Original Article

# Diagnostic Accuracy of MRI in Diagnosis of Ovarian Endometriosis Keeping Laparoscopic Findings as Gold Standard

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## Abstract

Objectives: To assess the diagnostic accuracy of MRI in the diagnosis of ovarian endometriosis, compared to laparoscopy as the gold standard.
Methodology: This descriptive, cross-sectional validation study was conducted in the Department of Radiology at Holy Family Hospital from April 30, 2019, to October 29, 2019 Rawalpindi. A total of 211 female patients, aged 15-70 years, with suspected ovarian endometriosis were enrolled. All patients underwent an MRI according to the specified protocol, followed by laparoscopy. All patients were enrolled in the study according to inclusion and exclusion criteria. Qualitative variables (history of surgeries) were reported in terms of frequency and percentage, and quantitative variables (age, mean creatinine, mean hemoglobin) were presented as mean ± standard deviation. MRI findings were then compared to laparoscopic findings.
Results: All patients underwent MRI, revealing that 115 were true positives and 7 were false positives. Among the 89 MRI-negative patients, 7 were false negatives, indicating the presence of ovarian endometriosis upon laparoscopy, while 82 were true negatives (p=0.0001). The overall sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of MRI for diagnosing ovarian endometriosis compared to laparoscopy as the gold standard were 94.26%, 92.13%, 94.26%, 92.13%, and 93.36%, respectively.
Conclusion: This study concludes that MRI demonstrates the highest diagnostic accuracy for diagnosing ovarian endometriosis among all available diagnostic tools, making it a safe and accurate option for reducing patient morbidity.
Keywords: Magnetic Resonance Imaging, Transvaginal Ultrasound, Ovarian Endometriosis, Negative Predictive ValueNPV)

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## Introduction

Endometriosis is a significant and clinically distressing condition in women of reproductive age, defined as the presence of endometrial stroma and glands outside the endometrium.[1] It is a heterogeneous disease comprising ovarian, peritoneal, and deep infiltrating types.[2] The estimated prevalence in the female population is generally 6-10%, while it ranges from 35-50% in women with pelvic pain and infertility.[3] The widely accepted gold standard for diagnosing this condition is visual inspection of pelvic organs performed during surgery, preferably complemented by histopathological diagnosis.[4] Due to the impracticality of this diagnostic method, in most cases, it takes an average of 12 years for affected women to be diagnosed and receive appropriate treatment.[5] This represents a substantial hidden aspect of this disease. Additionally, extensive manipulation of pelvic organs during diagnosis and excision is associated with multiple complications. Therefore, the importance of pre-operative diagnostic tests with reasonable accuracy to prevent unnecessary surgery and undue complications cannot be overstated.

Currently available non-invasive diagnostic tools include transvaginal and trans-rectal sonography, Magnetic Resonance Imaging (MRI), and 3-D ultrasound, each with its own advantages and limitations.[6] Transvaginal sonography (TVS) is limited to married patients and is not virtually painless, while the widespread use of MRI is constrained by its cost.[7] Reported sensitivities and specificities for MRI in one study were in the range of 86.4% and 95.2%, respectively[8], and in another study, they were 73.1% and 94.3%, respectively.[9] For TVS, the values ranged between 73.9% and 87.5% in one study[10]

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and 70.9% and 92.8%, respectively, in another study[11] While the diagnostic accuracy of these modalities has been extensively evaluated for deep infiltrating and peritoneal endometriosis, studies for the diagnosis of ovarian endometriosis are lacking. Therefore, the challenge remains in selecting the most preferred imaging modality for diagnosing ovarian endometriosis. The aim of the present study was to determine the diagnostic accuracy of MRI in patients with ovarian endometriosis.

## Methodology

This was a descriptive (cross-sectional) validation study conducted in the Department of Radiology at Holy Family Hospital in Rawalpindi. The study was conducted from April 30, 2019, to October 29, 2019. The sample size was calculated using the WHO sample size calculator, employing statistics for MRI (with a sensitivity of 0.8646, specificity of 0.9526, a confidence level of 95%, absolute precision for sensitivity of 10%, absolute precision for specificity of 5%, and a prevalence of 15.7%). Our sample size was determined to be 211. This sampling was conducted using the non-probability consecutive sampling method.

Inclusion Criteria: All female patients aged 15-70 years with a suspicion of ovarian endometriosis were included in this study. Clinical suspicion was based on symptomatology (chronic pelvic pain, dyspareunia, and dysmenorrhea) and physical examination findings.

Exclusion Criteria: Patients with deep infiltrative endometriosis (other than ovarian endometriosis), a history of allergy to gadolinium contrast, claustrophobia, renal failure, a history of any metallic implants preventing MRI study, structural anomalies of the reproductive system, pregnancy, or refusal were excluded from the study.

