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Value of endorectal coil versus body coil MRI for diagnosis of recurrent pelvic malignancies

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Abstract

Background: To compare endorectal coil magnetic resonance imaging (MRI) with body coil MRI in detecting local recurrence of gynecologic tumors and prostate and rectal cancers.

Methods: Forty-six patients with suspected recurrent pelvic malignancies (13 gynecologic, 15 prostatic, and 18 anorectal primaries) were enrolled in the study. Axial T1- and T2-weighted body coil images and T2- and contrast-enhanced T1-weighted axial endorectal coil images were obtained on a 1.5 T system. Results of the MR examinations were compared with histogical findings and follow-up examinations with respect to the diagnostic accuracy and diagnostic confidence for assessment or exclusion of local recurrence.

Results: Recurrent disease was histologically confirmed in eight patients with primary gynecologic malignancies, seven with suspected prostatic recurrence, and seven with suspected anorectal recurrence. Overall, accuracy of body coil MRI was 67% for gynecologic tumors, 36% for prostatic recurrences, and 59% for rectal recurrences. T2- and contrast-enhanced T1-weighted endorectal sequences yielded similar results, with an accuracy of 73% for depiction of gynecologic recurrence, 77% for prostatic recurrence, and 77% for rectal recurrence. The difference in accuracy between body coil and endorectal coil examinations was statistically significant ($p < 0.05$) only for prostatic cancer. Diagnostic confidence was, however, significantly improved ($p < 0.05$) in all tumors (T2-weighted endorectal coil examination was superior to T2-weighted body coil images in 71% of cases).

Conclusion: Although the results of endorectal coil MRI are only slightly superior to those of body coil MRI for the detection of recurrent gynecologic and anorectal tumors, diagnosis can be made with greater diagnostic confidence in many cases. For detection of prostatic recurrence, endorectal MRI is highly recommended.

Key words: MRI—Endorectal surface coil—Body coil—Recurrence—Prostate carcinoma—Gynecologic cancer—Anorectal carcinoma.

Diagnosis of recurrent malignant disease in the pelvis is often difficult. The symptoms may be unspecific, and scar tissue or fibrosis following surgery or radiation therapy can mimic tumor recurrence. Clinical examination and tumor markers are used for follow up of oncologic patients; however, their value is limited. At present, endoluminal sonography, computed tomography (CT), and magnetic resonance imaging (MRI) are the most accepted imaging modalities for detection of recurrent gynecologic, prostatic, and rectal tumors [1–7].

Endorectal surface coils proved to be useful for MR examination of the pelvis [8–12]. Due to an increased signal-to-noise ratio, they provide higher spatial resolution than body coil MRI. This increased spatial resolution should be beneficial, especially in patients with suspected recurrent malignancies, in whom anatomic structures are altered by previous surgery.

The aim of this study was to compare endorectal coil MRI with body coil MRI in the detection of local

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recurrent gynecologic tumors and prostate and rectal cancers.

Materials and Methods

Patient Population

Forty-six consecutive patients with suspected recurrent malignancies of the pelvis were enrolled in the study. Fifteen of these patients (mean = 59.8 years old, range = 19–85 years old) were referred for suspected local recurrence of malignant gynecologic tumors. Primary tumors were cervical (n = 9), endometrial (n = 5), and ovarian carcinoma (n = 1). Twelve patients had undergone total hysterectomy and bilateral adnexectomy, with additional radiation therapy in three cases. Two patients had had hysterectomy without adnexectomy. One patient underwent radiation therapy only. All patients were examined at least 10 months (10 months to 15 years) after completion of initial treatment. Suspicion of recurrent disease was based on gynecologic examination in seven patients, clinical symptoms (tenesms, stool irregularities, pain, dysuria) in four, equivocal findings at CT in two, and transvaginal ultrasound in two. In eight of these patients, recurrent disease was confirmed by biopsy; in the other seven patients, a recurrence was excluded based on biopsy (n = 5) or follow-up examinations for over 12 months (n = 2).

Thirteen patients (mean = 67.8 years old, ragne = 53–78 years old) had suspected recurrent prostate cancer. All patients had undergone radical prostatectomy at least 12 months prior to the actual examination. None of the patients was treated by additional radiation therapy. The primary lesion was stage pT2 in seven patients and stage pT3 in the other six. One patient with stage pT3 disease had a positive surgical margin at pathology. Suspicion for a recurrence was raised by increasing and elevated prostate-specific antigen (PSA) levels (>5.0 mg/L, n = 10) or unclear digital rectal examination (n = 5). In seven of these patients, a recurrent tumor was confirmed by biopsy; in the six other patients, a recurrence was excluded by multiple biopsies (n = 3) or by follow-up examinations for 11–17 months (n = 3).

