

ORIGINAL PAPER

A Study of the Sensitivity and Specificity of the Magnetic Resonance Imaging (MRI) Technique used in the Diagnosis of Endometriosis versus the Intraoperative Appearance Considered the Reference Standard in the Diagnosis of Endometriosis

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Abstract

Endometriosis is a gynecological pathology with chronic symptoms, which negatively affects the patient's quality of life¹. The prevalence of endometriosis in asymptomatic women is between 2% and 50%, depending on the populations studied and the method of diagnosis. The severity of the symptoms as well as the probability of diagnosing endometriosis increases with age⁹. Because endometriosis is a gynecological condition with a non-specific clinical picture, sometimes even asymptomatic, imaging technology can be considered the first line of diagnosis for this pathology. The main objective of this study is to evaluate the sensitivity and specificity of nuclear magnetic resonance imaging (MRI) used in the diagnosis of endometriotic lesions depending on their location, and compare the results obtained with the intraoperative appearance considered a reference standard in the diagnosis of endometriosis. Our study revealed the highest specificity for MRI in the case of endometriotic bladder invasion, respectively the highest sensitivity for endometriotic rectal nodules.

Keywords: endometriosis, MRI, sensitivity, specificity, intraoperative.

Rezumat

Endometrioza reprezintă o patologie ginecologică cu simptomatologie cronică, care afectează în mod negativ calitatea vieții pacientelor¹. Prevalența endometriozei la femeile asimptomatice este cuprinsă între 2% și 50%, în funcție de populațiile studiate, precum și de metodele de diagnostic utilizate. Severitatea simptomelor precum și probabilitatea diagnosticării endometriozei crește odată cu vârsta⁹. Fiindcă endometrioza reprezintă o afecțiune ginecologică cu un tablou clinic nespecific, câteodată chiar asimptomatică, tehnologia imagistică poate fi considerată prima linie de diagnostic pentru această patologie. Obiectivul principal al prezentului studiu este evaluarea sensibilității și specificității tehnicii imagistice prin rezonanță magnetică nucleară (RMN) utilizată în diagnosticul leziunilor endometriozeice în funcție de localizarea acestora, precum și compararea rezultatelor obținute cu aspectul intraoperator considerat standardul de referință în diagnosticul endometriozei. Studiul nostru a relevat cea mai mare specificitate pentru RMN în cazul invaziei endometriozeice a vezicii urinare, respectiv cea mai mare sensibilitate pentru nodulii rectali endometriozeici.

Cuvinte cheie: endometrioza, RMN, sensibilitate, specificitate, intraoperator.

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INTRODUCTION

Endometriosis is a gynecological disease first identified in 1860, following the microscopic findings of the Austrian pathologist Karl von Rokitansky, characterized by the presence of endometrial stroma and dysfunctional glands of the endometrial type, often accompanied by reactive fibrosis and muscle metaplasia outside the cavity^{1,2}.

This definition of endometriotic disease is a limited and inefficient anatomical definition in describing the natural history of endometriosis, the complexity of its clinical picture, its frequent recurrence, the basic molecular pathophysiology or even its ability to react to currently available management methods^{2,3,4,5,6}.

Lately, the definition of endometriosis has evolved, focusing more on the patient, the natural history of the disease from adolescence to menopause, the variety of tissues involved, its complex, chronic and systemic nature, but also the need for treatments that have as a long-term ovulation suppression effect^{2,4,7}.

Progress in the last two decades shows that endometriosis is a complex clinical syndrome characterized by a chronic estrogen-dependent inflammatory process that mainly affects the pelvic organs². The multifactorial etiology, along with its high prevalence, make it extremely similar to various other inflammatory diseases such as inflammatory bowel disease or gastroesophageal reflux disease^{2,3,4}. However, the uniqueness of the disease comes precisely from its addiction on the hormone estrogen considered as the biological trigger for the inflammatory process².

