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Can MR imaging be useful in differentiating low rectal cancer from anal cancer?

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Abstract

Purpose: To evaluate the role of pelvic MR imaging in differentiating between low rectal and anal cancers using the pathological results as the gold standard.
Materials and methods: In this study, retrospective analysis of 100 patients with a history of low rectal (n = 50) or anal (n = 50) cancers who underwent staging pelvic MR imaging before treatment was performed. The following parameters were analyzed: distance from the anal verge to the tumor, percentage of tumor above puborectalis muscle, tumor size, T2W signal intensity, sphincter/levator muscles invasion, organ invasion, and MRI diagnosis. Multivariable logistic regression was performed to determine factors associated with low rectal and anal cancers. Distances from the anal verge to the tumor were compared using receiver-operating characteristic (ROC) curves.
Results: From the ROC curves, the cut-off value for the distance from the anal verge to the tumor in differentiating between low rectal and anal cancers was 2.1 cm and the area under the ROC curve was 0.90 (95% CI 0.84–0.97). Multivariate logistic regression revealed three significant factors in differentiating between low rectal and anal cancers, including T2 mixed hyper- and hyposignal intensity (OR 66.00, 95% CI 4.66–934.81), distance cut-off value (OR 34.72, 95% CI 5.73–210.27), and absence of sphincter invasion (OR 18.75, 95% CI 1.91–183.96), with sensitivity, specificity, PPV, and NPV of 98%, 88%, 89%, and 97%, respectively, and diagnostic accuracy increased from 79% (reader 1) and 82% (reader 2) to 93%.
Conclusion: MR imaging can be useful to differentiating between low rectal and anal cancers which benefits staging and treatment planning.

Key words: Low rectal cancer—Anal cancer—MRI—Cancer imaging

Colorectal cancer remains the third most common cancer in the United States representing 135,430 new cases, while anal cancer is less common representing 8200 new cases in 2017. Even though anal cancer is considered to be a rare type of cancer, its incidence rate, increased by 1.6% per year from 2004 to 2013 and anal cancer death rate, also increased by 3% per year from 1998 to 2014 [1].

Anatomically, the rectum and the anal canal are related. The rectum extends from the fusion of the taenia distally to the upper border of the puborectalis muscle and the anal canal extends from the upper border of the puborectalis muscle distally to the anal verge [2–6]. However, rectal and anal cancers are separate tumors. Most primary cancers of the rectum are adenocarcinomas (95–97%). The presence of squamous cell carcinoma in the rectum is usually due to proximal extension of the anal primary tumor [2]. On the other hand, squamous cell carcinomas represent the most common histologic form of anal cancer, whereas, anal adenocarcinomas which originate from the anal glands are extremely rare [3]. The treatment approaches for rectal and anal cancers are also different. Majority of patients with non-metastatic rectal cancer will undergo surgical treatment, whereas, most patients with anal cancer will undergo chemotherapy with/without radiation therapy [3, 4].

The American Joint Committee on Cancer (AJCC) uses the anatomical location to differentiate rectal and anal cancers. They recommend that if the epicenter of the

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tumor is located more than 2 cm proximal to the dentate line or proximal to the anorectal ring on digital examination, defined as the upper border of the puborectalis muscle, the tumor should be classified as rectal cancer. If the epicenter of the tumor is located 2 cm or less from the dentate line, the tumor should be classified as anal cancer [5]. The European Society for Medical Oncology (ESMO) used the distance from the anal verge to the lowest aspect of the mass to define rectal cancer, as this was a useful reference point for clinicians when they performed colonoscopy. They classified low rectal cancer as the lowest aspect of the tumor located less than 5 cm from the anal verge, which can be overlapping the anal cancer location [7].

Currently, MR imaging plays a major role in clinical staging for rectal and anal cancers because of it superior soft tissue differentiation, multiplanar capability, and non-invasiveness [2, 8]. In most cases, radiologist can identify the origin of the tumor through imaging findings in cross-sectional techniques. Nevertheless, for low rectal or anorectal masses, it is difficult for the radiologist to confidently establish its origin. In cases that the histopathological data are unavailable when the MR imaging was done, radiologist can easily make false diagnosis of anorectal mass leading to misinterpretation and using incorrect staging system. Therefore, a biopsy is usually required before the patient undergoes MR imaging.