Written informed consent was obtained from the patients included in the study. Prior approval was sought from the hospital's ethical committee. All patients were enrolled in the study according to inclusion and exclusion criteria. Relevant patient information was collected on a structured proforma. All patients underwent an MRI as per the protocol mentioned below, followed by laparoscopic evaluation afterward.

The prerequisites for this examination included a partially filled bladder, and images were captured using a 1.5 Tesla (GE Healthcare Machine) through the pelvic coil. The protocol comprised axial, coronal, and sagittal T1- and T2-weighted images. T1 axial and sagittal fat saturation techniques without contrast were also performed. Endometriosis was characterized by a high signal on T1- and a low signal on T2-weighted images. All MRI examinations were evaluated by an experienced and blinded operator. Figure I shows the signal characteristics of endometriomas on T1WI.

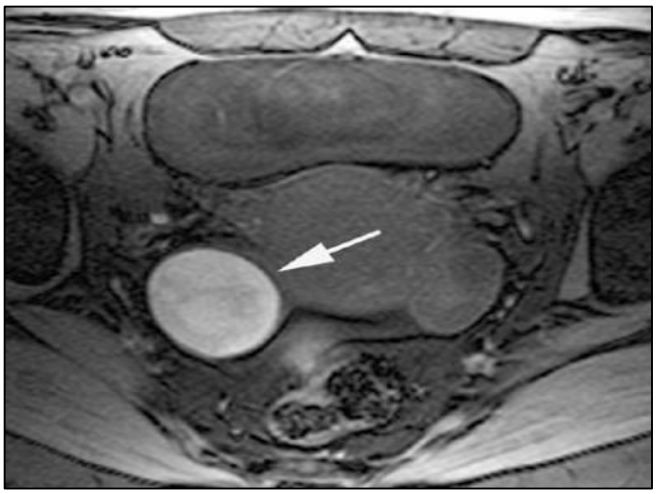

**Figure 1. Signal Characteristics of Endometrioms on T1WI**.

Laparoscopy was performed by an experienced gynecologist. The pelvic cavity was explored, and endometriosis was classified according to the revised American Society for Reproductive Medicine classification. Laparoscopic findings were considered the gold standard for the diagnosis of ovarian endometriosis.

Data was recorded and analyzed using the Statistical Package for the Social Sciences (SPSS, version 22.0) for Windows. Qualitative variables (history of surgeries) were reported in terms of frequency and percentage, and quantitative variables (age, mean creatinine, mean hemoglobin) were presented as mean ± standard deviation. Effect modifiers (age, previous history of surgery) were controlled through stratification. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were computed according to the formulas mentioned in Table I.

**Table I: Formulae for Sensitivity, Specificity, PPV & NPV.**

| | Disorder | No Disorder |
|---|---|---|
| Positive Test Results | True Positive (TP) | False Positive (FP) |
| Negative Test Results | False Negative (FN) | True Negative (TN) |
| Sensitivity = TP/(TP+FN) | | Specificity = TN/(TN+FP) |
| PPV = TP/(TP+FP) | | NPV = TN/(FN+TN) |

## Results

Age range in this study was from 15-70 years with mean age of 33.64 ± 10.07 years. Majority of the patients 169 (80.09%) were between 15-40 years of age as shown in Table II. Distribution of patients according to previous history of surgery is shown in Figure 2.

**Table II: Distribution of patients according to Age**

| Age (years) | No. of Patients | %age |
|---|---|---|
| **15-40** | 169 | 80.09 |
| **41-70** | 42 | 19.91 |
| **Total** | 211 | 100.0 |

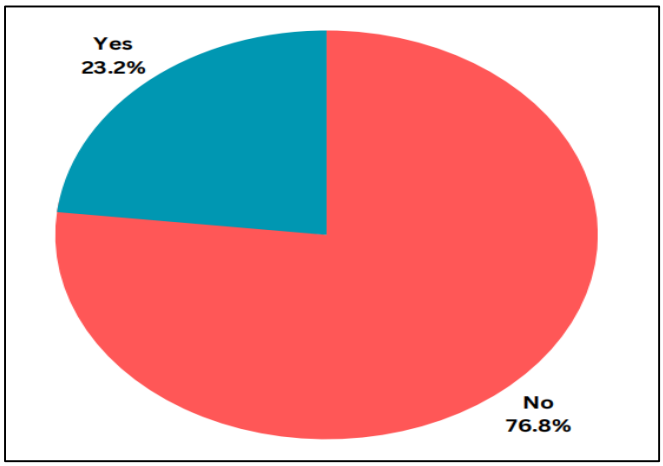


**Figure 2. Showing the Distribution of patients according to previous history of surgery (n=211)**

All the patients were subjected to MRI and found that 115 were True Positive and 07 were False Positive. Among 89, MRI negative patients, 07 (False Negative) had ovarian endometriosis on laparoscopy whereas 82 (True Negative) had no ovarian endometriosis on laparoscopy (p=0.0001) as shown in Table III. Overall sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of MRI for diagnosis of ovarian endometriosis in comparison with laparoscopy as gold standard was 94.26%, 92.13%, 94.26%, 92.13% and 93.36% respectively.

