Section: Radio-Diagnosis

Original Research Article

ROLE OF 3T MRI INCLUDING DWI IN EVALUATION OF RECTAL CARCINOMA

P. Haritha[1], A. Sravan Krishna Reddy[2], K. Siva Sankar Reddy[3]

[1,2]*Assistant Professor, Department of Radiodignosis, Narayana Medical College& Hospital, Nellore, Andhra Pradesh, India.*
[3]*Assistant Professor, Department of Orthopedics, Narayana Medical College& Hospital, Nellore, Andhra Pradesh, India.*

Received *: 10/03/2024*
Received in revised form *: 02/05/2024*
Accepted *: 18/05/2024*

Corresponding Author:
Dr.A. Sravan Krishna Reddy
Assistant Professor, Department of Radiodignosis, Narayana Medical College& Hospital, Nellore, Andhra Pradesh, India.
Email:sravankrishna1011@gmail.com

DOI:10.5530/ijmedph.2024.2.76

Source of Support: Nil,
Conflict of Interest: Nonedeclared

Int J Med Pub Health
2024; 14 (2); 387-394

ABSTRACT

Colorectal cancer is the third most common oncological disease worldwide. The standard treatment of locally advanced rectal tumors is neo adjuvant radio chemotherapy in combination with surgical resection. The choice of specific treatment algorithm is highly dependent on MRI findings. The aim of this study is to show the potential role of ADC measurements in rectal cancer and their usage in different clinical scenario. For local staging of rectal cancer, the correlation between MRI and histopathology was better when a given standard rectal imaging protocol was used. The standard protocol used in our study was T1 and T2-weighted fast spin echo sequences, Standard T2W imaging in the coronal, axial and sagittal plane of the pelvis. Axial diffusion weighted imaging with a single-shot echo-planar imaging sequence. Furthermore, the staging as assessed by MRI was in good correlation with histopathological analysis. The role of DWI as assessed by our study showed its role in localization of primary tumor and also helped in characterization of lymph node status.

Keywords: MRI, DWI, Colorectal cancer, Histopathology.

INTRODUCTION

Rectal carcinoma constitutes 1/3rdof all gastrointestinal tumors and because of its high recurrence it is important to accurately stage the disease.

High-resolution magnetic resonance (MR) imaging has an important role in the preoperative assessment of primary rectal cancer. The initial evaluation is made by a combination of endoscopy and biopsy.[1] MRI in particular is required to assess the depth of invasion of the tumor.

High resolution MR images of rectal cancers show a high degree of resemblance to histopathology sections and with careful interpretation of the images, further important prognostic information can be obtained that supplements the T and N staging.[2]

Without MRI staging, many of the findings and important prognostic variables would only be detected on histopathology examination of the operative specimen. The effectiveness of pre-operative therapy over post-operative treatments means that a technique identifying these factors pre-operatively is beneficial for patients.[3]

Preoperative imaging for rectal cancer staging is also useful to determine which surgical technique would be more appropriate: recently-developed local excision method of transanal resection or traditional radical resections such as low anterior resection or abdominoperineal resection.[1,2] It is essential that the radiologist provides accurate description of the disease spread. This allows the surgeons to decide on further treatment; in particular, if surgery is required.

The success of MRI depends on obtaining good-quality high-resolution T2-weighted images of the primary tumor; the mesorectal fascia, peritoneal reflection, and other pelvic viscera; and superior rectal and pelvic sidewall lymph nodes.[1]

Aims and objectives

1. To describe the utilization of a standard protocol in imaging of rectal cancer.
2. To correlate the MRI findings in rectal carcinoma with histopathology where possible.
3. To accurately stage the disease.
4. To assess the advantages of diffusion weighted imaging in staging of rectal cancer with a series of clinical cases.

MATERIAL AND METHODS

Study Design: Observational study (Descriptive study).

Study area and period

This study will be a prospective study from January 2022 up to January 2023 in Department of Radiodiagnosis at Narayana Medical College, Nellore. Data from the retrospective cases shall also be included in the study.

Study Population

All patients suspected of rectal carcinoma would be included in the study population. Histopathological correlation was done post imaging.

Sample Size

Minimum of 30 cases subjected to MR rectum will be included.

TECHNIQUE

Non Imaging Data

The non –imaging data will be collected as described in proforma.