BACKGROUND AND AIMS

Endometriosis is a worldwide gynecological disease that primarily affects women of reproductive age. To a lesser extent, endometriosis is also found in adolescents or menopausal women⁸.

Given the non-specific symptoms of this gynecological disease, it is often the case that the diagnosis of endometriosis is overlooked by medical staff.

However, when the patient describes localized pelvic pain with a cyclical character, the anamnesis becomes an essential tool in the diagnosis of endometriotic disease. Although there are situations in which the clinical examination of patients with endometriosis is devoid of pathological changes, often the pelvic examination reveals either a „frozen” retroverted uterus or palpable nodules located in the posterior fornix of the vagina¹⁰.

Although there are a multitude of diagnostic imaging possibilities, they also have a different sensitivity and specificity depending on the location of endometriotic lesions.

Therefore, in order to obtain a diagnosis, the anamnesis and the clinical examination are completed with the use of imaging investigations. Transvaginal ultrasound (TVU) is considered the first-line imaging method in the examination of patients with suspected endometriosis^{11,12}. Additionally, the use of MRI increases the accuracy of the diagnosis of endometriotic disease. In most cases, the clinical signs identified on physical examination require additional MRI examination with adequate intestinal preparation¹³.

Starting from the premises mentioned above in the text, it results that endometriosis is a current public health problem and a pathology of interest to specialists in the field, and the study of sensitivity and specificity of MRI technique used in the diagnosis of endometriosis can have a positive impact on the monitoring management of patients suspected of endometriosis.

The general objectives of the study are: to assess the sensitivity and specificity of the MRI technique used to diagnose endometriotic lesions, depending on their location in the three pelvic compartments, as follows: anterior pelvic compartment represented by the bladder, middle pelvic compartment represented by the utero-sacral ligaments and the cardinal ligaments and the posterior pelvic compartment represented by the recto-vaginal septum and intestinal nodules. Endometriotic lesions located at the level of parameters were further investigated. Also, another objective of the study is to compare the results obtained after MRI examination of patients with endometriosis, with the results obtained after surgery for endometriosis.

PATIENTS AND METHODS

Study Design

The present study is a prospective, observational study, which included a total of 144 patients with endometriosis, of which only 99 patients were eligible according to the selection criteria for the purpose of the proposed study. It took place over a period of two years, between October 2018 and December 2020, in three specialized medical centers represented by: „Prof. Dr. Panait Sarbu” Clinical Hospital of Obstetrics and Gynecology Bucharest, Monza Hospital Bucharest and „Euroclinic – Regina Maria” Hospital Bucharest.

The prospective study required the development of a protocol for imaging examination of patients, depending on the clinical suspicion of the location of endometriotic lesions.

Both the research methodology and the informed consent of the patients included in the study were approved by the Ethics Commissions of the three specialized medical centers mentioned above.

The inclusion and exclusion criteria for the study population and the study research methodology were summarized as follows:

Inclusion criteria for the study group:

- clinical picture suggestive for endometriosis;
- MRI examination highly suggestive for endometriosis;
- informed consent signed for MRI examination to include patients in the study;
- informed consent signed for the surgical therapeutic conduct of endometriosis at the inclusion of patients in the study;
- informed consent signed for taking intraoperative histopathological samples to include patients in the study.

Exclusion criteria for the study group:

- failure to give the informed consent signed for the MRI examination;
- failure to give the informed consent signed for the surgical therapeutic conduct of endometriosis.

Patients

All of the patients selected to be part of this study underwent imaging examination using a 3 Tesla nuclear magnetic resonance system and surgical treatment consisting of resection of endometriotic lesions. The final diagnosis of endometriosis was confirmed by histopathological examination. MRI examinations were performed by radiologists competent in MRI and involved a preparation and examination protocol specific to endometriosis. The MRI investigation was scheduled starting with the 8th day of the menstrual cycle, the oral feeding was stopped 4-6 hours before the examination, the patients were examined with the bladder in semi-replenishment and the digestive tract was prepared by administering an enema with 2-3 hours before the imaging investigation. For a better visualization of the vagina and rectum, distension media (ultrasound gel) were used. The evaluation included MRI images using T2 and T1 weighted multiplanar sequences.

