Prospective Comparative Study of Magnetic Resonance Imaging Versus Transrectal Ultrasound for Preoperative Staging and Follow-Up of Rectal Cancer

Preliminary Report

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The efficiency of magnetic resonance imaging (MRI) and that of transrectal ultrasound (TRUS) were compared in preoperative staging of 15 patients with rectal cancer and in postoperative follow-up of 12 patients. Thirteen of the 15 patients evaluated for preoperative staging were operated on. Preoperative staging and pathologic finding were identical in 11 patients (84.6 percent) examined by TRUS and in 10 patients (76.9 percent) examined by MRI. Recurrent cancer was detected in 3 of 12 patients in the follow-up group. MRI was able to diagnose correctly 10 of 12 patients (83.2 percent), one patient was misdiagnosed, and in one patient the MRI could not distinguish between fibrous tissue and recurrent cancer. TRUS diagnosed correctly only 5 of 12 patients (41.6 percent). One was falsely diagnosed, and, in 6 patients (50 percent), this examination could not differentiate between fibrous tissue and recurrent tumor. According to our results, both MRI and TRUS have a place in the preoperative staging of patients with rectal cancer. The main differences between the two methods were in the differential diagnoses of fibrous tissue and recurrent cancer. MRI being more specific in detection of recurrence. [Key Words: Rectal cancer; Staging; Transrectal ultrasound; Magnetic resonance imaging]

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Preoperative staging of newly diagnosed rectal cancer is of major importance in planning treatment and evaluating the prognosis. A close follow-up of patients operated on for middle and low rectal cancer facilitated early detection of local recurrence, making reoperation still possible.

A number of options are available for detection and follow-up of rectal cancer, but the ability to evaluate the depth of tumor invasion through the rectal wall or the spread to regional lymph nodes remains limited. Computerized tomography (CT), transrectal ultrasound (TRUS), and magnetic resonance imaging (MRI) have been added in recent years to our diagnostic armamentarium, and numerous studies[1–5] have compared their efficacy in preoperative staging and detection of recurrences during postoperative follow-up. Both MRI and TRUS were found to be more accurate than CT.[3–6] We could find only one work comparing the efficiency of TRUS with that of MRI.[7]

The purpose of the present study was to evaluate and compare the abilities of MRI and TRUS to assess the depth of rectal wall invasion by rectal cancer preoperatively and in patients with recurrent tumors.

MATERIALS AND METHODS

Twenty-seven patients with rectal tumors were examined: 18 women and 9 men, ranging in age from 60 to 80 years (mean, 66 years). Fifteen were newly diagnosed patients (Group 1) in whom the examinations were a part of the preoperative evaluation, and 12 were follow-up patients (Group 2) who had undergone surgery for middle and low rectal cancer one to four years earlier. Eleven of

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these 12 patients underwent anterior resections, and one had a local excision of a malignant rectal polyp. Thirteen of the 15 newly diagnosed patients were operated on, the preoperative MRI and TRUS staging being compared with the histopathologic findings.

All 27 patients underwent routine barium enema and/or colonoscopy. Screening for distant metastases included carcinoembryonic antigen (CEA) blood samplings, chest x-ray, and abdominal ultrasound. All patients were examined by TRUS and MRI. TRUS was performed with an ultrasound scanner, Real Time Rotating Transrectal Ultrasound™ (Brul and Kjur; Denmark), using a 7-mHz probe. MRI was performed with a Telsa 0.5 Gyrex 5000™ system (Elscint; Israel). The patient was prepared with an enema two hours before examination. The scanning was done using T_1 short, T_1 and T_2 weighted images in coronary, axial, and sagittal scans.

Ultrasound grading assessed tumor invasion according to a modification of our previously published grading scale[4]: O, no tumor detected; A, tumor invasion to the mucosa and submucosa; B, tumor invasion to the muscular wall; and C, tumor invasion to perirectal fat and/or surrounding organs.

