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RESEARCH ARTICLE

# Diagnostic Effectiveness of High-Resolution T2-Weighted Magnetic Resonance Imaging in Restaging Rectal Cancer After Neoadjuvant Chemoradiotherapy

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## ABSTRACT

**Objective:** The staging of rectal cancer after neoadjuvant chemoradiotherapy (nCRT) influences treatment planning. It is critical to have an accurate and practical radiological identification. The technical success of a high-resolution T2-weighted magnetic resonance imaging (hT2W-MRI) sequence in restaging locally progressed rectal cancer treated with nCRT was investigated in this study.

**Materials and Methods:** The study included 19 patients (mean age=56, range=37–76) who had rectal cancer surgery between 2020 and 2022, a rectum MRI, and nCRT. Following surgery, MRI data were compared to relevant histological studies.

**Results:** hT2W-MRI correctly predicted all cancers with pathological stage T3 (100%, 5/5). Three out of four patients (75%) with pathological stages T4a and T4b were correctly predicted by hT2W-MRI. When lymph node positivity was taken into account, the hT2W-MRI prediction rate was 42.1% (8/19). All tumors with a circumferential resection margin (CRM), peritoneal reflection involvement, and extramural venous invasion were appropriately predicted by hT2W-MRI. hT2W-MRI had a good success rate in predicting pathological response (residual tumor) (89.5%, 17/19).

**Conclusion:** Incorporating the hT2W-MRI sequence into routine pelvic MRI examination sequences can be beneficial for detecting residual tumor and staging rectal cancer after nCRT.

**Keywords:** Advanced rectal cancer, circumferential resection margin, extramural venous invasion, magnetic resonance imaging, neoadjuvant chemoradiotherapy

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## INTRODUCTION

Nowadays, neoadjuvant chemoradiotherapy (nCRT) is routinely applied in locally advanced rectal cancer and has been shown to reduce the size and stage of the tumor.[1,2] Thus, it enhances local control by raising the likelihood of carrying out the sphincter preservation technique in addition to radical resection, leading to long-term survival.[3,4]

It has been reported that tumor response downstaging with nCRT is associated with better clinical outcome.[5] If the tumor response to nCRT can be precisely measured, the best possible treatment outcome can be reached. Pre-operative magnetic resonance imaging (MRI) has been extensively applied and has played an important role in restaging locally advanced rectal cancer after pre-operative nCRT.[6–8] There have been a few studies on the use of MRI after nCRT and its prognostic role in post-operative pathological staging.

The purpose of this study was to assess the diagnostic performance of high-resolution T2-weighted magnetic reso-

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nance imaging (hT2W-MRI) of the pelvic and rectum, together with pathological outcomes, after nCRT.

## MATERIALS and METHODS

Our hospital's ethics committee accepted this retrospective single-center investigation (No:KAEK/2023.07.100, date: July 27, 2023), and the informed consent form was waived. This study was conducted in accordance with the declaration of Helsinki. By scanning the digital data of our hospital, we collected information about patients with locally advanced rectal cancer who underwent colonoscopy biopsy and were diagnosed with histopathological rectal adenocarcinoma between 2020 and 2022. There were 19 patients that met the study criteria. The study comprised patients with histologically confirmed rectal adenocarcinoma who had undergone nCRT before surgery and had pelvic MRI and rectal MRI. Patients who did not have surgery following nCRT, whose pathological data could not be obtained, or who had previously had radiotherapy for other reasons were excluded from the study.

The patients' hT2W-MRI staging (Siemens Magnetom Avanto, 2014, Germany, 1.5 tesla) was evaluated by a radiologist with 13 years of abdominal radiology experience who was blind to the pathological stage. Following definitive surgery, hT2W-MRI staging was compared to related histopathological studies (Fig. 1). hT2W-MRI parameters; MRI sequences in three planes, 3 mm slice thickness, field of view 200 mm, matrix 256×256, fat-free were obtained. The dimensions of the suspected residual tumor areas were measured in the craniocaudal plane and totaled. The depth of tumor invasion (T) and lymph node involvement (N) were classified based on tumor stage. The size of metastatic lymph nodes (>0.5 cm) was used to define them.[8,9] Circumferential resection margin (CRM) was assessed in terms of peritoneal reflection and involvement of adjacent organs (Figs. 2, 3). Rectal MRI and hT2W-MRI examinations were performed on the patients 6–8 weeks after nCRT and 1–2 weeks before surgery.