At least two orthogonal planes were used for the T2-weighted MRI sequences. Two bidimensional weighted T2 MRI sequences (sagittal, axial, oblique) were used to evaluate deep endometriosis. For the systematic visualization of the kidneys and the abdominal cavity (cecum, appendix, small intestines, large intestines) the T2-weighted axial two-dimensional MRI sequences were used.

The MRI examination reports included a detailed description of the endometriotic lesions including the size of the lesions, as well as the anatomical location of the endometriotic lesions visible on examination.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics 25 and Microsoft Office Excel / Word 2013. Quantitative variables were tested for distribution using the Shapiro-Wilk test and were expressed as means with standard deviations or medians with inter-percentile intervals. Categorical variables were expressed in absolute or percentage form and were tested using Fisher's Exact Test. The existing correlations were made using the Pearson and Spearman's rho correlation coefficient depending on the distribution of quantitative variables.

RESULTS

Baseline characteristics of the study population

For the 99 patients with endometriosis included in the study, the following variables obtained from the anamnesis and clinical and paraclinical examinations were studied: clinical appearance, anti-mullerian hormone (AMH) value prior to surgery, American Fertility Society (AFS) score, MRI examinations, but also postoperative complication rate as suggested in Table 1.

Table 1. Baseline characteristics of the study population

Parameter	Value
<i>Clinical examination appearance (No. ,(%))</i>	
Modified	83 (83.8%)
Normal	10 (10.1%)
Inconclusive	6 (6.1%)
<i>MRI</i>	99 (100%)
<i>AMH prior to surgery (average ± SD)</i>	1.803 ± 2.833,
<i>AFS-R total Score (average ± SD)</i>	3.46 ± 0.747
<i>Postoperative complications (No. ,(%))</i>	1 (1.0%)

MRI examination of the study group

Following the MRI investigation of the patients included in the study, the following aspects were found, also presented in Table 2. Among the patients included in the study, 29.6% had parametrial endometriotic lesions, more frequently bilateral (11.2%); 27.1% of patients had lesions of the recto-vaginal septum; 44.9% of patients had utero-sacral ligament (USL) lesions, more frequently bilateral (27.6%); 29.6% of patients had endometriotic nodules of the rectum, more frequently unique (28.6%); 13.4% of patients had sigmoid endometriotic nodules more frequently unique (11.3%); 2% of patients had ileal endometriotic nodules; 14.3% of patients had bladder invasion; 67.3% of patients had other locations of endometriosis; The mean size of the endometriotic nodules of the rectum was 21.86 ± 8.883 mm, with a median of 20 mm; The mean size of the endometriotic sigmoid nodules was 27.23 ± 8.974 mm, with a median of 27 mm; the mean distance of intestinal lesions from the external anal sphincter (EAS) is 123.4 ± 17.75 mm, with a median of 120 mm.

The intraoperative appearance of the studied population group

The intraoperative appearance of the patients included in the study revealed the following aspects described in Table 3.