Imaging Data

MRI: MRI equipment, General electric Medical Systems, 3T strength.

Technique of MR

The MR examinations would be performed on GE 3T. Basic sequence protocol for MR imaging of the rectum consists of T1 and T2-weighted fast spin echo sequences on a 3T MR imager (GE Medical Systems) using the phased-array torso coil. Standard T2W imaging is performed in the coronal, axial and sagittal plane of the pelvis with axial high-resolutionT2-weighted imaging performed through the rectum [thin-section (3mm) imaging, FOV260x260mm]. The T1-weighted imaging is an axial fast spin echo sequence of the pelvis. Axial diffusion weighted imaging is performed with a single-shot echo-planar imaging sequence. A b value of0 and 800 sec/mm2 is ideal. Standard sequence parameters as follows; TR 8000ms, TE100 ms ETL 1, Matrix 160 x 160, FOV 260 x 260 mm, NSA 4.

Inclusion Criteria

All patients with a palpable rectal mass, colonoscopic presence of mass, clinical suspicious of carcinoma rectum referred to the Department of Radio diagnosis, Narayana Medical College, Nellore will be included in the study.

Exclusion Criteria's

1. Patients with a history of severe infections / inflammation (wait for it to subside)

Data Analysis

This is an observational study, where the technique and indications of MRI for Carcinoma rectum are to be studied and it's utility as a diagnostic radiologic technique for evaluation of the rectal carcinoma. The findings of MR would be compared with histopathological findings, post-surgery to determine the efficacy of MR as a diagnostic tool in evaluation of carcinoma rectum. The additional role of diffusion weighted imaging is assessed.

Image Interpretation

All cases are reviewed on a work station with standard correlation tools to correlate abnormalities on diffusion weighted imaging and standard T2Wsequences. We highlight areas where diffusion has been useful and possible pitfalls. The work forms part of study assessing diffusion weighted imaging in primary rectal cancer staging.

Below is the up to date AJCC staging system which is referred to in the text.

AJCC (TNM) Staging System for rectal cancer

T1: The cancer has grown through the muscularis mucosa and extends into thesubmucosa.

T2: The cancer has grown through the submucosa and extends into the muscularispropria (outer muscle layer).

T3: The cancer has grown through the muscularispropria and into the subserosa but not to any neighboring organs or tissues.

T4: The cancer has grown through the wall of the colon or rectum and into nearby tissues or organs

Nx: No description of lymph node involvement is possible because of incomplete information.

N0: No lymph node involvement is found.

N1: Cancer cells found in 1 to 3 nearby lymph nodes.

N2: Cancer cells found in 4 or more nearby lymph nodes.

RESULTS

The present study deals with results of correlation between MRI imaging and histopathological findings.

Out of 30 patients 29 underwent surgery and 01 patient underwent colonoscopic biopsy. [Table 1]

Incidence of carcinoma rectum was found in males (76.67 and 23.33 %).

The commonest presenting complaint was bleeding per rectum with a percentage of 56.67 % and a p value of 0.00. [Table 2]

The mean age was above 50 years with 50-70 years being the commonest. [Table 3]

Out of 29 patients who underwent surgery, 25 patients were categorized as T3 and 05 patients had no tumor perforation(T2), the statistical significance (p value) is 0.00** and r value of 0.57. [Table 4]

Mesorectal fascia involvement was seen in 16.67 of the patients with a P value of 0.08. [Table 5]

The commonest location of carcinoma rectum noted in mid/lower rectum73.33%. [Table 6]

The commonest lymph node stage observed was N2. [Table 7]

Perirectal extension was noted in 25 patients (83%) on MRI and on histopathology was found to be in 18 patients(60%), the sensitivity of 95.2 % and a specificity of 62.5 % and r value of 0.69. [Table 8]

DWI showed restricted diffusion in lymph nodes in 6 patients (20%) out of 24 patients with lymph node positivity on conventional MRI. [Table 10]
On histopathology lymph nodes positive for tumor cells was noted in 7 patients (29%) of 24 patients with lymph node positivity on MRI cases and 29 % of total number of cases. [Table 11]

