ULTRASOUND STAGING OF RECTAL TUMOURS

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Introduction: A variety of surgical options are nowadays available in the treatment of patients with rectal cancers (1,4,9). The choice of treatment depends on the height of tumor from the anal verge, the stage, the presence of lymph nodes, the differenciation, the presence of synchronous lesions, the nature of the underlying pathology. Local treatment by surgical excision or local radiotherapy for early cancer requires precise identification of cases suitable for such treatment without risk of increased long term mortality.

Digital assessment is limited to tumours located within 8 to 10 cm of the anal margin and gives information only on the height, size and fixity of the lesion but doesn't provide with accurate data on the degree of wall penetration nor on the presence of pararectal lymph nodes involvement. Studies of Mason (21) and Nicholls (25) report a 75 % accuracy in predicting pathological state. More recent data show that the digital examination is particularly poor in early lesions (5,28). Need for more accurate investigations is necessary and explains the increasing interest for endorectal ultrasonography.

Ultrasonography is an imaging technique whose principle is based on the interaction between transmitted sound waves and the juxtaposed different tissue densities of the body.

Ultrasonography is less expensive, relatively quick and is well tolerated by the patient. Moreover, the patient is not exposed to radiation during the course of the examination.

The development of rotating probes allows real-time 360° radial scanning of the anorectum and the surrounding structures. Among many other applications, preoperative staging of rectal cancers has gain more and more clinical importance.

Technique of Endorectal Ultrasonography

The patient is instructed to prepare his bowel with one or two Fleet enemas 1 hour before the examination. There is no need for sedation, and therefore no need for specialised monitoring. The patient is placed in the gynecologic position. With digital rectal examination a significant anal stenosis should be excluded and the anal canal lubricated.

We currently use the 1846 Bruel & Kjaer (Naerum, Denmark) scanner and a 7.0 M H z 8539 transducer with a focal length of 2 to 5 cm. A small finger cot balloon is placed over the transducer and properly secured in place. The probe is introduced through the anus or passed through a short rectoscope in order to reach the upper part of the rectum and be placed in the proper position in front of the identified rectal lesion.The balloon is distended with water. Any bubble should be eliminated. By convention, the ultrasound probe is held with the spigot in the upright position, and the probe is maintained in the centre of the lumen.

Technical pitfalls (18) in E R U S include proximity of the lesion to the anal verge, improper balloon inflation, a non perpendicular imaging plane, shadowing artifacts due to air or stool, reverberation artifacts, refraction artifacts and a transducer gain setting that is too high.

After a more or less long learning curve and increasing experience of the examinator these artifacts can be identified or prevented and diagnosis accuracy increased.

Normal endorectal ultrasonography (E R U S) image

The normal rectal wall is represented by concentric circles of alternating hyperechoic and hypoechoic bands. The majority of investigators agree on a 5-layer model of the rectal wall (Fig 1), although there is some disagreement on the anatomic correlation of each of these lines (Table 1). Hildebrandt et al (11) believe that the three white lines represent interfaces, whereas the inner dark lines represent actual anatomic layers. In this model, the first white line is the interface between the balloon and the mucosa. The first dark line represents both the mucosa and the submucosa, which is followed by the middle white line, which they feel represents the interface between the submucosa and the muscularis propria: The outer dark line represents the muscularis propria followed by the interface with the perirectal fat, the outer white line.

Table 1. Interpretation of the Anatomic Correlation of the 5-Layer Rectal Wall Model

Series	Line 1	Line 2	Line3	Line 4	Line 5 "
	(White)	(Dark)	(White)	(Dark)	(White)
Hildebrandt et al 11	Interface (balloon/ mucosa)	Mucosa/ submucosa	Interface (submucosa /muscularis propria)	Muscularis propria	Interface (rectal wall/perirectal fat
Beynon et al 2	Interface (balloon/ mucosa	Mucosa/ muscularis mucosa	Submucosa	Muscularis propna	Perirectal fat
Saitoh et al 31	Interface (balloon/ mucosa)	Mucosa	Submucosa	Muscularis propria	Perirectal fat

Preoperative Staging of Rectal Neoplasm With Endorectal Ultrasonography

The crucial layer is the middle white line, which, if broken, implies invasion through the muscularis mucosa into the submucosa (T1). If there is widening of the outer dark line, but no break in the outer white line, then the tumour is confined to the muscularis propria (T2), and if there is a break in the outer white line, the tumour has invaded the perirectal fat (T3).

In order to correlate US datas with T N M pathological findings, E R U S observations are quoted U T 1, UT2, UT3 and U T 4 (Table 2).

Table 2.

