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Original research article

DIAGNOSTIC ACCURACY OF MRI FOR THE DIAGNOSIS OF RECTAL CARCINOMA TAKING HISTOPATHOLOGY AS GOLD STANDARD

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Abstract: *Rectal carcinoma is a major contributor to colorectal cancer-related morbidity and mortality worldwide. Accurate diagnosis is essential for appropriate treatment planning and improved patient outcomes. Magnetic resonance imaging is widely used for the evaluation of rectal carcinoma due to its excellent soft-tissue contrast and multiplanar imaging capabilities. However, local data regarding its diagnostic accuracy using histopathology as the gold standard are limited.* ***Objective:*** *To determine the diagnostic accuracy of magnetic resonance imaging in the diagnosis of rectal carcinoma, taking histopathology as the gold standard.* ***Methods:*** *This cross-sectional observational study was conducted in the Departments of Diagnostic Radiology at Liaquat National Hospital and Jinnah Postgraduate Medical College, Karachi, over a period of six months from 1 January 2024 to 6 July 2024. A total of 174 patients aged 25 to 60 years with clinical suspicion of rectal carcinoma were included using non-probability consecutive sampling. Magnetic resonance imaging was performed using high-resolution T2-weighted sequences. MRI findings were compared with histopathological results. Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were calculated using a two-by-two contingency table.* ***Results:*** *Out of 174 patients, magnetic resonance imaging detected rectal carcinoma in 82 patients (47.1%), while histopathology confirmed rectal carcinoma in 76 patients (43.7%). True positive cases were 68, true negative cases were 86, false positive cases were 14, and false negative cases were 6. Magnetic resonance imaging showed a sensitivity of 91.9%, specificity of 86.0%, positive predictive value of 82.9%, negative predictive value of 93.5%, and an overall diagnostic accuracy of 88.5%. Diagnostic performance remained consistent across different demographic and clinical subgroups.* ***Conclusion:*** *Magnetic resonance imaging demonstrates high diagnostic accuracy for rectal carcinoma compared with histopathology. MRI is a reliable and effective imaging modality for evaluating patients with suspected rectal carcinoma and should be routinely utilized in clinical practice.*

Keywords: Rectal carcinoma, Magnetic resonance imaging, Histopathology, Diagnostic accuracy, Colorectal cancer.

Introduction

Rectal carcinoma represents a major global health challenge and constitutes a significant proportion of colorectal malignancies worldwide. Cancer has emerged as an increasing public health problem in both Asian and Western countries, largely due to population ageing, urbanization, and lifestyle modifications. Among gastrointestinal malignancies, colorectal cancer ranks as one of the most frequently diagnosed cancers and remains a leading cause of cancer-related morbidity and mortality across the globe(1). The global burden of colorectal cancer continues to rise, with an estimated 2.2 million new cases projected by the year 2030. Rectal cancer forms a substantial subset of colorectal cancers and contributes considerably to cancer-related deaths, particularly in developing countries where screening programs are limited(2).

The incidence of rectal carcinoma increases significantly after the age of 50 years and shows a mild male predominance. In Asian countries, including Pakistan, the disease burden has shown a consistent upward trend over the past decade. Local data indicate that colorectal cancers account for approximately one-quarter of gastrointestinal malignancies in males and one-fifth in females(3). The rising incidence in younger age groups has also been reported, highlighting the importance of early detection and accurate diagnosis. Patients with rectal carcinoma commonly present with bleeding per rectum, altered bowel habits, unexplained weight loss, abdominal pain, and features of intestinal obstruction(4). However, these symptoms are often nonspecific and may overlap with benign anorectal conditions, resulting in delayed diagnosis.

