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The Role of Diffusion Weighted MRI in Assessment of Rectal Cancer

Ahmed Abdel Fattah Abu Rashed, Mohamed Ismail Hammad, Mahmoud Sabry Qutb Sallam*
Department of Radiodiagnosis, Faculty of Medicine, Al-Azhar University
***Corresponding author:** Mahmoud S. Q. Sallam, **Mobile:** 01003882827, **Email:** mahmoudsallam1989for@gmail.com

ABSTRACT

Background: Magnetic resonance imaging has become the most accurate technique in local staging of rectal cancer. The identification and staging of rectal cancers at MR imaging is largely based on differences in T2 signal intensity between the tumor, the mucosa and submucosal layers, the muscular layer, the perirectal fat, and the mesorectal fascia.

Objective: Was to assess the role of Diffusion Weighted MRI in assessment of rectal cancer and correlation of these findings with available histopathological findings.

Patients and Methods: A total of 30 patients, proved by colonoscopy to have rectal carcinoma, were included in this retrospective **s**tudy wich was carried out in the Radiology Department of Al-Azhar University Hospitals. The work took place during the period between June 2018 and Januray 2019.written consent was taken from each patient. The study was carried out after approval of the ethical committee of scientific research, faculty of medicine, Al-Azhar University.

Results: we found that DW MRI measurement increased the specificity of the rectal MRI in characterizing different rectal cancers especially when it is combined with conventional MRI.Also the use of additional DW MR imaging yields better diagnostic accuracy than does use of conventional MR imaging alone in the evaluation of complete response (CR) to neoadjuvant chemoradiation treatment (CRT) in patients with locally advanced rectal cancer.

Conclusion: DW MRI has a growing role in rectal cancer staging either primary staging or evaluating the post chemo radiotherapy state.

Keywords: diffusion weighted , Magnetic resonance imaging, Rectal Cancer.

INTRODUCTION

Rectal cancer is one of the most common tumors in industrialized countries and one of the most common malignant tumors of the gastrointestinal tract. MRI is the modality of choice for staging rectal cancer to assist surgeons in obtaining negative surgical margins. MRI facilitates the accurate assessment of MRF and the sphincter complex for surgical planning [(1)]. Diffusion weighted imaging (DWI) has an increasing clinical role in the imaging of patients with rectal cancer, especially in the restaging phase after chemoradiation treatment (CRT). Diffusion imaging is gaining increasing attention for rectal cancer imaging not only qualitatively but also quantitatively [(2)]

The challenge for preoperative imaging in rectal cancer is to determine subgroups of patients with different risks for recurrence; those with superficial tumors who can be treated with surgery alone, those with operable tumors and a wide circumferential resection margin who can be treated with a short course of radiation therapy followed by total mesorectal excision, and those with advanced cancer and a close or involved resection margin who require a long course of radiation therapy with or without chemotherapy and extensive surgery [(3)].

AIM OF THE WORK

The aim of this work is to assess the role of magnetic resonance with diffusion in staging of rectal carcinoma in relation to histopathological findings.

PATIENTS AND METHODS

The present study started on June 2018 till January 2019. The study included 30 patients; some of them referred from surgical department and others are from outpatient clinic. All cases were examined on GENERAL ELERTRIC 1.5 Tesla Machine at MRI unit, Al-Hussein University Hospital. They proved by colonoscopy to have rectal cancer. This study was composed of full history and clinical data. They underwent MR examination prior to which written consent was taken from each patient.

In our study we classified our patients into 2 groups: Group I: The group included 11 patients who were treated surgically without chemo or radio therapy, suggested by MRI examination to be at T1-T2-T3, N0-N1, and M0 stage, who underwent MR examination before surgery. Group II: The group included 19 patients who were treated surgically after neoadjuvant therapy, suggested by MRI examination to be at Tx N2 M0 and T3-T4 Nx M0 stage, who underwent preoperative MR before neoadjuvant chemoradiation therapy and again 6-8 wks after the end of the treatment for the re-staging of disease.

A- Preparation: The patient should avoid large movements. Each patient was subjected to rectal luminal distension by sterile gel.

B- Patient position: The patient asked to lie supine on the examination couch with the body-array coil was placed on the pelvis .

