ROLE OF MAGNETIC RESONANCE IMAGING IN DIAGNOSIS OF ENDOMETRIOSIS

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ABSTRACT:

Background: Endometriosis refers to the presence of functional endometrial glands outside of the uterine cavity. Although laparoscopy is the gold standard for diagnosing endometriosis, reliable identification of the disease before laparoscopy would be of value for the gynecologist in choosing the preferred therapeutic approach, medical or surgical. Ultrasound is the initial investigation performed, but MRI is increasingly being used, particularly when sonographic findings are inconclusive, when deep pelvic endometriosis is suspected or when surgery is indicated.

Aim of the work: This study aimed to evaluate the accuracy of Magnetic Resonance Imaging in the diagnosis of Endometriosis.

Patients and Methods: 40 premenopausal female patients with clinical and/or sonographic suspicion of endometriosis underwent pelvic MRI. All our imaging results were finally compared to the laparoscopic data with histopathological verification as the gold standard. The main outcome parameters, the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of MRI in diagnosing endometriosis were calculated.

Results: The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of MRI in diagnosing endometriosis were 95.65%, 57.14%, 88%, 80%, 86.7% respectively.

Conclusion: MRI is the best problem-solving tool in cases of indeterminate adnexal findings on sonography, when deep infiltrating endometriosis is suspected, or for presurgical mapping.

Keywords: Endometriosis, MRI, Pelvis, Ultrasound, Laparoscopy

INTRODUCTION:

Endometriosis is a common gyneco-logical disease affecting women of reproductive age. It refers to the presence of functional endometrial glands and stroma outside of the uterine cavity. This ectopic tissue responds to hormonal changes resulting in cyclic hemorrhage and pain, giving the disease its distinct clinical features[1].

Its estimated prevalence ranges between 2% and 10% among the general female population, although it may increase to about 50% in infertile women[2].

Secondary dysmenorrhea, deep dys-pareunia, sacral pain with menses, perimenstrual diarrhea, pelvic cramps and dyschezia, dysuria, and hematuria are the most common clinical manifestations of this condition[3].

Laparoscopy is the gold standard for the diagnosis of endometriosis followed by histologic verification[4].

Currently, ultrasound is performed for the initial assessment of both endometriomas and deep pelvic endometriosis. However, transvaginal ultrasound, even with adequate bowel preparation and the use of high-frequency probes has some important limitations, owing to its relatively small field-of-view and operator dependency[5].

MRI is increasingly used for the evaluation of endometriosis, with sensitivity and specificity values ranging from 69 - 92% and 75 - 98%, respectively[5].

1. Excellent at demonstrating the hemo-rrhagic content (of variable age) of endometriomas.

2. Used in identifying deep invasive endometriotic implants. Particularly helpful in the pre-operative assessment of disease distribution and the presence of adhesions, especially in the posterior compartment and Douglas pouch, which helps guide subsequent laparoscopic surgery.

3. Vital as a problem-solving tool when assessing an indeterminate adnexal mass on ultrasound, helping to differentiate ovarian neoplastic lesions from endometriomas and also in the detection of malignant transformation within an endometrioma[6].

AIM OF THE WORK:

This study aimed to evaluate the accuracy of Magnetic Resonance Imaging in the diagnosis of Endometriosis.

PATIENTS AND METHODS:

Patients:

This is a retrospective study that included 40 female patients referred from the Gynecology Department to the Radiodiagnosis Department (Women's imaging unit) of Ain Shams University Hospitals in the period from November 2017 to June 2019.

A- Inclusion criteria included:

• Premenopausal female Patients with clinically or sonographically suspected endometriosis.

• Performance of a standardized laparoscopy with histopathological verification after MRI examination as a gold standard.

B- Exclusion criteria included:

• General contraindications against MRI examination (i.e., claustrophobia and metallic implants).

• Postmenopausal status.

All cases were subjected to the following:

1. Full history taking with particular emphasis on age, parity, age of menarche, past history of gynecological diseases or operations, menstrual history, and presenting complaint.

2. Routine laboratory investigation for all patients including CBC, random blood sugar, liver and renal function tests.

3. Ultrasound examination: All patients underwent a pelvic ultrasound examination. The examination was performed using GE logic 7 ultrasound machine, using trans-abdominal and trans-vaginal approaches via 3-4 MHz and 7-8 MHz probes respectively.

4. MR imaging using a 1.5-T MR imaging unit (Achieva, Philips medical system). All the patients were imaged in the supine position, head pointing to the magnet (HFS) with a pelvic phased array coil.

