

ORIGINAL RESEARCH

Evaluation of the relationship between the muscle involvement and the appearance of rectal endometriosis in MRI imaging

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Abstract

Objective: MRI is a non-invasive imaging technique with high accuracy for detecting the appearance features of endometriosis, including rectal endometriosis. The degree of muscle involvement is also an important factor in determining the degree and progression of rectal endometriosis, which is based on the results of histopathology. The aim of this study is to investigate the relationship between the degree of muscle involvement and the appearance features of rectal endometriosis in patients referred to the Imam Hossein Medical and Educational Center in 2021 to 2023; so that by determining the relationship between the appearance features of endometriosis and the degree of involvement of the rectal muscle, we can predict the degree of muscle involvement and the progression of endometriosis using MRI as a non-invasive method compared to histopathology

Materials and Methods: The present study is a descriptive-analytical study conducted on 144 patients with rectal endometriosis who referred to Imam Hossein Hospital between 2021 and 2023. In this study, patients who underwent MRI before surgery or histopathology of rectal endometriosis were included. The data were analyzed using SPSS version 27 software and logistic regression test.

Results: The results of two-level logistic regression analysis show that there is a significant relationship between the variable of muscle involvement and the length and number of rectal endometriosis (P-value <0.05). So that for each unit increase in length, the chance of muscle involvement increases by a factor of 1.03 and for each unit increase in the number of involved nodules, the chance of muscle involvement increases by a factor of 4.65. The results also show that there is no significant relationship between the variable of muscle involvement and the thickness of rectal endometriosis (P-value >0.05).

Conclusion: According to the results obtained from the two-level logistic regression test, it can be understood that the length and number of rectal endometriosis nodules have a positive effect on muscle involvement and increase the chance of muscle involvement. While the thickness of rectal endometriosis has almost no effect on muscle involvement.

Keywords: Endometriosis, Rectum, Muscle involvement, Magnetic Resonance Imaging (MRI).

Introduction

Endometriosis is a condition in which tissue similar to the lining of the uterus (endometrium) grows outside the uterus. This tissue can grow in various areas of the body. Endometriosis is a common chronic gynecological disease that affects millions of women worldwide (1, 2). This disease is characterized by the development and presence of tissue elements such as endometrial glands and stroma in anatomical locations and organs outside the uterine cavity (3) and it can cause a wide range of symptoms, including pelvic pain, infertility, and bowel dysfunction (4, 5) and affects approximately 10 percent of women of reproductive age (6). One of the most common locations for endometriosis is the rectum, which can cause significant discomfort and affect the patient's quality of life (7). The rectum in this study refers to the most distal part of the large intestine, which is bounded proximally by the sigmoid colon and converges distally to the anal canal (8). Rectal endometriosis nodules are among the complications that may occur in patients with endometriosis and can cause symptoms such as severe pelvic pain during menstruation, changes in bowel habits such as alternating diarrhea and constipation, pain during sex, rectal bleeding, dysmenorrhea, and infertility (9). The characteristics of rectal endometriosis can vary depending on the degree of muscle involvement and the depth of penetration of the endometriosis lesions (10). Rectal involvement may result in changes in bowel habits such as constipation, diarrhea, dyspepsia, tenesmus, and rarely rectal bleeding. Chronic pelvic pain, which is often worse during menstruation or around the time of ovulation, is the most common symptom associated with endometriosis (11). Transvaginal, transrectal ultrasound, and magnetic resonance imaging (MRI) are the main methods currently used to diagnose intestinal endometriosis (12). Morphological features of endometriosis are important variables that should be considered in determining the best treatment strategy for a patient with deep endometriosis involving the sigmoid or rectum (13). In cases of severe symptoms, surgery may be required to remove the nodules or abnormal tissue. The thickness of the nodules and the extent of rectal muscle involvement greatly influence the choice of surgical approach and treatment. If the nodule has penetrated superficially into the rectal wall, less invasive surgical techniques such as laparoscopy may be sufficient. If the nodule has