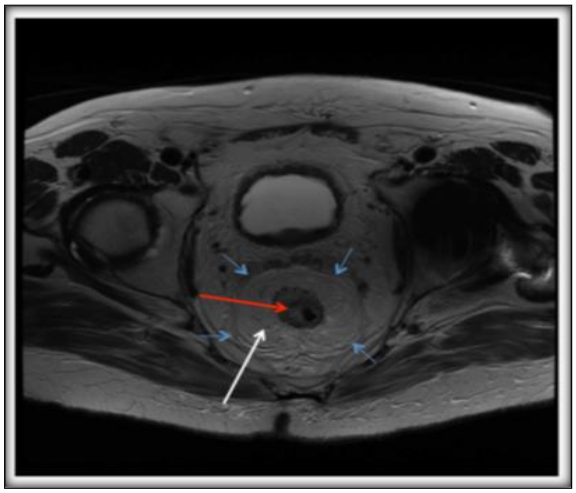

Figure 1: Anatomy on MRI axial image. Blue arrows outline the mesorectal fascia, white arrow mesorectal fat and the red arrow shows the rectum

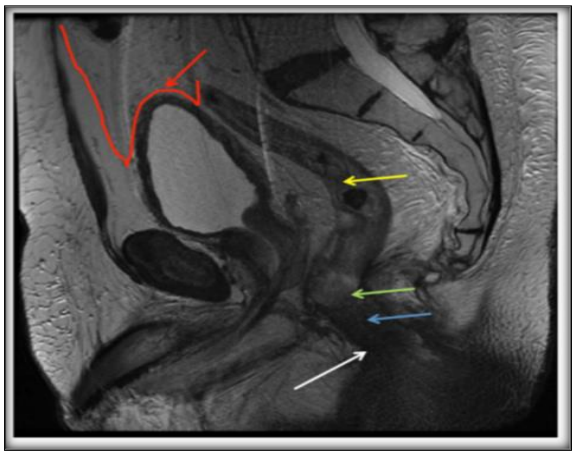

Figure: 2 Red arrow shows the peritoneal reflection over the pelvic organs. (Yellow arrow) rectum, (Green arrow) anorectal angle, (Blue arrow) rectum, (white arrow) anal verge

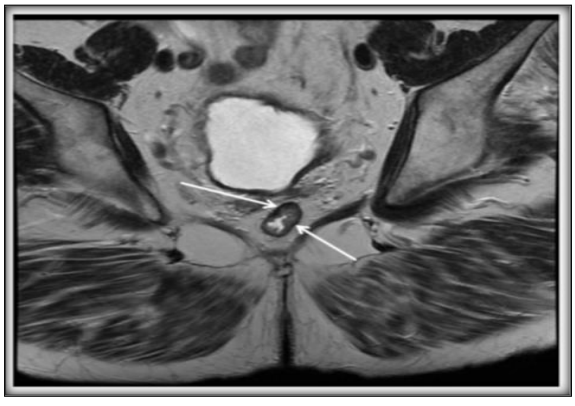

Figure 3: The low attenuation linear ring forming the outer margin of the rectum is the muscularispropria (Arrow)