## RESULTS

The patients ranged in age from 37 to 76 years old (mean 56). Nine of the 19 patients were men, while 10 were women. Four patients were diagnosed with mucinous adenocarcinoma, and 15 patients with adenocarcinoma (Fig. 1). 6–8 weeks later after nCRT, 7 patients had abdominoperineal resection, 11 had low anterior resection, and 1 had total proctocolectomy. In patients with pathological stage T2 and lower (T1-T2-Tins-no tumor), the success rate of hT2W-MRI decreased dramatically (Figs. 2, 4). About 100% (5/5) of all tumors with pathological stage T3 were correctly predicted by hT2W-MRI (Figs. 2, 3). Three out of four patients (75%) had hT2W-MRI accurately identify their pathological stages for T4a and T4b cancers (Figs. 2, 5). Compared with the pathogenic stage, the correct prediction rate of hT2W-MRI in nodal staging was low, while the overstage rate was significantly higher. hT2W-MRI could predict correctly in only 3 patients (15.7%). After excluding nodal staging and focusing solely on lymph node-positive, yT2W-MRI accurately predicted eight out of 19 patients (42.1%) (Fig. 3). All tumors with extramural venous invasion, involvement of the peritoneal reflection, and circumferential resection margin (CRM) were accurately predicted by hT2W-MRI. (Figs. 2, 3). The tumor's craniocaudal dimensions were 4 cm (0–14 cm) in pathological measurement and 3.2 cm (1.9–7 cm) in hT2W-MRI. hT2W-MRI had a high success rate in predicting pathological response (residual tumor) (89.5%, 17/19).

## DISCUSSION

Colorectal cancer is a common malignant tumor with a high mortality rate.[10] Rectal MRI is now essential for the staging of rectal adenocarcinomas, which account for roughly one-third of all colorectal adenocarcinoma cases, both for the evaluation of patients newly diagnosed with rectal cancer and for the evaluation of nCRT after therapy. The non-surgical "watch and wait" method for rectal adenocarcinoma has gained popularity due to a better knowledge of the effects of nCRT on rectal tumors and the realization that histological full response can be reached in up to 30% of patients. Candidates for this organ-preserving approach should have no signs of cancer on digital rectal examination, endoscopy, or rectal MRI, which are the three components of neoadjuvant therapy response assessment.[10,11] As a result, rectal MRI plays a significant role in guiding patient care and preventing unnecessary surgical morbidity. This study examined the effectiveness of hT2W-MRI in restaging rectal adenocarcinoma after nCRT treatment for patients with rectal adenocarcinoma.

Preoperative nCRT can increase patient lifespan by increasing CRM-negative resections, as well as reducing the stage of locally progressed disease and allowing sphincter-sparing resection in patients with lower rectal tumors.[12] It has also been proven to reduce the frequency of local recurrence or distant metastasis. The same technique utilized for initial staging is applied for tumor restaging after nCRT, as well as the correlation of rectal MRI parameters obtained in the same planes with post-treatment and pre-treatment images.[13]