To our knowledge, there are no published studies that objectively evaluate the role of MRI in differentiating low rectal and anal cancers. Therefore, the purpose of our study was to assess the value of MR imaging in distinguishing between low rectal cancer and anal cancer. This could be of great help to radiologists in diagnosing cases where histopathological data are not available.

Materials and methods

Study population

The institutional review board approved our retrospective study, which was compliant with the Health Insurance Portability and Accountability Act (HIPAA), and waived the requirement for informed consent. We searched our radiology database using Render software, which acquired radiologic image data from the diagnostic Picture Archiving and Communication System (PACS) workstations (AGFA Impax; AGFA Technical Imaging Systems, Ridgefield Park, NJ, USA) for consecutive patients between January 2004 and December 2017. The inclusion criteria were patients with prior histopathological results confirming rectal adenocarcinoma or anal squamous cell carcinoma and the patients having had pelvic MR imaging prior to surgical resection. In addition, the lower aspect of the tumors was located less than 5 cm proximal to the upper border of the puborectalis muscle on pelvic MR imaging. The exclusion criteria were (a) no histopathological result (n = 9), (b) no pelvic MR imaging before surgery (n = 206), (c) the tumors were located more than 5 cm proximal to the upper border of the puborectalis muscle on pelvic MR imaging (n = 21), and (d) an endorectal coil was used in the pelvic MR imaging (n = 7) (Fig. 1).

MR imaging protocol

MRI scans were performed either on a 1.5 T (Signa, GE Healthcare or Avanto, Siemens Healthcare) or on a 3.0 T (Discovery MR750w, GE Healthcare or Skyra, Siemens Healthcare) scanner, using a phase-array coil. The minimum sequence required was high-spatial-resolution axial oblique T2-weighted imaging, coronal T2-weighted imaging and sagittal T2-weighted imaging through the tumor. Axial DW imaging and post gadolinium contrast studies were used when available.

Qualitative MR evaluation

Two radiologists with 3 and 8 years of experience in pelvic MR imaging separately reviewed the studies. They were blinded to the clinical histories and histological results. Each reader diagnosed each image using their experience and the location of the mass. The recorded measurements and assessments were the distance from the anal verge to the lowest aspect of the tumor, percentage of the tumor above the upper border of the puborectalis muscle, size of the tumor, T2W signal intensity, anal sphincter/levator muscles invasion, and adjacent organ invasion.

The maximal axial diameter was measured in the axial oblique T2-weighted image. Tumor length and the distance from the anal verge to the lowest aspect of the tumor were measured in sagittal view T2-weighted image. The epicenter of the tumor was defined as 50% of the tumor length. The percentage of the tumor above the upper border of puborectalis muscle was measured as the percentage of the distance from the upper border of the

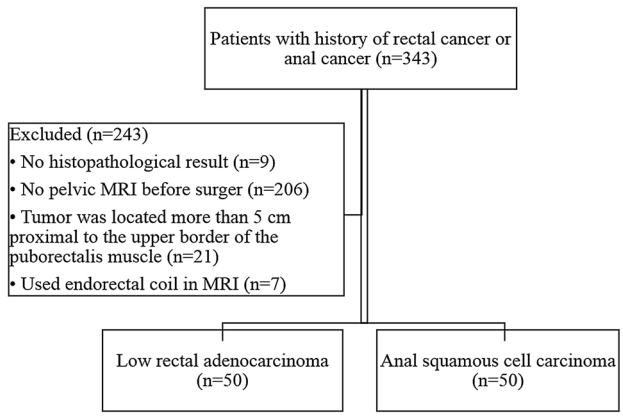

Fig. 1. Flow chart of our retrospective study design.

puborectalis muscle to the highest aspect of the tumor divided by the tumor length in sagittal T2-weighted image (Fig. 2).

The signal intensity of the muscularis propria and submucosa in T2-weighted MR images was the reference for interpretation of tumor signal [9]. Hypointense tumors showed lower signal intensity compared to muscularis propria. Intermediate signal intensity tumors showed slightly higher signal intensity than the muscularis propria but lower than the submucosa layer. Hyperintense tumors showed higher signal intensity compared to the submucosa layer. Mixed hyper- and hypointense signal tumors were defined as mixed composition of both signal intensities within the tumor (Fig. 3). Anal sphincter and levator muscles invasion were evaluated in axial and coronal T2-weighted image. All disagreements were resolved by consensus.