The examiner was instructed to search for recurrent tumor, to differentiate between perirectal fibrosis and tumor recurrence and/or invasions, and to try to detect lymph node(s) close to the rectal wall invaded by tumor. For this purpose, two stages were added: E (equivocal), fibrosis and malignant tissue cannot be differentiated; and C_1, tumor invading the rectal wall, with lymph nodes suspected to be invaded by tumor.

MRI grading was based on Thoeni *et al.*'s[8] classification: I, intraluminal rectal tumor without thickening of the rectal wall (equivalent to ultrasound Grade A); II, thickening of the rectal wall 0.5 cm or more without invasion to perirectal fat (equivalent to Grade B); IIIA, invasion to perirectal fat and muscles without spread to the pelvic walls (equivalent to Grade C); IIIB, spread of tumor to the pelvic walls; and IV, tumor of the pelvis with distant metastases. We add two more stages; E, tissue in the pelvis in the area of a previous operation that cannot be differentiated as fibrosis or recurrent cancer; and O, no tumor detected in the rectal wall (with or without fibrosis).

Pathologic staging was according to Dukes' and Bussey's classification.[9,10] This classification was used when our study was started three years ago; part of the way through, we changed the staging to the TNM method.

RESULTS

Preoperative Studies

Thirteen of the 15 newly diagnosed rectal cancer patients (Group 1) were operated on: three had abdominoperineal resections, eight had anterior resections, and two had local excisions. Two rectal cancer patients were defined as inoperable, and they were treated by irradiation and chemotherapy only (Table 1). Therefore, MRI and TRUS results were compared only in the 13 patients operated upon, in whom histopathologic staging was available, including the two with local excisions, where a full thickness of the rectal wall was examined.

TRUS examination diagnosed one patient as Stage A, three as Stage B, and nine as Stage C (Fig. 1). Comparison with the histologic findings showed accurate staging in eight of nine cases diagnosed as Stage C; histologic evidence showed one case to be Stage B. Three of four cases diagnosed by TRUS as Stage A or B were found to be accurate; one was found histologically to be Stage C. Overall, there was accuracy in 11 of 13 patients (84.6 percent).

MRI examination placed four patients in Grade II, eight patients in Grade IIIA, and one patient in Grade IIIB. Histopathologic data showed that one patient graded as II should have been graded IIIA, one patient of eight graded IIIA should have been graded II, and one patient graded IIIB should have been graded IIIA (Fig. 2). Thus, overall accuracy of MRI in this group occurred with 10 of 13 examinations (76.9 percent). The difference in accuracy between the two examinations was not statistically significant in this group (Fig. 3).

Follow-Up Studies

Twelve patients who were followed up one to four years after surgery (Group 2) underwent MRI

Table 1.
Group 1 Patients' Types of Operations

Operation	Number of Patients
Low anterior resection	8
Abdominoperineal resection	3
Local excision	2
Irradiation and chemotherapy	2
Total	15

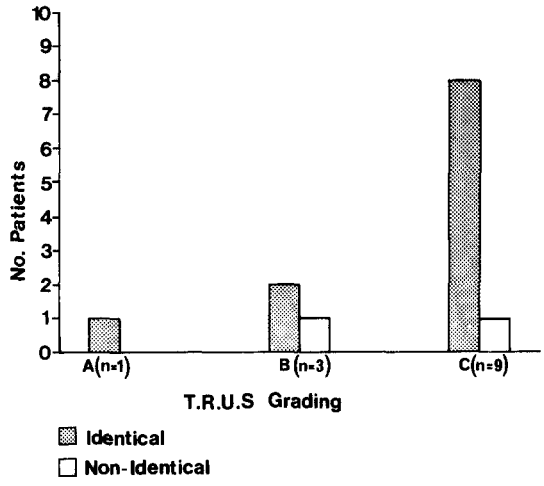

Figure 1. Transrectal ultrasound grading compared with pathologic staging after operation (Group 1).