C- MRI Sequence: The routine protocol used for rectal imaging that includes: Localizer images in three orthogonal planes were taken first.Sagittal,T2-weighted, fast (turbo) spin-echo sequence from one pelvic sidewall to the other. Axial sections of the pelvis with large field of view T1 and T2 weighted images, T2-weighted high resolution axial oblique images through

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the rectal cancer and adjacent tissues. Axial post-contrast fat suppressed T1 WI ± sagittal post-contrast T1 WI used in some cases.

DW MR study: After all MRI sequences had been performed, Axial DWI with single shot echo planar imaging (EPI) Performed at b values of 0, 500 and 800 s/mm2. ADC map are done automatically on the scanner.

Image Interpretation: All lesions or areas of abnormal T2 signal intensity detected were evaluated, as regard: (A) Lesion topographical assessment: 1-Dimensions.2-Distal Resection Margin. 3-Circumferential resection margin 4-Enhancement pattern (homogenous, heterogeneous). 5- Diffusion study: Whether the lesion showed diffusion restriction and the mean ADC value was measured.

The study was approved by the Ethics Board of Al-Azhar University.

Statistical Methods

The Shapiro-Wilk test was used to examine the normality of numerical data distribution. Normally distributed continuous data were presented as mean ± SD and non-normally distributed data as median (interquartile range). Categorical data were presented as number (%).

The diagnostic value of various radiological tools for discrimination between malignant and benign lesions was examined versus the result of histopathology (or follow-up) as the gold-standard test. The following diagnostic/predictive indices were calculated: sensitivity, specificity, positive and negative predictive values, positive and negative likelihood ratios, and correct classification and misclassification rates.

Agreement between radiological tools was examined by calculation of the Cohen kappa coefficient (κ) and the bias and prevalence adjusted kappa coefficient (PABAK). The Cohen κ and PABAK are interpreted as follows:

The Cohen κ and PABAK:

Cohen κ or PABAK	ength of agreement
< 0.20	Poor
0.21 - 0.40	Fair
0.41 - 0.60	Moderate
0.61 - 0.80	Good
0.81 - 1.00	Very good

The study was carried out after approval of the Ethical committee of scientific Research, faculty of medicine, Al-Azhar University.