Eighteen patients (mean = 59.1 years old, range = 38–76 years old) were enrolled in the study for suspected recurrent anorectal cancer. The primaries were adenocarcinomas of the rectum or sigmoid (n = 16) and anal carcinoma (n = 2). None of the patients had undergone additional radiation therapy. The primary tumors had been treated at least 12 months prior to the actual exam by rectosigmoid resection in 10 patients, lower anterior resection in four, and local tumor extirpation in four. Recurrent disease was suspected because of patients' symptoms (tenesms, melena, stool irregularities, n = 11), equivocal or suspicious endorectal ultrasound findings (n = 10), digital examination (n = 1), and elevated serum CEA levels (n = 3). In one patient with recurrent disease, the endorectal coil could not be inserted, and only body coil images were obtained. This case was therefore excluded from the study population. A recurrent tumor was confirmed by biopsies in six patients amenable to endorectal coil examinations. In the other 11 patients, tumor recurrence was excluded by multiple biopsies (n = 5) or by follow-up by endoscopic ultrasound and clinical examination for over 12 months (n = 6).

MRI

All imaging was performed on a 1.5 T MRI system (Signa, General Electric Medical Systems, Milwaukee, WI, USA). For the body coil examination, axial T1-weighted spin echo (SE; TR = 500 ms, TE = 11–17 ms) and axial T2-weighted fast spin echo (FSE; TR = 3500–5000 ms, TE = 85–102 ms) images were performed. The images were acquired by using a 256 × 192 image matrix, a 28–32-cm field of view (FOV), two NEX, and 7-mm section thickness with a 1.5-mm intersection gap. In 17 patients, additional sagittal T2-weighted FSE images were obtained with the body coil. In five cases, fat saturation was employed for the axial T2-weighted sequence.

Following insertion of the endorectal surface coil (Medrad, Pittsburgh, PA, USA), sagittal localizing images using the body coil as a receiver were obtained to confirm the correct coil position. Based on these, subsequent images were planned. Axial and additional oblique coronal (n = 19) or sagittal (n = 5) T2-weighted FSE images (TR = 4500–5000 ms, TE = 95–115 ms) were acquired with the endorectal coil with the following imaging parameters: 3-mm section thickness, 1-mm intersection gap, 256 × 256 image matrix, two NEX, and a 16-cm FOV. Axial T1-weighted images (TR = 500 ms, TE = 12–27 ms) with the endorectal coil were performed following administration of contrast material (0.1 mmol/kg bw Gd-DOTA, Guerbet, Charles de Gaulle, France) in all cases.

Image Analysis

MR examinations were assessed retrospectively, blinded to the final histologic results for the presence of recurrent tumor, size of the lesions, and involvement of adjacent anatomic structures. In patients with rectal or gynecologic tumors as primaries, recurrence was suspected if a lesion was detected that was relatively hyperintense on T2-weighted images and enhanced on contrast-enhanced T1-weighted images [1, 2]. In patients with primary prostate cancer, a recurrence was diagnosed if the remaining hyperintense tissue in the prostatic fossa showed hypointense areas on T2-weighted sequences and contrast-enhancement on T1-weighted images.

Interpretations were performed separately based on axial body coil images, axial T2-weighted endorectal coil images, and axial contrast-enhanced T1-weighted endorectal coil images. Diagnostic confidence was further compared between body coil and endorectal coil T2-weighted and between endorectal T2-weighted and endorectal contrast-enhanced T1-weighted image sets and classified as equal, inferior, or superior. The extent of motion artifacts for each sequence was classified as artifact free (0), mild (+), moderate (++), and severe (+++).

Statistical Analysis

Diagnostic accuracy, sensitivity, specificity, and negative and positive predictive values were determined for body coil and endorectal coil T2- and T1-weighted MR examinations. For the purpose of statistical analysis, equivocal findings were considered as false results. Body coil, endorectal T2-weighted, and endorectal contrast-enhanced T1-weighted sequences were compared pairwise with regard to sensitivity, specificity, and accuracy: a fourfold table was contructed by cross-tabulating results of two different sequences, and off-diagonal elements were tested for hypothesis of equal frequency (McNemar's test).

Diagnostic confidence in establishing a correct diagnosis was compared for the body coil versus endorectal coil T2-weighted sequences and for the endorectal T2-weighted versus endorectal contrast-enhanced T1-weighted sequences by the Wilcoxon rank-sum test (superior = 2, equal = 1, inferior = 0).

Results

Recurrenct Gynecologic Cancer

Recurrent disease was correctly detected with body coil MRI in four of eight patients; on endorectal T2-weighted

and T1-weighted contrast-enhanced sequences, recurrence was detected in one additional patient. Malignancy was correctly excluded with each sequence in six of the seven other patients (Figs. 1, 2, Table 1). The differences in accuracy, sensitivity, and specificity of endorectal coil MRI versus body coil MRI were not statistically significant.