Accurate preoperative staging of rectal carcinoma is of paramount importance because it directly influences treatment planning, surgical approach, and overall prognosis. Rectal cancer is associated with a high local recurrence rate, reported to be up to 30 percent, particularly when tumors are inadequately staged or incompletely resected. Advances in surgical techniques, especially total mesorectal excision, have significantly improved outcomes, but the success of surgery is highly dependent on precise preoperative assessment(5). Identification of tumor extent, depth of invasion, involvement of the mesorectal fascia, and regional lymph node status is essential to select patients who may benefit from neoadjuvant chemoradiotherapy and to reduce the risk of local recurrence (6).

Various imaging modalities are employed for the evaluation and staging of rectal carcinoma, including computed tomography, endorectal ultrasound, and magnetic resonance imaging. Computed tomography is widely used to assess

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distant metastases but has limited accuracy for local tumor staging due to suboptimal soft-tissue contrast. Endorectal ultrasound is highly accurate for early-stage tumors but is operator-dependent and limited in advanced or stenotic lesions. (7) Magnetic resonance imaging has emerged as the imaging modality of choice for local staging of rectal carcinoma because of its superior soft tissue resolution, multiplanar imaging capability, and ability to delineate pelvic anatomy accurately.

High-resolution magnetic resonance imaging plays a critical role in evaluating tumor size, depth of mural invasion, involvement of the mesorectal fascia, the sphincter complex, and adjacent pelvic structures. It also assists in identifying circumferential resection margin involvement, which is considered one of the most important prognostic factors affecting surgical outcomes(8). Preoperative magnetic resonance imaging enables precise risk stratification and helps guide multidisciplinary treatment decisions, particularly in selecting patients for neoadjuvant therapy. As a result, magnetic resonance imaging has become an integral component of rectal cancer management protocols worldwide(9).

Histopathological examination remains the gold standard for definitive diagnosis of rectal carcinoma. It provides confirmation of malignancy, tumor differentiation, histological subtype, and the presence of adverse features, such as mucinous or signet-ring components. Correlation of imaging findings with histopathology is essential to determine the diagnostic accuracy of imaging modalities. Several international studies have evaluated the performance of magnetic resonance imaging in diagnosing and staging rectal carcinoma, reporting high sensitivity and specificity for tumor detection and T staging(10). However, variations in imaging protocols, expertise, and patient populations have led to varying levels of diagnostic accuracy.

In the local context, there is a relative paucity of published data on the diagnostic accuracy of magnetic resonance imaging for rectal carcinoma, with histopathology as the reference standard. Most available studies are limited by small sample sizes or focus primarily on staging rather than diagnostic performance. Given the increasing incidence of rectal cancer in Pakistan and the expanding role of magnetic resonance imaging in clinical practice, there is a need for robust local evidence to validate its diagnostic accuracy. Establishing the reliability of magnetic resonance imaging in diagnosing rectal carcinoma will support its routine use, optimize patient management, and contribute to the Development of standardized imaging protocols within the local healthcare system(11).

Therefore, this study aims to determine the diagnostic accuracy of magnetic resonance imaging for rectal carcinoma, using histopathology as the gold standard. The findings of this study are expected to provide valuable insight into the effectiveness of magnetic resonance imaging in the local population and help improve diagnostic confidence, treatment planning, and patient outcomes in rectal carcinoma.

Methodology

This was a cross-sectional observational study conducted in the Departments of Diagnostic Radiology at Liaquat National Hospital, Karachi, and Jinnah Postgraduate Medical College, Karachi. The study was conducted from 1 January 2024 to 6 July 2024, after approval of the research synopsis by the College of Physicians and Surgeons Pakistan (CPSP/REU/RAD-2022-192-3833) and the Institutional Ethical Review Committees of the respective hospitals.

The sample size was calculated using the sample size calculator. The calculation was based on previously reported sensitivities of 85.9 percent and 79.5 percent, and a specificity of 79.5 percent, for magnetic resonance imaging in the detection of rectal carcinoma, with a reported prevalence of 43.6 percent. A 95 percent confidence interval was used, with desired precisions of 7 percent for sensitivity and 8 percent for specificity. The final calculated sample size was 174 patients. A non-probability consecutive sampling technique was used (12).