penetrated deeply into the rectal muscle, surgery may require more invasive methods such as open surgery. In this case, reconstruction or repair of the rectal muscle may also be required. Therefore, accurate diagnosis and proper evaluation by a physician are essential to determine the best surgical and treatment approach. In the case of rectal lesions, the distance from the anus and the appearance of endometriosis can be assessed with transrectal ultrasound (14), but MRI is a non-invasive imaging technique that is becoming increasingly important in the evaluation of endometriosis (15) and it has shown high diagnostic power in deep infiltrative endometriosis (DIE) (16). In general, MRI is a highly accurate non-invasive imaging technique for diagnosing the appearance of endometriosis, including rectal endometriosis. The degree of muscle involvement is also an important factor in determining the degree and progression of rectal endometriosis, which is based on the results of histopathology; therefore, we decided to conduct the present study with the aim of investigating the relationship between the degree of muscle involvement and the appearance of rectal endometriosis in magnetic resonance imaging in patients referred to the Imam Hossein Medical and Educational Center in 2021 to 2023. By determining the relationship between the appearance of endometriosis and the degree of involvement of the rectal muscle, we can use MRI as a non-invasive method compared to histopathology to predict the degree of muscle involvement and the progression of endometriosis. Rectal muscle involvement by endometriosis refers to the infiltration of the muscular layer of the rectal wall by endometriotic lesions (17). Figure 1 shows a view of multiple nodules of rectosigmoid endometriosis on MRI and after surgery.

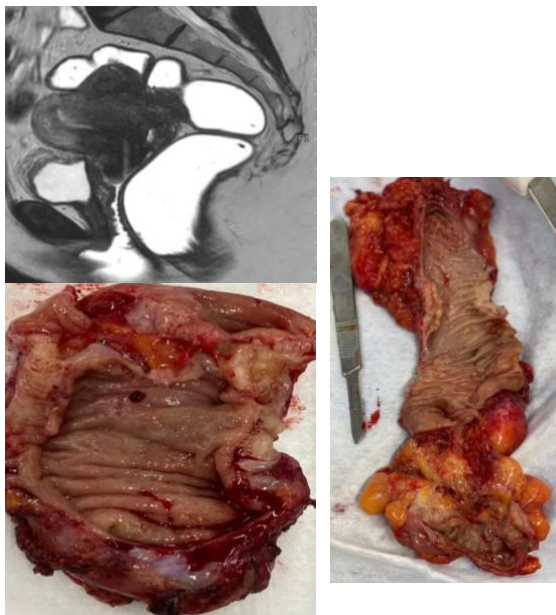


Figure 1: Multiple nodules of rectosigmoidal endometriosis.

Overall, this study investigated the relationship between muscle involvement using endometriosis histopathology and the characteristics of rectal endometriosis on MRI scans. This study focused on patients referred to Imam Hossein Medical and Educational Center between 2021 and 2023. It identifies the strengths and weaknesses of previous studies and provides valuable information on how to use pelvic MRI imaging to diagnose endometriosis in women.

According to the studies conducted in this field, the following studies have been categorized:

A paper titled “Deep infiltrating endometriosis of the bowel: MR imaging as a method to predict muscular invasion” was conducted by Busard et al. This study was conducted to evaluate the utility of MRI imaging in predicting muscle and submucosal invasion of the bowel in endometriosis. The study was conducted on 28 patients who underwent partial bowel resection between 2004 and 2010. MRI images were independently analyzed by two experienced radiologists and the results were compared with histopathology. The results showed that MRI imaging at 1.5 Tesla is useful in predicting muscle invasion of endometriosis

in the bowel, while it has limited value in detecting submucosal invasion. The sensitivity, specificity, positive and negative predictive values, and accuracy for detecting muscle invasion of endometriosis in the bowel were 100%, 75%, 96%, 100%, and 96%, respectively. The evaluators agreement coefficient was 0.84 (18).

A paper titled “Deep endometriosis muscular infiltration of the bowel wall: correlation between MRI and histopathology” was conducted by Vlek et al. in 2023. This study was conducted to evaluate the correlation between MRI imaging and histopathology in predicting muscle invasion of the bowel wall by endometriosis in patients undergoing colorectal surgery. The study included 84 patients who underwent colorectal surgery for deep endometriosis with preoperative MRI imaging. MRI imaging results regarding the depth of invasion (serosal, muscular, submucosal, or mucosal) and the extent of the endometriosis lesion were compared with histopathology. The results showed that MRI imaging is valuable in predicting muscle invasion of the bowel wall. The sensitivity of MRI imaging for predicting muscle invasion of the bowel wall was 89% and the positive predictive value was 97%. Therefore, the researchers concluded that MRI imaging is useful in guiding colorectal surgery in patients with symptomatic bowel endometriosis (19).