RESULTS

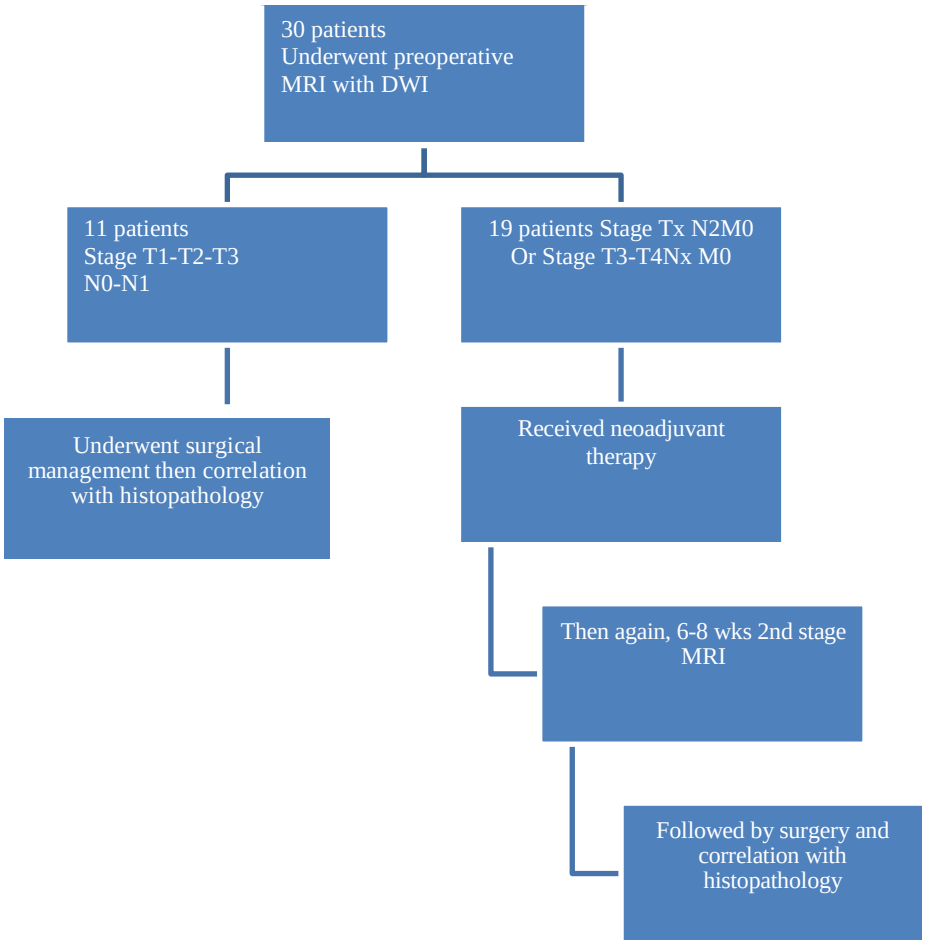

Figure (1): Flow chart shows the description of our population and sub groups.

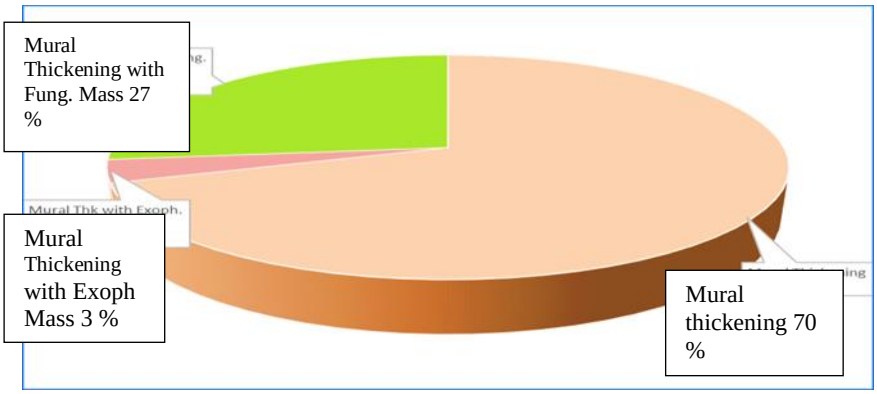

Figure (2): pie chart shows the number and percent of MR pattern of lesion among the studied groups.

-These pie chart show that 70% of the patients of the studied groups presented with mural thickening and 27%presented with mural thickening with fungating endoluminal mass while 3% presented with mural thickening with exophytic mass.

-Assessment of T stage for group I:

-Table (1) Shows correlation of the T stage using conventional MRI without DWI for group I with the pathological results.

T stage by MRI without DWI		Pathological stage	
		T2	T3
T2	3	2	1
T3	8	1	7
Total (cases)	11	3	8

-Table (2) Shows correlation of the T stage using conventional MRI without DWI for group I with the pathological results.

T stage by MRI with DWI		Pathological stage	
		T2	T3
T2	3	2	1
T3	8	1	7
Total (cases)	11	3	8

-Both tables show no difference between MRI with DWI and MRI alone. This gives
9 true positive results giving 81.8 % sensitivity (an overall accuracy rate 81.8%)

-Assessment of nodal staging for group I:

- Table (3): Comparison between rectal MRI without DWI as regard nodal staging versus histopathology among group I.

N stage by MRI without DWI		Pathological stage	
		Benign	Malignant
Benign LN	9	6	3
Malignant LN	13	3	10

- Table (3) show (76% sensitivity & 66% specificity with accuracy 72% as regard nodal staging versus histopathology among group I) .

-Table (4): Comparison between rectal MRI with DWI as regard nodal staging versus histopathology among group I.

N stage by MRI with DWI		Pathological stage	
		Benign	Malignant
Benign LN	10	7	3
Malignant LN	15	2	13

-Table (4) Show (81% sensitivity &79%specificty with accuracy 80% as regard nodal staging versus histopathology among group I) .

-Assessment of CRM for group I:

At **group I,** there was no evidence of mesorectal fascia involvement by conventional MRI with or without DWI, which was accurately evaluated when correlated with the histopathological results giving an accuracy rate 100% in evaluation of CRM**.**

-Assessment of T stage for group II:

-Table (5) shows correlation of the T stage after the adjuvant therapy for group II with the pathological results using conventional MRI without DWI.

