Int J Colorect Dis (1992) 7:4–7

International Journal of Colorectal Disease

Rectal endosonography accurately predicts depth of penetration in rectal cancer

J. Beynon [1], N. J. McC. Mortensen [2], J. L. Channer [3] and H. Rigby [3]

[1] Department of Surgery, Wrexham Maelor Hospital, Wrexham, UK
[2] Department of Surgery, John Radcliffe Hospital, Oxford, UK
[3] Department of Pathology, Bristol Royal Infirmary, Oxford, UK

Accepted: 10 October 1991

Abstract. Sixty-three patients with primary rectal adenocarcinomas have been examined prior to surgery with rectal endosonography (ES). Maximum depths of tumour penetration measured endosonographically have been compared with subsequent maximum depths measured on the fixed resected specimen ($n = 30$) and the histological slide ($n = 61$). In both cases there was a good degree of correlation between the ultrasonic estimations of depth and the histological ones ($r = 0.36$, $p = 0.05$, CI = 95% and $r = 0.46$, $p < 0.001$, CI = 99% respectively). In 12 cases ultrasonic depths of tumour were also measured in the laboratory and then compared with depths from fixed ($n = 12$) and fresh specimens ($n = 5$) with a good correlation ($r = 0.75$, $p = 0.005$, CI = 99% and $r = 0.79$, $p = 0.036$, CI = 95% respectively). Rectal endosonographic estimation of rectal cancer depth of invasion is an accurate measure of tumour penetration and may help distinguish between fixation due to inflammatory tissue and tumour fixity.

Résumé. 63 malades atteints d'un cancer primitif du rectum ont été examinés par échographie endo-rectale avant la chirurgie. La profondeur maximum de la pénétration tumorale mesurée par échographie a été comparée avec la profondeur maximale mesurée sur la pièce d'exérèse fixée ($n = 30$) ou sur une diapositive histologique ($n = 61$). Dans les deux cas il y avait une bonne corrélation entre l'estimation échographique de la profondeur et l'estimation histologique ($r = 0.36$, $p = 0.05$, CI = 95% et $r = 0.46$, $p < 0.001$, CI = 99% respectivement). Dans 12 cas la pénétration échographique de la tumeur a été aussi mesurée au laboratoire et comparée avec la pénétration des pièces fixées ($n = 12$) ou fraiches ($n = > 5$) avec une bonne corrélation ($r = 0.75$, $p = 0.005$, CI = 99%, et $r = 0.79$, $p = 0.036$, CI = 95% respectivement). L'estimation par échographie endorectale de la profondeur d'invasion des cancers du rectum est une mesure appropriée de la pénétration tumorale et peut permettre de distinguer entre la fixation par adhérences inflammatoires et la fixité tumorale.

Introduction

The operability of a rectal cancer, and the feasibility of restorative sphincter saving surgery have traditionally rested on accessibility and mobility judged by digital rectal examination. The extent of local infiltration of rectal tumours has a well recognised effect on both the risk of local recurrence and overall survival [1–6]. Inflammatory fixation is by contrast association with an improved prognosis when compared to those with malignant infiltration [7]. It is unlikely that preoperative digital examination can differentiate between these types of fixation.

Rectal endosonography (ES) is an accurate method for staging rectal cancer [8–25] but can it help in differentiating malignant from inflammatory fixation? In this study we have compared the maximum ultrasonic assessments of tumour depth with those taken from the operative specimen and histological slides to assess if what is visualised endosonographically accurately corresponds to tumour penetration.

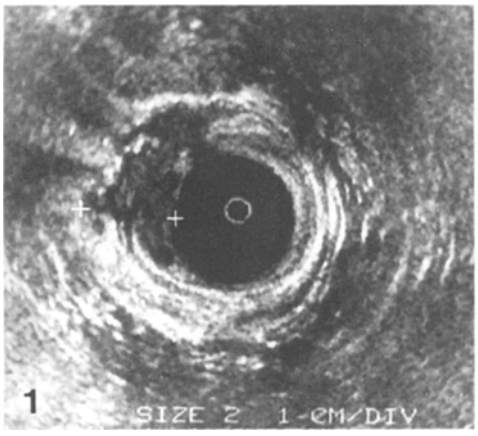
Patients, methods and materials

Sixty-three patients (age range 36–91 years, median 70) with primary rectal adenocarcinomas have been examined preoperatively using ES and all cases were subsequently subjected to surgical resection.