Reference standard

The reference standard was the histopathological report of the tissue biopsy ($n = 89$), surgical resection ($n = 7$), polypectomy ($n = 3$), and excision ($n = 1$) specimens.

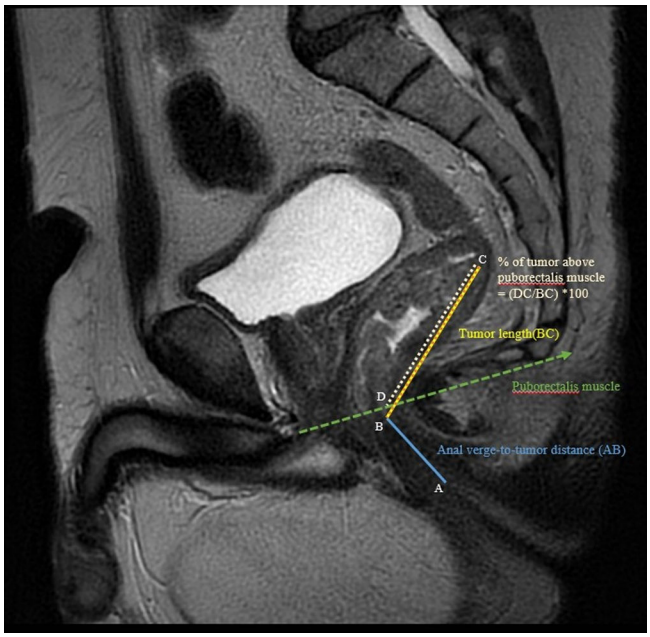

Fig. 2. Sagittal T2W image shows the measurements in this study. Distance from A to B is from the anal verge (*A*) to the lowest aspect of the tumor (*B*). Tumor length is measured from the lowest aspect of the tumor (*B*) to the highest aspect of the tumor (*C*). The upper border of the puborectalis muscle (green line) is the reference line for the anorectal junction. The percentage of the tumor above the upper border of the puborectalis muscle is measured as the distance from the upper border of the puborectalis muscle (*D*) to the highest aspect of the tumor (*C*) divided by the tumor length.

Statistical analysis

Normally distributed continuous data are presented as mean ± standard deviation. Nonparametric data are presented as numbers of cases and percentages. Cohen kappa (κ) statistic was used to define the level of inter-observer agreement. The scale used for interpretation of weighted κ statistics was slight agreement 0–0.20, fair agreement 0.21–0.40, moderate agreement 0.41–0.60, substantial agreement 0.61–0.80, and almost perfect agreement 0.81–0.99. Receiver-operating characteristic (ROC) analysis was used to evaluate the distance from the anal verge to the lowest aspect of the tumor. The area under the ROC curve (AUC) with 95% confidence interval (CI) and the cut-off value are reported. The significant variables from the univariable regression analysis were adopted for the multivariable regression analysis and stepwise method was used for further variable selection. The univariable and multivariable logistic regression analyses were performed to identify factors related to the low rectal and anal cancers. Odds ratios with 95% CI are reported. Finally, leave-one-out cross validation was performed to avoid optimistic bias in the accuracy value when choosing the optimal predictors. A p value < 0.05 was considered to indicate statistical significance. All statistical analyses were performed using Stata software package (Stata/IC 15.0; Stata Statistical Software, College Station, TX, USA).

Results

Study population

Our final study population consisted of 100 of 343 patients. Fifty cases were rectal cancer that included 31 males and 19 females and the mean age was 60 years. The other 50 cases were anal cancer that included 14 males and 36 females and the mean age was 61 years. Low rectal cancer was significantly male predominant and anal cancer was significantly predominant in females ($p = 0.001$).