T stage by MRI without		Pathological stage		
		T0	T2	T3
T0	1	1	0	0
T2	10	4	3	3
T3	8	0	2	6
Total (cases)	19	5	5	9

-This table (5) shows the down staging & distribution of group II using conventional MRI without DWI .This gives 60% sensitivity and 33 % specificity with overall diagnostic accuracy 46.5%.

- Table (6) shows correlation of the T stage after the adjuvant therapy for group II with the pathological results using conventional MRI with DWI.

T stage by MRI with DWI after CRT at group II		Pathological stage		
		T0	T2	T3
T0	4	4	0	0
T2	7	1	4	2
T3	8	0	1	7
Total (cases)	19	5	5	9

-This table (6) shows the down staging & distribution of group II using conventional MRI with DWI .This gives 79% sensitivity and specificity 80 % with overall accuracy 79.5%.

Assessment of N staging for group II:

-Table (7) Comparison between rectal MRI without DWI as regard nodal staging versus histopathology among group II.

stage by MRI without DWI in group II		Pathological stage	
		Benign	Malignant
Benign LN	13	8	5
Malignant LN	19	2	17

-This table (7) show 74% sensitivity and 80% specificity with on overall accuracy 78% as regard nodal staging versus histopathology among group II.

-Table (8) Comparison between rectal MRI with DWI as regard nodal staging versus histopathology among group II.

N stage by MRI with DWI in group II		Pathological stage	
		Benign	Malignant
Benign LN	14	10	4
Malignant LN	22	2	20

-This table (8) show 83% sensitivity and 83% specificity with on overall accuracy 83% as regard nodal staging versus histopathology among group II.

-Table (9) shows the minimum and maximum value for the ADC before and after therapy.

	Min.	**Max.**	**Mean**	**SD**
ADC Before CRT	0.5	1.2	0.7365	0.18077
ADC After CRT	1.3	2.2	1.7167	0.16539

-ADC values for this studied group estimated before and after adjuvant therapy. When these values compared with each other by paired T test revealed t value -12.15 and p value 0 meaning that it is highly significant in estimating response to therapy; when there is response to therapy there is increase in the corresponding ADC.

Assessment of Circumferential resection margin for group II:

-Table (10) Comparison between rectal MRI without DWI as regard CRM assessment versus histopathology among group II after the neoadjuvant therapy.

CRM assessment by MRI without DWI		Pathologically	
		+ve	-ve
CRM -ve	18	2	16
CRM +ve	1	0	1
Total (cases)	19	2	17

-This table (10) shows that among this group when we used conventional MRI without DWI 18 cases were suggested to be –ve for CRM involvement when correlated with histpathology 16 were proved to be true –ve with 2 cases understaged and the other one case which was suggested to be +ve is overstaged when using conventional MRI only giving diagnostic accuracy 84.2%.

-Table (11) Comparison between rectal MRI with DWI as regard CRM assessment versus histopathology among group II after the neoadjuvant therapy.

CRM assessment by MRI With DWI		Pathologically	
		+ve	-ve
CRM -ve	18	1	17
CRM +ve	1	1	0
Total (cases)	19	2	17

-This table (11) shows that among this group 18 cases are suggested to be –ve for CRM by conventional MRI with DWI when correlated with histopathology 17 proved to be true –ve with 1cases false –ve given accuracy rate 94.7% The under- staged case at DW image interpretation was a LN that abutted the MRF with no diffusion restriction that corresponded to necrotic LN containing scanty tumor cells

DISCUSSION

During the past decade, (MRI) has been proven to be the most accurate staging modality for primary rectal cancer [(4)].

The evolution of surgical techniques and the shift to neoadjuvant chemotherapy–radiation therapy, along with the prognostic heterogeneity of stage T3 tumors, necessitate accurate preoperative staging primarily in terms of tumor (T) and nodal (N) staging, depth of tumor invasion outside the muscularis propria and the relationship of the tumor to the potential CRM. The accurate assessment of these factors allows the triage of patients to up-front surgical resection or short- or long-course preoperative radiation therapy or chemo therapy–radiation therapy with appropriate modification of the CRM [(5)].