All examinations were performed using type 1846 ultrasound scanner (Bruel and Kjaer, Denmark), rotating endoprobe type 1850 5.5 and 7.0 MHz (focal length 2–5 cm) transducers.

The maximum depth of tumour invasion was measured using the ultrasound scanner in all cases where it was felt that the complete longitudinal length of the tumour had been examined (Fig. 1). These ultrasonic depths were compared with the maximum tumour depths measured on the fixed operative specimen ($n=30$) and the histological slide ($n=61$). In two patients where the depth of the operative specimen was estimated there was no estimation of the slide depth. In this group of 63 patients all but two patients were deemed clinically to have mobile tumours [18].

In addition, 12 specimens were examined endosonographically in the laboratory while suspended vertically in a water tank on a specially constructed polyethylene jig [26]. Maximum ultrasonic depths of tumor where determined (Fig. 2) and subsequently com-



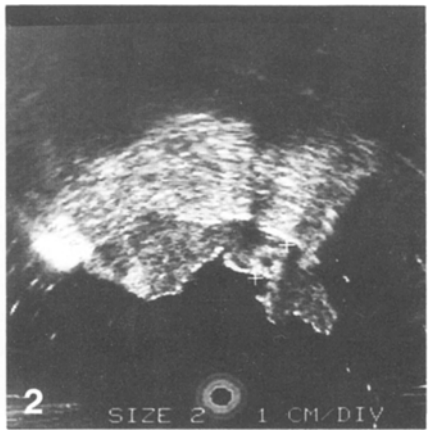
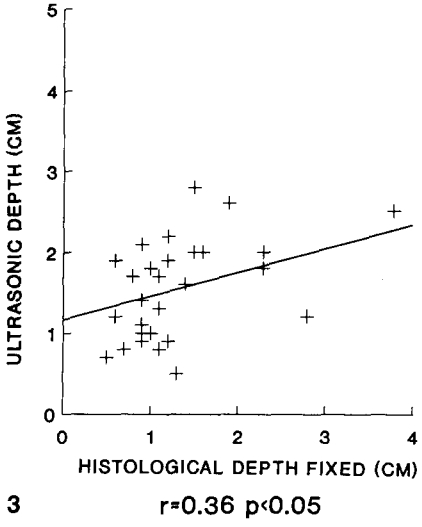
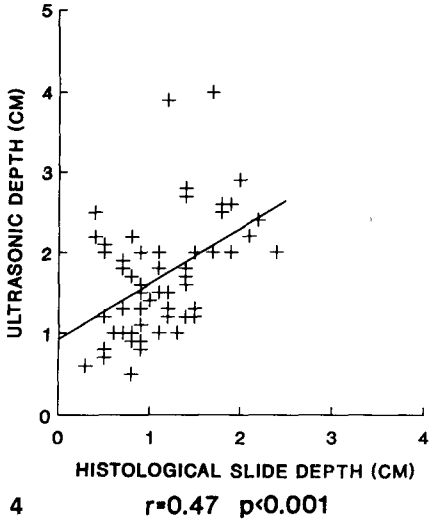
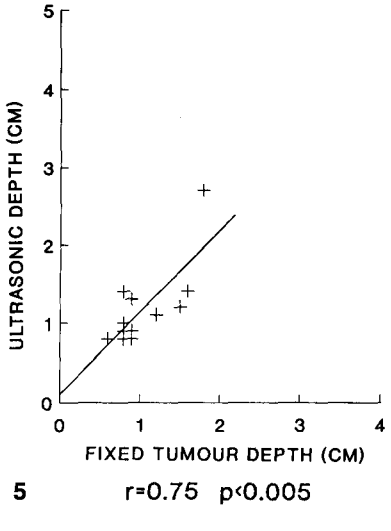


Fig. 1. Tumor depth estimation in an ultrasonic T3 tumor

Fig. 2. Ultrasonic depth estimation in vitro. The specimen has been suspended vertically in front of the probe







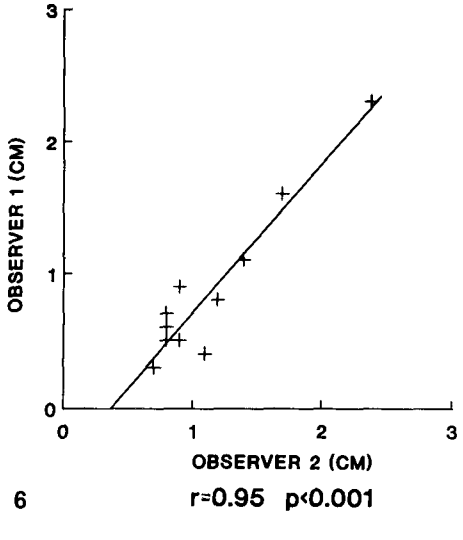


Fig. 3. Comparison of maximum ultrasonic depth of tumor with maximum depth measured on the fixed resected specimen ($n=30$)