The diagnostic confidence of the T2-weighted endorectal coil examinations was superior to the T2-weighted body coil examination in 11 patients (68.8%) and comparable in five (31.2%). The difference between body coil and endorectal coil sequences was statisticaly significant ($p < 0.05$). The endorectal T2-weighted and endorectal contrast-enhanced T1-weighted sequences yielded a similar diagnostic confidence in eight patients (53.3%). In two patients (13.3%), the endorectal T2-weighted images were superior due to better delineation of pathologic structures. In the remaining five patients (33.3%), the T2-weighted sequence was inferior: in one case, delineation of the pathology was superior on the contrast-enhanced sequence, and in the other four cases, image quality of the T2-weighted sequence was degraded by artifacts. However, the difference in diagnostic confidence between T2-weighted and contrast-enhanced T1-weighted endorectal coil images was not statisticaly significant. Severe motion artifacts were seen in two T2-weighted endorectal examinations (12.5%). Six endorectal T2-weighted and two endorectal T1-weighted examinations were degraded by moderate artifacts (Table 4).

Recurrent Prostate Cancer

On the body coil examination, recurrent disease was correctly detected in only two patients and excluded in two others. The results were falsely positive in one patient and falsely negative in four; in the remaining four patients, the findings were equivocal, and a definite diagnosis was not possible (Table 2).

On T2-weighted and T1-weighted contrast-enhanced endorectal coil images, recurrence was correctly diagnosed in six patients and excluded in four. Diagnoses were falsely positive in two patients and falsely negative in one (Figs. 3–5, Table 2).

The diagnostic accuracy of the T2-weighted and contrast-enhanced T1-weighted endorectal coil images was significantly higher than that of the body coil sequence ($p < 0.05$). Due to the small number of cases, a significant difference could not be shown for sensitivity and specificity values.

The diagnostic confidence was significantly improved by the endorectal coil examination. The endorectal T2-weighted sequence was superior to the body coil examination in eight patients (61.5%). In four patients (30.8%), the two modalities were equivalent, and, in one case (7.7%), the body coil examination was superior due to a pararectal enlarged lymph node that was not visible on the endorectal coil examination. Comparing the two endorectal coil sequences, diagnostic confidence was equal with both modalities in seven patients (53.8%). In four patients (30.8%), the T1-weighted contrast-enhanced sequence was superior due to the additional information of enhancement patterns. In two patients (15.4%), the T1-weighted sequence was inferior.

None of the examinations showed severe motion artifacts. Moderate artifacts were present in three endorectal T2-weighted (23.1%) and one endorectal T1-weighted (7.7%) examinations. Mild artifacts were found in six T2-weighted (46.2%) and one T1-weighted (7.7%) endorectal coil examinations.

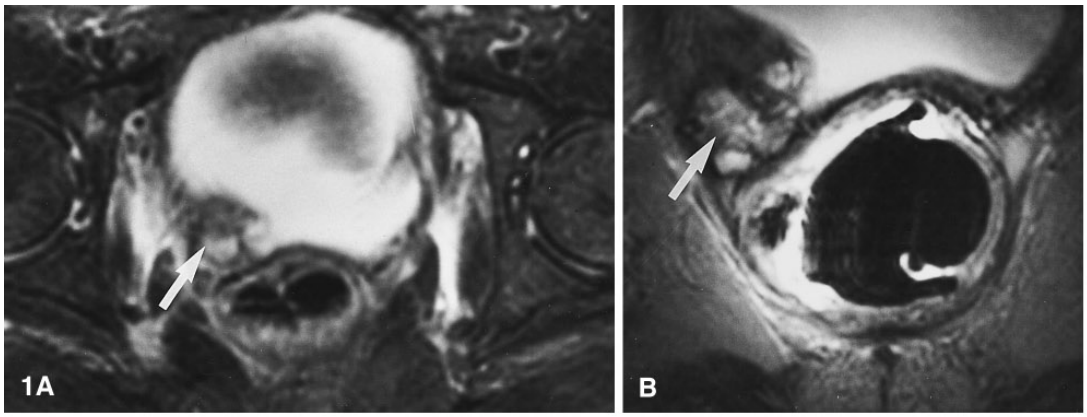
Recurrent Anorectal Cancer

Malignancy was correctly detected on body coil MRI in one patient and correctly excluded in nine (Fig. 6). In two patients, recurrent tumors were missed, and a false positive diagnosis was made in one. In the remaining four patients, body coil MRI findings were equivocal (Table 3).

Recurrent tumors were depicted in three of six cases on the endorectal coil T2-weighted images (Fig. 6). Due to avid contrast enhancement, recurrence was correctly diagnosed on the endorectal coil T1-weighted images in four patients. Recurrence was correctly excluded in 10 of 11 cases on endorectal T2-weighted and nine of 11 cases on contrast-enhanced T1-weighted images (Table 3). The differences in accuracy, sensitivity, and specificity of endorectal coil MRI versus body coil MRI were not statistically significant.