Table 3. Description of the intraoperative findings

<i>Uterus appearance</i>	<i>Anterior cul-de-sac-appearance</i>	<i>Right parametrium – Enzian Score</i>	<i>Right parametrium-appearance</i>	<i>Left parametrium – Enzian Score</i>	<i>Left parametrium-appearance</i>
65 (65.7%) Normal	7 (7.1%) Red	11 (11.1%) B1	1 (1%) Red	11 (11.1%) B1	4 (4%) Red
15 (15.2%) Fibroid	1 (1%) White	24 (24.2%) B2	3 (3%) White	28 (28.3%) B2	3 (3%) White
19 (19.2%) Adenomyosis	50 (50.5%) Black	6 (6.1%) B3	37 (37.4%) Black	12 (12.1%) B3	44 (44.4%) Black
<i>Recto-vaginal septum – Enzian Score</i>	<i>Right USL- appearance</i>	<i>Light USL appearance</i>	<i>Intestinal lesions – Enzian Score</i>	<i>Rectum lesions</i>	<i>Sigmoid lesions</i>
5 (5.1%) A1	2 (2%) Red	5 (5.1%) Red	11 (11.1%) C1	33 (33.3%) Unique	15 (15.2%) Unique
11 (11.1%) A2	4 (4%) White	1 (1%) White	17 (17.2%) C2	3 (3%) Multiple	4 (4%) Multiple
5 (5.1%) A3	18 (18.2%) Black	20 (20.2%) Black	22 (22.2%) C3		
<i>Ileum lesions</i>	<i>Bladder Invasion</i>	<i>Diaphragmatic lesions</i>	<i>Appendicular lesions</i>		
3 (3%)	21 (21.2%)	1 (1%)	1 (1%)		

Table 2. Description of endometriotic lesions observed on MRI

<i>Endometriotic lesions – MRI (No. ,(%)</i>	
<i>Parametrial endometriosis</i>	
Right	9 (9.2%)
Left	9 (9.2%)
Bilateral	11 (11.2%)
<i>Recto-vaginal septum endometriosis</i>	26 (27.1%)
<i>USL endometriotic lesions</i>	
Right	14 (14.3%)
Left	3 (3.1%)
Bilateral	27 (27.6%)
<i>Endometriotic nodules of the rectum</i>	28 (28.6%) – unique, 1 (1%) – multiple
<i>Sigmoid endometriotic nodules</i>	11 (11.3%) – unique, 2 (2.1%) – multiple
<i>Ileal endometriotic nodules</i>	2 (2%)
<i>Bladder invasion of endometriosis</i>	14 (14.3%)
<i>Other endometriotic implants</i>	66 (67.3%)
<i>Lesion size – MRI (average ± SD)</i>	
<i>Endometriotic nodules of rectum (mm)</i>	21.86 ± 8.883
<i>Sigmoid endometriotic nodules (mm)</i>	27.23 ± 8.974
<i>Distance of intestinal lesions from EAS (mm)</i>	123.4 ± 17.75

Lesion Size – Intraoperative findings (average ± SD) (mm)	
<i>Anterior cul-de-sac</i>	25.18 ± 6.746
<i>Right USL</i>	14.32 ± 6.611
<i>Left USL</i>	14.0 ± 7.532
<i>Rectum</i>	22.61 ± 8.771
<i>Sigmoid</i>	25.1 ± 8.704
<i>Ileum</i>	16.67 ± 5.774