Tumor characterization

Tumor size

In the low rectal cancer group, the tumor sizes ranged from 2 to 7.9 cm in maximal axial diameter. The mean tumor diameter was 3.82 ± 1.13 cm. The tumor lengths ranged from 2.7 to 16.2 cm and the mean tumor length was 6.38 ± 2.51 cm. In the anal cancer group, the tumor sizes ranged from 1.6 to 9.5 cm in maximal axial diameter. The mean tumor diameter was 4.02 ± 1.65 cm. The tumor lengths ranged from 2.2 to 15.5 cm and the mean tumor length was 6.5 ± 2.78 cm. There were no significant differences in maximal axial diameter ($p = 0.483$) or tumor length ($p = 0.819$) (Table 1).

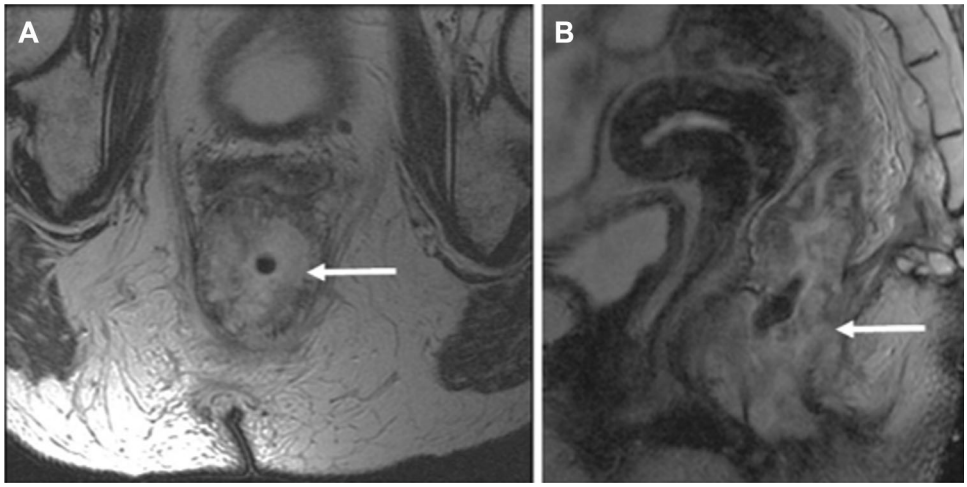

Fig. 3. Axial (**A**) and sagittal (**B**) T2-weighted MRI of a female patient with a mucinous adenocarcinoma of the rectum that shows T2W mixed hyper- and hypointense signal intensity (arrows).

Table 1. Baseline characteristics of the patients

Demographics/tumor	Low rectal cancer (n = 50)	Anal cancer (n = 50)	p value
Age (mean ± SD)	60.96 ± 14.71	61.64 ± 11.32	0.794
Gender			
Male	31 (62)	14 (28)	0.001*
Female	19 (38)	36 (72)	
Tumor size, cm			
Maximal axial diameter (mean ± SD)	3.82 ± 1.13	4.02 ± 1.65	0.483
Tumor length (mean ± SD)	6.38 ± 2.51	6.50 ± 2.78	0.819
T2W signal intensity			
Mixed hyper- and hyposignal intensity	10 (20)	1 (2)	0.019*
Intermediate signal intensity	40 (80)	49 (98)	
Distance from anal verge to tumor, cm (mean ± SD)	3.22 ± 1.32	0.97 ± 1.04	
≥ 2.1 cm	45 (90)	6 (12)	< 0.0001*
≤ 2.1 cm	5 (10)	44 (88)	
Percentage of the tumor above puborectalis muscle, % (mean ± SD)	83.06 ± 16.24	55.20 ± 21.44	< 0.0001*
Epicenter of the tumor			
Above the puborectalis muscle	50 (100)	31 (62)	
Below the puborectalis muscle	0 (0)	19 (38)	
Sphincter invasion			
Y	14 (28)	49 (98)	
N	36 (72)	1 (2)	< 0.0001*
Levator muscles invasion			
Y	7 (14)	30 (60)	
N	43 (86)	20 (40)	< 0.0001*
Adjacent organ invasion			
Y	2 (4)	15 (30)	
N	48 (96)	35 (70)	0.003*
Associated perianal fistula			
Y	1 (2)	6 (12)	0.084
N	49 (98)	44 (88)	

Values are presented as number (%) unless indicated otherwise
*p value < 0.05 was considered to indicate a statistically significant difference

T2 signal intensity

There was substantial agreement between the two readers for the evaluation of T2 signal intensity (kappa = 0.757). In the low rectal cancer group, 40 (80%) cases showed intermediate signal intensity and 10 (20%) cases showed mixed hyper- and hypointense signal intensity. Four out of these ten cases were histologically proven mucinous type of adenocarcinoma. In the anal cancer group, 49 (98%) cases showed intermediate signal intensity and one (2%) case showed mixed hyper- and hypointense signal intensity (Table 1).