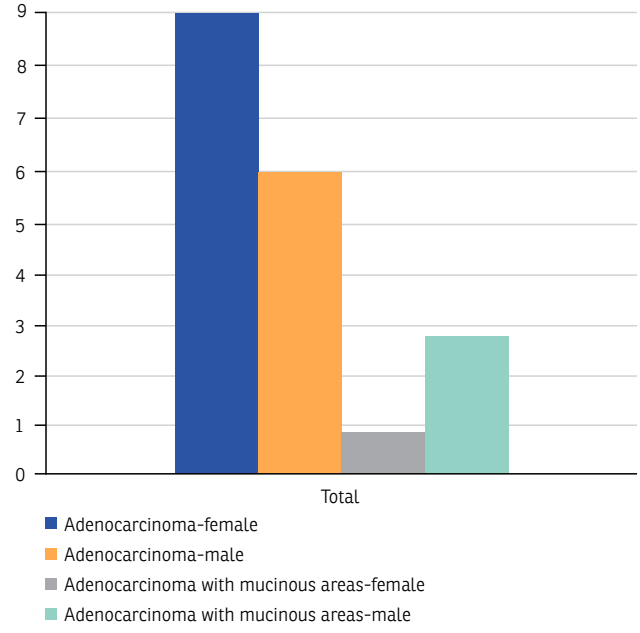


**Figure 1.** Demographic data and histopathological results are shown

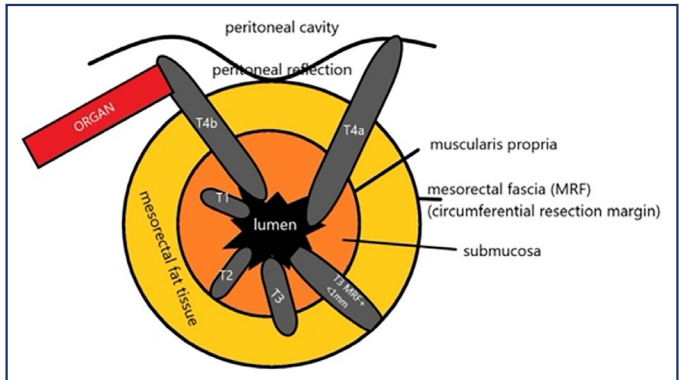


**Figure 2.** The illustration displays the anatomy of the rectum as well as the probable locations of rectal cancer, along with the related T categories

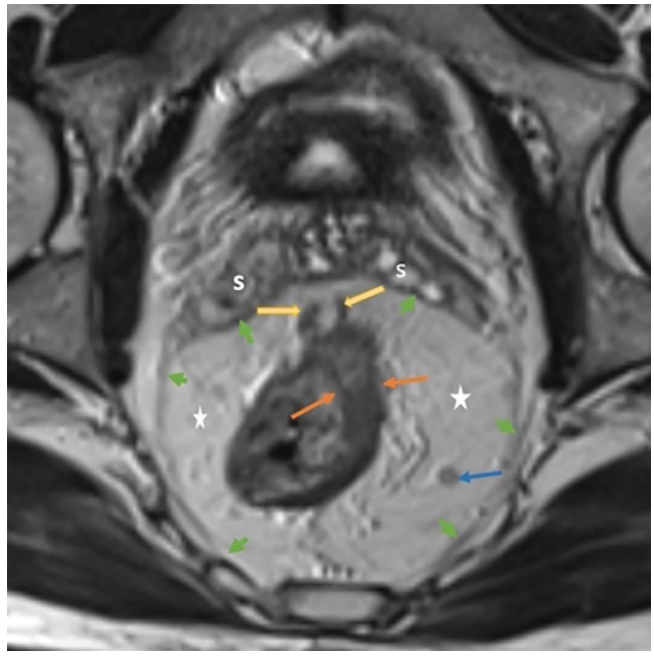


**Figure 3.** Extramural venous invasion in a T3 tumor: A 48-year-old male patient had a high-resolution T2 axial magnetic resonance imaging 7 weeks following chemoradiotherapy. The tumor has spread into the mesorectal fat tissue (stars), and its margins have become irregular (orange arrows). There is also evidence of extramural venous invasion (yellow arrows). Seminal vesicles (S). Green arrows indicate the mesorectal fascia (circumferential resection margin), while blue arrows indicate the lymph node

The primary imaging modality for the pre-operative and post-operative evaluation of patients with rectal cancer is high-resolution MRI. The morphological appearance of the tumor, its length, and its distance from the anal verge are all demonstrated in detail. The involvement of probable extra mesorectal and mesorectal lymph nodes, as well as the likely involvement of anterior peritoneal reflection, circumferential resection margin (EMVI), and CRM, is investigated during restaging.[14]

To summarize our study's T staging results, hT2W-MRI properly diagnosed all tumors with pathological stage T3 100% of the time (5/5). hT2W-MRI was reported to be ineffective in patients with pathological stages T2 and lower (T1-T2-Tis-no tumor). hT2W-MRI correctly predicted pathological stages T4a and T4b in three of four patients (75%). A meta-analysis research demonstrated that restaging MRI after nCRT had a low mean sensitivity (50.4%).[15] Another study found that MRI had 47–52% accuracy for T staging and 64–68% accuracy for nodal staging in patients undergoing nCRT.[16] According to another study, high-resolution rectal MRI overstaging of tumor invasion and poor staging of lymph node involvement.[17] While it accurately predicted T3 and T4 tumors in our investigation, it was demonstrated to be poor at detecting lymph node involvement. In our study, hT2W-MRI correctly predicted all tumors with CRM, peritoneal reflection involvement, and extramural venous invasion. This high probability of prediction is a guide to guide surgical planning. hT2W-MRI correctly predicted all tumors with CRM, peritoneal reflection involvement, and extramural venous invasion

