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THE VALUE OF MAGNETIC RESONANCE IMAGING AS COMPARED TO LAPAROSCOPY FOR THE DETECTION OF ENDOMETRIOSIS

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ABSTRACT

The objective of the study is to determine the value of MRI for detecting Endometriosis by considering the main determinants of diagnostic accuracy which are essential to minimize false positive and false negative diagnoses. The present study aims to assess the diagnostic value of MRI as a standard reference to detect endometriosis as compared to the laparoscopic findings. According to the opinion given by a panel of experts, forty consecutive patients with complaints of chronic pelvic pain, infertility, dysmenorrhea, dyspareunia, cyclic hematuria, pelvic pain between menstrual cycles and corresponding gastrointestinal symptoms, were referred to the Radiology department for further evaluation. The MRI examinations were performed with a 1.5-T unit. After MRI, the patients underwent laparoscopy within a maximum interval of 10 days as the reference standard. Data was analysis by SPSS. Sixteen patients underwent normal laparoscopy and normal MRI without any endometriotic lesions. In the other 16 patients, laparoscopy could identify 24 sites of endometriosis (20 endometriomas, 3 in posterior cul-de-sac, 1 in trigon of bladder). 20 out of these 24 sites (83.3%) were reported in their MRI. It is evident that the MRI had a sensitivity, specificity, PPV, NPV, and accuracy of 93.7%, 100%, 100%, 94.1%, and 96.8%, respectively for the diagnosis of Endometriosis. MRI with its high sensitivity and specificity can be considered as a high reproducible tool to explore Endometriosis.

KEYWORDS: ***Endometriosis, Magnetic Resonance Imaging, Laparoscopy, Accuracy.***

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INTRODUCTION

Endometriosis is a typical estrogen-subordinate sickness with a general predominance of 10% among female premenopausal populace especially in conceptive ages [1-2]. It is usually detected with the presence of the endometrial tissue outside the uterus. Although baseline pathologies of endometriosis remain uncertain, some theories have been presented to explain the pathophysiology of the disease [3,4]. It is suggested that endometriosis may develop from the metaplasia of pelvic peritoneal tissue originated from transforming the circulatory stem cells [5]. Despite wide variation in clinical manifestations ranging from asymptomatic condition to severe complaints, the most frequent symptoms of the disease include pelvic pain, dysmenorrhea, and even infertility [6]. However, the final diagnosis is defined pathologically by laparoscopic biopsy of the suspected lesions made through histological assessment [7]. Along with the definitive method, the use of some imaging modalities led to the obviation of unnecessary exploring surgeries. In addition, the various supportive radiological assays led to the clear differentiation of endometriosis from other pelvic lesions. Recently, Magnetic Resonance Imaging (MRI) has been introduced as a detecting and characterizing modality for pelvic endometriosis [8]. The use of T1-weighted fat-suppressed sequences is recommended to facilitate differentiation of endometriosis-related lesions from other pelvic masses like teratomas [9,-10]. However, the accuracy of MRI to detect Endometriosis can be potentially affected by several factors. As the benign lesions frequently exhibit restricted diffusion, the diagnosis of endometriosis may be underestimated [11]. Whether superficial or intense, the position of the lesion may affect the accuracy of MRI technique especially in deep infiltrative condition [12]. In total, determining the value of MRI for detecting endometriosis by considering the main determinants of diagnostic accuracy is essential to minimize false positive and false negative diagnoses.