MR Imaging analysis:

Criteria for endometriosis in MRI were described by ***Bazot et al.***[7]. In

summary, low signal intensity lesions on T2W images, with associated hyperintense lesions on T1W images and cystic regions were diagnostic of endometriosis. T1W high signal intensity cysts possibly with thickened walls and fluid levels were interpreted as positive for ovarian endometriosis. For invasive deep endometriosis, high signal intensity spots on fat saturated T1W images were considered positive for endometriosis.

MR images were analyzed for the following:
- Presence of ovarian cystic lesions.
- The involvement of one or both ovaries.
- Signal intensity of the cyst on T1WIs, T2WIs and on the fat suppressed sequences.
- Presence of septations and fluid levels within the cyst.
- Presence of solid components.
- Enhancement of the solid component if present.
- Presence of adhesions.
- Screening the vesicouterine pouch, vesicovaginal septum, urinary bladder, fallopian tubes, uterine ligaments, pouch of Douglas, rectovaginal septum, anterior abdominal wall and bowel for deep endometriotic implants.

All our imaging results were finally compared to the laparoscopic results with histopathologic verification which was our standard of reference.

RESULTS:

The patients age ranged from 22 - 48 years with the mean age of 36.00 ± 7.46. Twenty eight patients were nulliparous (70%) and 12 patients were nulliparous (30%).

Clinical presentations were as follows: 19 were presented with pelvic pain (47.5%), 9 were presented with infertility (22.5%), 4 were presented with dysmenorrhea (10%), 2 were presented with Caesarean section scar palpable mass (5%), 2 were presented with contact bleeding (5%), 2 were presented with loin pain (5%), 1 was presented with dysuria (2.5%) and 1 was presented with dyschezia (2.5%) (Table 1).

Table 1: Thenumber and percentage of different clinical presentations and parity of the studied patients

		No.	%
Complain	Pelvic pain	19	47.5%
	Infertility	9	22.5%
	Dysmenorrhea	4	10.0%
	Contact bleeding	2	5.0%
	Caesarean section scar palpable mass	2	5.0%
	Loin pain	2	5.0%
	Dysuria	1	2.5%
	Dyschezia	1	2.5%
	Total	40	100%
Nulliparous/ Multiparous	Nulliparous	28	70.0%
	Multiparous	12	30.0%

Findings in cases diagnosed as endometriosis on MRI study:

This group included 35/40 patients diagnosed with endometriosis on MRI study (87.5%). Their ages ranged from 22 to 48 years.

In 31 of the 40 patients, endometriosis was found in the ovaries as ovarian cysts (77.5%). In 2 of the 40 patients, endometriosis was located in the anterior abdominal wall (5%). In 3 of the 40 patients; endometriosis was implanted in the lower ureters (7.5%). In 2 of the 40 patients,

endometriosis was seen as a vaginal nodule (5%). In 1 of the 25 patients, endometriosis was found on the urinary bladder wall (2.5%) In 4 of the 25 patients, endometriosis was found on the rectal wall (10%) In 2 of the 40 patients, endometriosis was seen as ileal implants (5%).In 2 of the 40 patients, endometriosis was seen as peritoneal implants (5%). (Table 2).

Table 2: Infiltration sites of cases diagnosed as endometriosis on MRI study.

		No.	**%**
Unilateral/bilateral endometriosis	Normal MRI	1	2.5%
	Unilateral (ovarian)	12	30.0%
	Bilateral (ovarian)	19	47.5%
	Ureteric implants	3	7.5%
	Anterior pelvic wall	2	5.0%
	Vaginal nodule	2	5.0%
	Urinary bladder implants	1	2.5%
	Rectal	4	10.0%
	Ileal implant	2	5.0%
	Peritoneal implant	2	5.0%

On MRI, 11 out of 40 cases (27.5%) showed relatively low signal intensity on T1WI, 29 out of 40 cases (72.5%) showed high signal intensity on T1WI.Fifteen out of 40 cases (37.5%) showed low signal intensity on T2WI, 10 out of 40 cases (25%) showed intermediate signal intensity on T2WI, and 15 out of 40 cases (37.5%) showed high signal intensity on T2WI. (Table3).

All cases were not suppressed on fat suppression sequences indicating a hemorrhagic nature.

Table 3: Pattern of MRIsignals of the studied endometriotic lesions.

MRI signal		No.	%
T1	Low	11	27.5%
	Intermediate	0	0.0%
	High	29	72.5%
T2	Low	15	37.5%
	Intermediate	10	25.0%
	High	15	37.5%

Table 4: Results of MRI examination compared to histopathology.

True positive 32	False positive 3	Diagnosed positive= 35
False negative 1	True negative 4	Diagnosed negative= 5
33	7	Total = 40

The Sensitivity, Specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of MRI in diagnosing endometriosis were calculated and illustrated in the following table.

Table 5: Sensitivity, Specificity, PPV, NPV and accuracy of MRI.