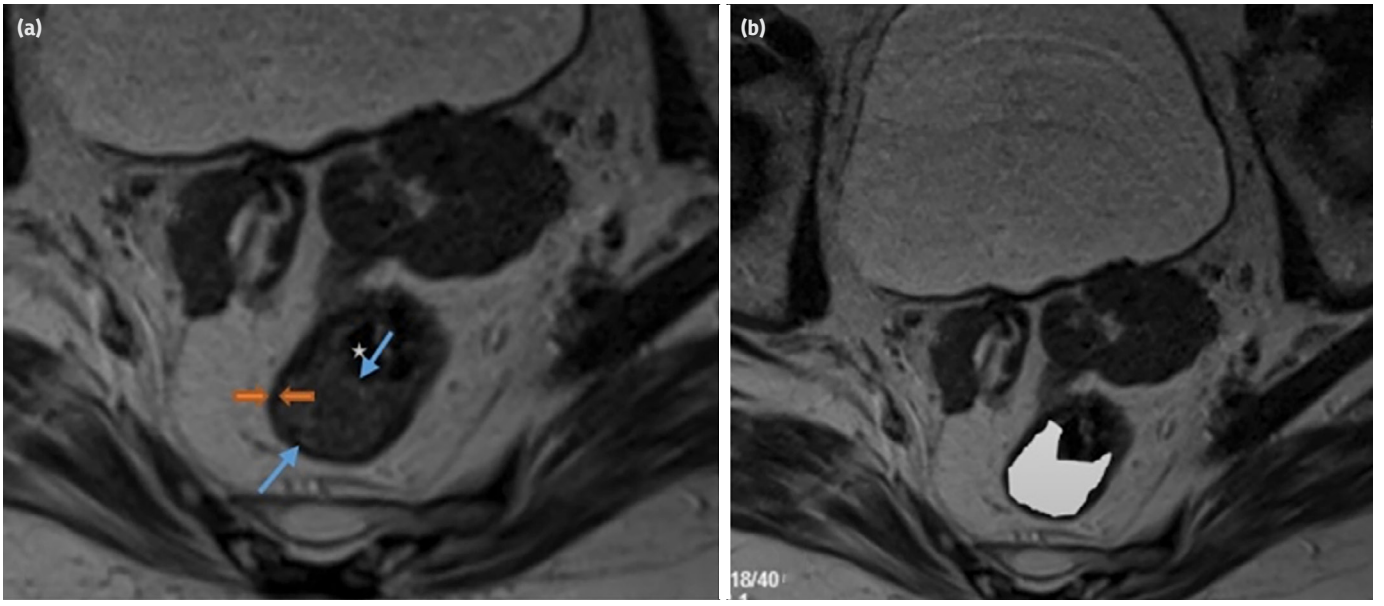


**Figure 4.** T2 rectal tumor: Rectal cancer has been found in a 76-year-old patient. Eight weeks following neoadjuvant chemoradiotherapy treatment, a high-resolution T2-weighted axial **(a, b)** MRI scan appears to accurately predict the T stage as T2 (pathological stage T2). An intact muscularis propria is seen (orange arrows). When compared to the muscularis propria, the tumor tissue was seen at an intermediate intensity (hyperintense) and had asymmetric semicircular wall involvement (between blue arrows). **(b)** The tumor tissue's boundaries are drawn. An asterisk marks the colon's open lumen