Distance from the anal verge to the lowest aspect of the tumor

The mean distance from the anal verge to the lowest aspect of the tumor was 3.22 ± 1.32 cm (range 0–5.4 cm)

in the low rectal cancer group which was significantly greater than the mean distance of 0.97 ± 1.04 cm (range 0–4.5 cm) in the anal cancer group, ($p = 0.019$). Using the distance from the anal verge to the lowest aspect of the tumor in differentiating between low rectal and anal cancers, the area under the ROC curve was 0.9058 (95% CI 0.841–0.970) (Fig. 4). A cut-off value of 2.1 cm was obtained from the ROC curve with an accuracy of 90%, sensitivity of 90%, and specificity of 90% to differentiate low rectal cancer from anal cancer.

Percentage of the part of the tumor above the upper border of the puborectalis muscle

Nineteen of the 100 cases (19%) had the entire mass located above the upper border of the puborectalis muscle and were histologically proven to be low rectal cancer. All low rectal cancer cases ($n = 50$) had their epicenter above the upper border of the puborectalis muscle. In the anal cancer group, the epicenter of 31 (62%) cases were located above the upper border of the puborectalis muscle, whereas in 19 (38%) cases the epicenter was located below.

Anal sphincter, levator muscles, and adjacent organ invasions

There was almost perfect agreement in the evaluation of anal sphincter invasion (kappa = 0.945) and perfect agreement in the evaluation of levator muscles invasion and adjacent organ invasion (kappa = 1.0). For anal sphincter invasion, the low rectal cancer group showed 8 (16%) cases of internal anal sphincter invasion, 3 (6%) cases of combined internal anal sphincter and intersphincteric fat invasions, and 3 (6%) cases of combined internal and external anal sphincter invasions. In the anal cancer group, there were 17 (34%) cases of internal anal sphincter invasion, 19 (38%) cases of combined internal anal sphincter and intersphincteric fat invasions, and 13 (26%) cases of combined internal and external anal sphincter invasions.

Levator muscle invasion was noted in 14% (7/50) in the low rectal cancer group and in 60% (30/50) in the anal cancer group (Table 1). Adjacent organ involvement of the vagina was noted in 4% (2/15) in the low rectal cancer group. Fifteen of 50 cases (30%) in the anal cancer group had adjacent organ invasions, including vagina ($n = 12$), urethra ($n = 4$), cervix ($n = 2$), seminal vesicle ($n = 2$), labia ($n = 1$), bladder ($n = 1$), and prostate ($n = 1$).

Perianal fistula

There was perfect agreement in evaluating perianal fistula (kappa = 1.0). Six (12%) cases in the anal cancer group had perianal fistula. Two of these 6 cases had a history of perianal Crohn's disease and one of the 6 cases had a history of refractory ulcerative colitis. One (2%) case in the low rectal cancer group with a history of anal ulcer had perianal fistula.

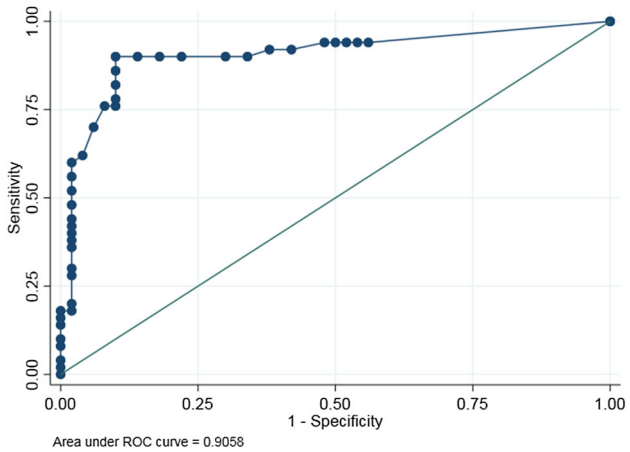

Fig. 4. Receiver operator characteristics (ROC) curve for the distance from the anal verge to the lowest aspect of the tumor. The ROC curve was used to determine the optimal cut-off value to differentiate the location of low rectal and anal cancers. The cut-off value was 2.1 cm from the anal verge (sensitivity = 90%, specificity = 90%, AUC = 0.9058 [95% CI 0.841–0.970]). This figure was made by using Stata software package (Stata/IC 15.0; Stata Statistical Software, College Station, TX, USA).

