the rectal wall (perirectal fat negative), 2) tumor infiltrating the perirectal fat and 3) tumor infiltrating neighboring organs.

RESULTS

Thirty-six patient were classified by transrectal ultrasonographic staging sysytem. They were 26 cases of $uT_3N_0M_0$, 1 case of $uT_3N_1M_0$, 2 cases of $uT_4N_0M_0$, 2 cases of $uT_4N_1M_0$, 1 case of $uT_1N_0M_0$ and 2 cases of $uT_2N_0M_0$ (Table 3).

Among 36 patients who were accessed for depth of invasion by transrectal ultrasonography, thirty-four patients underwent operation consisiting of abdominoperineal resection in 15 cases (44.2%), low anterior resection in 17 cases (50.0%), local excision in 1 case and pelvic exenteration in 1 case.

Table 3. Transrectal ultrasonographic staging

Stage	No.
UT1N0M0	1
UT1N1M0	0
UT2N0M0	2
UT2N1M0	2
UT3N0M0	26
UT3N1M0	1
UT4N0M0	2
UT4N1M0	2
	36

Table 4. Name of operation (n=34)

Name of operation	No. (%)
Abdominoperineal resection	15(44.2)
Low anterior resection	17(50.0)
Local excision	1(2.9)
Pelvic exenteration	1(2.9)

* 2cases: preoperative XRT for down staging

Table 5. TNM staging by UICC (N=34)

TNM	No.
T1N0M0	1
T2N0M0	4
T3N0M0	17
T4N0M0	1
any T N1M0	9
any T N2, 3 M0	1
any T any N M1	1

Preoperative radiotherapy for down staging was recommended in remaining two cases (Table 4).

The pathologic tumor staging was performed in accordance with the TNM system provided by the UICC. The stages of our cases by UICC's TNM system were 1 $_pT_1$, 4 $_pT_2$, 17 $_pT_3$, 1 $_pT_4$, 9 anyTN_1, 1 anyTN_2 and 1 anyTanyNM_1 (Table 5).

The histopathologic staging of tumor, concerning the depth of invasion, correctly correlated with ultrasonographic staging in thirty of these 34 patients. Of those who were incorrectly staged, two were overstaged and two were understaged (Table 6).

Table 6. Correlation of transrectal sonographic and pathologic staging of rectal cancer in determining of depth of invasion

UT \ PT	PT1	PT2	PT3	PT4
UT1	1			
UT2		3	1	
UT3		1	25	1
UT4			1	1

▨ Understaging ○ Correct ◇ Overstaging

Table 7. Comparative studies in determining depth of invasion by CT and transrectal ultrasound

	CT(%)	TRUS(%)
Accuracy	61.8	88.8
Overstaging	5.8	5.8
Understaging	32.3	5.8

The overall accuracy in determination of the depth of invasion for all thirty-four patients was 88.2% by transrectal ultrasound and 61.8% by CT scanning.

The overstaged cases were in 2 patients (5.8%) by transrectal ultrasound and in 2 patients by CT scanning. The understaging were in 2 patients by transrectal ultrasound and in 11 patients (32.3%) by CT scanning (Table 7).

The CT scanning shows that a $_pT_1$ lesion can not be seen and 17 cases of $_pT_3$ lesion present infiltration into perirectal fat (correct staging), but 11 cases of $_pT_3$ lesion present no infiltration of perirectal fat. Two cases of $_pT_4$ show evidence of invasion to the surrounding organ on CT scanning (Table 8).

When perirectal tissue was examined for

Table 8. Correlation of histologic staging and CT finding of rectal cancer (N=34)

Pathology	Abdominopelvic CT			
	non-visualization	perirectal fat(+)	perirectal fat(−)	direct invasion to surr. organ
$_pT_1$	1			
$_pT_2$		1	2	
$_pT_3$		17	11	
$_pT_4$				2

Table 9. Accuracy of CT and transrectal ultrasonography in detection of nodal involvement

	CT(%)	TRUS(%)
Accuracy	73.5	85.3
Sensitivity	33.3	71.7
Specificity	88.0	88.8
PPV	33.3	62.5
NPV	78.5	92.3

PPV: Positive Predictive Value
NPV: Negative Predictive Value

the presence or absence of lymph nodes involved with disease, transrectal ultrasonographic diagnostic evaluation of nodal disease resulted in an overall accuracy of 85.3 percent, a sensitivity of 71.7 percent and a specificity of 88.8 percent. In contrast to transrectal ultrasonography, the CT scanning showed an accuracy of 73.5 percent, a sensitivity of 33.3 percent and a specificity of 88.0 percent (Table 9).

DISCUSSION

The preoperative staging of rectal cancer impacts on treatment plans and ultimate survival. Methods of preoperative staging include digital rectal examination, proctoscopy and CT scanning. The CT scanning has been heralded as the most accurate preoperative staging tool for rectal cancer, but its accuracy rates were not high. In addition, CT scanning is not accurate in assessing the depth of wall penetration in the rectum and appears to lack an ability to detect pelvic lymph nodes.

The transrectal ultrasonograph is a new diagnostic modality that has become useful in aiding the surgeon in selecting appropriate therapy for rectal cancer because of its high accuracy in determining the depth of invasion of the rectal cancer and the presence or absence of metastatic lymph nodes preoperatively (Hildebrandt and Feifel, 1985; Senagore *et al.* 1988; Waizer *et al.* 1989; Orrom *et al.* 1990).