Patients of either gender aged between 25 and 60 years with clinical suspicion of rectal carcinoma based on altered bowel habits, bleeding per rectum, unexplained weight loss, abdominal pain, or a palpable rectal mass were included in the study. Patients who did not give consent, pregnant patients, those with a history of pelvic or rectal surgery within the last six months, and patients already receiving chemotherapy or radiotherapy were excluded.

All patients with clinical suspicion of rectal carcinoma who were referred to the Departments of Diagnostic Radiology at Liaquat National Hospital and Jinnah Postgraduate Medical College, Karachi, and fulfilled the inclusion criteria were enrolled in the study. Approval was obtained from the Institutional Ethical Review Committees of both hospitals and the College of Physicians and Surgeons, Pakistan, prior to commencement of the study. Written informed consent was taken from each patient after explaining the procedure and purpose of the study.

Consultant radiologists performed magnetic resonance imaging with more than 5 years of post-fellowship experience in diagnostic radiology. The examination was carried out using a standard rectal cancer imaging protocol. High-resolution two-dimensional T2-weighted fast spin-echo sequences were acquired in the sagittal, axial, and coronal planes. Axial images were obtained perpendicular to the long axis of the rectum at the level of the lesion. The field of view extended from below the anal canal to the level of the sacral promontory to ensure adequate visualization of the rectum and mesorectal fascia. Intravenous contrast was administered where required as per institutional protocol.

Magnetic resonance imaging findings were recorded on a predesigned proforma. Rectal carcinoma on MRI was labeled as positive based on the presence of abnormal circumferential or eccentric rectal wall thickening, intermediate signal intensity mass on T2-weighted images, loss of normal rectal wall layering, or evidence of extramural tumor extension.

Histopathological diagnosis was obtained from biopsy or surgical specimens processed in the histopathology laboratories of the respective hospitals. Histopathology reports confirming rectal carcinoma based on malignant glandular architecture, nuclear pleomorphism, hyperchromasia, mucin production, or variant histological subtypes were considered positive and taken as the gold standard. Magnetic resonance imaging findings were correlated with histopathological results for each patient, and all data were systematically recorded in the study pro forma. Confounding variables were controlled by strict

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adherence to the inclusion and exclusion criteria and through stratification during data analysis.

Data were entered and analyzed using the Statistical Package for the Social Sciences. Quantitative variables, such as age and symptom duration, were reported as mean ± standard deviation. Qualitative variables such as gender, residence, diabetes mellitus, hypertension, smoking status, and diagnosis of rectal carcinoma on MRI and histopathology were expressed as frequencies and percentages. Diagnostic accuracy of magnetic resonance imaging was calculated using a 2×2 contingency table, with histopathology as the gold standard. Sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy were calculated using standard formulas. Effect modifiers, including age, gender, duration of symptoms, residence, diabetes mellitus, hypertension, and smoking status, were controlled through stratification, and post-stratification sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were recalculated.

Results

A total of 174 patients with clinical suspicion of rectal carcinoma were included in the study. The mean age of the patients was 47.6 ± 8.9 years, ranging from 25 to 60 years. Male patients constituted the majority with 102 cases (58.6%), while 72 patients (41.4%) were female. Most patients belonged to urban areas. The demographic characteristics of the study population are summarized in Table 1.

Table 1: Demographic Characteristics of the Study Population (n = 174)

Variable	Frequency	Percentage
Age (years), mean ± SD	47.6 ± 8.9	—
Gender		
Male	102	58.6
Female	72	41.4
Residence		
Urban	109	62.6
Rural	65	37.4

The clinical presentation and associated risk factors of the patients are shown in Table 2. Bleeding per rectum was the most common presenting complaint, followed by altered bowel habits and weight loss. Diabetes mellitus was present in 46 patients (26.4%), hypertension in 39 patients (22.4%), and 51 patients (29.3%) had a history of smoking.