Fig. 4. Comparison of maximum ultrasonic depth of tumor with maximum depth measured on the histological slides ($n=61$)

Fig. 5. In vitro estimations of ultrasonic depth compared with histological depths on the fixed specimen

Fig. 6. Comparison of the histological depths of tumor in two independent observers

pared with maximum histological depths measured on the fixed ($n=12$) and fresh ($n=5$) specimen. Two pathologists (JC/HR) were involved in the assessments of the histological slides and an assessment of observer variation was made on 12 tumours.

In this study a comparison of the ultrasonic depths of tumour have been made with the actual depths of tumour measured histopathologically. A correlation coefficient was calculated according to the methods of Siegal [27] using the Oxstat statistics package run on a IBM computer in the Department of Surgery, Bristol Royal Infirmary.

Results

Comparison of maximum tumour depth measured on the 30 fixed specimens with that measured on ES gave a corre-

lation coefficient of 0.362 ($df=28$, $p=0.05$, CI=95%) (Fig. 3). Secondly, comparison of the maximum endosonographic tumour depths with the maximum depths on the 61 paraffin sections gave a correlation coefficient of 0.46 ($df=58$, $p<0.001$, CI=99%) (Fig. 4).

The comparison of the laboratory estimations of ultrasonic depth of tumor with the maximum depth measure of the fixed specimens produced a correlation of 0.75 ($df=10$, $p=0.005$, CI=99%) (Fig. 5). Comparison of the endosonographic depths with those estimated from the fresh specimens gave a correlation of 0.79 ($df=5$, $p=0.036$, CI=95%).

The tumour depths measured both on the fixed specimen and the histological section have been compared and show a high degree of correlation ($r=0.75$, $df=26$, $p<0.001$, CI=99%).

In independently measuring the histological slide depths in twelve tumors the two pathologists achieved a correlation of 0.946 ($df=10$, $p<0.001$, CI=99%) (Fig. 6).

When examined endosonographically the two tumours which clinically were thought to be fixed were found to show invasion beyond the muscularis propria but no invasion into adjacent viscera. In both cases excision was deemed potentially curative clinically and histopathologically.

Discussion

Dukes and Bussey [1] found that extensive local invasion was a critical factor in determining survival. Their results showed that the extent of local spread was at least as important as lymphatic metastases, histological grading or venous invasion and was closely related to these factors.

The significant effect on survival of local tumour invasion was shown more recently by Gunderson and Sosin [3]. They reported on the reason for local treatment failure in 74 patients who underwent reoperation after apparently curative resection of carcinoma of the rectum. They found that survival rates decreased and local failures increased when tumours extended through the bowel wall and the degree of extra rectal spread was related to prognosis.

Local extension of tumour has also been found to be of greater significance in the development of local recurrence than regional nodal involvement. Moosa et al. found that local recurrence following abdomino-perineal resection was significantly higher in those patients with spread into the peri-rectal fat [4]. Godwin and Brown reporting the results of a multi-centre study of 11 374 patients found that those with 'limited extension' had almost a 50% improvement in survival when compared to those with 'further' extension [5]. These reports suggest that the local extent of disease was the variable with the greatest effect on survival.

Wood et al. have re-emphasised the importance of extramural tumour spread and proposed a classification based on the extent of local tumour invasion [2]. There were major differences in survival for Dukes' B and C1 cases in their prospective study of 404 patients if subdivided for the presence or absence of histologically confirmed local tumour invasion of adjacent structures. In 19% of resected Dukes' B tumours and 36% of C1 tumours local invasion was confirmed. Crude 5-year survival rates for all Dukes' B tumours was 85% and for Dukes' C1 tumours 83%. In contrast, if local invasion was present 4-year survival was 42% for Dukes' B cases and 20% for Dukes' C1. They concluded that local tumour invasion may have more effect on survival than early lymph node spread.