MATERIALS AND METHODS

Study population: The cross-sectional study was conducted at a Tertiary Academic Gynecology and Obstetrics hospital in Tehran between April 2012 and April 2013. The study was approved by the Institutional Ethics committee. A written informed consent was obtained from all the patients. Exclusion criteria included patients below 18 years, patients of postmenopausal status, body mass index of more than 30 kg/m2 or less than 17 kg/m2, patients with history of multiple prior abdominal surgery, known abdominal or pelvic infection (including generalized peritonitis), known chronic bowel disease, large pelvic or abdominal mass, intrauterine pregnancy, diaphragmatic hernia, advanced heart disease, chronic obstructive lung disease, metallic implants or artificial heart valves, claustrophobia, and patients' reluctance to undergo MRI or laparoscopy for any reason. The clinical presentation and physical examination of the patients were recorded by an experienced gynecologist before being enrolled in the current study. Imaging technique: The patients had been fasting for 6 hours before MRI study. The MRI examinations were performed with a 1.5-T unit (Magnetom Avanto; Siemens Healthcare, Erlangen, Germany) after administration of both intrarectal and intravaginal ultrasound gel. T2-weighted turbo spin-echo sequences [slice thickness, 4–5 mm; field of view (FOV), 350–380 mm; repetition time (TR)/echo time (TE), 3500/90 ms] were obtained in sagittal and axial planes. T1-weighted images (slice thickness, 4–5 mm; FOV, 350–380 mm; TR/TE, 600/7 ms) were performed without fat suppression in axial and sagittal planes after fat suppression. An additional T2* gradient-echo sequence (slice thickness, 4–5 mm; FOV, 350–380 mm flip angle, 75°; TR/TE, 135/10 ms) was obtained in both axial and sagittal planes. MRI images were interpreted by an expert who did not possess the patients' history and laparoscopic results. Laparoscopy: After MRI, the patients underwent laparoscopy within a maximum interval of 10 days by a single gynecologist. A systematic exploration of abdominal and pelvic spaces was performed, and biopsies were taken from suspicious sites and laparoscopic findings were recorded. When the histopathology findings were compatible with endometriosis, diagnosis was made. The presence or absence of Endometriosis was compared site by site between MRI and laparoscopy. Statistical analysis: Results were presented as mean ± standard deviation (SD) for quantitative variables and were summarized by frequency (percentage) for categorical variables. Categorical variables were, on the other hand, compared using chi-square test. Considering laparoscopy as the gold standard, specificity, sensitivity, positive predictive value (PPV) and negative predictive value (NPV), and accuracy of MRI were determined by cross tabulation and using the following equations: (i) the sensitivity was defined as the ratio of true positive

to true positive plus false negative, (ii) specificity as the ratio of true negative to true negative plus false positive, (iii) the PPV as the ratio of true positive to true positive plus false positive, (iv) the NPV as the ratio of true negative to true negative plus false negative, and (v) accuracy as the ratio of the number of correct MRI diagnosis to number of confirmed final diagnosis for each MRI feature.

STATISTICAL ANALYSIS

P values of ≤ 0.05 were considered statistically significant. For the statistical analysis, the statistical software SPSS version 23.0 for windows (IBM, Armonk, New York) was used.

RESULTS

Forty patients were assessed for eligibility out of which 2 patients refused to participate, 4 had multiple previous abdominopelvic surgery, and 2 had active pelvic inflammatory disease. Finally, 32 patients were enrolled for the present study. The Mean age of the patients was 34 years (range, 23–55 years). Seventeen (46.9%) patients were nulliparous, and 15 (53.1%) were multiparous. The most prevalent complaint of the patients was chronic pelvic pain in 43.8%, followed by primary infertility in 37.5%, dysmenorrhea in 15.6%, dyspareunia in 15.6%, secondary infertility in 12.5%, and spotting in 3.1%. The clinical presentations of the patients with and without the final diagnosis of endometriosis are shown in Table 1 (considering this point that some patients had two or more symptoms). No difference was revealed in clinical manifestations between the groups with and without endometriosis. Twenty (61.5%) patients had no history of previous abdominal/pelvic surgery. The most common previous surgery in the remaining patients was cesarean section. Overall, 16 (50.0%) patients had normal physical examination, while 6 (18.8%) had right ovarian mass, 2 (6.3%) had left ovarian mass, 1 (3.1%) had bilateral adnexal mass, 3 (9.4%) had disturbed cervical motion, 2 (6.3%) had abnormal displacement in structures, 1 (3.1%) had pain in septum, and 1 (3.1%) had adnexal pain. The physical exam findings of the patients with (n = 16) and without (n = 16) the final diagnosis of endometriosis are shown in Table 2. Similar to clinical symptoms, there was no difference in physical findings in examination between the patients with and without endometriosis. Comparing the findings of laparoscopy and MRI regarding diagnosis of endometriosis, it is evident that 16 patients had normal laparoscopy without any endometriotic lesions that all also had normal MRI (without any false positive or false negative results). In the other 16 patients, laparoscopy could identify 24 sites of endometriosis (20 endometriomas, 3 in posterior cul-de-sac, 1 in trigon of bladder) and 20 out of these 24 sites (83.3%) were reported in their MRI. MRI could identify 20 sites of 24 sites of endometriosis accurately (83.3%) but could not identify 4 sites (2 endometriomas, 2 in posterior cul-de-sac) that were diagnosed in laparoscopy. Hence, MRI had a sensitivity of 83.3%, a specificity of 100%, a PPV of 100%, a NPV of 88.8% and an accuracy of 85% in the diagnosis of Eendometrioma when compared to laparoscopy. In diagnosis of cul-de-sac endometriosis, MRI had a sensitivity of 33.3%, a specificity of 100%, a PPV of 100%, a NPV of 88.8% and an accuracy of 42.5%. Overall, MRI possessa sensitivity, specificity, PPV, NPV, and accuracy of 93.7%, 100%, 100%, 94.1%, and 96.8%, respectively for the diagnosis of Endometriosis.