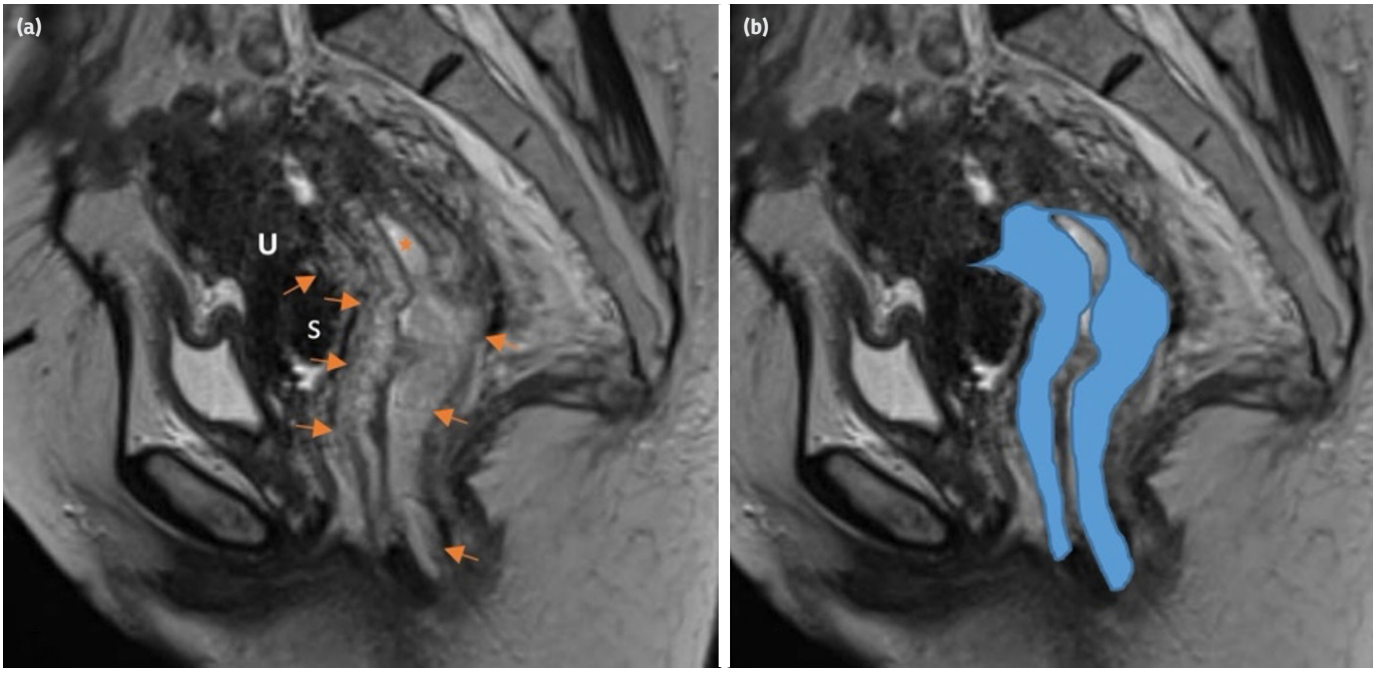


**Figure 5.** T4b rectal tumor **(a, b)**. The patient, 46 years old, was diagnosed with mucinous components in her adenocarcinoma. Nine weeks following chemoradiotherapy, a high resolution T2 sagittal MRI was acquired. Orange arrows indicate the apparent invasion of the uterine corpus anteriorly and the anal canal caudally by the tumor tissue. Tumor borders are shown in blue **(b)**

*U: Uterus; S: Cervix; asterisk: Mucin lake; MRI: Magnetic resonance imaging*

in our investigation. This high prediction probability serves as a guidance for surgical planning. As a result, if hT2W-MRI reveals tumor invasion into nearby organs, en bloc resection of the rectum and adjacent organs is likely. Furthermore, if hT2W-MRI restaging reveals an earlier T staging, it is quite likely that obvious limits will be achieved following surgery. On the other hand, one of its problems is the risk of hT2W-MRI wrongly predicting T staging from residual tumor fibrotic change caused by radiation-induced changes that generate mesorectal fat reticulation, rectal wall thickening, and surrounding edema in the main tumor. When combined with diffusion-weighted MRI of the rectum and MRI with dynamic contrast, these unwanted false positives can be eliminated.

Our research had some limitations. First and foremost, our patient population was small. Not every therapy procedure could be followed effectively. The strength of our study is that the restaging accuracy after nCRT treatment was similar to the literature and even higher than some others. Furthermore, CRM was accurately predicted by hT2W-MRI in all rectal cancer patients with peritoneal reflection involvement and positive EMVI. Similar to the literature, its drawback in lymph node staging is a low estimation rate.

## CONCLUSION

In multidisciplinary surgical tumor councils, radiologists play a critical role in the approach to rectal cancer treatment. To give adequate treatment, accurate staging is essential. hT2W-MRI also gives prognostic information by evaluating the degree of extramural invasion, EMVI, and CRM, highlighting its importance in the preoperative evaluation of rectal cancer. Further, the use of sequences such as DWI-MRI aids in assessing therapy response, which is especially important when conservative management strategies (a wait-and-see strategy) become more clinically relevant. Restaging with hT2W-MRI, on the other hand, has limitations and should be interpreted with caution.

### Disclosures

**Ethics Committee Approval:** The study was approved by the University of Health Sciences Kanuni Sultan Süleyman Training and Research Hospital Ethics Committee (No: 2023.07.100, Date: 27/07/2023).

**Informed Consent:** The ethics committee waived the informed written consent form.

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**Conflict of Interest:** No conflict of interest was declared by the authors.

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