Clinical assessment of the extent of tumour invasion is subjective and it is impossible to differentiate between malignant and inflammatory fixation. Habib et al. have shown that survival rates in mobile tumours are improved when compared to fixed tumours [7]. In their study of 301 patients 5-year survival for mobile stage B tumours was 62%, comparing favourably with fixed stage B tumours and a survival rate of 26%. They also reported similar differences for the mobile and fixed C1 tumours (survival rates of 33% and 15%, respectively).

There are a number of studies on the effectiveness of endosonography in staging rectal cancer both for the extent of local disease and the involvement or otherwise of adjacent lymph nodes [8–24] but none to date have tried to correlate actual tumour depth with ultrasonic depth.

Measurement of rectal tumour depth ultrasonically in patients may be inaccurate when the probe is lying at an oblique angle within the rectum and not taking a true transverse section at that point (Fig. 7). This has been overcome in our second set of observations in the laboratory with the probe and tumours fixed at right angles to each other reducing this possible inaccuracy.

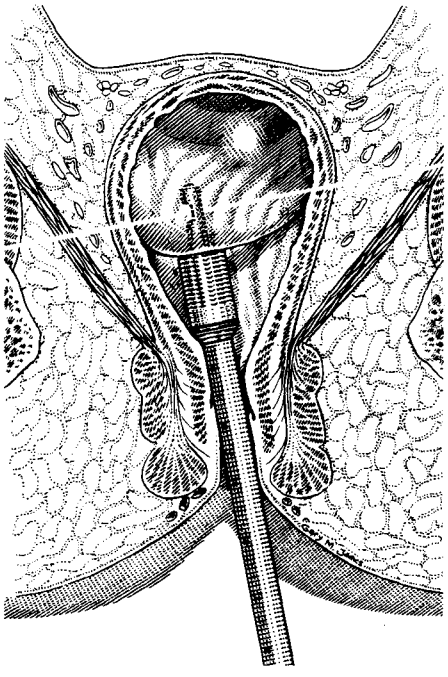


Fig. 7. The ultrasonic probe when present in the rectum may not be vertical, this error can be abolished in vitro by positioning the probe and specimen vertically

Table 1. Accuracy of endosonography for primary rectal cancer

	No. patients	No. correct	Accuracy (%)
Dragsted and Gammelgaard (1983)	13	11	85
Hildebrandt and Fiefel (1985)	25	23	92
Romano et al. (1985)	23	21	91
Saitoh et al. (1986)	88	79	90
Hildebrandt et al. (1986)	76	67	88
Rifkin and Wechsler (1986)	81	68	84
Acarpio et al. (1987)	54	51	94
Beynon (1989)	100	93	93
Holdsworth et al. (1988)	36	31	86
Orrom et al. (1990)	77	58	75
Glaser et al. (1990)	86	76	88

It appears from these data that ES may provide an objective method of differentiating inflammatory from malignant infiltration in rectal tumours since what is visualised endosonographically is almost tumour.

We and others have been able to show a high degree of correlation between ES and post-operative histopathology (Table 1). This prediction of the degree of local invasion is better than digital examination, the most commonly used method of clinical assessment [18].

We recommend that "fixed" tumours on palpation should be examined sonographically. Where there is evidence of major degrees of local extension or direct invasion of an adjacent organ demonstrated by rectal ultrasound preoperative radiotherapy is indicated. Where there is confinement to the rectal wall or only early local invasion even if the tumour feels fixed a trial surgical dissection of the pelvis is warranted.