Diffusion-weighted MRI (DW-MRI) is becoming increasingly important in the assessment of malignant tumors. It is generally accepted that DW-MRI enables noninvasive characterization of biologic tissues on the basis of their water diffusion properties; it provides information about the biophysical properties of tissues such as cell organization, density, microstructure, and microcirculation. DW-MRI is widely used in neuroimaging but its application within the abdomen is hindered by the presence of bulk physiologic motion such as respiration, peristalsis, and blood flow [(6)].

In this study we investigated the role of DW MRI with ADC as a malignancy marker in primary staging in rectal cancer wich proved by colonoscopy biopsy and in restaging of locally advanced rectal cancers. Then, these lesions were correlated with histopathological data.

In our study the DWI was searched for at multiple b values (0.200.800) mm2/sec. The ADC was automatically calculated at the work station. ADC findings would be defined as positive if the ADC 1.2 $x10^{-3}mm^2$/sec, AND as negative in all other cases. We used the same ADC cut off value used by ***Kim et al.*** [4] .

At ***group I;*** 2 patients were accurately staged as ≤T2 and 7 patients were accurately staged as T3 while the other 2 patients one patient was down staged which was T3 stage and one patient was over staged which was ≤T2 stage .the over staged case was due to a 1-2 mm a desmoplastic reaction that could not be differentiated from a true mesorectal fat tumor invasion.The under staged case was due to a minimal mesorectal fat invasion that could not be depicted .This gives 9 true positive results giving 81.8 % sensitivity (an overall accuracy rate 81.8%).

A study by **Iannicelli *et al.*** [7], studied 73 patients with primary rectal cancer who underwent high-resolution MRI with a phased-array coil without DWI, the study performed before line shows sensitivity 79% and specificity 82%. Surgery then MRI results were compared to postoperative histopathological findings which showed overall accuracy 93.6%. MRI correctly assessed the rectal wall tumor invasion in 25/29 intramural lesions ≤T2, in 35/37 pT3 and in 6/7 pT4. Four patients with T2 lesions were overstaged as T3 and two patients with pT3 tumors were understaged.

The difference in accuracy between our study and **Iannicelli *et al.*** [7], study was attributed to the small number of our population at this subgroup ***(group I)***.

Also **Halefoglu *et al.*** [8], studied 34 patients who have biopsy proven rectal tumor underwent both MRI and ERUS examinations before surgery. All patients were evaluated to determine the diagnostic accuracy of MRI and ERUS for depth of transmural tumor invasion and lymph node metastases. Imaging results were correlated with histopathological findings regarded as the gold standard revealing that the accuracy of T staging for MRI was 89.70% (27 out of 34).

However, **Dzik *et al.*** [9], concluded that high-b- value DW-MRI showed a sufficient diagnostic ability for detecting colorectal cancers as reflected in its high sensitivity (91%) and specificity (100%), the difference between this study & our study was that the whole patients included in our study were rectal carcinoma while

Dzic *et al.* [9], used DWI to differentiate between malignant and other rectal lesions as ulcerative colitis.

Iannicelli *et al.* [7], reported that the MRI accuracy for N staging was 68.49%, they evaluated the nodes on the basis of the size. Nodes with a short axis of 5 mm or greater were considered metastatic, while those less than 5 mm were assumed to be uninvolved While in our study the LN considered malignant if the size > 5mm, irregular margin, with heterogeneous signal intensity and enhancement following the 1ry rectal lesion with diffusion restriction on DWI using cut off value 1.2 x 10-3mm2/sec for the ADC to differentiate benign from malignant one (less than 1.2x10-3mm2/sec was considered malignant), while considered benign if size > 5mm, regular margin, homogenous signal intensity and enhancement. This gives higher sensitivities and specificities with accuracy rate 80%. **Halefoglu *et al.*** [8], using phased array MRI revealed that detection of lymph node metastases with accuracy of 74.50% (21 out of 34). The sensitivity and specificity were found to be 61.76% and 80.88%, respectively. Their results were on the basis of size and morphological feature without DWI.

As regard the nodal staging in our study using conventional MRI without DWI 3 out of 13 were falsely positive and 3 out of 9 were falsely negative according to histopathological evaluation giving 76% sensitivity &66%specificty with accuracy 72% while this result was improved by adding DWI to be 81% sensitivity, 79% specificity with accuracy rate 80% with increasing the number of detected lymph nodes.