	Ultrasonic stage	Clinical stage
	Tumour confined to submucosa	Tumour 2 cm or less in greatest dimension
	Tumour invades muscle	Tumour larger than 2 cm but not more than 5 cm
	Tumour involves perirectal fat	Tumour larger than 5 cm in greatest dimension
T4	Tumour invades adjacent organ	Tumour involves adjacent organ

UT1 Lesion: Confined to Submucosa

If the middle white line (submucosa) seen on E R U S is broken by a malignant lesion, this corresponds to submucosal invasion. The lesion is said to be confined to the submucosa and is hence a U T 1 tumour.

The reported incidence of lymph node metastases in such a lesion varies from 6% to 11%.
(9-24).

UT2 Lesion: Involving Muscularis Propria but Confined to Bowel Wall

Breach of the middle white line with expansion of the outer black line (muscularis propria) but preservation of the outer white line (perirectal fat) constitutes a U T 2 lesion.

The incidence of regional lymph node involvement is between 10% and 35% (31-33) when the muscularis propria is involved.

UT3 Lesion: invasion into Perirectal Fat

When the outermost white line (perirectal fat) is broken, often by a hypoechoic irregular extension of a tumour, into perirectal fat the lesion described a U T 3.

UT4 Lesion

Invasion of adjacent organs constitutes a U T 4 lesion. It is possible to visualise several structures in close proximity to the rectum by ultrasound. In women, the vagina, uterus, and bladder may be visualised. In men, interruption of Denonvilliers fascia (a white line between the rectum and the prostate gland and seminal vesicles) suggests tumor extension into these structures.

In man the seminal vesicles are clearly observed and must be distinguished from lymph nodes. The prostate is also clearly observed, and any tumor invasion through Denonvillier' s fascia can be easily recognised.

Lymph nodes

The ultrasound allows visualisation of the immediate perirectal tissue, and therefore a search for enlarged lymph nodes should be a routine step in the evaluation of a rectal tumour. One must be careful not to confuse blood vessels with enlarged lymph nodes.

Only a minority of lymph nodes are detected by E R U S. Detry et coll (7) could demonstrate by preoperative E R U S correlated with anatomical studies of operative specimens that detection of lymph nodes increases with their size: 12,8 % of the 3 to 5 mm nodes, 43.4 % of 6 to 10 mm nodes and 85.7 % of over 10 mm nodes. Metastatic lymph nodes are reported as having a hypoechogenic appearance. Metastatic and non metastatic lymph nodes exhibit a great variety of morphological features and it is difficult to reliably correlate a specific appearance with invasion. An enlarged lymph node located adjacent or superior to the level of the tumour, having a round appearance with sharp border, and of the same hypoechoic echogenicity as the primary tumour should be considered as a metastatic node (12).

The differentiation between an inflammatory node versus a metastatic one can be difficult and their size is of little value in differentiating them (3).

Table 3. Comparison of Lymph Node Staging

Author	Year	Number	Accuracy	Sensitivity	Specificity	PPV	NPV
Holdsworth 13	1988	36	61%	59%	64%	50%	70%
Beynon 3	1989	95	83%	88%	79%	78%	89%
Milsom 22	1993	61	77%	64%	87%	74%	81%
Herzog 10	1993	111	80%	89%	73%	71%	90%
Solomon 32	1993	517	58%	79%	80%	74%	84%
Deen 6	1993	106	77%	68%	84%	68%	83%

In published series (Tabl 3) comparing E R U S and histopathology the ability of sonography to assess non-involved nodes - specificity- range from 64 % to 87 %. The sensitivity or ability to predict lymph nodes metastasis range from 59 % to 88 %. The accuracy or ability of E R U S to predict involved and non-involved nodes range from 61 % to 83 %. Evaluation of lymph node involvement is still an important weakness of E R U S.

Improvement could be achieved by ultrasound-guided biopsies of enlarged lymph nodes (23) but further evaluation is necessary.

Benign Villous Adenoma.

Villous adenoma that appears benign on clinical examination may include carcinomatous changes in 9 % to 42 % (26,27). Random biopsies are not representative and excisional biopsy of the whole lesion may require a subsquent procedure in case of malignant changes.

Using E R U S, a reliable preoperative assessment of malignant change in large villous lesions may be obtained thus helping to plan definitive treatment.

The middle white line (hyperechoic) seen on ultrasound is the

key to diagnose a benign lesion. This line corresponds to the submucosa and, if intact ascertains that no invasive malignancy is present: the lesion is quoted UTO. An invasive tumor is when malignancy has extended beyond the muscularis mucosae and into the submucosa crossing the white line on ERUS.

Results

ERUS correlated with pathological examination of operative specimens shows a high accuracy, ranging from 80 to 92 %, in evaluating the depth of rectal wall penetration (Tabl 4).