Accuracy in differentiating low rectal and anal cancer of both readers

There was substantial agreement between both readers in differentiating low rectal from anal cancers (kappa = 0.6501). The accuracy of reader 1 and reader 2 in differentiating low rectal cancer from anal cancer was 79% and 82%, respectively. Readers 1 and 2 made false diagnoses of anal cancer in 18 and 16 cases, respectively, and false diagnoses of low rectal cancer in 3 and 2 cases, respectively (Fig. 5).

Predictor for differentiation between low rectal and anal cancers

Univariate regression analysis identified gender ($p = 0.001$), T2-mixed hyper- and hypointense signal intensity ($p = 0.019$), distance from the anal verge to the lowest aspect of the tumor ≥ 2.1 cm ($p < 0.0001$), percentage of the tumor above the upper border of the puborectalis muscle ($p < 0.0001$), absence of anal sphincter invasion ($p < 0.0001$), absence of levator muscles invasion ($p < 0.0001$), and absence of adjacent organ invasion ($p = 0.03$) as significant predictors to differentiate between low rectal cancer and anal cancer.

In multivariate logistic regression analysis, T2-mixed hyper- and hypointense signal intensity (OR 66.004, 95% CI 4.660, 934.818), distance from the anal verge to the

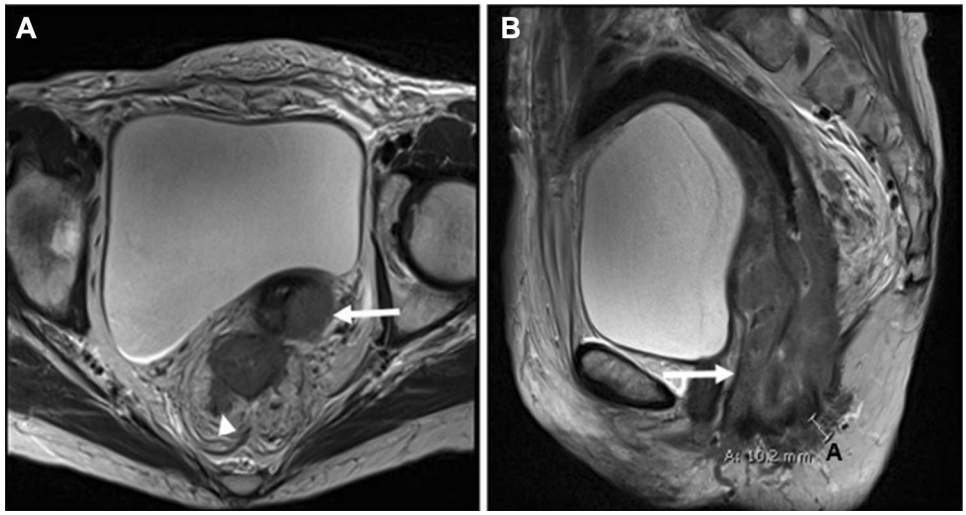

Fig. 5. Axial (**A**) and sagittal (**B**) T2-weighted MRI of a female patient with anal squamous cell carcinoma. The mass showed intermediate signal intensity with vaginal and cervical invasions (arrows) with positive extramural vascular invasion (arrowhead). The mass was diagnosed as rectal cancer by reader 2. Using the distance from the anal verge to the lowest aspect of the mass (**A**) increased the accuracy of the diagnosis in this patient. This figure was made by using Stata software package (Stata/IC 15.0; Stata Statistical Software, College Station, TX, USA).