Although T staging is a stronger predictor of overall prognosis, CRM is probably a more important prognostic indicator in detecting the proximity of the tumor extension to the resection margin and hence local recurrence.

Beets *et al.* [3], used contrast-enhanced thin-section MRI (slice thickness, 3 mm) on a 1.5-T scanner with a phased-array coil and reported that the depth of transmural tumor invasion and mesorectal fascia involvement were predicted correctly in 83% and 100% of their patients, respectively. Also, **Rao *et al.*** [10], studied the role of high resolution MRI in predilection of MRF involvement showed that mesorectal fascia was involved in 15 patients found by pathologists using a cutoff distance of 2 mm between a tumor and the mesorectal fascia. The

overall accuracy was 88% for predicting mesorectal fascia involvement.

Among our 1st group there was no evidence of MRF involvement that was accurately evaluated when correlated with the histopathological results giving an accuracy rate 100% in evaluation of CRM (circumferential resection margin) by conventional MRI with and without DWI.

Beets *et al.* [3], gave similar result to our study as regard the MRF invasion and also the transmural invasion (tumor staging) where we reported100% accuracy as regard the CRM and 81.8% as regard the T staging, while **Rao *et al.*** [10], reported a lower accuracy at predicting MRF involvement , this could be attributed to difference in the studied population in which the locally advanced rectal tumors were involved in their study and not involved in our sub group **(group I).**

Locally advanced rectal cancer has a poor prognosis because of the high frequency of metastasis and local recurrence. In particular, the presence of local recurrence is critical in terms of the patient‘s morbidity and quality of life. Thus, in a patient with locally advanced rectal cancer a wide surgical resection is needed to remove the tumor with a clear margin; however, sometimes the tumor is not completely removed or the patient loses anal sphincter function [4].

As a result, the rationale behind preoperative concurrent chemoradiation treatment (CCRT) is to first downstage and downsizes locally advanced rectal cancer. The benefits of down staging and downsizing locally advanced cancer include improvement in respectability, better local control, sphincter preservation, decreased rates of local recurrence, and most important is to improve overall survival. Thus, (CCRT) is performed in rectal cancer patients in whom the (CRM) or anal sphincter is threatened or involved, as identified at preoperative high-resolution pelvic MR imaging [11].

After neoadjuvant CRT, the tumor response is classified as complete response (no residual tumor), partial response (tumor volume decreased > 50% or down staging), or no response after postoperative pathologic analysis of the tumor specimens [4].

Allen *et al.* [12], evaluated T2-weighted MR imaging before and immediately after CRT in 30 patients with locally advanced adenocarcinoma and showed that 18 of 30 tumors were correctly T staged after treatment. Staging errors in that series were mainly in the small T3 tumor group.

Chen *et al.* [13], reported that in restaging of irradiated rectal cancer, MR imaging had an accuracy of 52% for T stage; this result was likely due to over staging of tumors of the pT0–pT2 stage.

In our study the restaging after neoadjuvant CRT for the group II (patients with locally advanced rectal carcinoma) using DWI with the calculation of ADC values This gives 4 true negative and 11 true positive results giving 79%sensitivity and specificity 80 % with overall accuracy 79.5%.While when we used conventional MRI without DWI this gives one true negative and 9 true positive results giving 60 % sensitivity and specificity 33% with overall accuracy 46.5%.

This gave similar results to our study when we did T staging depending on morphological features using T2weighted images and the inaccuracy was in the over staging of T2 stage due to inability to differentiate fibrosis from tiny residual tumoral tissue within the desmoplastic reaction induced by neoadjuvant therapy and also in the inability to diagnose complete response from residual tumoral tissues.

While, in **Dresen *et al.*** [14], study they focused on the discrimination between ypT0–2 (post therapy pathological T0-2) and ypT3–4 (post therapy pathological T3-4) tumors instead of the determination of each tumor stage separately. Their results were that after radiation therapy with concomitant chemotherapy, MR images had a PPV of 91% for the prediction of tumors confined to the rectal wall (ypT0–2 lesions) on the basis of morphologic criteria alone. A high PPV indicates that, when a tumor is predicted as a ypT0–2 tumor, it is an accurate prediction. Apparently, the visualization of an intact hypo intense bowel wall on T2-weighted MR images is highly predictive of a tumor limited to the bowel wall, thus explaining the high PPV. Understaging occurred in only one (1%) patient. In this patient, in the whole specimen only two residual tumor cell clusters in the mesorectal fat were found and because of the presence of fibrosis, many ypT2 tumors were over staged in their study and this factor led to a lower NPV as the interpretation of fibrosis with or without residual tumor on MR images remains difficult issue.