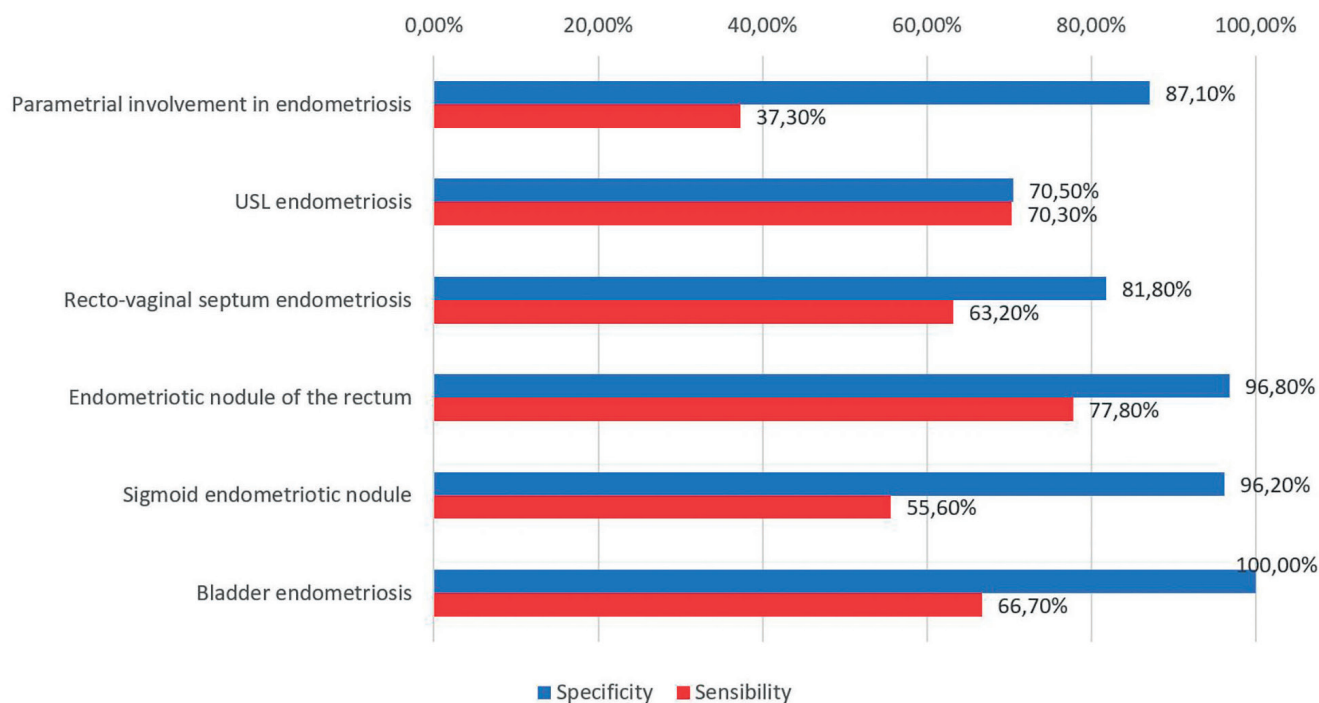


Figure 1. Sensitivity and specificity of MRI diagnoses in relation to the pathologies investigated

The data in the Figure 1 represent the comparison of MRI and intraoperative diagnoses for endometriosis. Associations of MRI diagnoses versus intraoperative appearance are statistically significant, according to Fisher tests ($p < 0.05$). The results are described in Table 4, as follows:

Table 4. Sensitivity and Specificity of MRI in relation to the endometriotic lesions

Type of endometriotic lesion	Sensitivity of the MRI	Specificity of the MRI
Parametrial endometriotic lesion	37.3%;	87.1%
USL endometriotic lesion	70.3%;	70.5%
Recto-vaginal septum endometriotic lesion	63.2%;	81.8%
Endometriotic nodules of the rectum	77.8%	96.8%
Endometriotic sigmoid nodule	55.6%	96.2%
Endometriotic bladder invasion	66.7%	100%

Our study also revealed that the dimensions of the rectal nodules had a non-parametric distribution ($p < 0.05$) and the dimensions of the sigmoid nodules had a normal distribution ($p > 0.05$) according to the Shapiro-Wilk test, the correlation between the dimensions of the observed rectal nodules on MRI vs. Intraoperative appearance it is significant and of high degree ($p = 0.001$, $R = 0.599$) and the correlation between the dimensions of the sigmoid nodules observed on MRI vs. Intraoperative appearance, it is significant and of a very high degree ($p = 0.005$, $R = 0.809$), the similarity between the dimensions being much higher.

DISCUSSION

In a recently published meta-analysis, the sensitivity and specificity of MRI for the diagnosis of endometriosis of the recto-vaginal septum were 82% and 77%^{14,16}. However, in the case of our study, we found a sensitivity of 63.2% and a specificity of 81.8% for the diagnosis of endometriosis of the recto-vaginal septum on MRI.