lowest aspect of the tumor ≥ 2.1 cm (OR 34.729, 95% CI 5.735, 210.278), and absence of anal sphincter invasion (OR 18.751, 95% CI 1.911, 183.968) were extracted as independent predictors to differentiate between low rectal cancer and anal cancer (Table 2). Using these three predictors gave an accuracy, sensitivity, specificity, positive predictive value, and negative predictive value of 93%, 98%, 88%, 89.09%, and 97.78%, respectively. The AUC values obtained from the ROC curves to differentiate the tumors from reader 1, reader 2, and using those three predictors were 0.79 (95% CI 0.715, 0.864), 0.82 (95% CI 0.749, 0.890), and 0.9532 (95% CI 0.907, 0.999), respectively. Significant differences were found between these AUC values ($p < 0.0001$). After using a leave-one-out cross validation technique, the optimal AUC value for those three predictors was 0.9364 (95% CI 0.8771, 0.995)

Discussion

MR imaging has been shown to be a useful tool for the assessment of both rectal and anal cancers [3, 9–14]. However, its role in differentiating the site of origin of carcinomas that overlap the anorectal junction is limited, as most of the cases need histological confirmation for a final diagnosis. In cases where histopathological data are unavailable at the time when MR imaging was performed, the radiologist can often make the misdiagnosis of anorectal mass. In our study, we found that both readers made false diagnoses of anal cancer more than rectal cancer (16–18 cases vs. 2–3 cases). This could be due to higher prevalence of rectal cancer compared to anal cancer [1]. In this study, we aimed to find predictors that could increase diagnosis accuracy in cases with anorectal mass where histopathological data at the time of MR imaging are not available.

The AJCC states that if the epicenter of the tumor is located more than 2 cm proximal to the dentate line or proximal to the anorectal ring on digital examination, defined as the upper border of the puborectalis muscle, the tumor should be classified as rectal cancer. However, if the epicenter of the tumor is located 2 cm or less from the dentate line, the tumor should be classified as anal cancer [5]. Since the dentate line cannot be visualized in MR imaging [10], alternatively we can use the upper border of the puborectalis muscle as the reference mar-

Table 2. Multivariate analysis using multiple logistic regression model to differentiate between low rectal and anal cancers on MR imaging

	p value	Odds ratio	95% CI
Male gender	0.762	0.763	0.133–4.379
T2 mixed hyper- and hyposignal intensity	0.002†	66.004	4.660–934.818
Distance from anal verge to tumor ≥ 2.1 cm	< 0.0001†	34.729	5.735–210.278
Percentage of tumor above puborectalis muscle	0.262	1.033	0.975–1.094
Absence of sphincter invasion	0.012†	18.751	1.911–183.968
Absence of levator muscles invasion	0.051	6.054	0.989–37.065
Absence of adjacent organ invasion	0.536	2.490	0.138–44.838

†p value < 0.05 was considered to indicate a statistically significant difference

ker. We found that tumors with an epicenter located above the upper border of the puborectalis muscle ($n = 81$) could be either rectal cancer ($n = 50$) or anal cancer ($n = 31$), whereas tumors with an epicenter below the upper border of the puborectalis muscle were all anal cancer ($n = 19$). Therefore, there was still an overlap of anal and rectal cancers using this reference line.

The ESMO and Nougaret et al. used the distance from the anal verge to the lowest aspect of the mass to define rectal cancer, as this was a useful reference point for clinicians when they performed a colonoscopy [7, 15]. They classified low rectal cancer as the lowest aspect of the tumor located less than 5 cm from the anal verge. The MERCURY II study and Crane et al. defined low rectal cancer as the distance from the anal verge to the lowest aspect of the mass ≤ 6 cm [16, 17]. When we used the distance from the anal verge to the lowest aspect of the mass ≤ 6 cm from previous studies to define low rectal cancer, we found that half of the cases ($n = 50$) were rectal cancer and the other half were anal cancer ($n = 50$). Even when we considered the distance from the anal verge up to 6 cm to the lowest aspect of the mass, we could not differentiate between low rectal and anal cancers with higher accuracy.

Our results showed that using only the readers' experience achieved overall accuracy levels of 79% and 82% in distinguishing these two tumors. We then used the ROC curve analysis to determine the optimal cut-off value for the distance from anal verge to the lowest aspect of the tumor to distinguish low rectal and anal cancers. We found that a cut-off value of 2.1 cm obtained from the ROC curve had an accuracy of 90%, sensitivity of 90%, and specificity of 90% to differentiate between low rectal cancer and anal cancer.