Table 2: Clinical Characteristics and Risk Factors (n = 174)

Variable	Frequency	Percentage
Bleeding per rectum	112	64.4
Altered bowel habits	94	54.0
Weight loss	71	40.8
Abdominal pain	58	33.3
Palpable rectal mass	49	28.2
Diabetes mellitus	46	26.4
Hypertension	39	22.4
Smoking	51	29.3

Magnetic resonance imaging findings and histopathological results are compared in Table 3. Rectal carcinoma was detected on MRI in 82 patients (47.1%), whereas histopathology confirmed rectal carcinoma in 76 patients (43.7%). MRI was negative in 92 patients (52.9%), while histopathology was negative in 98 patients (56.3%).

Table 3: Frequency of Rectal Carcinoma on MRI and Histopathology (n = 174)

Diagnostic Modality	Positive	Negative
MRI	82 (47.1%)	92 (52.9%)
Histopathology	76 (43.7%)	98 (56.3%)

The correlation between MRI findings and histopathological diagnosis is demonstrated in Table 4. True-positive results were observed in 68 patients, and 86 were true negatives. 14 false positives and 6 false negatives were identified on MRI compared with histopathology.

Table 4: MRI versus Histopathology Findings (2×2 Contingency Table)

MRI Findings	Histopathology Positive	Histopathology Negative	Total
Positive	68 (TP)	14 (FP)	82
Negative	6 (FN)	86 (TN)	92
Total	74	100	174

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Based on the contingency table analysis shown in Table 4, diagnostic performance parameters of magnetic resonance imaging were calculated and are presented in Table 5. MRI demonstrated a sensitivity of 91.9%, specificity of 86.0%, positive predictive value of 82.9%, negative predictive value of 93.5%, and an overall diagnostic accuracy of 88.5%.

Table 5: Diagnostic Accuracy of MRI Taking Histopathology as Gold Standard

Parameter	Value (%)
Sensitivity	91.9
Specificity	86.0
Positive Predictive Value	82.9
Negative Predictive Value	93.5
Diagnostic Accuracy	88.5

Stratified analysis showed that MRI diagnostic accuracy remained consistently high across age groups, genders, and clinical subgroups. No significant variation in sensitivity or specificity was observed after stratification by diabetes mellitus, hypertension, smoking status, residence, or symptom duration.

Discussion

Accurate diagnosis and preoperative evaluation of rectal carcinoma are essential for optimal patient management and improved clinical outcomes. Magnetic resonance imaging has emerged as the preferred imaging modality for local assessment of rectal carcinoma due to its excellent soft-tissue contrast and multiplanar imaging capabilities. The present study evaluated the diagnostic accuracy of magnetic resonance imaging for rectal carcinoma, using histopathology as the gold standard, and demonstrated high overall diagnostic performance (13).

In the current study, the mean age of patients was 47.6 years, with the majority in the fifth and sixth decades of life. This age distribution is comparable to previously published local and regional studies, which have reported a rising incidence of rectal carcinoma in relatively younger populations in South Asia(14). Male predominance observed in this study is consistent with earlier reports, suggesting a higher burden of colorectal malignancies among males, possibly related to lifestyle factors, dietary habits, and higher prevalence of smoking.

Bleeding per rectum was the most common presenting symptom in the study population, followed by altered bowel habits and weight loss. These findings are in agreement with earlier studies that have identified rectal bleeding as the most frequent initial symptom prompting medical consultation. The presence of comorbidities such as diabetes mellitus and hypertension in a considerable proportion of patients reflects the growing burden of non-communicable diseases in the local population. It highlights the importance of comprehensive patient evaluation(15).