References

1. Dukes CE, Bussey HJR (1985) The spread of rectal cancer and its effect on prognosis. Br J Cancer 12:309–320
2. Wood CB, Ratcliffe JG, Burt TW ET, Malcolm AJH, Blumgart LH (1981) Local tumour invasion as a prognostic factor in colorectal carcinoma. Br J Surg 68:326–328
3. Gunderson LL; Sosin H (1974) Areas of failure found at reoperation (second or symptomatic look) following "curative surgery" for adenocarcinoma of the rectum. Cancer 34:1278–1292
4. Moosa AR, Ree PC, Marks JE, Levin B, Platz CE, Skinner DB (1975) Factors influencing local recurrence after abdominoperineal resection for cancer of the rectum and rectosigmoid. Br J Surg 62:727–730
5. Godwin JC II, Brown CC (1975) Some prognostic factors in survival of patients with cancer of the colon and rectum. J Chronic Dis 28:441–454
6. Quirke P, Durdey P, Dixon MF, Williams NS (1986) Local recurrence of rectal adenocarcinoma due to inadequate surgical resection. Lancet 996–998
7. Habib NA, Peck MA, Sawyer CN, Blaxland JW, Luck RJ (1983) Does fixity affect prognosis in colorectal tumours? Br J Surg 70:423–424
8. Dragsted J, Gammelgaard J (1983) Endoluminal ultrasonic scanning in the evaluation of rectal cancer. Gastrointest Radiol 8:367–369
9. Hildebrandt U, Fiefel G (1985) Pre-operative staging of rectal cancer by intrarectal ultrasound. Dis Colon Rectum 28:42–46
10. Saitoh N, Okui K, Sarashina H, Suzuki M, Arai T, Nunomura M (1986) Evaluation of echographic diagnosis of rectal cancer using intrarectal ultrasonic examination. Dis Colon Rectum 29:234–242
11. Rifkin MD, Marks GJ (1985) Transrectal US as an adjunct in the diagnosis of rectal and extrarectal tumours. Rad 157:499–502
12. Hildebrandt U, Fiefel G, Schwarz HP, Scherr O (1986) Endorectal ultrasound: Instrumentation and clinical aspects. Int J Colorectal Dis 1:203–207
13. Beynon J, Mortensen NJMcC, Foy DMA, Channer JL, Virjee J, Goddard P (1986) Endorectal sonography: Laboratory and clinical experience in Bristol. Int J Colorectal Dis 1:212–215
14. Hildebrandt U, Fiefel G (1986) Endosonographische Bestimmung der Infiltrationstiefe und Beurteilung von Lymphknoten beim Rektumkarzinom. Ultraschall Klin Prax 1:89–94
15. Rifkin MD, Wechsler RJ (1986) A comparison of computed tomography and endorectal ultrasound in staging rectal cancer. Int J Colorect Dis 1:219–223
16. Romano G, De Rosa P, Vallone G, Rotondo A, Grassi R, Santangelo ML (1985) Intrarectal ultrasound and computed tomography in the pre- and post-operative assessment of patients with rectal carcinoma. Br J Surg 72:Supp S117–S119
17. Beynon J, Foy DMA, Roe AM, Temple LN, Mortensen NJMc (1986) Endoluminal ultrasound in the assessment of local invasion in rectal cancer. Br J Surg 73:474–477
18. Beynon J, Mortensen NJMcC, Foy DMA, Channer JL, Virjee J, Goddard P (1986) Pre-operative assessment of local invasion in rectal cancer: digital examination, endoluminal sonography or computed tomography? Br J Surg 73:1015–1017
19. Beynon J, Mortensen NJMcC, Foy DMA, Channer JL, Rigby H, Virjee J (1988) Pre-operative assessment of meso-rectal lymph node involvement in rectal cancer. Br J Surg 76:276–279
20. Beynon J (1989) An evaluation of the role of rectal endosonography in rectal cancer. Ann Roy Coll Surg of Eng 71:131–139
21. Kramann B, Hildebrandt U (1986) Computed tomography versus endosonography in the staging of rectal carcinoma: a comparative study. Int J Colorectal Dis 1:216–218
22. Holdsworth PJ, Johnston D, Chalmers AG, Chennels P, Dixon MF, Finan PJ, Primrose JN and Quirke P (1988) Endoluminal ultrasound and computed tomography in the staging of rectal cancer. Br J Surg 75:1019–1022
23. Orrom WJ, Wong WD, Rothenberger DA, Jensen LL, Goldberg SM (1990) Endorectal ultrasound in the preoperative staging of rectal tumours. A learning experience. Dis Colon Rectum 33:654–659
24. Glaser F, Schlag P, Herfarth Ch (1990) Endorectal ultrasonography for the assessment of invasion of rectal tumours and lymph node involvement. Br J Surg 77:883–887
25. Accarpio G, Scopinaro G, Claudiani F, Davini D, Mallarini D, Saitta S (1987) Experience with local rectal cancer excision in light of two recent preoperative diagnostic methods. Dis Colon Rectum 30:296–298
26. Beynon J, Foy DMA, Channer JL, Temple LN, Virjee J, Mortensen NJMcC (1986) The endosonic appearances of normal colon and rectum. Dis Colon Rectum 29:810–813
27. Siegal S (1956) Nonparametric Statistics for the Behavioural Sciences. McGraw-Hill Kogakusha, Tokyo

Mr. J. Beynon M.S. F.R.C.S.
Wrexham Maelor Hospital
Croesnewydd Road
Wrexham
Clwyd LL13 7TD
UK