Our results from univariate regression analysis showed gender, mixed hyper- and hypointense signal intensity in T2-weighted MR image, distance from the anal verge to the lowest aspect of the mass ≥ 2.1 cm, percentage of the tumor above the upper border of the puborectalis muscle, absence of anal sphincter invasion, absence of levator muscles invasions, and absence of adjacent organ invasion were significant predictors in differentiating between low rectal and anal cancers.

In our study, males were predominant in the low rectal cancer group (31/50, 62%), whereas females were predominant in the anal group (36/50,72%) which was similar to a report by the American Cancer Society [1]. They reported 23,720 estimated new rectal cancer cases in males vs. 16,190 cases in females, and 2950 estimated new anal cancer cases in males vs. 5250 cases in females in the year 2017.

Our results showed more mixed hyper- and hypointense signal intensity from tumor masses in T2-weighted MR images in patients with low rectal cancer than patients with anal cancer. Hussain et al. revealed that MR images can differentiate mucinous from non-mucinous rectal tumors [18]. They reported higher signal intensity from mucinous type rectal cancer on T2-weighted MR images compared to non-mucinous type. In our study, four of ten (40%) cases with low rectal cancer with mixed hyper- and hypointense signal intensity in T2-weighted MR images had histologically proven mucinous type. This could be due to large pools of extracellular mucin (≥ 50%) within the tumor mass [9, 18, 19].

The low rectal cancer group showed less anal sphincter invasion (28% vs. 98%, $p < 0.0001$) and levator muscles invasion (14% vs. 60%, $p < 0.0001$) compared to anal cancer group. Holzer et al. studied 40 patients with low rectal cancer. They reported less than 33% of cases with anal sphincter invasion [20]. The multicenter MERCURY II study reported 36.92% of low rectal cancer cases with sphincter or levator muscles invasions or both. This could be due to the greater distance between the anal sphincter/levator muscles to the lowest aspect of the rectal mass.

In our study, we found less adjacent organ invasion in the low rectal cancer group compared to the anal cancer group. Our study showed that 4% (2/50) of the cases in the rectal cancer group vs. 30% (15/50) of the cases in the anal cancer group had adjacent organ invasion. Ghieda et al. revealed that 12% (3/25) of the cases of rectal adenocarcinoma had invasion of the adjacent organs [21].

We found perianal fistula-associated anal squamous cell carcinoma more than rectal adenocarcinoma. Two patients (2%) with a history of Crohn's disease and one patient (1%) with a history of refractory ulcerative colitis had perianal fistula-associated anal squamous cell carcinoma. In contrast, Beaugerie et al. studied a subgroup of 2911 patients with a history of perianal Crohn's lesions and they found three patients with perianal fistula-related adenocarcinoma [22].

The results from multivariate regression analysis showed that T2-mixed hyper- and hypointense signal intensity, distance from the anal verge to the lowest aspect of the tumor ≥ 2.1 cm, and the absence of anal sphincter invasion were significant predictors to differentiate between low rectal cancer and anal cancer. Using these predictors improved the AUC values in distinguishing low rectal cancer from anal cancer in both readers, from 0.79 (95% CI 0.715, 0.864) and 0.82 (95% CI 0.749, 0.890) to be 0.9364 (95% CI 0.8771, 0.995).

Our study had few limitations. First, we included patients with histologically proven rectal adenocarcinoma and anal squamous cell carcinoma. This possibly led to selection bias. Second, it was a retrospective single institute analysis. Several cases did not have pretreatment MR imaging, especially, in the anal cancer group and were therefore excluded, which was another source for bias.

In conclusion, our study showed that using T2-mixed hyper- and hypointense signal intensity, distance from the anal verge to the lowest aspect of the tumor ≥ 2.1 cm, and the absence of anal sphincter invasion are helpful predictors in distinguishing low rectal cancers from anal cancers. These predictors could immensely help radiologists in diagnosing cases with anorectal mass, where histopathological data are not available. However, it should be noted that the results of histopathological studies are needed before initiating the treatment.

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Compliance with ethical standards

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Ethical approval This article does not contain any studies with human participants performed by any of the authors.

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