Diagnostic confidence was significantly improved by the use of the T2-weighted and contrast-enhanced T1-weighted endorectal sequences ($p < 0.05$). In 13 patients, the diagnostic confidence of the endorectal coil sequences was superior to the body coil examination (76.5%) mainly due to the distended bowel and increased spatial resolution. In the other four patients, body coil and endorectal coil examinations were equivalent. In two of these cases, the diagnosis was already obvious on the body coil examination; the endorectal surface coil could not be placed correctly in one case, and image quality of the endorectal examination was strongly degraded in the last case.

Diagnostic confidence of T2-weighted and T1-weighted contrast-enhanced endorectal coil sequences was similar in eight cases (47.1%). In one case (5.9%), recurrence could be excluded on the T2-weighted endorectal coil image, and a diffuse enhancement on the contrast-enhanced T1-weighted sequence yielded an equivocal result. In the other eight cases (47.1%), the contrast-enhanced sequence was superior due to fewer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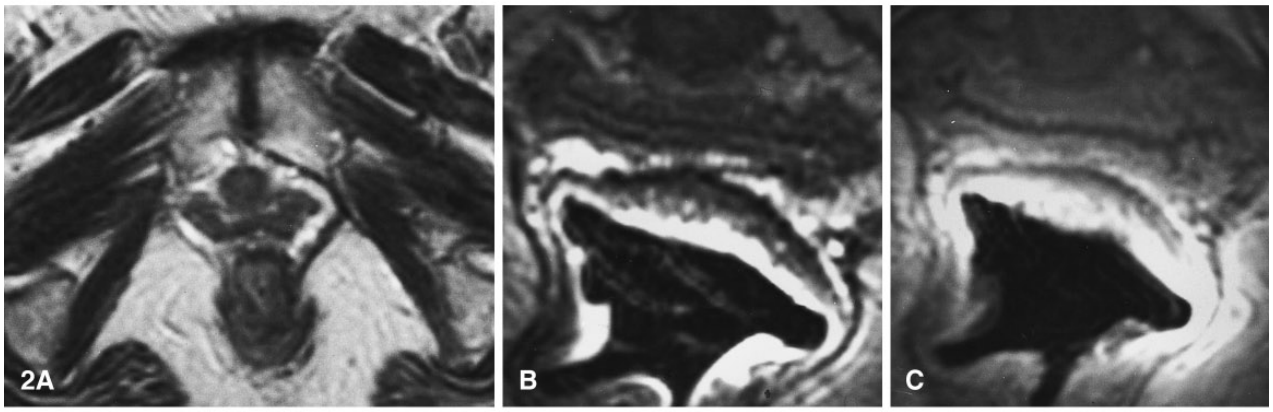
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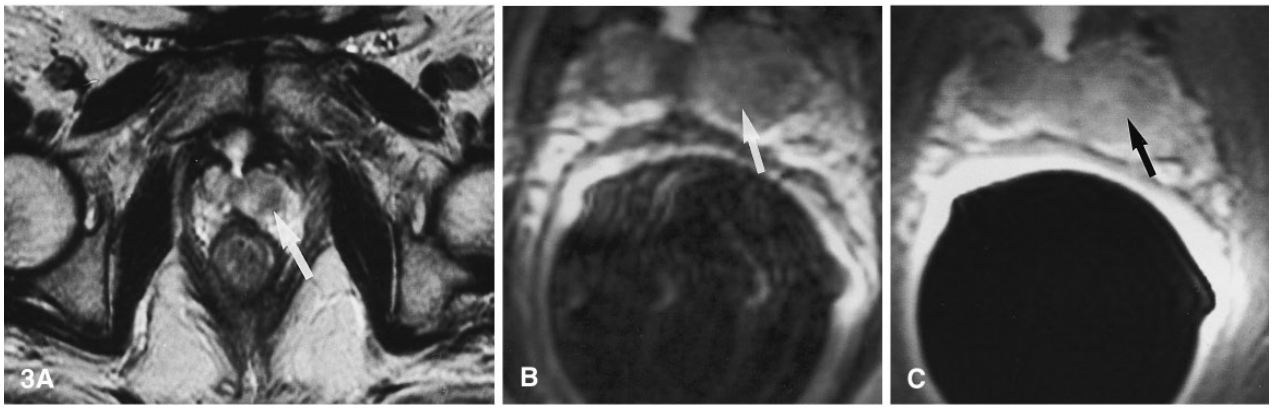
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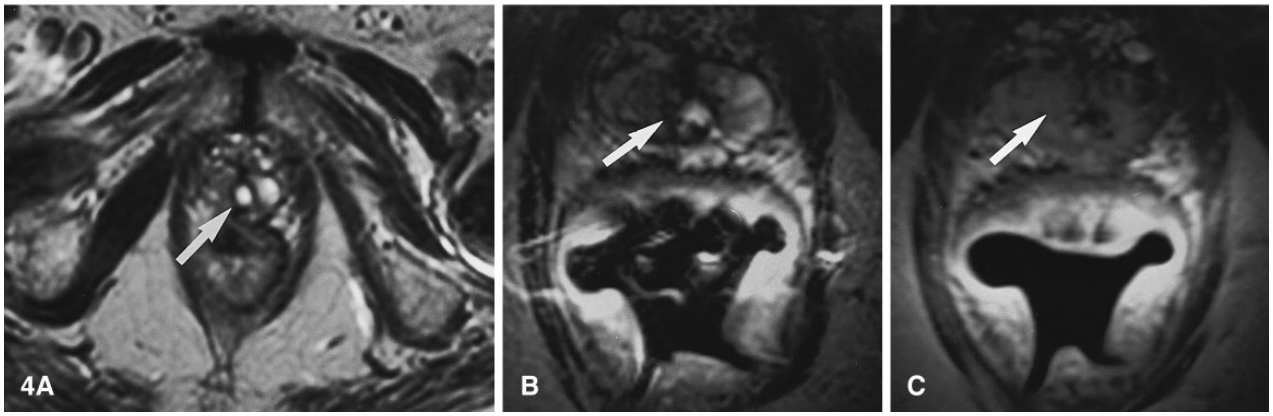
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Table 1. Detection of recurrent gynecologic cancer[a]