It is used to distinguish fine discrete lines of the normal rectal wall, allowing discrimination of cancers confined to the submucosa, those extending into the muscularis propria but confined to the intestinal wall and those invading the perirectal fat. Beynon *et al.* (1989) proposed a five layer anatomic model that is useful in assessing the depth of rectal wall invasion by a cancer.

Once the transrectal ultrasound is used to assess the depth of invasion, a modified TNM classification, as proposed by Hildebrandt and Feifel (1985), is used to stage the cancer. An invasive rectal cancer confined to the mucosa and submucosa is staged as an ultrasound $_uT_1$ lesion. An $_uT_2$ lesion penetrate the muscularis propria, but is confined to the rectal wall. An $_uT_3$ lesion invades the perirectal fat. An $_uT_4$ lesion shows ultrasound evidence of invasion of an adjacent organ.

When the accuracy of ultrasonographically determined depth of invasion is compared with the histologic results, accuracy rates in the 90 percent range have been documented

by many authors (Holdsworth *et al.* 1988; Hildebrandt and Feifel, 1992; Herzog *et al.* 1993). Some studies have shown the superiority of transrectal ultrasonography, compared to CT scanning, but others have shown little difference (Morson *et al.* 1981; Adalsteinson *et al.* 1985; Freeny *et al.* 1986; Waizer *et al.* 1989). Even though overall accuracy rates are strongly dependent on the investigator's experience, in our study, the overall accuracy in determining the depth of invasion was 88.8 percent. 5.8 percent was understaged and 5.8 percent was overstaged. Thus, our result was comparable to that of other investigators.

There are some controversies in the interpretation of the images obtained from transrectal ultrasonography. It is difficult to differentiate an ${}_{U}T_2$ or ${}_{U}T_3$ lesions clearly. It is also difficult to diagnose an ${}_{U}T_4$ lesion because of the short focal length of transducer. With invasive lesion confined to the submucosa, the second hyperechoic layer becomes less distinct and moth-eaten. If the outer hyperechoic layer is enlarged, the muscle is clearly involved with tumor and is staged an ${}_{U}T_2$ lesion. Once the outer hyperechoic layer is shown to be incomplete, perirectal fat invasion is present and the tumor is staged ${}_{U}T_3$. In our under/overstaged cases, there were some blurring of hyperechoic lines. Thus the definite depth of tumor invasion was not able to define. Understaging is more serious than overstaging since it may cause inadequate treatment.

The therapeutic approach for cancer of the lower rectum —local excision vs. low anterior resection— may be evaluated with the help of exact preoperative staging. It is well known that, with CT scanning, it is impossible to distinguish between T_1 and T_2 tumor, However infiltration into the perirectal fat or into neighboring organs is more easily demonstrated (Morson *et al.* 1981). In our series, we obtained an accuracy of 61.8 %. Comparing both methods, CT scanning and transrectal ultrasonography, transrectal ultrasonography was always superior. The accuracy of transrectal ultrasound in accessment of the depth of invasion of the tumor is now verified by results from numerous studies. The accuracy rate ranges from 84% to 93% (Orrom *et al.* 1990). But the CT scanning has a lower accuracy than the transrectal ultrasound in many studies as ranging from 69% to 83% (Adalstein *et al.* 1985; Holdsworth *et al.* 1988; Hildebrandt and Feifel, 1992).

Recently endorectal magnetic resonance imaging has been tried and its accuracy in determination of the depth of invasion was about 81 %, which was similar to that was claimed for endorectal sonography. It was also excellent for depicting perirectal lymph nodes as small as 2~3 mm in diameter (Schnall *et al.* 1994).

There are many controversies about the assessment of nodal disease. Tio and Tytgat (1984) first described the hypoechoic pattern of metastatic lymph node. Later on, Beynon *et al.* (1989), Hildebrandt and Feifel (1985) applied Tio and Tytgat's observation to the rectum. At present, an accuracy of 72 to 83 percent with ultrasonic diagnosis of nodal improvement is reported (Hildebrandt *et al.* 1990). It is difficult to predict the nodal involvement accurately by CT scanning because nodes smaller than 1 cm are seen only with difficulty and some visible lymph nodes may finally show reactive inflammatory changes. Glaser *et al.* (1990) validated that hyperechoic lymph nodes correspond to inflammmatory nodes and hypoechoic lymph nodes are metastatic lymph nodes. Inflammatory nodes are more hyperechoic with more contrast. This observation is independent of the size of the nodes and surrounding fat tissue. By Hildebrandt *et al.* (1990), physical basis of differentiaiton of lymph nodes was assessed. They found no difference in the speed of sound between involved and uninvolved lymph nodes, a tendency toward a lower acoustic impedance involved nodes. There is significant lower attenuation coefficiency in tumorous nodes. These differences may be be explained by the different architecture of inflammatory and metastatic nodes.

The accuracy of the ultrasound in the di-

agnosis of lymph node metastasis varies from 74 percent to 86 percent (Orrom *et al.* 1990). Beynon *et al.* (1989) have recently reported an accuracy of 83 percent with a sensitivity of 88 percent and specificity of 79 percent. This technique is considerably more accurate than either CT scanning, digital examination or magnetic resonance imaging (Orrom *et al.* 1990). The experience of the authors has yielded an accuracy rate of 85.3 percent.

Another important application of transrectal ultrasonography is the early detection of local recurrence of rectal cancer by the regular interval imaging of the pelvis after anterior resection or local excision (Hildebrandt *et al.* 1992).

Transrectal Ultrasonography is highly accurate preoperative staging tool for rectal cancer. In other words, it shows high accuracy in determining the depth of wall penetration and high percent accuracy in assessing regional lymph nodes. It is safe and well tolerated by the patients and is less expensive than other imaging modalities.

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