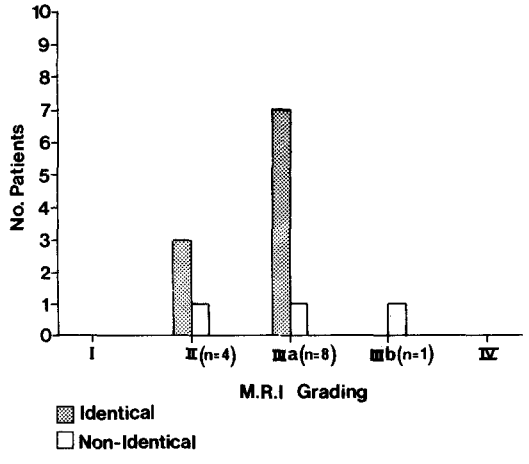

Figure 2. Magnetic resonance imaging grading compared with pathologic staging after operation (Group 1).

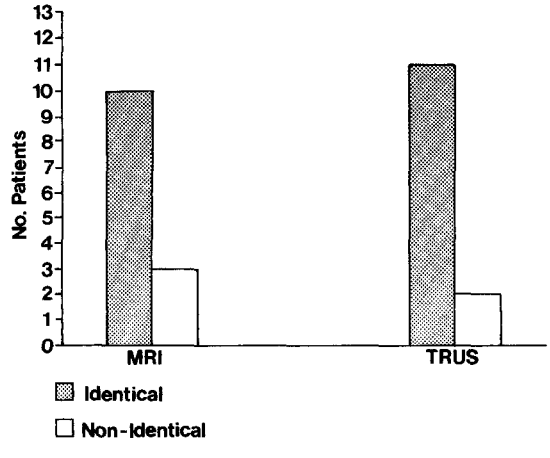

Figure 3. Comparison of MRI and TRUS in the newly diagnosed cancer patients (Group 1).

and TRUS once, at which time CEA blood sampling was also taken. Results were expressed as follows: O, no tumor found; E (equivocal), the result cannot be definitively interpreted; or RT, recurrent tumor in the bowel wall, perirectal fat, or regional lymph nodes.

Results of TRUS were as follows: three patients were classified as O, three as RT, and six as E (Fig. 4). Of the six cases classified as O or RT, the follow-up data showed five to be accurate and one to be false positive. Of the six equivocal cases, one was diagnosed by rectoscopy and biopsy as recurrent tumor (Fig. 5).

MRI results were as follows: seven patients were classified as O, four as RT, and one as E (Fig. 4). Of the four interpreted as RT, one was false positive and proved to be fibrosis on biopsy and subsequent follow-up. Overall accuracy of MRI occurred with 10 of 12 examinations (83.2 percent), while that of TRUS occurred with only 5 of 12 examinations (41.6 percent) (Fig. 5).

Three of the 12 follow-up patients were found to have recurrent rectal carcinoma during the first two years of follow-up. Two of them had CEA levels above 3 μg percent. Abdominoperineal resection

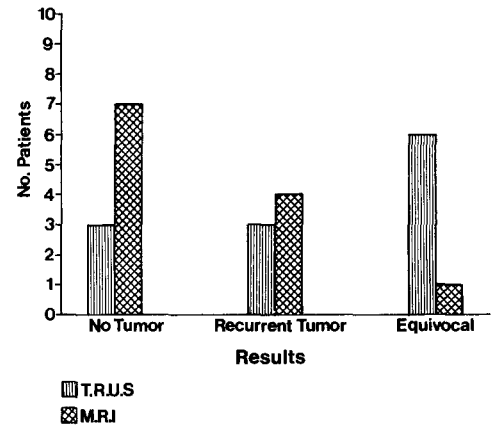

Figure 4. Results of tumor detections by TRUS and MRI in the follow-up group (Group 2).

