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Efficacy of MRI in Preoperative Staging of Carcinoma of Rectum: Correlation with Surgical and Histopathological Findings

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Abstract
Objective: *In this study our main goal is to evaluate efficacy of MRI in Preoperative Staging of Carcinoma of Rectum.*
Method: *This prospective observational study was done in the Jalalabad Ragib-Rabeya Medical College, Sylhet from June 2015 to May 2019. A total of 82 consecutive patients who were selected after confirmation with histopathological examination as rectal carcinoma.*
Results: *During the study, 7.32% (n = 6) of the tumors are classified as T1, 65.9% (n = 54) are staged as T2 and 26.8% (n = 22) as T3 staged by MR .The value of Kw for staging was calculated, in order to determine the correlation between MR versus anatomopathological staging; there is poor agreement between the two forms of staging.*
Conclusion: *From our study we can conclude that, preoperative staging of carcinoma rectum remains a topic of great concern. The MR imaging can be a valuable technique for preoperative staging of carcinoma rectum in the therapeutic management. Further study is needed for better outcome.*
Keywords: *Carcinoma Rectum, Magnetic Resonance Imaging (MRI).*

Introduction

Rectal cancer is a common disease with a high rate of mortality in Bangladesh. Many improvements have been made over the past 20 years in the surgical, radiologic, and oncologic treatment of rectal cancer.[1] However, this neoplasm remains associated with a poor prognosis owing to the high risk of metastases and local recurrence. After surgical treatment, local recurrence rates for rectal cancer can vary from

3% to 32% (1–5).[2] Total mesorecta excision (TME) involves resection of both the tumor and the surrounding mesolectal fat. At present, TME is the surgical treatment of choice for rectal cancer, being associated with a recurrence rate of less than 10%when used as a single-modality therapy.[3] The introduction of this surgical technique reduced the mortality rate associated with rectal cancer from 16% to 9% in one study.[4]In selected patients with involvement of themes rectal fascia at the time of diagnosis, the use of preoperative radiation therapy is advocated and has been shown to reduce the recurrence rate from 8.2% to 2.4% at 2 years.[5-6] This therapeutic approach demands accurate preoperative tumor staging—namely, detection of rectal carcinoma, infiltration into the mesolectal fat, involvement of the mesolectal fascia, and nodal involvement.

The goal of imaging in rectal cancer is to stratify cases on the basis of the risks of recurrence by means of accurate evaluation of the staging. At present, there are few consensus on the role of diagnostic imaging (endorectal ultrasonography [US], computed tomography, and magnetic resonance [MR] imaging) in the preoperative staging of rectal cancer.

In this study our main goal is to evaluate efficacy of MRI in Preoperative Staging of Carcinoma of Rectum with Surgical and Histopathological correlation.

Materials and Methods

Patients: This prospective observational study done from June 2015 to May 2019in Jalabad Ragib-Rabeya Medical college hospital, Sylhet, Bangladesh. During this period total eighty patients with histopathologically proven primary rectal cancer were prospectively examined using MRI with body coil for preoperative staging. The patients included 48 male and 34femalewith age ranging 31–78 years. None of the patients had received neoadjuvant radio chemotherapy.

MRI technique: MRI was performed using a 1.5-T MRI scanner (Magnetom Avanto, Siemens Healthcare Ltd) equipped with a body coil. All patients underwent the hospital's standard cleaning enema procedure. No rectal distension, antispasmodic medication or rectal or intravenous contrast agent administration was performed. The patients were placed in a supine position on the MRI table with their feet first entering the gantry. Axial, coronal and sagittal T2-weighted fast spin-echo (T2W-FSE) images without fat suppression were obtained. The scan protocol was TR 4000 ms, TE 110 ms, echo train length 16, field of view (FOV) 260×260 mm, matrix 288–384, slice thickness 4 mm and Nex 2. The whole examination took approximately 30 minutes.