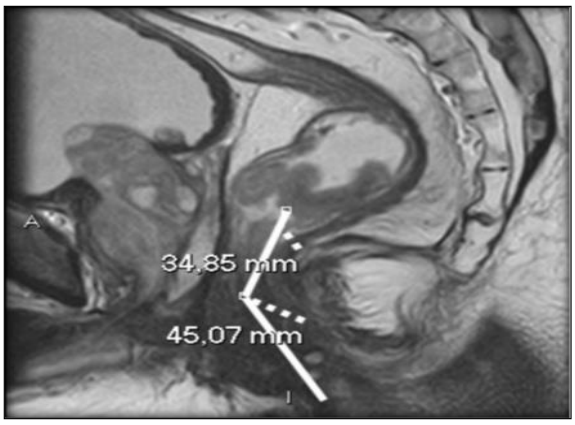

Figure 5: Assessment of distance from anal verge

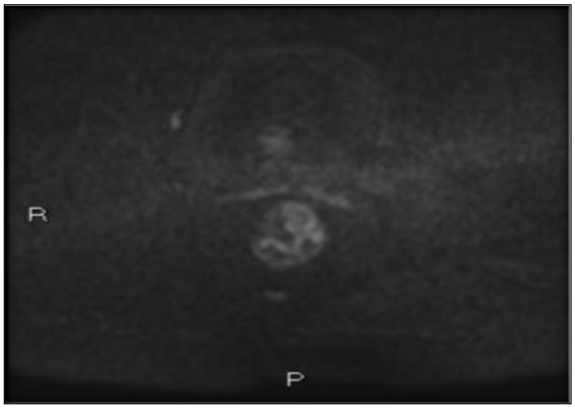

Figure 4: Location of tumor by DWI

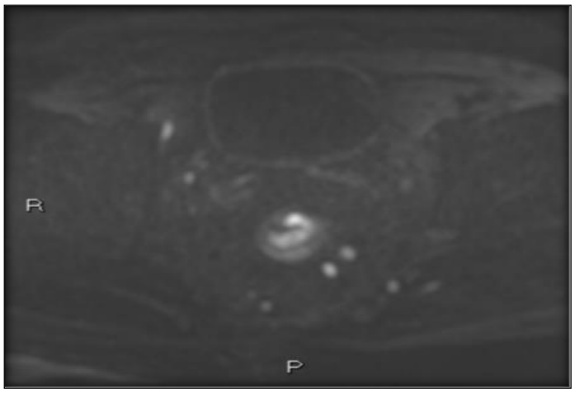

Figure 5: Location of nodes by DWI

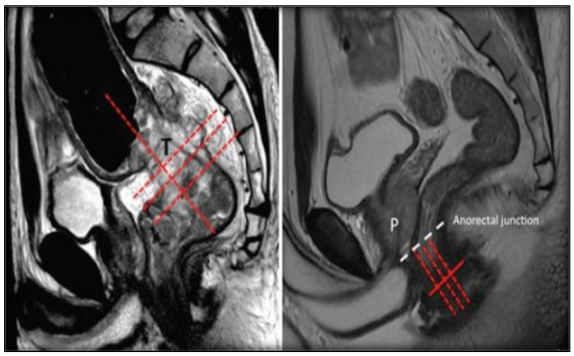

Figure 6: Planning MRI. (A) Sagittal T2W MRI. A bulky mid-rectal tumor (T); axial and coronal sequences are planned perpendicular and parallel to the tumor (lines). (B) Sagittal T2W MRI. Scan planes in the anal canal region (red lines)

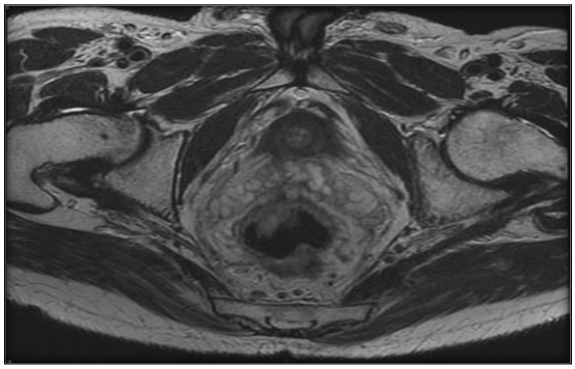

Figure 7: AXIAL T2W MRI shows poypoidal lesion in the mid/lower rectum, categorized as T2 tumor

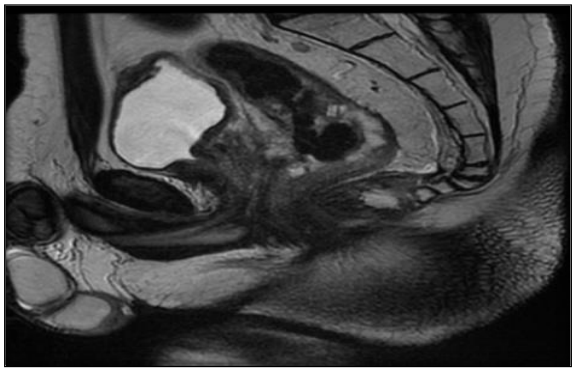

Figure 8: Sagittal T2W MRI shows circumferential mid-lower rectal tumor

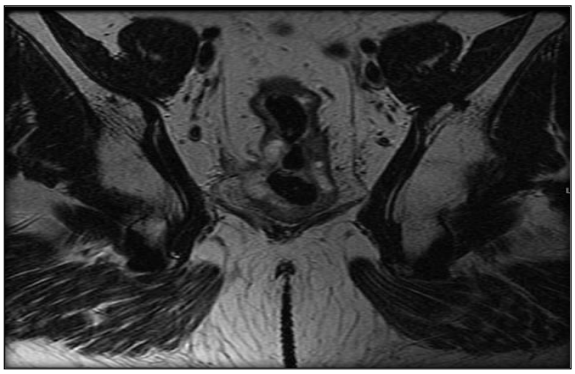

Figure 9: CORONAL T2W MRI shows circumferential mid-lower rectal tumor appearing intermediate to high signal intensity

