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Role of MRI with Diffusion and Whole Tumor Volume Calculation in Detection of Response in Rectal Cancer Patients under Therapy

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Abstract---Background: MRI examination of the rectum has evolved as the standard technique in the assessment of cancer rectum having multiplaner capabilities and high tissue contrast imaging. The aim of this study: The aim of this study is to evaluate the role of MRI in assessment of rectal neoplasm. Patients and methods: In this study we prospectively evaluated 40 patients (24 male -60%) and (16 females - 40%), who referred to the MRI unit, Radiology department, (Minia Oncology Center) for further assessment of histopathology proven rectal carcinoma, during the period of (August 2019) to (August 2021). Results: 10% of patients (4 participants) had high rectal cancer while 55% of them (22 patients) had middle rectal cancer. On the other hand, 35% of them (14 patients) had low rectal cancer. 85% of participants (34 patients) were diagnosed as adenocarcinoma while the remaining 6 participants (15% of patients) were diagnosed as mucinous adenocarcinoma. 77.5% of patients (31 participants) had grade II rectal cancer while 9 patients (22.5% of participants) were diagnosed as grade III rectal cancer. On performing TNM staging, we found that the majority of cases; 37.5% of participants (15 patients); were found to be in stage IIA. Conclusions: MRI examination of the rectum has evolved as the standard technique in the assessment of cancer rectum having multiplaner capabilities and high tissue contrast imaging. Our study

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results demonstrate that high resolution MRI has pivotal role in accurate staging of rectal cancer and predicting involvement of the perirectal and pelvic lymph nodes.

Keywords--Colorectal cancer, Magnetic resonance, cancer rectum, perirectal, pelvic.

Introduction

Colorectal cancer is the third most common cancer in men and the second most common in women. **(1)** Imaging has become an essential tool in the preoperative decision making to avoid both under- and overtreatment. **(2)** Magnetic resonance (MR) imaging is a useful tool for determining the depth of tumor invasion into the rectal wall or mesorectal fascia. MR imaging, because of its high accuracy in evaluating local tumor progression and lymph node involvement—both of which are crucial for decision making and used for determining the treatment strategy. **(3)** Although MR imaging has been widely adopted for primary staging of rectal cancer, its use for restaging after (CRT) has limitations because the differentiation of fibrosis, desmoplastic reaction, and colloid from residual viable tumor is difficult. Conventional MR imaging is used for anatomic imaging only. **(3)**

Patients and Methods

In this study we prospectively evaluated 40 patients (24 male -60%) and (16 females -40%), who referred to the MRI unit, Radiology department, (Minia Oncology Center) for further assessment of histopathology proven rectal carcinoma, during the period of (August 2019) to (August 2021). This study was approved by the local ethic committee. All patients were diagnosed with histologically confirmed rectal carcinoma by endoscopic rectal biopsy, and had a baseline MRI data

Inclusion Criteria: Locally advanced rectal cancer, T3/4 or node positive rectal cancer, suitable for pre-operative chemo-irradiation and surgical resection and no contraindication to MRI (pacemaker, severe claustrophobia)

Exclusion Criteria: Previous radiotherapy to pelvis, orang metastasis at presentation, unable/unwilling to do MRI (e.g.: claustrophobic patients), pacemaker or implanted defibrillator, presence of other malignancy other than the rectal cancer and poor general condition not tolerable for chemo-irradiation.

Imaging technique

Imaging acquisition: Rectal MR examination was carried out before and after neoadjuvant CT, respectively, on a 1.5.0 T MR scanner (**SIGNA™ Explorer - GE Healthcare (United States)**), using an abdominal phase array coil. No special preparation was done before the examination.

Image analysis: The morphological features of each lesion were recorded included size, border, signal characteristics at T1, T2 and FAT-SATURATED signal characteristics. Pattern of enhancement in the dynamic imaging, subtracted images, color mapping. Signal intensity on diffusion images were also evaluated in different b values.

Tumor staging: Tumor staging was done according to the American Joint

Committee on Cancer (**AJCC**) TNM staging system, Eighth Edition through combination of both radiological and histopathological data of each case.

Statistical Analysis: Data was analyzed using statistical package for social sciences (**SPSS - version 24**) for analyzing the data. Quantitative data was described in terms of mean and standard deviation if normally distributed and median and interquartile ranges if non parametric. Kolmogorov-smirnov test was used to test the normality of distribution of numerical variables. Chi square test was used to test the association between categorical variables. Independent sample t test was used to test the difference of numerical outcomes between 2 groups. Anova was used in case of more than 3 groups. Paired sample t test was used in case of paired numerical outcomes. Mann Whitney U test and Wilcoxon signed rank test was used in case of non-parametric numerical outcomes comparison. p value less than 0.05 was considered statistically significant.