Image analysis: MRI images were evaluated on a workstation. The tumors were subcategorized into 2 groups according to their anatomic location: low rectal tumors were less than 5 cm from the anal verge, and upper-middle rectal tumors were more than 5 cm from the anal verge. Distances were measured using electronic calipers. The rectal mucosa and submucosa (inner hyperintense layer), muscularis propria (hypointense intermediate layer), perirectal fat tissue (external hyperintense layer), mesorectal fascia (thin low intensity structure that envelops the mesorectum and surrounding perirectal fat tissue) and the mesorectal and extramesorectal lymph nodes were visualized. The depth of the transmural invasion by the tumor, mesorectal involvement of the tumor, the number of detected lymph nodesand the smallest short-axis diameters of the lymph nodes were assessed. The lateral and posterior boundaries of the mesorectal fascia were clearly delineated, but its anterior aspect was difficult to differentiate from Denonvilliers' fascia in some of the male patients. The tumor itself was recognized by an intermediate signal intensity between the high signal intensity of the fat tissue and the low signal intensity of the muscular layer. Each rectal tumor was staged according to the MRI findings and was later correlated with the operative and pathological findings. The depth of transmural invasion by each tumor was categorized according to the TNM classification and was assessed according to the reported criteria.[7,8] We

characterized T1 tumors by an infiltration of the submucosal layer and a sparing of the muscularis propria. When the tumor invades muscularis propria we accepted the tumor as T2. T2 lesions were differentiated from T3 lesions by the identification of a smooth outer tumor border within the rectal wall with no invasion into the fat surrounding the rectum. T3 lesions had irregular outer borders and invaded the fat surrounding the rectum with a plaque, mass, or cordlike signal intensity that projected into the perirectal fat. The presence of spiculation within the fat alone was not sufficient evidence of an extramural invasion[8, 9]. In T4 lesions, fat planes between the rectal carcinoma and surrounding organs disappeared. Mesorectal fascia involvement and the invasion of adjacent organs were also noted as indicators of T4 tumors. CRM involvement was defined as a tumor that was <2 mm from the mesolectal fascia. This crucial distance of at least 2 mm can be predicted with 97% confidence when the distance on MRI is at least 6 mm[10]. Mesorectal and extramesorectal lymph nodes with irregular margins and/or a short axis greater than 5 mm were accepted as metastatic[11].

Histopathological study: All patients underwent radical surgery. TME was performed in patients with T2 and T3 tumors. TME was performed according to standardized techniques using a low anterior resection or abdominoperineal resection.[2] The sections were evaluated microscopically for determinations of the depth of transmural tumor invasion and lymph node metastasis according to TNM classification.[12]

Statistical study: Agreement between MRI- and histologically determined tumor stages was assessed using the weighted kappa statistic. Over staging and understaging of the tumors by phased-array MRI were compared using Fischer's exact test. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of MRI in the differentiation of stage T1, T2 and T3 tumors and CRM were calculated.

Results

Among the study population, 58.5% (n = 48) are male, aged between 31 and 78 years. As for tumor localization, 14.6% (n = 12) of the cases are located in the lower par and 85.4% (n = 70) in the upper-middle part of the rectum.

Regarding MR tumor staging, 7.32% (n = 6) of the tumors are classified as T1, 65.9% (n = 54) are staged as T2 and 26.8% (n = 22)as T3 (Table 2). With regard to anatomopathological staging of surgical specimens, 7.32% (n = 6) neoplasms are classified as T1, 39%(n = 32) are staged as T2 and 53.7% (n = 44) as T3 (Table 2).Comparing MR staging versus anatomopathological results based on surgical specimen (Table 3), we noted substaging in4.88% of cases (n = 4) staged by MR as T1; overstaging in 4.88%(n = 4) and substaging in 36.6% (n = 36) of tumors staged by MRI as T2; and overstaging in 9.76% (n = 8) of patients staged as T3.The sensitivity of MRI in the preoperative staging of carcinoma rectum relative to T was calculated, and sensitivities of 33.3%) for T1, 62.5% for T2 and 31.8%(95% for T3 were observed. As for specificity, this parameter is 94.7% for T1, 32% for T2 and 79% for T3. The PPV calculated is 33.3% for T1, 37.0% for T2 and 63.6% for T3. In relation to NPV, values of 94.7% for T1, 57.1% for T2 and 50% for T3 were found. MRI shows efficacy of 43.9% for T staging, 90.2%in particular for T1 staging, 43.9% for T2 staging and 53.7.6%for T3 staging.