The goal of **Barbaro *et al.*** [15], was not to discriminate between post therapy T0–T2 stages but to identify T3 tumors that converted to T2 or lower stages or T4 tumors that converted to T3 or lower stages, although they performed post treatment MR imaging 8 weeks after CRT, when post treatment fibrosis was well developed, resulting in a decrease in signal intensity at MR imaging. Yet MR imaging could not depict small clusters of residual viable tumor cells within the fibrosis as replacement of

tumor by mucin pools caused persistence of high T2 signal intensity, resulting in substantial errors in interpretation of the amount of residual active tumor present. However they had a PPV and an NPV of 84.2% (32 of 38) and 66.7% (10 of 15), respectively. The overall accuracy was 79.2% (42 of 53) which are better than our study when depending on signal intensity of T2 WI as they considered T0, T1 and T2 as one stage so they overcome the difficulty in differentiating T0 – T2 stage which are the main difficulty in our study using conventional imaging only in group II and also lead to decrease the diagnostic accuracy using the conventional MR imaging only.

Although MRI is considered the most accurate tool for primary tumor staging in rectal cancer, this modality has intrinsic limitations in the differentiation of residual viable tumor from surrounding fibrosis after neoadjuvant CRT of rectal cancer. The fibrous tissue present after treatment causes thickening of the rectal wall; thus, MR imaging cannot readily differentiate T0 or T1 stage tumors from T2 stage tumors because it is not possible to visualize individual rectal wall layer [(15)].

Kim *et al.* [(4)], showed that neoadjuvant CRT caused a significant increase in the ADC values of 76 rectal cancer patients .These give similar results to our study which showed significant increase in the ADC values after CRT with the mean ADC values prior to treatment were 0.7x10-3mm2/sec while after treatments1.7x10-3mm2/sec using1.2x10-3 mm2/sec as cut off values to discriminate residual tumor from fibrosis.

Kim *et al.* [(4)], reported that adding DW imaging to T2-weighted imaging gave diagnostic accuracy range 82% [33 of 40] to 85% [34 of 40]) and was more helpful for detecting viable tumors after neoadjuvant CRT than T2- weighted imaging alone (accuracy, 70% [28 of 40]) in patients with locally advanced rectal cancer, that agreed with our results when we used DWI there was significant increase in the diagnostic accuracy especially the specificity, giving also high negative predictive value as we are able to differentiate between complete responder and non-responder.

Song *et al.* [(16)], evaluated the added value of diffusion- weighted imaging (DWI) in combination with T2 weighted imaging (T2WI) compared with T2WI alone or positron emission tomography (PET)/CT for detecting viable tumor after neoadjuvant chemo radiation therapy (CRT) in patients with locally advanced rectal cancer, their results were that in detecting viable tumors, DWI with T2WI improved the diagnostic accuracies (86% to 90% in both reviewers) over T2WI alone (64% to 76%) The sensitivity of DWI with T2WI was significantly higher than those of T2WI alone. The mean ADC of the viable tumor group (0.936x 10-3mm2 /sc) was significantly lower than that of the non-viable tumor group (1.556 x10-3 mm2/ sec). 1.045 x 10-3mm2 /sec was used as the cut-off value for distinguishing the viable tumor group from the non-viable tumor group which are different from that used in our study and suggested by **Kim *et al.*** [(4)], (1.2 x 10-3mm2/ sec used as the cut-off value for distinguishing the CR group from the non-CR group). This difference might be due to different MR scanner field strengths as our study was performed on low field strength 1.5 tesla in comparison to 3 tesla at **Song *et al.*** [(16)], study.

Their results showed agreement with our results regarding the increased overall accuracy using DWI + T2 WI although the relatively high value using T2 alone at the study of Song et al., 2012 could be attributed to the higher field strength with better spatial and temporal resolution at T2 WI. While at DWI still there are limitations in detecting microscopic tumor disease because the tumor microenvironment is both spatially and temporally heterogeneous, DWI with minute voxels can not be used to determine the tumor response at the level of individual cells [(16)].