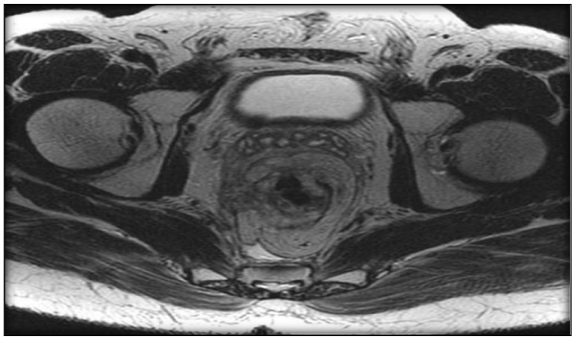

Figure10: AXIAL T2W MRI shows circumferentialtumor,T3 tumor with mesorectalFascia involvement

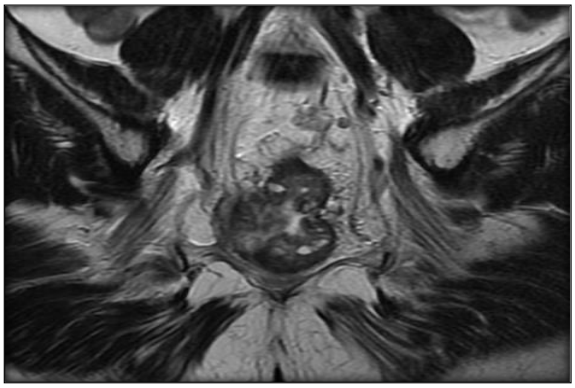

Figure 11: CORONAL T2W MRI shows T3 tumor from 7o' clock position to 10 o' clock positionwith mesorectal fascia involvement

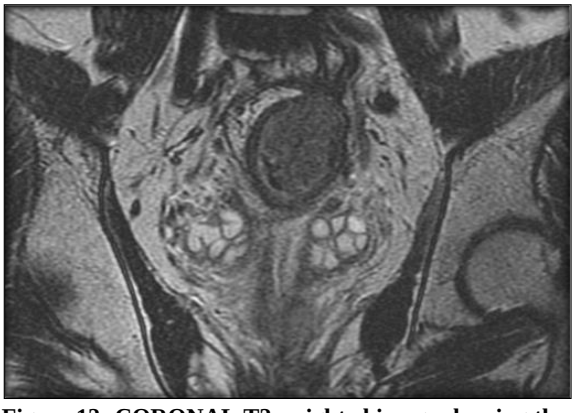

Figure 12: CORONAL T2 weighted image showing the presence of local perirectal lymph nodes

Table 1: Gender distribution of the patients

GENDER	No	%
MALE	23	76.67
FEMALE	7	23.33

Table 2: History of the patients

History	No	%	P-value
Altered bowel habits	05	16.67	0.00
Bleeding PR	17	56.67	0.00
Bleeding PR+, loss of weight and anemia	04	13.33	0.09
Bleeding PR, Tinnismus, loss of appetite	01	3.33	0.33
Fatigue, mass per rectum	01	3.33	0.42
Increased frequency stools	01	3.33	0.38
Loss of weight, constipation	01	3.33	0.44
Total	30	100	

Table 3: Age wise break up

Age(In years)	No	%
40-50	08	26.67
51-60	07	23.33
61-70	07	23.33
>71 Years	08	26.67
Total	30	100

Table 4: Tumor staging MRI vs HISTOPATHOLOGICAL FINDINGS

TUMOR STAGE	MRI		HISTOPATHOLOGY		P-Value	
	T3	T2	T3	T2	T3	T2
NO OF CASES	29	01	24	05	0.00	0.00*

Table 5: MRF –Status

MRF INVOLVEMENT	No	%	P-Value
MRF NEGATIVE	25	83.34	0.00
MRF POSITIVE	05	16.67	0.01

Table 6: FOR LOCATION OF TUMOR

LOCATION OF TUMOR	No of patients	%
UPPER RECTUM	05	16.6
UPPER /MID RECTUM	02	6.66
MID RECTUM	11	36.66
MID/LOWER RECTUM	11	36.66
LOWER RECTUM	02	6.67