Results

40 participants were eligible to participate in the study. Their mean age was 48.03 ± 11.9 years old. 60% of them (24 patients) were males. All patients were diagnosed as rectal carcinoma but with different sites; high, mid and low. 10% of patients (4 participants) had high rectal cancer while 55% of them (22 patients) had middle rectal cancer. On the other hand, 35% of them (14 patients) had low rectal cancer. 85% of participants (34 patients) were diagnosed as adenocarcinoma while the remaining 6 participants (15% of patients) were diagnosed as mucinous adenocarcinoma. 77.5% of patients (31 participants) had grade II rectal cancer while 9 patients (22.5% of participants) were diagnosed as grade III rectal cancer. On performing TNM staging, we found that the majority of cases; 37.5% of participants (15 patients); were found to be in stage IIA. This was followed by stage IIIB which included 27.5% of patients (11 participants). We also found that nearly half of cases (22 patients; 55% of participants) were found to have free nodal metastasis. **Table 1**

Table 1; showing the sociodemographic characteristics of included patients (n=40)

Variable	Value
Group	
Disease regression	29 (72.5 %)
Disease progression	6 (15 %)
Complete response	5 (12.5 %)
Age	48.03 ± 11.9*
Gender	
Male	24 (60 %)
Female	16 (40 %)
Site of the tumor	
High	4 (10 %)
Mid	22 (55 %)
Low	14 (35 %)
Histology	
Adenocarcinoma	34 (85 %)
Mucinous adenocarcinoma	6 (15 %)

Grade	
II	31 (77.5 %)
III	9 (22.5 %)
T stage	
TIII	37 (92.5 %)
T IVB	3 (7.5 %)
N stage	
N0	22 (55 %)
N1	9 (22.5 %)
N2	6 (15 %)
N2a	2 (5 %)
N2b	1 (2.5 %)
M stage	
M0	40 (100)
TNM	
IIA	15 (37.5 %)
IIB	7 (17.5 % %)
IIIB	11 (27.5 %)
IIIC	6 (15 %)
* Mean ± SD	

The tumor volume was found to be significantly correlated with tumor response, with average tumor volume in the responding group was (33.5 cm³), while being (65 cm³) in the non-responding group (p<0.001). **Table 2**

Table2: Correlation between the tumor volume and tumor response in all participants (n: 40)

	Response		P value
	NR	R	
Volume cm3 (pre)	65 (49-82.8)	33.5 (23.8-50)	0.004*
Volume cm3 (post)	75 (49.3-90)	10 (5-15.8)	<0.001*
NR: Non-responder , R: Responder			

The tumor volume, as well as the pre-skewness and pre- ADC mode, were found to be significantly correlated with presence of the metastatic LNs. with average tumor volume in the non-metastatic group was (30.5 cm³), while being (53.5 cm³) in the LN metastatic group (p<0.005). **Table 3**

Table 3: Correlation between the tumor volume and presence of metastatic LNs in all participants (n: 40)

	Metastasis		P value
	No	Yes	
Volume cm3 (pre)	30.5 (22.3-45)	53.5 (33.8-71.3)	0.003*
Volume cm3 (post)	8.5 (5-15)	21.5 (9.5-56.3)	0.016*

*: significant correlation

Discussion

The incidence of rectal cancer begins to rise after age 40, a sharp increase is seen after age 50, with the vast majority (over 90%) of cases being diagnosed in people > age 50 years of age **(4, 5)** Rectal cancer is known to have a tendency toward male predominance and toward younger population in comparison to colon cancer **(6, 7)**, as found in the current study; the mean age of participants was 48.03 ± 11.9 years old and 60% of them were males.

Over the past decade, there has, however, been a decrease in the incidence of rectal cancer in people age ≥ 50 , with a steady increase in those patients under 50 years of age.**(8)** The annual percentage change in incidence continues to rise at approximately 1.8% per annum in individuals < age 50 with a decrease of 1.5% per annum observed in the 50–64 year age group and a 4.5% decrease in the annual percentage change in the 65 year and older age group. A major potential reason for this declining incidence in older patients is the increased use of screening colonoscopy and sigmoidoscopy in this age group**(9)** Gender is strongly associated with the varying incidence of rectal cancer where it is generally about 25% higher in men when compared with women **(10)** male predominance was reported in many studies that was considered as a risk factor for rectal cancer**(11)**

In the present study, the main rectal cancer position was middle rectal cancer (50%), the main type was adenocarcinoma(85%) and grade II was found in 77.5% of patients ,by TNM staging, 37.5% of participants were stage IIA followed by stage IIIB 27.5% of patients. We also found that (55% of participants) were found to have free nodal metastasis.

TNM stage was also found to be significantly correlated with tumor response among our patients. In agreement with **Liu et al., (12)** as worse pathological TNM stage (HR=1.789, P=0.005, and higher risk score (HR=1.084, P<0.001) were significantly associated with impaired disease-free survival, also in **Kuo et al., (13)** study, the final pathologic TMN stage was correlated to the outcome in disease relapse for rectal cancer after neoadjuvant chemoradiation therapy.

There was a number of differences that may account for the variations in results observed between studies. The standardization of MRI protocols is important to compare quantitative studies; the differences in the number of b-values and b-values used in the protocols could result in differences in the ADC maps produced, making it difficult to compare studies.

Accurate assessment of lymph node (LN) status in patients with rectal cancer is essential for planning treatment and predicting local recurrence and overall survival **(14)**. However, the accuracy of MRI in evaluating LN in rectal cancer was

poor, and the sensitivity and specificity were 77% and 71% based on size and morphological features **(15)**.

Conclusions

MRI examination of the rectum has evolved as the standard technique in the assessment of cancer rectum having multiplaner capabilities and high tissue contrast imaging. Our study results demonstrate that high resolution MRI has pivotal role in accurate staging of rectal cancer and predicting involvement of the perirectal and pelvic lymph nodes.

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