In this study, magnetic resonance imaging detected rectal carcinoma in 47.1 percent of patients, while histopathology confirmed malignancy in 43.7 percent. The close agreement between MRI and histopathological findings indicates the reliability of MRI in identifying rectal carcinoma (16). The diagnostic accuracy analysis showed a sensitivity of 91.9 percent and specificity of 86.0 percent, with an overall diagnostic accuracy of 88.5 percent. These results demonstrate that MRI is highly effective in correctly identifying patients with rectal carcinoma and in excluding disease in non-affected individuals.

The high sensitivity observed in this study indicates that magnetic resonance imaging is particularly effective at detecting true positives, minimizing the likelihood of missed diagnoses. This is clinically significant, as false negative results may delay treatment and adversely affect prognosis. The specificity observed in the present study also reflects a low rate of false positive results, which is important to avoid unnecessary invasive procedures and patient anxiety (17). The high negative predictive value further supports the usefulness of MRI as a reliable tool to rule out rectal carcinoma in clinically suspicious cases.

The findings of this study are comparable to those reported in previous national and international studies. Sukhni et al. reported a sensitivity of 85.9% and specificity of 79.5% for MRI in detecting rectal carcinoma, with an overall diagnostic accuracy of approximately 82%. The slightly higher sensitivity and specificity observed in the present study may be attributed to improved imaging techniques, standardized MRI protocols, and interpretation by experienced radiologists(18). Similarly, Rehman et al. reported high MRI sensitivity in the preoperative evaluation of rectal carcinoma, particularly in assessing tumor invasion and mesorectal fascia involvement.

The role of magnetic resonance imaging extends beyond mere detection of rectal carcinoma and includes accurate assessment of tumor extent, depth of invasion, and relationship to surrounding structures. Although the present study focused on diagnostic accuracy rather than detailed staging, the high concordance between MRI and histopathology supports the routine use of MRI in the diagnostic workup of rectal carcinoma. Accurate preoperative diagnosis facilitates appropriate surgical planning and identification of patients who may benefit from neoadjuvant chemoradiotherapy, thereby reducing local recurrence rates (18).

Stratified analysis in the present study showed no significant variation in diagnostic accuracy across different age groups, gender, residence, or presence of comorbid conditions such as diabetes mellitus, hypertension, and smoking status. This indicates that MRI's diagnostic performance remains consistent across patient subgroups and supports its general applicability across diverse clinical settings. The consistency of MRI performance across different strata enhances its value as a dependable diagnostic modality in routine practice (19).

Despite the strengths of this study, certain limitations should be acknowledged. The study was conducted in tertiary care hospitals, which may limit generalizability to peripheral healthcare settings (20). The study design was cross-sectional, and long-term outcomes were not assessed. In addition, interobserver variability was not evaluated, which

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could influence diagnostic interpretation. Future studies with multicenter designs, larger sample sizes, and inclusion of interobserver agreement analysis are recommended to validate these findings further

Conclusion

In conclusion, the present study demonstrates that magnetic resonance imaging has high sensitivity, specificity, and overall diagnostic accuracy in the diagnosis of rectal carcinoma when compared with histopathology. MRI is a reliable, non-invasive imaging modality that can be effectively used in the diagnostic evaluation of patients with suspected rectal carcinoma. The results of this study support the routine use of MRI in the local clinical setting and provide valuable evidence to optimize diagnostic protocols and improve patient management strategies.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.
Ethics approval and consent to participate.
Approved by the department concerned. (IRB-CPSP/REU/RAD-2022-192-3833)
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Conflict of interest

The authors declared no conflicts of interest.

Authors Contribution

Muhammad Awais Ansari & Muhammad Misbah Tahir (Associate Professor)
Final Approval of version, Data collection
Danial Khalid & Raesa Altaf Malik
Revisiting Critically, Data Analysis
Shaiq Hussain & Bushra Shamim
Data Analysis
Shaista Shoukat & Khalid Mustafa
Drafting, review of lietrature

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