Table 7: LYMPH NODE STAGING

LYMPH NODE STAGE	No of patients	%
N0	05	16.66
N1	06	20
N1/N2	01	3.33
N2	18	60%

Table 8: Peirectal extension on MRI and perirectal extension on Histopathology

MRI	Histopathology	P-value
25	18	0.01

Table 9: Diffusion Positivity

Variable	DWI		P-Value
	Positive	Negative	
Tumor	29	1	0.00

Table 10: For DWI Findings for tumor Assessment

VARIABLE	DWI		P-Value
	POSITIVE	NEGATIVE	
LYMPHNODE	06	24	0.00

Table 11: For Histopathological Correlation of Lymph Nodes Positivity for Tumor Cells

	HISTOPATHOLOGY	
	Positive	Negative
LYMPHNODE	07	22

Table 12: Correlation between the MRI findings and histopathology

SL	Variables	MRI-Findings	Histopathology	P-value	r-value correlation
01	Tumor	30 +Ve	29+Ve	0.00	0.82
02	MRF	25-Ve 05 +Ve	25-Ve 05 +Ve	0.00	0.74
03	PRE	25 +Ve	18 +Ve	0.01	0.69
04	Lymph node	06 +Ve	07 +Ve	0.00	0.58

DISCUSSION

MRI scan is one of the tools used in the evaluation of rectal pathologies. Its anatomic location, fixation in the pelvic fat, and absence of peristalsis makes the rectum an ideal organ for imaging with MRI.[4]

MRI has known to be invaluable in the diagnosis and staging of rectal cancers. Although rectal tumors can be diagnosed with digital rectal examination, and colonoscopy or sigmoidoscopy, these techniques do not provide sufficient information about the extraluminal spread of the tumour, which is a must for preoperative planning.[5]

With the better soft tissue contrast provided by MRI, it is the recommended modality of investigation, especially for low-lying rectal tumors.[6]

A precise preoperative staging of carcinoma is critical for the proper management of this disease, since the therapeutic strategies should be individualized.[7,8,9]Moreover, this staging is also a predictor of prognosis.[9,10]

Therefore, the imaging techniques used in tumor staging were proved to be decisive, and it is extremely important to determine their effectiveness.[10]

The standard imaging protocol used in the current study demonstrated rectal MRI as an excellent diagnostic tool for preoperative evaluation of rectal carcinoma, allowing the correct identification of tumor location, assessing involvement of mesorectal fascia and estimating proper nodal involvement.

The results of our study showed good correlation between preoperative imaging and histopathology in the given imaging protocol similar to the previous studies done by Fiona G.M et al.[11]

EUS and MR are the main tools of preoperative staging, but there is no consensus on which is the best method; however, several studies indicate MR to be superior to EUS; therefore, MRI was considered the standard imaging modality for preoperative staging of rectal carcinomas in the previous studies.[12,13,14,15]

Rectal carcinoma is generally found in people above the age 50 (as was in our study also)

Our study showed an increased incidence in males(males 76.66% and females 23.33 %).The most common presenting complaint was bleeding per rectum(56.67%). These findings were similar to the results of the study done by Fatima A. Haggar et al.[16]

The most common site observed was mid/lower rectum(73.33 %). The findings of our imaging study correlated with colonoscopic and surgical findings with statistical significance.

The most frequent tumor stage in our study was T3(96.67%).

One case showing thickening in mid rectum, staged as T2 turned out to be a villous adenoma on histopathology– a benign pathology.

The agreement between MRI assessment of T stage and histopathological findings was 87%, similar to the study done by SoraiaFilipaMacado Abreu et al.