Sequence	Sensitivity (%)	Specificity (%)	ppv (%)	npv (%)	Accuracy (%)
bc T1, T2	50.0	85.7	80.0	60.0	66.7
ec T2	62.5	85.7	83.3	66.7	73.3
ec T1C	62.5	85.7	83.3	66.7	73.3

[a] ppv = positive predictive value, npv = negative predictive value, bc T1, T2 = body coil MRI, ec T2 = T2-weighted endorectal coil images, ec T1C = T1-weighted contrast-enhanced T1-weighted image

Table 2. Detection of recurrent prostate cancer

Sequence	Sensitivity (%)	Specificity (%)	ppv (%)	npv (%)	Accuracy (%)
bc T1, T2	28.6	33.3	25.0	28.6	36.4
ec T2	85.7	66.7	75.0	80.0	76.9
ec T1C	85.7	66.7	75.0	80.0	76.9

Fig. 1. A 50-year-old woman with histologically confirmed, second recurrence of a primary cervical stage IIb carcinoma. **A** Axial T2-weighted fat-suppressed FSE body coil MRI: inhomogeneous, mostly hyperintense right parasagittal lesion located behind the urinary bladder (*arrow*). **B** Axial T2-weighted FSE endorectal coil image: the inhomogeneous lesion is visualized with a higher spatial resolution, and the relation to the compressed bladder wall is more obvious (*arrow*).

Fig. 2. A 58-year-old woman with clinically suspected, recurrent cervical carcinoma (primary stage IIB). Recurrence could be excluded by clinical and ultrasonographic follow-up examination over 1.5 years. **A** Axial T2-weighted FSE body coil image shows the normal appearance of the vagina. **B** Axial T2-weighted endorectal coil image: the normal vagina is clearly visualized, and a recurrent tumor can be excluded with greater diagnostic confidence. **C** Axial contrast-enhanced T1-weighted endorectal coil image shows the homogeneous enhancement of the vaginal wall and confirms the result of the other sequences.

Fig. 3. A 67-year-old man with histologically proven, recurrent prostate cancer. **A** Axial T2-weighted body coil image shows inhomogeneous lobulated soft tissue in the prostatic fossa (*arrow*). **B** Axial T2-weighted endorectal coil image shows inhomogeneous lesion depicted to a better advantage (*arrow*). **C** Axial contrast-enhanced endorectal coil image shows the lesion demonstrating a homogeneous marked enhancement, characteristic for recurrent cancer (*arrow*).

Fig. 4. A 75-year-old man with recurrent prostate cancer. **A** Axial T2-weighted body coil image: at the level of the vesico-urethral anastomosis, low signal intensity tissue on the right suggests fibrotic scar (*arrow*), and a high signal intensity area on the left represents remnant prostatic tissue. **B** Axial T2-weighted endorectal coil image: the hypointense area on the ride side is clearly located within the prostatic tissue and is therefore consistent with recurrent tumor (*arrow*). **C** Axial contrast-enhanced T1-weighted endorectal coil image: the lesion is enhanced following administration of contrast material. Lesion detection is, however, not improved (*arrow*).

artifacts (n = 4) or additional information given by the contrast-enhancement pattern (n = 6). The diagnostic confidence of the T1-weighted contrast-enhanced endorectal coil images was significantly improved compared with the T2-weighted endorectal sequence ($p < 0.05$).

Severe motion artifacts were present in three of the T2-weighted sequences (17.6%) but in none of the T1-weighted endorectal coil examinations. Moderate artifacts were present in six T2-weighted endorectal coil examinations (35.3%) and one T1-weighted endorectal coil examination (5.9%). The body coil examinations were not degraded by motion artifacts.