## Discussion

Laparoscopy is considered the gold standard for diagnosing endometriosis.[12] One-step surgery, involving both diagnosis and complete excision of the lesions at the same time, is essential for the successful treatment of endometriosis. Therefore, presurgical mapping of endometriotic lesions becomes an important issue.[13] Currently, ultrasound is the preferred initial assessment method. Transvaginal ultrasound is more sensitive but has important limitations due to the relatively small field of view and operator dependency.[14] MRI is increasingly being used for the evaluation of endometriosis, with reported sensitivity and specificity values ranging from 69–92% and 75–98%, respectively.[15,16] Most authors recommend using MRI as an adjunct tool in cases where ultrasound results are inconclusive.

As demonstrated in a similar study[17], the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of MRI for diagnosing deeply infiltrative endometriosis were 90.3%, 91%, 92.1%, and 89%, respectively. Another study indicated[18] that MRI had high patient-level sensitivity for diagnosing endometriosis in lesion stages II to IV but not in stage I, while the specificity of this tool was high in all stages. The accuracy of MRI in detecting endometriosis was found to be independent of the lesion's stage. A similar study.[19] also reported a wide range of sensitivity for 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 the peritoneum and the highest sensitivity in the pouch of Douglas.[20] In another study by Manganaro et al[21,22], high percentages of sensitivity (96.97%), specificity (100.00%), PPV (100.00%), and NPV (92.86%) were obtained for MRI in detecting endometriosis.

Medeiros et al. recently published a meta-analysis on the diagnostic efficiency of pelvic MRIs in the diagnosis of deep endometriosis.[23] This meta-analysis reviewed 20 studies that compared findings from high-field MRIs (1.0-3.0 T) to surgical findings (laparoscopic or open) and histology as a reference standard. In summary, the MRI studies showed 83% sensitivity and 90% specificity in diagnosing endometriosis-related injuries. The location that exhibited the highest sensitivity was the pouch of Douglas (sensitivity = 89%, specificity = 94%),

**Table III: Comparison of MRI findings with laparoscopy results**

| | Positive result on laparoscopy | Negative result on laparoscopy | P-value |
|---|---|---|---|
| Positive result on MRI | 115 (TP)* | 07 (FP)*** | **0.0001** |
| Negative result on MRI | 07 (FN)** | 82 (TN)**** | |
| *-TP=True positive **-FP=False positive ***-FN=False negative ****-TN=True negative | | | |
| Sensitivity: 94.26%, Specificity: 92.13%, PPV: 94.26%, NPV: 92.13%, Diagnostic Accuracy: 93.36% | | | |

while in the anterior compartment, MRI sensitivity was lower (bladder sensitivity = 64%, specificity = 98%).[24]

In conclusion, laparoscopy is undoubtedly a definitive tool for the diagnosis and treatment of endometriosis, but it requires presurgical mapping. Ultrasound (USG) is used as an initial diagnostic method due to its availability, affordability, and non-invasiveness, but it has limited diagnostic value. Transvaginal ultrasound (TVS) is a sensitive method with the same benefits as TAS but is operator-dependent, has a limited field of view, and may face patient hesitancy. MRI retains its position as the most sensitive non-operative tool for diagnosing the disease compared to laparoscopy. Furthermore, we lack local data regarding the accuracy of MRI due to its limited availability in the past. However, with the increasing availability of MRI in our society, this study can be helpful in establishing local guidelines regarding its accuracy.

## Conclusion

This study concluded that diagnostic accuracy of MRI for diagnosis of ovarian endometriosis is quite high. So, we recommend that MRI should be used routinely for early diagnosis of this condition in order to reduce the morbidity of patients.