It was determined that prediction of lymph node involvement with MR imaging by using imaging criteria, such as spiculated or indistinct margins and mottled or heterogeneous signal intensity may increase the accuracy in primary staging. However, it is difficult to differentiate a metastatic lymph node and irradiated lymph node change with post-CRT MR imaging by using morphologic criteria [(4)].

Lambregts *et al.* [(17)], found that the main role of DWI for lymph node evaluation was that it improved the number of detected nodes (both benign and malignant), because nodes were more easily detected on DWI due to their high signal intensity compared with the suppressed background signal of surrounding tissues as lymph nodes have a high cellular density, they generally show restricted diffusion and are easily detected on DWI , This showed agreement with our study in group II as regard the increased detection rate of the involved LN where by conventional MRI only 32 LNs were detected while after the adding DWI 36LNs were detected. Also we found that there was no marked difference in the overall diagnostic accuracy esp. the specificity this could be attributed to the increased ADC values for irradiated LNs making us unable to

accurately use the ADC values for discriminating malignant from benign nodes.

Tumor down staging and complete pathologic response after neoadjuvant chemotherapy and radiation therapy (CRT) followed by definitive surgical resection for advanced rectal cancer has decreased the overall recurrence rate and improved disease-free survival. The current surgical approach continues to be total mesorectal excision (TME) for all patients, regardless of the extent of the residual viable tumor. In TME, the mesorectum, which contains the rectum and mesorectal fat, is removed by sharp dissection along the mesorectal fascia (MRF). Tumors that have invaded or come very close to the MRF have a higher risk for local recurrence after TME. There is some debate on the necessity of this aggressive surgical approach in patients who have shown a favorable response to neoadjuvant CRT; thus, it is important to predict whether there is tumor invasion of the MRF before surgery. Although this subject requires further scientific exploration, favorable responders to CRT without tumor present in the MRF may benefit from less extensive resection. In contrast, those with residual tumor invading the MRF would require more extensive resection with larger resection margins than standard TME to reduce the risk of local recurrence **Park *et al.* [18].**

Park *et al.* [18], evaluated the utility of adding DW imaging to conventional post-CRT MR imaging to predict tumor clearance of the MRF in patients with locally advanced rectal cancer. They showed that combined analysis of DW and T2-weighted images (accuracy range, 89% [40 of 45] to 93% [42 of 45] yielded more accurate results than analysis of T2-weighted images alone (accuracy range, 40% [18 of 45] to 69%, which showed agreement with our study when we incorporated DWI with conventional MRI in group II 18 cases who were suggested to be –ve for CRM by conventional MRI with DWI when correlated with histopathology 17 proved to be true –ve with 1case false –ve and the other case was accurately suggested as +ve for CRM involvement this gave accuracy rate 94.7% with improvement in the diagnostic performance with 2 cases were corrected after adding DW image (one case was under staged and the other case was down staged) while The other under staged case which was not corrected at DW image was a tiny LN that abutted the MRF with no diffusion restriction that corresponded to an necrotic LN containing scanty tumor cells on histopathology.

In our study, we assessed the distance between the tumor and the MRF only on T2-weighted images, while we used DW imaging to detect viable tumor signal at the corresponding site, because of the limitations (signal suppression and low spatial resolution) of DW imaging in delineating the MRF.

CONCLUSION

DW MR imaging is a non-invasive scan that can be added easily to standard rectal MRI protocols as an adjuvant tool. Detection of negative circumferential resection margin is a reliable and reproducible technique .However, as regard the nodal staging with adding DWI there were increase in the number of detected LNs with no marked increases in the diagnostic accuracy .While in the case of locally advanced rectal tumors the diagnostic accuracy in the evaluation of CR ,it is significantly increased when DW MR imaging was added. Furthermore, the diagnostic accuracy in the evaluation of the tumor response and mesorectal fascia involvement was much improved after the addition of DW MR images. But as regard the N staging after neoadjuvant therapy our results revealed the increased detection rate of the involved LN after the adding DWI but there was no marked difference in the overall diagnostic accuracy.

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