Discussion

Most recurrent tumors appear within the first years after treatment. Clinical examinations are often equivocal, and symptoms may occur late. Tumor markers for recurrent gynecologic and anorectal cancers are not always reliable [13, 14]. Although PSA is highly sensitive for prostatic carcinoma, increasing levels after radical prostatectomy can indicate recurrence and distant metastases [15, 16]. Thus, imaging modalities such as endoluminal sonography, CT, MRI, and, more recently, positron emission tomography are being employed in the follow up of these patients [12–14, 17–22].

MRI proved to be most valuable in the evaluation of the pelvis by offering the advantage of high tissue contrast, multiplanar imaging capabilites, and high spatial resolution. The latter can be further increased by the use of an endorectal surface coil [11, 23–28]. The high spatial resolution of endorectal MRI was helpful in the detection of the often small recurrent tumors; in our study, only one lesion exceeded 3 cm in size.

In this study, as expected, diagnostic accuracy in detecting recurrent pelvic malignancies could be significantly improved by using the endorectal coil (overall accuracy for all cases was 75.6% with the endorectal coil versus 53.3% with the body coil). The results were different for the three included primary malignancies. Endorectal coil examinations were significantly superior to the body coil examination in prostate carcinoma, but only slightly better in anorectal cancer, and similar in patients with gynecologic tumors. This different performance may be explained by the high number of examinations degraded by motion artifacts in patients with gynecologic and anorectal malignancies, probably due to increased discomfort during the examination. In fact, in one case with stenosing rectal recurrence, the coil could not even be inserted. The use of antiperistaltic agents might have mitigated these effects somewhat, but we rejected its use to maintain standardized conditions during the entire examination and keep the examination protocol as simple as possible.

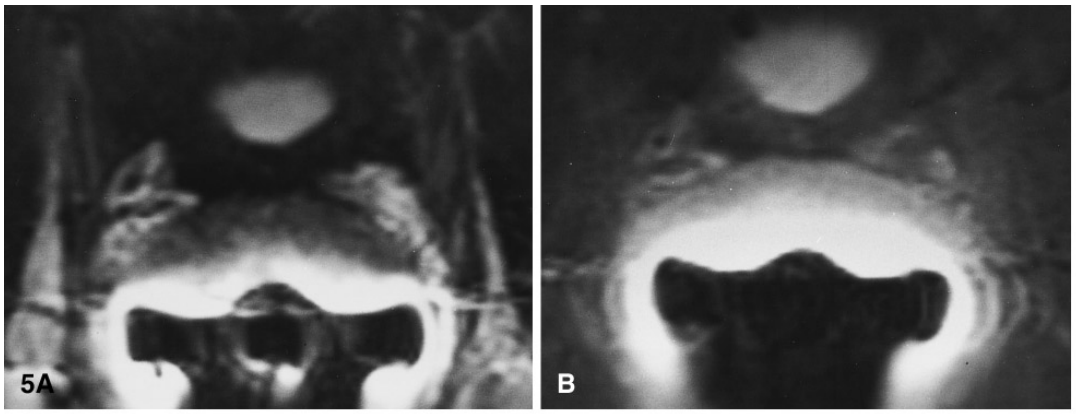

Fig. 5. A 68-year-old patient with slightly increased PSA levels. A local recurrence was excluded by MRI and biopsy. **A** Axial T2-weighted endorectal coil image: at the level of the vesico-urethral anastomosis, a low signal intensity ring suggests concentric scar formation. **B** Axial contrast-enhanced T1-weighted endorectal coil image demonstrates the lack of pathologic enhancement, thereby excluding tumor recurrence.