A paper entitled “Magnetic resonance imaging characteristics of deep endometriosis” was conducted by Kinkel et al. The aim of this study was to describe MRI findings in deep endometriosis with histopathological confirmation that it had infiltrated the uterosacral ligaments, douglas pouch, rectum, and bladder. Twenty patients underwent preoperative MRI for deep endometriosis. T2- and T1-weighted spin-echo images were obtained in the sagittal and axial axes. Four patients had post-contrast images. MRI results were compared with histopathology results. Histopathology detected 24 deep endometriosis lesions in the uterosacral ligament (n=12), Douglas pouch (n=2), rectum (n=3), and bladder (n=7). Uterosacral ligaments with deep endometriosis were statistically different in proximal nodularity (P=0.001) from normal uterosacral ligaments. There was no difference

in signal intensity between normal and abnormal uterosacral ligaments. Contrast-enhanced images in four patients with detrusor invasion showed detrusor rupture by contrast-enhancing bladder endometriosis. In two of the three patients, rectal endometriosis was missed, and in one patient, nonspecific rectal wall thickening was demonstrated; therefore, it was concluded that MRI can detect deep endometriosis of the uterosacral ligaments, bladder, and pouch of Douglas, but has low sensitivity in detecting rectal endometriosis without rectal swelling (20).

Materials and Methods

Study sample

The present study is a descriptive-analytical study conducted on patients with rectal endometriosis referred to Imam Hossein Hospital between 2021 and 2023. In this study, patients who underwent MRI before surgery or histopathology of rectal endometriosis were included. The extent of involvement of the rectal muscle by endometriosis was determined using pathology results, as well as the appearance of endometriosis, including thickness, length, and the number of nodules, using radiological findings from MRI reports extracted from the clinical records of patients in the hospital archives or using the hospital's health information system (HIS) and Pacs systems. After collection, the data will be analyzed using SPSS software and descriptive statistical tests of mean and analyticity. The Cochran formula was used to determine the sample size. In this formula, considering the frequency of samples in the studies of Busard et al. (18), Vlek et al. (19) and also, the study by Kinkel et al. and considering a 95% confidence level, a sample size of 100 samples was obtained (18, 19). Inclusion criteria: Patients with rectal endometriosis who had both MRI and histopathology of rectal endometriosis. Exclusion criteria: unavailability or incomplete patient information and failure to perform MRI and histopathology of endometriosis for the patient. Ethical considerations for the research, including obtaining a code of ethics from the university's research office under number IR.SBMU.MSP.REC.1402.553, were carried out by the relevant authorities. Statistical analysis: The research data were analyzed using SPSS-27 software and descriptive tests such as mean, variance, and standard deviation, and inferential tests such as logistic regression. Also, considering that we are looking for a

relationship between independent variables (appearance characteristics of rectal endometriosis) and dependent variable (muscle involvement), or in other words, predicting the muscle involvement status of patients due to the appearance characteristics of endometriosis. We use two-level logistic regression test in statistical analysis. To check the accuracy of model fit (correct prediction) in logistic regression, the Hosmer-Lemshaw test was also used, and in all tests, a P-Value of less than 0.05 was considered as a significant level. The frequency distribution of referring patients, according to the history of underlying disease, is given in Table 1. As can be seen, only 10.4% (15 people) of the people have a history of underlying disease.

Table 1: Frequency distribution of patients according to underlying disease history.

	Frequency (people)	Percentage
Underlying Disease: No	129	89.6
Underlying Disease: Yes	15	10.4
Total	144	100

Finally, the frequency distribution of patients according to their muscle involvement is given in Table 2. As can be seen in this table, 68.1 percent (98 people) of the referring patients have rectal muscle involvement. Also, to understand the relationship between muscle involvement as the dependent variable and the number of involved nodules as the independent variable, cross-tabulations of these two variables are given in Table 2. According to the data, it is observed that the number of people with 2 involved nodules includes only 14.6 percent (21 people).

Table 2: Number of people with variable muscle involvement and variable number of endometriosis nodules.

	Number of involved nodules: 1	Number of involved nodules: 2	frequency (people)	Percentage
Muscle Involvement: No	44	2	46	31.9
Muscle Involvement: Yes	79	19	98	68.1
Total	123 people (85.4%)	21 people (14.6%)	144	100

Results

In order to view all descriptive statistics, statistics such as minimum, maximum, mean, standard deviation, variance, skewness, and kurtosis are shown in Table 3. As can be seen, the average age of the patients is approximately 36 years. Also, the average thickness of endometriosis among patients is 10.5 mm and

the average length of endometriosis is 31.92 mm.