On MRI, normal USL are usually not visible^{14,17} or are described as thin, regular, hypointense semicircular cords that run from the sides of the cervix and vaginal vault and have a dorsocranial path to the sacrum¹⁸.

USL endometriosis is described as nodularity in the ligament or as unilateral or bilateral hypotensive thickening of the ligament, with regular or irregular edges^{17,18}. Hyperintense staining on fat-suppressed T1-weighted images, representing dotted foci of hemorrhage, can also be observed¹⁹. The proximal medial portion of the USL is most commonly affected by endometriosis¹⁸. According to Bazot et al.¹⁷ T2-weighted thin section oblique axial sequences may improve the ability of conventional MRI to assess USL endometriosis. The left uterosacral endometriosis may be more difficult to diagnose than the right, due to the frequent location of the rectosigmoid colon in the left side of the pelvic cavity¹⁷.

In a recently published meta-analysis, the sensitivity and specificity of MRI for the diagnosis of USL endometriosis were 85% and 80%¹⁶. In our study we found a sensitivity of 70.3% and a specificity of 70.5% for USL endometriosis on MRI.

In patients undergoing surgery, it is particularly relevant to determine whether USL endometriosis is unilateral or bilateral. The risk of urinary dysfunction and dysuria is significantly higher in patients after bilateral USL resection compared to unilateral LUS resection²⁰.

MRI technique is useful for detection of the infiltration of the muscle layer of the bowel with a sensitivity of 100% and a specificity of 75%. On the other hand, it has a limited value in diagnosing the infiltration of the mucosa, because of the thickening of the mucosa caused by edema without infiltration of endometriosis. However, extensive irregularities of the mucosal layer may raise the suspicion of mucosal involvement^{14,23}.

In a recently published meta-analysis, the sensitivity and specificity of MRI for the diagnosis of rectosigmoid colon endometriosis were 83% and 88%^{14,16}. However, our study revealed a sensitivity of 77.8% and a specificity of 96.8% for the diagnosis of the endome-

triotic lesions of the rectum and a sensitivity of 55.6% and respectively a specificity of 96.2% for the diagnosis of endometriotic sigmoid nodules.

Furthermore, according to the specialty literature, in the case of parametrial involvement in endometriosis, MRI showed an accuracy of 96.4%²⁴. On the other hand, our study showed a sensitivity for the MRI technique of only 37.3% and respectively a specificity of 87.1% for the parametrial lesions, which is less than what M. Bazot *et al.*²⁴ state in their study published in 2012.

Another aspect assessed by our study was the sensitivity and specificity of the MRI technique for endometriotic bladder invasion. Although the data found in the specialty literature support a higher sensitivity for MRI versus the intraoperative appearance (91% versus 82%) and a specificity of only 59% for the MRI technique versus 65% for the intraoperative appearance²⁵, our data showed a sensitivity of 66.7% and a specificity of 100% for the diagnosis of endometriotic invasion of the bladder with the MRI.

CONCLUSIONS

Endometriosis is a chronic gynecological condition that affects women during their reproductive life. The diagnosis of endometriosis should consider clinical symptoms, physical examination, laboratory tests and various imaging techniques. Ideally, surgery for endometriosis is planned on a careful preoperative investigation. From this point of view, the role of MRI technique to help the diagnose and plan the surgical strategy is essential in the management of the disease. Preoperative findings of all endometriotic lesions is recommended to choose the surgical approach and to plan a multidisciplinary team work²¹.

MRI can be recommended as the ideal imaging technique for mapping endometriotic lesions preoperative, as according to the results of our study, it demonstrated a specificity of at least 70.5% for endometriotic lesions.

Compliance with ethics requirements: The authors declare no conflict of interest regarding this article. The authors declare that all the procedures and experiments of this study respect the ethical standards in the Helsinki Declaration of 1975, as revised in 2008(5), as well as the national law. Informed consent was obtained from all the patients included in the study.

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