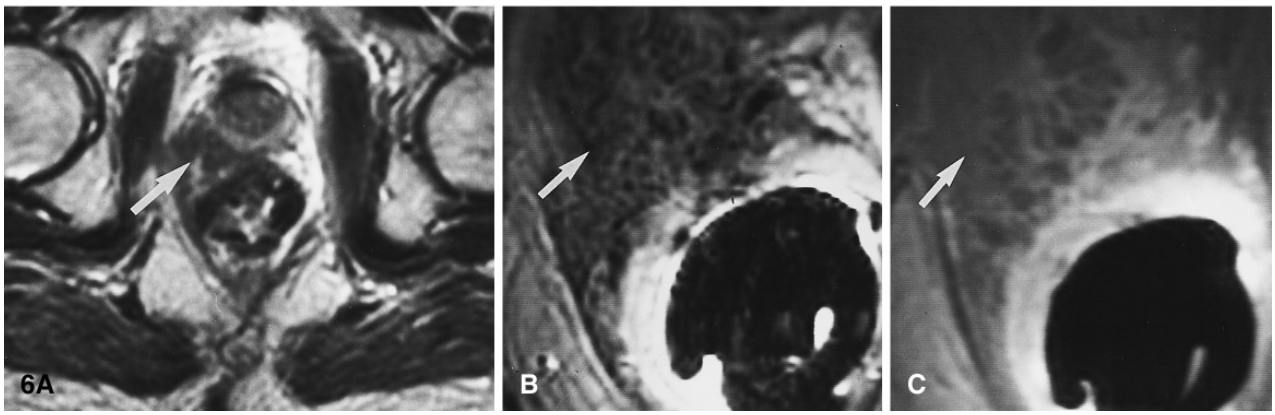

Fig. 6. A 51-year-old man with suspected local recurrence following rectosigmoid resection of a stage T3N2 rectal cancer. **A** Axial T2-weighted body coil image shows inhomogeneous hypointense extraluminal lesion between the rectum and the prostate gland (arrow). **B** Axial T2-weighted endorectal coil image: the lesion invades the prostate and the pelvic muscles and is therefore consistent with recurrent tumor (*arrow*). C Axial contrast-enhanced T1-weighted endorectal coil image: the inhomogeneous enhancement proves the presence of pathologic tumor tissue (*arrow*).

Even though the difference in accuracy between endorectal and body coil examination was not statistically significant for anorectal recurrences, it was improved by 59–82.4% by the use of the endorectal coil. This might be due not only to increased spatial resolution but also by the improved detection of bowel wall abnormalities due to the distention produced by the inflated baloon on the endorectal device.

A significantly better and therefore clinically important result could be achieved in patients with prostate cancer in whom, following prostatectomy, some soft tissue anterior to the vesicourethral anastomosis is found. This occurs in up to 80% of cases without recurrent disease, making the interpretations of body coil examination and even transrectal ultrasound difficult [6, 7].

Even if the sensitivity and specificity for detection of pelvic recurrent tumors could not be improved by using the endorectal coil in all included entities, the subjective confidence with which the diagnosis was established was significantly higher. The usually small recurrent masses and the inhomogeneities of post-therapeutic scarring could be identified more reliably due to the increased spatial resolution (voxel size of the endorectal examination was about five times smaller than that using the body coil).

However, although much less affected by motion artifacts than the T2-weighted sequences, the contrast-enhanced T1-weighted endorectal coil images did not improve the results further. The enhancement pattern of the thickened bowel wall yielded a significantly higher diagnostic confidence only in patients with anorectal primaries. In general, however, the routine use of gadolinium compounds is not warranted due to the high cost of these agents. Moreover, early postradiation fibrosis, inflammation, and desmoplastic reactions can present

Table 3. Detection of recurrent anorectal cancer

Sequence	Sensitivity (%)	Specificity (%)	ppv (%)	npv (%)	Accuracy (%)
bc T1, T2	16.7	81.9	33.0	64.3	58.8
ec T2	50.0	90.0	75.0	76.9	76.5
ec T1C	66.7	81.9	66.7	81.9	76.5

Table 4. Number of examinations (%) degraded by moderate or severe motion artifacts

	bc T1, T2	ec T2	ec T1C
Recurrent gynecologic tumors (n = 15)	0.0	50.0	12.5
Prostatic recurrence (n = 13)	0.0	23.1	7.7
Anorectal recurrence (n = 17)	0.0	52.9	5.9

similar enhancement patterns, rendering the use of gadolinium questionable [1, 2].

The accuracy and diagnostic confidence of the body coil examination in our study is somewhat lower than those reported in the literature [17, 18, 24, 29]. This may be due to the very small size of most recurrent tumors in gynecologic disease in our series, whereas only patients with rectal cancer following continence-saving surgery could be included. Krestin et al. decribed less reliable results when comparing patients who underwent rectal amputation [18].

In conclusion, MRI with endorectal coils did not improve the detection of gynecologic and anorectal recurrent tumors as expected. However, because the diagnosis can be made with more confidence in most cases, the use of this technique should be encourraged if the findings on body coil examination are equivocal. The body coil examination remains, however, essential for assessment of tumor spread beyond the pelvis, as in the case of ovarian cancer and possibly sigmoid cancer.

For detection of prostatic recurrence, endorectal coil MRI according to the results in this study can be highly recommended in all patients with elevated PSA levels, in whom metastatic spread was ruled out by bone scanning, sonography, computed tomography, and other appropriate imaging techniques. Body coil MRI is of very limited value for interpretation of the prostatic fossa but provides additional information on regional lymph nodes or pelvic bones. Further prospective studies in a greater number of patients and additional use of phased array coils should definitely prove the value of high-resolution MRI in early detection of pelvic recurrence.