Parameter	Accuracy	Sensitivity	Specificity	PPV	NPV
MRI	90.0	97.0	57.1	91.4	80.0

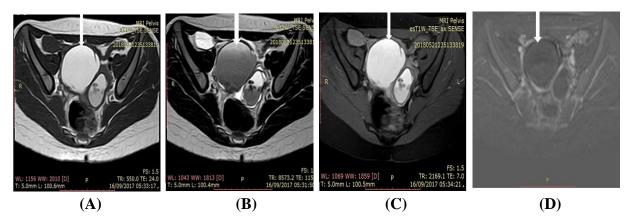**(A)**   **(B)**   **(C)**   **(D)**

Figure 1: A 24-year-old virgin presented with chronic pelvic pain and dysmenorrhea. Trans-abdominal US revealed a right complex adnexal cyst with low level internal echoes.**(A)** Axial T1WI shows a large right adnexal cystic lesion, It exhibits high signal intensity on T1WI.**(B)** Axial T2WI shows intermediate signal intensity of the lesion (T2 shading). **(C)** Axial T1WI with fat suppression shows high signal intensity of the lesion, indicating a hemorrhagic component. Another cystic lesion is seen in the left ovary, it shows blood/fluid level and few floating dark signal lesions on all pulse sequences (dark spots) denoting old blood content.**(D)** Axial Post-Contrast T1-Weighted subtracted image shows peripheral rim of enhancement of both lesions. Histopathological examination after laparoscopic right ovarian cystectomy revealed a right ovarian endometrioma.

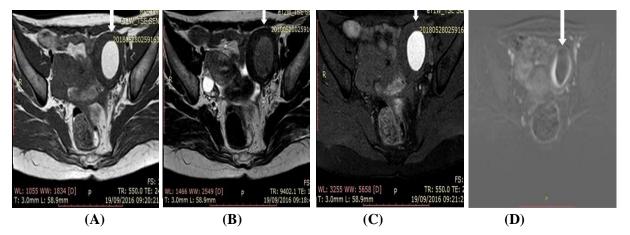**(A)**   **(B)**   **(C)**   **(D)**

Figure 2: A 35-year-oldmultiparous female patient presented with a 5 year history of chronic left sided pelvic pain. A TVUS was performed showing a left side dunilocular adnexal cyst with turbid content. (A)Axial T1WI shows a left ovarian cystic lesion with markedly thickened wall, with high signal intensity. (B) Axial T2WI shows intermediate signal intensity of the lesion (T2 shading). (C) Axial T1WI with fat suppression shows high signal intensity of the lesion, denoting the presence of hemorrhagic content. D. Axial Post-Contrast T1-Weighted subtracted image shows peripheral rim enhancement of the lesions. Laparoscopy revealed left non communicating rudimentary horn.

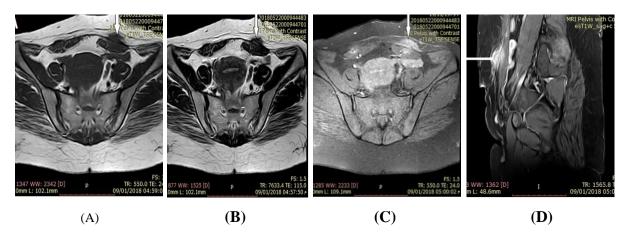(A)   **(B)**   **(C)**   **(D)**

Figure 3: A 39-year-oldmultiparous female patient who underwent a Caesarean section 5 years before presented with a palpable mass and pain at the site of Caesarean section scar. She stated that the pain is cyclic and the mass increases in size with menstruation. Ultrasound of the mass revealed a subcutaneous irregular heterogeneous hypoechoic lesion in the lower left quadrant in the left rectus abdominus muscle (at the site of the Caesarean section scar).**(A)**Axial T1WI shows an irregular anterior pelvic wall lesion with low signal intensity, it is seen overlying and partially inseparable from the left rectus abdominus muscle.**(B)**Axial T2WI show slow signal intensity of the lesion. **(C)** Axial T1WI with fat suppression shows high signal intensity of the lesion, indicating a hemorrhagic component. (D) Sagittal Fat Suppressed Contrast-Enhanced T1WI shows heterogeneous enhancement of the lesion. The mass was completely excised. Pathologic evaluation confirmed surgical scar endometriosis, secondary to the caesarian section.