The value of Kw for T staging was calculated, in order to determine the correlation between MR versus anatomopatho-logical staging. There is poor agreement between the two forms of staging: Kw= 0.14 (95% CI, 0–0.38) p > 0.05 (Table 4).

On MRI 87.8% (n = 72) of all tumors are classified as N0, and 12.2% (n = 10) as N+(Table 2). As to anatomopathological staging of surgical specimens, 56.1% (n = 46) of the tumors do not have lymph node involvement; in 26.8% (n = 22) there is a N1 staging, and9.76% (n = 8), received a N2 staging. In 7.32% (n = 6) of tumorsis not possible to classify N. Thus, the anatomopathological analysis, shown in Table 4,

reveals nodal involvement in 43.9% (n = 36) of cases, and no such involvement in the remaining 56.1% (n = 46).

Comparing the staging relative to N obtained by MRI and by anatomopathological analysis, a substaging is noted in 31.7% (n = 13) of cases, and an overstaging in 7.32% (n = 3). Table 5 compares both forms of staging.

As for M staging, 85.4% (n = 70) of patients were staged as M0 and 9.7% (n = 8) as M1; in 4.88% (n = 4) of cases it was not possible to determine the existence of distant metastases.

Table-1: Distribution of demographic of the patients

Characteristics	**Number**	**Percentage(%)**
Gender		
Male	48	58.5
Female	34	41.5
Age Group		
31-40 years	10	12.2
41-50 years	28	34.2
51-60 years	20	24.3
61-70 years	16	19.5
71-80 years	08	9.7

Table-2: Regarding MR and anatomopathological tumor staging related to T and N (n=82).

Stage	MR staging Frequency, (%)	Anatomopathological staging, Frequency, (%)
T0	0 (0)	0 (0)
T1	6 (7.2)	6 (7.2)
T2	54 (65.9)	32 (39.0)
T3	22 (26.8)	44 (53.7)
T4	0 (0)	0 (0)
N0	72 (87.8)	46 (56.1)
N+	10 (12.2)	36 (43.9)

Table-3: Comparing MR staging related to 'T' with anatomopathological results based on surgical specimen

Anatomopathological staging	MR staging		
	T1, (%)	**T2, (%)**	**T3,%**
T1	2 (2.44)	4 (4.88)	0 (0)
T2	4 (4.88)	20 (24.4)	8 (9.76)
T3	0 (0)	30(36.6)	14(17.1)

Table-4: Kw values related to T and N staging

Stage	*K*w (95%CI)	P value
T	0.14(0–0.38)	>0.05
N	0.16(0–0.42)	>0.05

Table-5: Comparison of 'N' staging obtained by MR and by anatomopathological analysis

Anatomopathological staging	MR staging	
	N0 (%)	**N+ (%)**
N0	40 (48.7)	26 (31.7)
N+	6 (7.3)	10 (12.2)

Discussion

MR imaging has been advocated as a problem-solving technique for therapeutic planning in patients with rectal carcinoma.[8] Initial results have been disappointing due to technical limitations. However, advances in terms of imaging equipment, coils, and sequences have progressively improved the technique, with a parallel increase in accuracy.[9] Because of its high-contrast spatial resolution and large field of view, MR imaging has now fulfilled the requirements for becoming the ideal imaging technique for the preoperative staging of locally advanced rectal cancer, although transrectal US still offers some advantages in terms of spatial resolution for differentiating between stage T1 and stage T2 tumors.[13]