## References


1. Bianek-Bodzak A, Szurowska E, Sawicki S, Liro M. The importance and perspective of magnetic resonance imaging in the evaluation of endometriosis. BioMed Res Int. 2013.
2. Vouk K, Hevir N, Ribič-Pucelj M, Haarpaintner G, Scherb H, Osredkar J *et al*. Discovery of phosphatidylcholines and sphingomyelins as biomarkers for ovarian endometriosis. Human Repro. 2012;27(10):2955-65.
3. Hayashi A, Tanabe A, Kawabe S, Hayashi M, Yuguchi H, Yamashita Y, *et al*. Dienogest increases the progesterone receptor isoform B/A ratio in patients with ovarian endometriosis. Journal of ovarian research. 2012 Dec;5(1):31-32.
4. May KE, Conduit-Hulbert SA, Villar J, Kirtley S, Kennedy SH, Becker CM. Peripheral biomarkers of endometriosis: a systematic review. Human Repro update. 2010 May 12;16(6):651-74.
5. Saba L, Guerriero S, Sulcis R, Pilloni M, Ajossa S, Melis G *et al*. MRI and "tenderness guided" transvaginal ultrasonography in the diagnosis of recto-sigmoid endometriosis. Journal Magn Reson Imaging. 2012 Feb;35(2):352-60..
6. Exacoustos C, Malzoni M, Di Giovanni A, Lazzeri L, Tosti C, Petraglia F, Zupi E. Ultrasound mapping system for the surgical management of deep infiltrating endometriosis. Fertil Steril. 2014 Jul 1;102(1):143-50.
7. Donnez J, García-Solares J, Dolmans MM. Ovarian endometriosis and fertility preservation: a challenge in 2018. Minerva Ginecologica: J Obst a Gynaecol. 2018;70:408.
8. Vercellini P, Viganò P, Somigliana E, Fedele L. Endometriosis: pathogenesis and treatment. Nature Reviews Endocrinology. 2014 May;10(5):261.
9. Socolov R, Butureanu S, Angioni S, Sindilar A, Boiculese L, Cozma L, Socolov D. The value of serological markers in the diagnosis and prognosis of endometriosis: a prospective case–control study. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2011 Feb 28;154(2):215-7.
10. Zomer MT, Ribeiro R, Trippia CH, Cavalcanti TC, Hayashi RM, Kondo W. Correlation between serum Ca-125 levels and surgical findings in women with symptoms evocative of endometriosis. Revista Brasileira de Ginecologia e Obstetrícia. 2013;35(6):262-7.
11. Wheeler JM. Epidemiology of endometriosis-associated infertility. J Reprod Med. 1989 Jan. 34(1):41-6.
12. Rawson JM. Prevalence of endometriosis in asymptomatic women. J Reprod Med. 1991 Jul. 36(7):513-5.
13. Strathy JH, Molgaard CA, Coulam CB, Melton LJ 3rd. Endometriosis and infertility: a laparoscopic study of endometriosis among fertile and infertile women. Fertil Steril. 1982 Dec. 38(6):667-72.
14. Liu DT, Hitchcock A. Endometriosis: its association with retrograde menstruation, dysmenorrhoea and tubal pathology. Br J Obstet Gynaecol. 1986 Aug. 93(8):859-62.
15. Kruitwagen RF, Poels LG, Willemsen WN, de Ronde IJ, Jap PH, Rolland R. Endometrial epithelial cells in peritoneal fluid during the early follicular phase. Fertil Steril. 1991 Feb. 55(2):297-303.
16. Scott RB, Te Linde RW, Wharton LR Jr. Further studies on experimental endometriosis. Am J Obstet Gynecol. 1953;66:1082.
17. Mathur S, Peress MR, Williamson HO, Youmans CD, Maney SA, Garvin AJ, et al. Autoimmunity to endometrium and ovary in endometriosis. Clin Exp Immunol. 1982 Nov. 50(2):259-66.
18. 18. Acién P, Velasco I, Gutiérrez M, Martínez-Beltrán M. Aromatase expression in endometriotic tissues and its relationship to clinical and analytical findings. Fertil Steril. 2007 Jul. 88(1):32-8.
19. Matsuzaki S, Canis M, Pouly JL, Wattiez A, Okamura K, Mage G. Cyclooxygenase-2 expression in deep endometriosis and matched eutopic endometrium. Fertil Steril. 2004 Nov. 82(5):1309-15.
20. Wölfler MM, Nagele F, Kolbus A, Seidl S, Schneider B, Huber JC, et al. A predictive model for endometriosis. Hum Reprod. 2005 Jun. 20(6):1702-8.75
21. Zeitoun KM, Bulun SE. Aromatase: a key molecule in the pathophysiology of endometriosis and a therapeutic target. Fertil Steril. 1999 Dec. 72(6):961-9.
22. Shippen ER, West WJ Jr. Successful treatment of severe endometriosis in two premenopausal women with an aromatase inhibitor. Fertil Steril. 2004 May. 81(5):1395-8.
23. Ailawadi RK, Jobanputra S, Kataria M, Gurates B, Bulun SE. Treatment of endometriosis and chronic pelvic pain with letrozole and norethindrone acetate: a pilot study. Fertil Steril. 2004 Feb. 81(2):290-6.