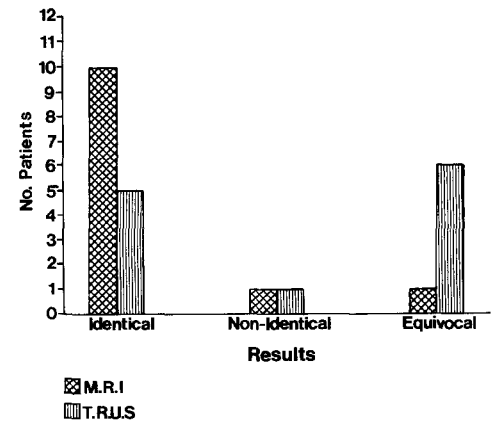

Figure 5. Comparison of tumor detections by TRUS and MRI with patients' outcome during follow-up (Group 2).

was performed on two of them; one was not reoperated on because of metastatic liver.

DISCUSSION

Determination of the depth of tumor invasion through the rectal wall by carcinoma of the rectum is essential for planning treatment and establishing prognosis. It has become increasingly important following recent reports of the beneficial effect of preoperative irradiation in selected cases of rectal cancer.[11,12]

Lazorthes *et al.*[13] reported a direct correlation between histopathologic staging and distal intramural infiltration by tumor, a fact of major importance in the decision to resect the macroscopic, distal, tumor-free margin. The standard preoperative diagnostic examinations, barium enema and sigmoidoscopy, do not provide information on the depth of invasion to the rectal wall, and, although there is good correlation between digital rectal examination by an experienced surgeon[4,14] and the pathologic examination, most surgeons prefer objective support for their subjective impression. The differentiation between local recurrence of rectal cancer and postoperative fibrous reaction is a problem that remains to be solved. The three options available today for assessment of cancer invasion preoperatively and for postoperative follow-up are CT, MRI, and TRUS. CT is considered a reliable tool for diagnosing tumor invasion preoperatively[6,8] and postoperatively,[15] although earlier work by our group and others[4,5,16] showed low sensitivity and reliability of pelvic CT scan examinations.

Numerous studies[1,2,4,7] have shown TRUS to be highly accurate, as high as 90 percent, in diagnosing and staging rectal cancer according to tumor invasiveness; TRUS proved capable of distinguishing among tumor invasions to the five layers of the rectal wall.[17] Comparison between TRUS preoperative assessment and postoperative pathologic findings reached 88 to 100 percent accuracy.[2,15] Comparison between TRUS and pelvic CT[4,7,18] showed TRUS to be more sensitive in identifying tumor in the rectal wall and its depth of invasion. On the other hand, we had difficulty with TRUS in identifying lymph nodes invaded by tumor and in distinguishing postoperatively between recurrent tumor and fibrosis. Beynon *et al.*[18,19] succeeded, using TRUS, in identifying mesorectal lymph nodes invaded by tumor with an accuracy of 83 percent.

MRI was found to distinguish between fibrosis following surgery and irradiation and recurrent carcinoma.[3,5,20] Recent studies compared MRI and CT in identification of fibrosis from recurrent tumor,[5-7] while only a few studies have been published comparing this capability by MRI and TRUS. Satoh *et al.*[7] compared MRI, CT, and TRUS. TRUS was superior to MRI and CT for detailed diagnosis of tumor invasion; MRI was the best examination for determination of resectability of recurrent tumor.

Our results show no significant difference between MRI and TRUS in the preoperative group; both demonstrated good accuracy: 76.9 percent and 84.6 percent, respectively. However, MRI was more accurate and gave better results in the postoperative follow-up group. The most pronounced difference was in the inability of TRUS to differentiate between recurrent tumor and fibrosis in 50 percent of cases (6 of 12 patients), while MRI had an 83.2 percent accuracy rate (10 of 12 patients), with only one case diagnosed as equivocal. MRI also gave more information regarding metastatic spread to local lymph nodes.

These differences were statistically significant using the correlated chi-squared test. *P* values were borderline (0.1094) because of the small number of patients and the short follow-up of one to four years' duration.

In conclusion, MRI and TRUS exhibited similar accuracy and reliability in preoperative diagnosis and staging of carcinoma of the middle to low rectum, while MRI proved more accurate and sensitive in postoperative assessment, especially in differentiating between local recurrence and fibrosis. These findings, despite being statistically of borderline significance, require confirmation on larger series of patients and for longer periods of follow-up.