Table 4. Comparison of Depth of Wall Penetration Using ERUS

Author	Year	Patients	Accuracy	Overstaged	Understaged
Hildebrandt 11	1986	76	88%	11%	9%
Beynon 2	1987	49	90%	6%	4%
Holdsworth 13	1988	36	86%	11%	3%
Zainea 35	1989	30	90%	3%	7%
Katsura 17	1992	120	92%	4%	4%
Lindmark 20	1992	63	81%	8%	8%
Milsom 22	1993	67	85%	12%	3%
Herzog 10	1993	118	89%	10%	1%
Deen6	1993	209	82%	12%	2%
Garetti 16	1997	58	80%	27%	8%

Overstaging is observed in 3 to 12% of cases mainly in UT3 / PT2 tumors. This is due to difficult evaluation of tumours just penetrating into the muscularis propria from penetration through the whole thickness of the muscularis propria. Furthermore, overstaging may be due to inflammation -spontaneous or iatrogenic- around a tumour which results in a hypoechogenic appearance, and from reaction or retraction of the muscularis propria in the neighbourgh of a tumour (6,15).

With ERUS benign villous tumours can be distinguished from lesions presenting malignant changes (26,27) and adequat treatment selected (30).

ERUS allows identification of small carcinoma with a low risk of lymph node involvement suitable for local excision .In case of larger tumours, precise staging helps in decision making about operative strategy and need for preoperative radiotherapy (30).

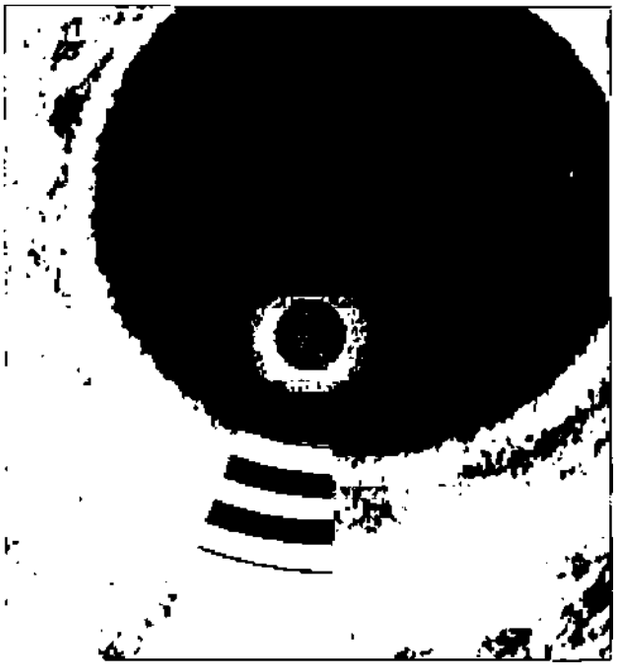
ERUS offers also a method for assessing degree of shrinkage and downstaging of UT3 and UT4 lesions after radio-chemotherapy (34). Better criteria should still be developped to distinguish tumour remnant from radiation induced changes to perirectal tissues. Our ability to assess local eradication of rectal cancer following radiation therapy remains poor.

ERUS has also been used postoperatively to identify locally recurrent rectal cancer at an early and potentially curable stage. 62 patients enrolled in a prospective study (29): 11 cases developped a local recurrence which has been suggested or identified by ERUS in all cases and not by other techniques.

New promissing development are under evaluation. Three-dimensional endosonography enhance the diagnostic accuracy (14,16). Even stenotic rectal cancers could be staged. With 3D-sonography compared with conventional ERUS, Hunerbein (14) could demonstrate an increase in accuracy in the assessment of infiltration depth from 82 % to 88 % and in accuracy in node involvement from 74 % to 79 %. In the future, three dimensional ERUS will also be useful to reconstruct tumours and to optimize the radiation target geometry.

Fig. 11. The majority of investigators agree on a 5-layer model of **the rectal wall:**

1. The first white line is the interface between the balloon and the mucosa
2. The first dark line represents both the mucosa and the submucosa
3. The middle white line, interface between the submucosa and the muscularis propria
4. Outer dark line muscularis propria
5. Outer white line interface with the perirectal fat



Conclusion

Endorectal ultrasound enables invasion between neoplasm confined to the mucosa and those that invade submucosa. Of invasive tumours, those confined to the submucosa (T1) are ideally suited to local excision, whereas some lesions which involve muscularis propria but do not penetrate this layer (T2) may also be suitable for local therapy. The technique is reliable in experienced hands and may change the management of patients with early cancers more than in patients with advanced cancer (32). It is a better predictor of wall invasion and para-rectal lymph node involvement compared with CT (35). However, further studies are required to assess the accuracy of ultrasound in comparison with MRI. Thus, in 1999, endorectal ultrasound remains the method of choice in preoperative assessment of patients with rectal neoplasm and in postoperative follow-up.

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