Table 1.
Comparison of chief complaints in patients with (n=21) and Without (n=20) endometriosis

Item	Patients with endometriosis	patients without endometriosis	P-value
Chronic pelvic pain	5 (23.8)	9 (45.0)	0.316
Infertility	9 (42.9)	7 (35.0)	0.733
Dysmenorrhea	2 (9.5)	3 (15.0)	0.999
Dyspareunia	4 (19.0)	1 (5.0)	0.357
Spotting	1 (4.8)	0 (0.0)	0.999
Total	21	20	

Table 2
Comparison of the physical findings in patients with (n=16) and Without (n=16) endometriosis

Item	Patients with endometriosis	patients without endometriosis	P-value
Normal exam	6 (37.5)	11 (68.8)	0.325
Right adnexal mass	3 (18.8)	2 (12.5)	0.999
Left adnexal mass	2 (12.5)	0 (0.0)	0.487
Bilateral adnexal mass	1 (6.3)	0 (0.0)	0.999
Cervical motion impairment	2 (12.5)	1 (6.3)	0.999
Uterine displacement	1 (6.3)	1 (6.3)	0.999
Pain in septum	1 (6.3)	0 (0.0)	0.999
Adnexal pain	0 (0.0)	1 (6.3)	0.999
Total	16	16	

DISCUSSION

The cross-sectional assay could well demonstrate high value of MRI to diagnose endometriosis as shown by previous studies. Due to noninvasive nature of MRI and its minimized contraindications, the use of this modality is preferred to other accurate instrument such as laparoscopy as semi-invasive methods to discover endometriosis. It is found out that MRI has high accuracy to show endometriosis regarding different aspects of the lesion such as deep or superficial, and also the position of the lesion. The use of invasive and safe modality may restrict the use of invasive histological assays to demonstrate endometriosis and its extension. In too, MRI has high sensitivity, specificity, and predictive value for detecting endometriosis and it can lead to minimizing both false positive and false negative results. The recent studies have emphasized its high accuracy and performance to detect deeply infiltrative endometriosis. As shown by Ito et al [13], the sensitivity, specificity, PPV and NPV of MRI to diagnose deeply infiltrative endometriosis included 90.3%, 91%, 92.1%, and 89%, respectively. A recent systematic review and meta-analysis on the accuracy of MRI to detect deeply infiltrative endometriosis showed that the overall sensitivity and specificity for MRI to detect this lesion were estimated to be 83% and 90% respectively [14]. As indicated by Thomeer et al [15], MRI had high patient-level sensitivity to diagnose endometriosis in lesion's stages II to IV but not in stage I, while the specificity of this tool was high in all stages. The accuracy of MRI to detect endometriosis was independent of lesion's stage. Krüger et al [(16)] also showed a wide range of sensitivity of MRI ranging from 35.3% to 87.6% but with high specificity ranging from 68.2% to 84.6% for diagnosing endometriosis. Thus, the sensitivity of this modality may be affected by the location of endometriosis with the lowest sensitivity in peritoneum and the highest sensitivity in the pouch of Douglas [16]. In another study by Manganaro et al in [17], high percentages of sensitivity (96.97%), specificity (100.00%), VPP (100.00%), and VPN (92.86%) were obtained for MRI to detect endometriosis. The revealing endometriosis on MRI not only depends on the experience of the operator and the location of the lesion, but also on the concentration of iron and protein in the fluid as products of degradation of the blood [18,19]. In some lesions with high contents of these products, endometriosis appeared as cystic masses with high signal intensity on T1-weighted images and adversely low signal intensity on T2-weighted images resulted from high density of Iron [20]. Unfortunately, MRI has low accuracy for differentiating cystic ovarian masses from endometriosis. As recently indicated, this tool had an acceptable specificity but low sensitivity to differentiate cystic masses from endometriosis [21]. Furthermore, peritoneal lesions usually escape from detection and may be ignored in MRI assessment [22, 23]. Therefore, the existence of these lesions may make difficult accurate diagnosis of endometriosis. In total, MRI can be considered as a high reproducible tool to explore endometriosis with high sensitivity and specificity.