This study was designed with the aim to determine the efficacy of MR in the preoperative staging process for RC. With regard to T staging, when comparing the staging performed by MR with the anatomopathological staging, asub-staging occurred in 4.88% (*n* = 4) of cases staged by MR as being T1; there was overstaging in 4.88% (*n* = 4) of patients and sub-staging in 36.6% (*n* = 30) of those tumors staged by MRI asT2 and an over-staging in 9.76% (*n* = 8) patients staged as T3; these subjects were staged as T2. The largest number of cases of incorrect staging by MRI was observed in the distinction between stages T2 and T3. This may in part be explained by the presence of a desmoplastic reaction in peritumoral tissues, making it difficult to distinguish between speculation of perirectal fat, caused simply by fibrosis, and that that contains viable tumor cells.[14,15]As for the 4 patients who were over-staged by MR as T3,when actually these were T2 tumors, these could have been over treated. However, that did not happen for reasons

unrelated to this study. With respect to the calculation of the MRI sensitivity for Tstaging, values of 33.3% for T1, 62.5% for T2, and 31.8% for T3were observed. These values are lower than those observed in several other studies.[16]However, Beaumont et al. obtained even smaller values in relation to T1 and T2 stages, namely: 27% for T1 and 59% for T2.[15]The values for specificity were of 94.7% for T1, 32% for T2and 79% for T3. With respect to T1 and T3, the results were consistent with the bibliography.[15,16] In the case of T2, these values were lower than those found in most of the referred studies. The positive PV calculated was 33.3% for T1, 37.0% for T2 and 63.6% for T3. Regarding negative PV, these values were 94.7% for T1, 57.1% for T2 and 50% for T3. These values were lower than those observed by Ucar et al. and Akasu et al., except in the case of negative PV for T1, which was similar to that calculated by Iannicelli et al.[17] The diagnostic efficacy for tumor staging has been benefited from improvements due to the development of Techniques; in early studies, the efficiency reached about 60%;currently, this indicator is between 92 and 94% for T stage and63% for N stage.[18] Usually the efficiency increases with T stage and varies, according to some authors, between 67 and 94%or 55 and 86%.[8] Efficacy calculated for T stage was 43.9%, particularly 90.2% for T1, 43.9% for T2, and 53.7% for T3. The results for T in general and for T2 and T3 were similar with Abreu et al.[3]Theresults for T in general and for T2 and T3 were lower than those found by other authors.[17] The effectiveness for T1stage was similar that in another study.[17]

N detection is the most challenging detection of any imaging examination.[18] The criterion "size" for detection of lymph node metastases is a poor predictor, since non-tumor enlarged nodes can exist, and the reverse is also true.[8] The irregular contour and heterogeneous signal intensity are more specific criteria for metastazisation.[17]In this study there was substaging in 31.7% (n = 26) of cases classified as N0, and overstaging in 7.32% (n = 6); in 31.7%(n = 26).The sensitivity, specificity, positive PV and negative PV relative to N were 27.8%, 87%, 62.5% and 60.6%, respectively. The value for sensitivity was lower than those found in several previous studies; however, the specificity showed values higher than those found in these same studies.[16]Positive and negative PVs were similar to those obtained in other studies.[15]The effectiveness of MR for N stagingwas 61%, a figure similar to that found by several authors, varying between 39 and 95%.[15] The agreement between the staging results obtained by MR and anatomopathological results, evaluated by *K*w value for T and N, were given as: *K*w= 0.14, $p < 0.05$ and *K*w= 0.16, $p < 0.05$, respectively. These figures revealed a poor agreement between the two staging forms; additionally, they differ from most studies consulted, where *K*w values between 0.71 and 0.89 for T and between 0:40to 0:56 to N were obtained.[17] The study by Tytherleigh MG et al. was that that obtained the closest values to ours, namely: 0:37 ($p < 0.001$) for T staging and 0.25 ($p < 0.002$) for N staging.[19] Thus, MR proved to be an ineffective or poor method for N staging. These values were discordant with those found by other authors, ranging from 0.81 to 0.94for T staging and from 0.57 to 0.78 for N staging.[20]

This study has some limitations, such as the relatively small number of patients, particularly those staged as T1. MR and anatomopathological staging were not always made by the same radiologist and pathologist; this may be an error factor. The results should be validated by future in multicenter prospective studies with better MR coil and specific subspecialty expert radiologist and pathologist.

