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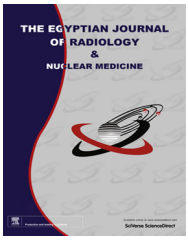

ORIGINAL ARTICLE

MRI of rectal carcinoma: Preoperative staging and planning of sphincter-sparing surgery

Usama Ghieda, Omar Hassanen, Mohamed A. Eltomey *

Radiology & Medical Imaging Department, Faculty of Medicine, Tanta University, Egypt

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KEYWORDS

Rectal;
Carcinoma;
MRI;
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Abstract *Background:* Rectal cancer constitutes about one-third of all gastrointestinal tract tumors. Because of its high recurrence rates reaching 30%, it is vitally important to accurately stage these tumors preoperatively, so that appropriate surgical resection can be undertaken. MRI is used to assist in staging, identifying patients who may benefit from preoperative chemotherapy–radiation therapy, and in surgical planning.

Aim: To determine the accuracy of MRI in the preoperative staging and planning of surgical management of rectal carcinoma.

Subjects and methods: Twenty-five patients (14 males, 11 females) with rectal carcinoma were included in this study. MRI scans were performed prior to surgery in all patients, on a 1.5T scanner, and images were evaluated by three experienced radiologists. Inter-observer agreement between the three radiologists and the correlation between the imaging findings, histopathology and operative findings were evaluated.

Results: MRI findings were correctly predictive of T category in 21 cases (accuracy, 84%). In 19 (86.4%) of the 22 resectable cases, sphincter-sparing surgical approaches were accurately chosen on the basis of MRI findings.

Conclusion: MRI of rectal cancer is accurate for prediction of tumor stage and the feasibility of sphincter-sparing surgery, which are the main factors affecting the outcome of surgery.

1. Introduction

Rectal cancer is one of the most common tumors in industrialized countries affecting about 40 cases in every 100.000 individuals, and one of the most common malignant tumors of the gastrointestinal tract (1). Rectal cancer has a slight male predilection and its prevalence increases steadily after the age of 50 years. Adenocarcinoma accounts for the vast majority (98%) of rectal cancer (2). The prognosis of rectal cancer is closely related to the stage at diagnosis and the choice of

Abbreviations: CRM, circumferential resection margin; FOV, field of view; SI, signal intensity

* Corresponding author. Tel.: +20 1288176817; fax: +20 403333893.
E-mail address: mohamed.eltomey@med.tanta.edu.eg (M.A. Eltomey).

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treatment (3). There is an increasing need for accurate preoperative staging because aggressive multimodality treatment approaches are being employed these days based on individual risk factors (4). Histopathologic tumor involvement of the circumferential resection margin (CRM), which is the peritoneal reflection of the mesorectal fascia has been shown to be an independent predictor of local recurrence and hence influences overall survival after primary resection (5). A distance greater than 1 mm between the tumor and the CRM at histopathologic examination has been shown to correlate with a decrease in local recurrence. Patients with involved or threatened margins, i.e., within 1 mm from the mesorectal fascia, are offered long course chemo-radiation to enable R0, i.e., microscopic tumor free, surgical resection (5) (see Fig. 4).

On the other hand the relationship between tumor and the peritoneal reflection is important in staging, since rectal tumors with invasion through the peritoneal reflection are categorized as stage T4 lesions (6).

MRI is a promising tool for staging rectal cancer preoperatively and can also provide measurements of the distance to the mesorectal fascia, which forms the potential resection margin in total mesorectal excision (7).

2. Subjects & methods

2.1. Patients

Between July 2011 and June 2012, twenty-five consecutive patients with adenocarcinoma of the rectum on the basis of their colonoscopic findings and the pathologic features of the biopsy specimen, were included in this study.

All patients were staged with MRI pre-operatively. After total mesorectal excision, the extent of local tumor staging was histopathologically assessed according to the tumor component of the TNM system (Table 1).

2.2. MRI technique

All the scans were performed on 1.5T MRI unit (Signa Excite, GE medical systems, Milwaukee, USA) with synergy body coil OR 8 channel cardiac coil.

The patients were asked to perform rectal cleansing 2 h before the MRI examination using two laxative rectal suppositories (e.g. Dulcolax bowel cleansing kit).

An initial three-plane localizer view covering the entire pelvis was obtained. Subsequent sequences included sagittal, axial and coronal T2WIs; the sagittal images were used to plan thin slices oblique axial images (the scan plane is angled to be perpendicular to the tumor bulk), and oblique coronal images (scan plane angled parallel to the long axis of the anal canal); TR/TE, 2500–5000/100; Echo train length 6; slice thickness 3 mm; image gap 0; 256 × 256 matrix; FOV 18–24; No. of signal acquired 4; acquisition time 4–6 min.

An additional axial T2 weighted scan through the pelvis, with a larger field of view and slice thickness of 6 mm, was performed up to the iliac crest for identifying lymph node involvement.

2.3. Image analysis

Three experienced radiologists independently reviewed the MR images in a random order and were blinded from each other's results. MRI allowed visualization and delineation of layers of both the rectal wall and mesorectal fascia of all patients. The tumor had higher signal intensity (SI) than the muscle layer on T2WIs. The depth of cancer invasion on MRI (T stage) was interpreted as follows; T1 if tumor SI was confined to the submucosal layer and had relatively low SI compared with the high SI of surrounding submucosa, T2 if tumor SI extended to the muscle layer leading to irregularity or thickening of the muscle layer but without perirectal tissue invasion (Fig. 1), T3 if tumor SI extended through the muscular layer into the perirectal tissue or angiolymphatic tumor invasion, appearing as irregular thickened strands, was present in the mesorectum (Fig. 2), and T4 if tumor SI extended to visceral peritoneum, adjacent organ, or structure (Table 2).

The distance between the lower margin of rectal cancer mass to the point at which the levator ani muscle is attached to the rectum was measured and reported as a criterion for feasibility of sphincter sparing surgery (Fig. 3).

Observers recorded the number of lymph nodes in the MRI of each patient with the criteria for lymph node metastasis including size, indistinct border, irregular margins or mixed SI.

2.4. Statistical analysis

Agreement on the MRI findings between the three radiologists was analyzed using the kappa statistical method. Comparison between the MRI staging and operative and pathological findings was performed using two-tailed tests. A value of $p < 0.05$ was considered statistically significant. All analyses were performed with SAS software (version 9.1, SAS institute).

Table 1 Guidelines for the T staging of rectal cancer, adapted from the American joint committee on cancer staging system (8).

Tumor stage	Criterion
Tx	Determination of tumor extent is not possible because of incomplete information
T is	Tumor in situ involves only the mucosa and has not grown beyond the muscularis mucosa (inner muscle layer)
T1	Tumor grows through the muscularis mucosa and extends into the submucosa
T2	Tumor grows through the submucosa and extends into the muscularis propria
T3	Tumor grows through the muscularis propria and into the mesorectum
	T3-A Tumor extends < 5 mm beyond the muscularis propria
	T3-B Tumor extends 5–10 mm beyond the muscularis propria
	T3-C Tumor extends > 10 mm beyond the muscularis propria
T4	T4-A Tumor penetrates the visceral peritoneum
	T4-B Tumor directly invades or is adherent to other organs or structures