CONCLUSION

Endometriosis should be suspected in women with reduced fertility, dysmenorrhea, dyspareunia, or chronic pelvic pain. However, these symptoms may

also be seen in other diseases. Endometriosis may be asymptomatic even in some of the advanced diseases (ovarian endometriosis or rectovaginal endometriosis with deep invasion).Definitive diagnosis of endometriosis is histologically based and therefore requires surgical procedures. If there is a high-power imaging technique in diagnosing lesions and consistent with histological findings, it can be a very suitable substitute for these invasive measures. In addition, this method will also be helpful in tracking treatment outcomes. Regarding the MRI advantages as an imaging method and its safety for women of childbearing age, which account for a majority of patients, if there is an acceptable consistency between these two methods, MRI is an appropriate alternative. In addition, there is no limit to detection of deeper lesions which cannot be easily accessed laparoscopically. The results of our study showed that MRI has a high positive predictive value (100%) in diagnosis of endometriosis. Therefore, if diagnosis is done by MRI, there is no need for invasive measures and surgery; treatment can be initiated for patients who are candidates for medical treatment and the patient can be followed up. The results of our study indicate that, given the 100% value of MRI, if a person is actually healthy, MRI will also be normal for endometriosis. Given the 93.7% sensitivity of MRI in diagnosing endometriosis, if a person has a strong clinical suspicion of endometriosis but MRI is normal for endometriosis, the patient should undergo laparoscopy. Given the negative predictive value of MRI (94.1%) in diagnosing endometriosis, normal MRI does not definitely mean that the patient is healthy. In conclusion, MRI has 96.8% diagnostic accuracy in diagnosis of endometriosis, which indicates high MRI value in diagnosis of endometriosis in patients suspected of endometriosis clinically. Given $P<0.002$ in improving MRI sensitivity by using gel injections, we used this study and conducted the whole study by gel injection; thus, MRI sensitivity was maximized in this study. The overall findings of this study showed that MRI has a high value in diagnosing endometriosis lesions in patients who are clinically suspected of endometriosis; this ability is to identify lower peritoneal implants, but also to identify other lesions as well.

LIMITATIONS AND SUGGESTIONS

Because of the limited incidence of endometriosis in peritoneum and cases of deep endometriosis, judgment of the ability of MRI to detect peritoneal implants of endometriosis or deep endometriosis requires another study, the main purpose of which is to study this, requiring more time and patients undergoing laparoscopy and only MRI of patients with peritoneal or deep endometriosis will be studied.

AUTHORS CONTRIBUTION STATEMENT

Shahrzad Zadehmodarres and Morteza SaneiTaheri designed the study, performed the statistical analysis and wrote the protocol. Mahtab Motevasselian and Zahra Naiji and Sara Bahramzadeh and Behnaz Amirnazari managed the analyses of the study, wrote the first draft of manuscript managed the literature searches. All authors read and approved the final manuscript.

CONFLICT OF INTEREST

Conflict of interest declared none.

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