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References

1. Ebner F, Kressel HY, Mintz MC, et al. Tumor recurrence versus fibrosis in the female pelvis: differentiation with MR imaging at 1.5 T. *Radiology* 1988;166:333–340
2. Glazer HS, Lee JKT, Levitt RG, et al. Radiation fibrosis: differentiation from recurrent tumor by MR imaging. Work in progress. *Radiology* 1985;156:721–726
3. Moss AA, Thoeni RF, Schnyder P, et al. Value of computed tomography in the detection and staging of recurrent rectal carcinomas. *J Comput Assist Tomogr* 1991;5:870–874
4. McCarthy S, Barnes D, Devney A, et al. Detection of recurrent rectosigmoid carcinoma: prospective evaluation of CT and clinical factors. *AJR* 1985;144:577–579
5. Freeny PC, Marks WM, Ryan JA, et al. Colorectal carcinoma evaluation with CT: preoperative staging and detection of postoperative recurrence. *Radiology* 1986;158:347–353
6. Wasserman NF, Kapoor DA, Hildebrandt WC, et al. Transrectal US in evaluation of patients after radical prostatectomy. Part I. Normal postoperative anatomy. *Radiology* 1992;185: 361–366
7. Wasserman NF, Kapoor DA, Hildebrandt WC, et al. Transrectal US in evaluation of patients after radical prostatectomy. Part II. Transrectal US and biopsy findings in the presence of residual and early recurrent prostatic cancer. *Radiology* 1992;185:367–372
8. Huch Böni RA, Boner JA, Lütolf UM, et al. Local staging of prostate carcinoma: contribution of contrast-enhanced, endorectal coil MR imaging. *J Comput Assist Tomogr,* in press.
9. Schiebler M, Schnall M, Pollack H, et al. Current role of MR imaging in the staging of adenocarcinoma of the prostate. *Radiology* 1993;189:339–352
10. Quinn S, Franzini D, Demlow T, et al. MR imaging of prostate cancer with an endorectal surface coil technique: correlation with whole-mount specimens. *Radiology* 1994;190:323–327
11. Milestone BN, Schnall MD, Lenkinski RE, et al. Cervical carcinoma: MR imaging with an endorectal surface coil. *Radiology* 1991;180:91–95
12. Chan TW, Kressel HY, Milestone B, et al. Rectal carcinoma: staging with MR imaging with endorectal surface coil. Work in progress. *Radiology* 1991;181:461–467
13. de Lange EE, Fechner RE, Wanebo HJ. Suspected recurrent rectosigmoid carcinoma after abdominoperineal resection: MR imaging and histopathologic findings. *Radiology* 1989;170:323–328
14. Ebner F, Ranner G, FLückiger F. Differenzierung von Narbengewebe und Tumorrezidiv nach Therapie von Tumoren des weiblichen Beckens. *Radiologe* 1994;34:384–389
15. Lange PH, Ercole CJ, Lightner EJ, et al. The value of serum prostate specific antigen determinations before and after radical prostatectomy. *J Urol* 1989;141:873–879
16. Hudson MA, Bahnson RR, Catalonas WJ. Clinical use of prostate specific antigen in patients with prostate cancer. *J Urol* 1989; 142:1011–1017
17. Müller-Schimpfle M, Brix G, Layer G, et al. Recurrent rectal cancer: diagnosis with dynamic MR imaging. *Radiology* 1993;189: 181–189
18. Krestin GP, Steinbrich W, Friedmann G. Recurrent rectal cancer: diagnosis with MR imaging versus CT. *Radiology* 1988;168: 307–311
19. Holdsworth PJ, Johnston D, Chalmers AG, et al. Endoluminal ultrasound and computed tomography in the staging of rectal cancer. *Br J Surg* 1988;75:1019–1022
20. Beynnon J, Mortensen NJ, Channer Jl, et al. The detection and evaluation of locally recurrent rectal cancer with rectal endosonography. *Dis Colon Rectum* 1989;32:509–517

21. Balzarini L, Ceglia E, D'Ippolito G, et al. Local recurrence of rectosigmoid cancer: what about the choice of MRI for diagnosis? *Gastrointest Radiol* 1990:338–342
22. Ito K, Kato T, Tadokor M, et al. Recurrent rectal cancer and scar: differentiation with PET and MR imaging. *Radiology* 1992;182: 549–552
23. Hricak H, Lacey CG, Sandels LS, et al. Invasive cervical carcinoma: comparison of MR imaging and surgical findings. *Radiology* 1988;166:623–631
24. Williams MP, Husband JE, Heron CW, et al. Magnetic resonance imaging in recurrent carcinoma of the cervix. *Br J Radiol* 1989; 62:544–550
25. Waggenspack GA, Amparo EG, Hannigan EV. MR imaging of uterine cervical carcinoma. *J Comput Assist Tomogr* 1988; 12:409–414
26. Yamashita Y, Takahashi M, Sawada T, et al. Carcinoma of the cervix: dynamic MR imaging. *Radiology* 1992;182:643–648
27. Fleuckiger F, Ebner F, Poschauko H, et al. Cervical cancer: serial MR imaging before and after primary radiation therapy—a 2-year follow-up study. *Radiology* 1992;184:89–93
28. Hricak H, Alpers C, Crooks L, et al. Magnetic resonance imaging of the female pelvis. *AJR* 1983;1141:1119–1128
29. Chang YCF, Hricak H, Thurnher S, et al. Vagina: evaluation with MR imaging. Part II. Neoplasms. *Radiology* 1988;169:175–179