REFERENCES

1. Hildebrandt U, Feifel G. Preoperative staging of rectal cancer by intrarectal ultrasound. Dis Colon Rectum 1985;28:42–6.
2. Beynon J, Mortensen NJ McC, Foy DM, Channer JL, Virgee J, Goddard P. Pre-operative assessment of local invasion in rectal cancer: digital examination, endoluminal sonography, or computed tomography? Br J Surg 1986;73:1015–7.
3. Krestin GP, Steibrich W, Friedmann G. Recurrent rectal cancer: diagnosis with MR imaging versus CT. Radiology 1988;168:307–11.
4. Waizer A, Zitron S, Ben-Baruch D, Baniel J, Wolloch

Y, Dintsman M. Comparative study for preoperative staging of rectal cancer. Dis Colon Rectum 1989; 32:53–6.

5. Gomberg JS, Friedman AC, Radecki PD, Grumbach K, Caroline DF. MRI differentiation of recurrent colorectal carcinoma from postoperative fibrosis. Gastrointest Radiol 1986;11:361–3.
6. Hodgman CG, MacCarty RL, Wolff BG, *et al.* Preoperative staging of rectal carcinoma by computed tomography and 0.15T magnetic resonance imaging: preliminary report. Dis Colon Rectum 1986;29: 446–50.
7. Satoh N, Ihara M, Sarahina H, *et al.* Studies of diagnosis of rectal cancer using MRI, CT and intrarectal ultrasonography. Rinsho Hoshasen 1989;34:573–81.
8. Thoeni RF, Moss AA, Schnyder P, Margulis AR. Detection and staging of primary rectal and rectosigmoid cancer by computed tomography. Radiology 1981;141:135–8.
9. Gabriel WB, Dukes CE, Bussey HJ. Lymphatic spread of cancer of the rectum. Br J Surg 1935;23: 395–413.
10. Zinkin LD. A critical review of the classifications and staging of colorectal cancer. Dis Colon Rectum 1983;26:37–43.
11. Kodner IF, Shemesh EI, Fry RD, *et al.* Preoperative irradiation for rectal cancer. Ann Surg 1989;209: 194–9.
12. Pahlman L, Glimelius B. Pre- or postoperative radiotherapy in rectal and rectosigmoid carcinoma. Ann Surg 1990;211:187–95.
13. Lazorthes F, Voigt JJ, Roques J, Chiotasso P, Chevreau P. Distal intramural spread of carcinoma of the rectum correlated with lymph nodal involvement. Surg Gynecol Obstet 1990;170:45–8.
14. Nicholls RJ, Mason AY, Morson BC, Dixon AK, Fry IK. The clinical staging of rectal cancer. Br J Surg 1982;69:404–9.
15. Grabbe E, Winkler R. Local recurrence after sphincter saving resection for rectal and rectosigmoid carcinoma. Radiology 1985;155:305–10.
16. Butch RJ, Stark DD, Wittenberg J. Staging of rectal cancer by MRI and CT. AJR 1986;146:1155–60.
17. Konishi F, Muto T, Takahashi H, Itoh K, Kanazawa K, Morioka Y. Transrectal ultrasound for the assessment of invasion of rectal carcinoma. Dis Colon Rectum 1985;28:889–94.
18. Beynon J. An evaluation of the role of rectal endosonography in rectal cancer. Ann R Coll Surg Engl 1989;71:131–9.
19. Beynon J, Mortensen NJ, Foy DM, Channer JL, Rigby H, Virjee J. Preoperative assessment of mesorectal lymph node involvement in rectal cancer. Br J Surg 1989;76:276–9.
20. De-Lange EE, Fechner RE, Wanebo HJ. Suspected recurrent rectosigmoid carcinoma after abdominoperineal resection: MR imaging and histopathologic findings. Radiology 1989;170:323–8.