With regard to T staging, when comparing the staging performed by MR with the histopathological staging, Stage T3 of the disease was the commonest observed stage. The staging observed histopathologically had a p value of 0.01 and an r value of 0.82for T3.These values are slightly lower than those observed in several other studies.[42,43,44,45] This is due to difficulty in differentiating between T2 and T3a tumor. However, the findings of our study was similar to the study Uc¸ ar et al. and Akasu et al.[17,18]

In our study, MR consistently helped categorizing the stage of the disease. However, the difference in distinguishing betweenT2 and T3 tumors could be due to the discrepancies between our measurements on individual sections. As a result MR has the potential tooverstageor understageborderlineT3-T2 tumors, as noted by others.[19]However, we must concede that the number of patients with T2 tumors studied was small.

However, differentiating between minimal T3infiltration and T2 lesions is probably of relatively little consequence for patient treatment, as patients with minimal T3infiltration into perirectal fat are at low risk of surgical failure from circumferential excision margin involvement.[17,19]

Our observation that MR imaging can provide accurate information on the extramural spread of rectal cancer, not only on its precise anatomic position but also on the depth of penetration beyond the muscle coat, is likely to be of considerable value in the management of this condition. This will allow better selection of patients for preoperative radiation therapy, facilitate the planning of how that radiation therapy is directed, and provide thesurgeon with useful additional information before embarking on the surgical procedure.

However, out of 29 patients with peri rectal extension observed in MRI, 15 of them actually had perirectal extension on histopathology with an r value of 0.[69].

This may in part be explained by the presence of a desmoplastic reaction in peritumoral tissues, making it difficult to distinguish between spiculation of perirectal fat caused simply by fibrosis, and those that contain viable tumor cells.

With regards to N staging, the commonest lymph node staging observed in our study was N2.

The size criterion for detection of lymphnode metastases was used as a predictor which was moderatively effective because non-malignant enlarged nodes can exist, and the vice versa is also true.

However the contour and heterogeneous signal intensity was not assessed in our study.

In our study the statistical variable showeda moderate agreement between the two staging forms; additionally, they differ from most studies done previously SoraiaFilipa Macado Abreu et al.[20]

The accuracy of MRI in the evaluation of lymph node involvement was 68%. 32% of
suspicious lymph nodes identified on MRI proved to be hyperplastic benign nodes.

The other aim of this study was to evaluate the diffusion weighted MRI as a useful technique for the assessment of lymph nodes during the primary staging of rectal cancer.

Our results show that DWI is of profound value in the evaluation of primary tumor, similar to the study done by Luc A. Heijnenet al,[21] DWI imaging was particular helpful to demonstrate the tumor location when the identification of tumor was difficult in a tortuous redundant rectum on conventional cross section imaging sequences.

The major benefit of DWI is that it is particularly helpful in identifying the lymph nodes. The differentiation between benign and metastatic lymph nodes was also possible. Our study demonstrated that out of 30 patients, 5 of them showed lymph nodes with diffusion restriction which were correlating with the histopathological findings.

However in1of the patients DWI did not demonstrate diffusion restriction, which were later proven to be met astatically involved(r value of 0.58). The probable reason could be a delay in the imaging and surgical periods.

Our results were correlating with those of a previous study byMizukami et al.All nodes that showed high signal intensity on high b value DWI were considered positive for metastases.

However with regards to a study done by Luc A. Heijnen et al,[21] in which they concluded that the addition of DWI increases the number of detected nodes , DWI may be beneficial in locating the nodes. They also concluded that DWI alone is not sufficiently accurateas a nodal staging tool. Our study showed a significant correlation with their study.

DWI with the calculation of ADC values is particularly useful in evaluation of chemo-radiotherapy and tumor response in case of locally advanced rectal tumors. This significantly increased when DWI was added to conventional MR imaging. DWI has a growing role in rectal cancer staging and evaluating the post chemo radiotherapy state. However, these parameters weren't assessed in our study.

CONCLUSION

Adding DW imaging with ADC value to conventional MRI yields better diagnostic accuracy than using conventional MR imaging alone in detection, correlation with tumor histologic grade, initial staging, and response evaluation to neoadjuvant CRT in patients with locally advanced colorectal cancer.

Conflict of Interest: None
Funding Support: Nil.