Table 3: Descriptive statistics of patient data

	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis
Age (years)	21	51	35.89	5.78	-0.15	0.47
Endometriosis thickness (in millimeters)	3	25	10.5	5.28	0.86	0.21
Endometriosis Length (in millimeters)	3	70	31.92	15.98	0.586	-0.321

To examine the relationship between each of the independent variables and the muscle involvement variable, a logistic regression model was used. The output results of this model, including the odds ratio for the effect of each of the different levels of the variables along with the 95% confidence interval and its statistical significance level, are summarized in Table 4. The results of the two-level logistic regression analysis show that there is a significant relationship between the muscle involvement variable and the length and number of rectal endometriosis (P-value <0.05). So that the results show that for each unit increase in length, the chance of muscle involvement increases by a factor of 1.036 and for each unit increase in the number of involved nodules, the chance of muscle involvement increases by a factor of 4.65. In fact, the effect of the length of endometriosis and the number of nodules on muscle involvement is positive and increasing. The results also show that there is no significant relationship between the muscle involvement variable and the thickness of rectal endometriosis (P-value >0.05). It is also seen in this table that the confidence interval for the thickness variable includes the number one, which indicates that this quantity does not affect muscle involvement.

Table 4: Results of logistic regression analysis in predicting muscle involvement due to changes in the appearance characteristics of rectal endometriosis.

	OR = $\text{Exp}(B)$	P-value	95%CI for OR
Thickness	1.048	0.298	1.14-0.96
Length	1.036	0.021	1.067-1.005
Number	4.65	0.049	21.57-1.004

Also, the overall significance test of the regression was performed by comparing the predicted and actual values of the dependent variable using the Hosmer-Lemshaw test. The chi-squared distribution statistic was obtained

with a value of 11.7, and considering the P-value of 0.165 obtained using the Hosmer-Lemshaw test, the accuracy of the model fit is confirmed, which confirms the appropriateness of the logistic regression model fitted to the data.

In this manuscript, we used a classification table to explain the dependence of the model on the dependent variable. In this table, the number of variables observed and predicted by the logistic regression model and the classification between the dependent variable of muscle involvement in two observed and predicted states are given.

The first row of this table shows that for the 18 people who did not have muscle involvement, the logistic regression model also reported no muscle involvement. However, for the 28 people who did not have muscle involvement, the model reported muscle involvement, which ultimately means that for those who did not have muscle involvement, the model predicted correctly with 39.1% (model accuracy).

In the second row, 12 people had muscle involvement, but the model did not confirm it. There were also 86 people who had muscle involvement, which the model also confirmed, so that the model correctly predicted 87.8% of those who had muscle involvement.

Finally, the logistic regression model correctly classified 72.2% of the total cases. That is, with a confidence of 72.2%, using 3 independent variables, we are able to predict changes related to muscle involvement.

Table 5: Classification between observed and predicted muscle involvement by logistic regression model.

Observed	Predicted by Regression Model		
	Percentage of Accuracy (Model Accuracy)	Muscle Involvement	
		No	Yes
Muscle Involvement	No	39.1	18 28
	Yes	87.8	12 86
Overall Percentage		72.2	

Discussion

Endometriosis is a condition in which tissue similar to the lining of the uterus (endometrium) grows outside the uterus. This tissue can grow in various areas of the body, including the rectum. Rectal endometriosis nodules are a complication that may occur in patients with endometriosis. In cases of severe symptoms, surgery may be required to remove the nodules or abnormal tissue. The thickness

of these nodules and the involvement of the rectal muscle greatly influence the choice of surgical type and treatment approach. If the nodule has penetrated the rectal wall superficially, less invasive surgical techniques such as laparoscopy may be sufficient. If the nodule has penetrated deeply into the rectal muscle, surgery may require more invasive methods such as open surgery. In this case, reconstruction or repair of the rectal muscle may also be required. Therefore, accurate diagnosis and appropriate evaluation by a doctor are essential to determine the best surgical and treatment method. MRI is a non-invasive imaging technique that has gained increasing importance in the evaluation of endometriosis and has shown high diagnostic power in diagnosing deep infiltrating endometriosis and examining its appearance features such as the length, number, and thickness of nodules. The severity of muscle involvement is also an important factor in determining the degree and extent of progression of rectal endometriosis and choosing its surgical approach, which is based on the results of biopsy pathology. Therefore, we decided to use MRI as a non-invasive method compared to biopsy in order to investigate the relationship between the degree of muscle involvement and the appearance features of rectal endometriosis in MRI imaging.

The present study investigated the relationship between the degree of muscle involvement and the appearance of endometriosis in patients

referred to the Imam Hossein Medical and Educational Center from 2021 to 2023. The results of two-level logistic regression showed that there is a significant relationship between muscle involvement and the appearance of endometriosis, such as the length and number of nodules. While the relationship between muscle involvement and thickness was not significant. The results show that for each unit increase in length, the chance of muscle involvement increases by a factor of 1.03 and for each unit increase in the number of involved nodules, the chance of muscle involvement increases by a factor of 4.65.

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Conflict of interest

Author declares no conflict of interest.

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