Conclusion

From our study we can conclude that carcinoma rectum is a common disease, and its preoperative staging remains topic of great concern. The use of MR imaging can be undeniable role in the therapeutic management of rectal cancer. Further study is needed for better outcome. The agreement

between values obtained by MR and anatomopathological results was poor for both T and N stages. Thus, in this study, it was an ineffective or poor method for staging.

References

1. Sagar PM, Pemberton JH. Surgical management of locally recurrent rectal cancer. Br J Surg 1996; 83:293–304.
2. Wieder HA, Rosenberg R, Lordick F, et al. Rectal cancer: MR imaging before neoadjuvant chemotherapy and radiation therapy for prediction of tumor-free circumferential resection margins and long-term survival. Radiology 2007; 243:744–751.
3. Abreu, S. F. M., & Martins, S. F. F. (2015). Preoperative staging of rectal cancer with MRI: correlation with pathologic staging. *Journal of Coloproctology (Rio de Janeiro)*, *35*(2), 77-82.
4. Quirke P, Dixon MF. The prediction of local recurrence in rectal adenocarcinoma by histopathological examination. Int J Colorectal Dis 1988;3: 127–131.
5. Vliegen RF, Beets G, Von Meyenfeldt MF, et al.Rectal cancer: MR imaging in local staging—is gadolinium-based contrast material helpful? Radiology 2005; 234:179–188.
6. Kapiteijn E, Marijnen CA, Nagtegaal ID, et al. Preoperative radiotherapy combined with total mesorectal excision for resectable rectal cancer. N Engl J Med 2001;345:638–646.
7. Goh V, Halligan S, Bartram CI. Local radiological staging of rectal cancer. Clin Radiol2004;59:215–226.
8. Beets-Tan RG, Beets GL. Rectal cancer: review with emphasis on MR imaging. Radiology 2004;232:335–346.
9. Maier A, Fuchsjager M. Preoperative staging of rectal cancer. Eur J Radiol2003;47:89–97.
10. Sobin LH, Wittekind CH (International Union Against Cancer), eds. TNM classification of malignant tumours, 5th ed. Baltimore, MD: Wiley-Liss, 1997.
11. Wieder HA, Rosenberg R, Lordick F, et al. Rectal cancer: MR imaging before neoadjuvant chemotherapy and radiation therapyfor prediction of tumor-free circumferential resection margins and long-term survival.Radiology 2007; 243:744–751.
12. Brown G, Richards CJ, Newcombe RG, etal. Rectal carcinoma: thin-section MR imaging for staging in 28 patients. Radiology 1999; 211:215–222.
13. Otchy DP, Nelson H. Radiation injuries of the colon and rectum. Surg Clin North Am1993; 73:1017–1035.
14. Halefoglu AM, Yildirim S, Avlanmis O, Sakiz D, Baykan A. Endorectal ultrasonography versus phased-array magnetic resonance imaging for preoperative staging of rectal cancer. World J Gastroenterol. 2008;14:3504–10.
15. Beaumont C, Pandey T, Fricke G, Laryea J, Jambhekar K. MR evaluation of rectal cancer: current concepts. Curr Probl Diagn Radiol. 2013;42:99–112.
16. HeeHeo S, Kim J, Shin S, Jeong Y, Kang H. Multimodal imaging evaluation in staging of rectal cancer. World J Gastroenterol. 2014;20:4244–55.11
17. Iannicelli E, Di Renzo S, Ferri M, et al. Accuracy of high-resolution MRI with lumen distention in rectal cancer staging and circumferential margin involvement prediction. Korean J Radiol. 2014;15:37–44.
18. Tapan Ü, Özbayrak M, That S. MRI in local staging of rectalcancer: an update. Diagn Interv Radiol. 2014;20:390–8.
19. Tytherleigh MG, Vivien N, Pittathankal AA, Wilson MJ, FaroukR. Preoperative staging of rectal cancer by magnetic resonance
20. Beets G, Beets-Tan R. Pretherapy imaging of rectal cancers:ERUS or MRI? Surg Oncol Clin N Am. 2010;19:733–41.