REFERENCES

1. Brown G, Radcliffe AG, Newcombe RG, Dallimore NS, Bourne MW, Williams GT. Preoperative assessment of prognostic factors in rectal cancer using high-resolution magnetic resonance imaging. Br J Surg 2003;90(3):355–364.
2. The size of regional lymph nodes does not correlate with the presence or absence ofmetastasis in lymph nodes in rectal cancer.J SurgOncol 1993;54(4):252–254
3. Brown G, Richards CJ, Newcombe RG, et al. Rectal carcinoma: thin-section MR imaging for staging in 28 patients. Radiology 1999;211(1):215–222.
4. Halefoglu AM, Yildirim S, Avlanmis O, Sakiz D, BaykanA.Endorectal ultrasonography versus phased-array magneticresonance imaging for preoperative staging of rectal cancer.World J Gastroenterol. 2008; 14:3504–10.14.
5. Zhang XM, Zhang HL, Yu D, Dai Y, Bi D, Prince MR, et al. 3-T MRI of rectal carcinoma: preoperative diagnosis, staging, and planning of sphincter-sparing surgery. AJR Am J Roentgenol. 2008; 190:1271–8.
6. Brown G, Kirkham A, Williams GT, Bourne M, Radcliffe AG, Sayman J, et al. High-resolution MRI of the anatomy important in total mesorectal excision of the rectum. AJR Am J Roentgenol. 2004; 182:431–9.
7. Hall NR, Finan PJ, al-Jaberi T, Tsang CS, Brown SR, Dixon MF, et al. Circumferential margin involvement after mesorectal excision of rectal cancer with curative intent. Predictor of survival but not local recurrence? Dis Colon Rectum. 1998; 41:979–83.
8. Beets-Tan RG, Beets GL. Rectal cancer: review with emphasis on MR imaging. Radiology. 2004; 232:335–46.
9. Bipat S, Glas AS, Slors FJ, Zwinderman AH, Bossuyt PM, Stoker J. Rectal cancer: local staging and assessment of lymph node involvement with endoluminal US, CT, and MR imaging--a meta-analysis. Radiology.2004;232:773–83.
10. Torricelli P. Rectal cancer staging. SurgOncol. 2007; 16:49–50.
11. Fiona G. M. Taylor, Robert I. Swift, LennartBlomqvist, and Gina BrownAmerican Journal of Roentgenology.A Systematic Approach to the Interpretation of Preoperative Staging MRI for Rectal Cancer 2008 191:6, 1827-1835
12. Barrett MW. Chemoradiation for rectal cancer: current methods. SeminSurgOncol. 1998; 15:114–9.
13. Smith N, Brown G. Preoperative staging of rectal cancer. ActaOncol. 2008; 47:20–
14. Videhult P, Smedh K, Lundin P, Kraaz W. Magnetic resonance imaging for preoperative staging of rectal cancer in clinical practice: high accuracy in predicting circumferential margin with clinical benefit. Colorectal Dis.2007; 9:412–9.
15. Brown G, Radcliffe AG, Newcombe RG, Dallimore NS, Bourne MW, Williams GT. Preoperative assessment of prognostic factors in rectal cancer using high-resolution magnetic resonance imaging. Br J Surg. 2003; 90:355–64.
16. Colorectal Cancer Epidemiology: Incidence, Mortality, Survival, and Risk FactorsFatima A. Haggar, M.P.H. and Robin P. Boushey, M.D., Ph. D,2009; 22,191-197.
17. Iannicelli E, Di Renzo S, Ferri M, et al. Accuracy ofhigh-resolution MRI with lumen distention in rectal cancerstaging and circumferential margin involvement prediction.Korean J Radiol. 2014; 15:37–44.

18. Akasu T, Iinuma G, Takawa M, Yamamoto S, MuramatsuY,Moriyama N. Accuracy of high-resolution magnetic resonanceimaging in preoperative staging of rectal cancer. Ann SurgOncol. 2009; 16:2787–94.
19. Chung CK, Stryker JA, Demuth WE. Patternsof failure following surgery alone forcolorectal carcinoma. J SurgOncol 1983; 22:65–70.
20. Preoperative staging of rectal cancer with MRI: correlation with pathologic stagingSoraiaFilipaMacadoAbreua, b, Sandra FátimaFernandesMartinsa, 201;02-05
21. Luc A. Heijnen&Doenja M. J. Lambregts&DipanjaliMondal&Milou H. Martens &Robert G. Riedl&Geerard L. Beets & Regina G. H. Beets-Tan Diffusion-weighted MR imaging in primary rectal cancer staging demonstrates but does not characterise lymph nodes. 2013 ;38: 131-148.