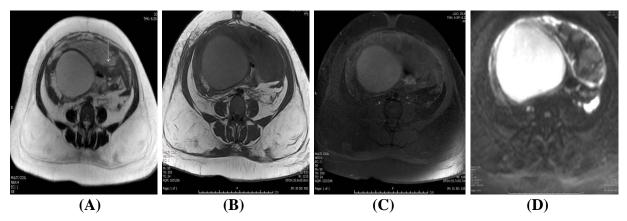**(A)**   **(B)**   **(C)**   **(D)**

Figure 4: A 38 year old female patient presented with infertility. Ultrasound examination revealed bilateral adnexal masses with low level internal echoes.(A) Axial T2W MR image showing a right sided ovarian endometrioma with endometriotic implants on the ileal loops and pareital peritoneum. (arrow). (B) Axial T1WI showing high signal in ovarian cyst and ileal and peritoneal implants. (C) Axial T1 fat suppressed image showing more apparent increased signal on T1. (D) Diffusion weighted image showing marked diffusion restriction in the ileal and peritoneal implants denoting hemorrhagic content.

DISCUSSION:

Endometriosis is defined as the presence of functional endometrial glands and stroma outside of the uterine cavityusually as implants in the ovaries and pelvic peritoneum[1].

The main clinical presentation of endometriosis is chronic pelvic pain and infertility[1].

Laparoscopy is the gold standard for the diagnosis of endometriosis and the definitive diagnosis of endometriosis is based on the histological confirmation of presence of endometrial glands and stroma outside of the endometrial cavity[4].

Radiologists are often involved in the diagnosis and work-up of endometriosis in one of two cases: They are asked to exclude endometriosis in a woman with chronic pelvic pain or infertility or they are considering endometriosis in the differential diagnosis of an indeterminate adnexal mass [8].

Ultrasound is preferred for the initial assessment of both endometriomas and deep pelvic endometriosis, due to its availability and decreased cost, but MRI is increasingly being used, especially when sonographic findings are unclear, when deep pelvic endometriosis is suspected or when surgery is indicated, as it provides better contrast resolution, multiplanar capabilities and a large field of view compared to ultrasound[9].

Jill et al.[10] reported that endometriosis, almost exclusively affects women during their reproductive years. It accounts for 20% of infertile females. In our study, the age group of women was between 22 and 48 years and 9 out of 40 patients (22.5%) were presented with infertility.

In our study, the ovarian involvement of 31 patients out of 40 (77.5%) was remarkably higher than ***Kruger et al.***[11] who reported ovarian involvement in 80 of 152 patients (52.6%).

In our patient population, anterior abdominal wall endometriotic implants were detected in 2 out of 40 patients (5%) which was slightly higher than ***Kruger et al.***[11] who reported abdominal wall involvement in 4 of 152 patients (2.6%).

In our study, deep invasive endometriotic implants were detected in 16 out of 40 patients (40%) which was in concordance

with *Zanardi et al.*[12] who reported detection of deep implants in 20 out of 44 patients (45.5%).

In our study, 11 out of 40 cases (27.5%) showed relatively low signal intensity on T1WI, 29 out of 40 cases (72.5%) showed high signal intensity on T1WI. Fifteen out of 40 cases (37.5%) showed low signal intensity on T2WI, 10 out of 40 cases (25%) showed intermediate signal intensity on T2WI, and 15 out of 40 cases (37.5%) showed high signal intensity on T2WI. This agreed with the study by *Imaoka et al.*[13] which concluded that The diagnostic MRI findings for ovarian endometriomas were (a) adnexal cysts of high signal intensity on both T1- and T2-weighted images or (b) high signal intensity on T1-weighted images and intermediate or low signal intensity on T2-weighted images (shading) the dense concentration of cyclic hemorrhage and the high viscosity of the contents in the endometrioma cause T2 shortening and produce shading.

Our main differential diagnosis with endometriomas was dermoid cysts. On MRI they show high signal on T1, yet the distinguishing feature is the signal dropout on fat suppressed images, compared to endometrioma that retains its high signal on T1 fat suppressed images. This was in keeping with *Iyer and Lee*[14], who stated that endometriomas don't suppress on fat suppression, unlike a dermoid which has signal dropout on fat suppressed images.

This also agreed with the study by ***Imaoka et al.***[13] who reported that T1-weighted sequences with fat suppression better demonstrate the increased signal of hemorrhagic lesions relative to the fatty tissue.

In our study the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of MRI in diagnosing endometriosis were 97%, 57.14%, 91.4%, 80%, and 90% respectively.

Except for our remarkably lower specificity, these results are consistent with the study by *Choudharyet al.*[15] who reported that MRI yielded an overall sensitivity, specificity, and accuracy of 90%, 98%, and 96%, respectively, for diagnosing endometriomas and in differentiating them from other gynecological masses.

Conclusion:

Ultrasound should be the primary imaging modality used in women with pelvic symptoms. It is sufficient to characterize most endometriotic cysts, however if there are atypical ultrasound or clinical features, MRI will be the best problem-solving tool. MRI is useful in indeterminate adnexal findings on sonography, when deep invasive endometriosis is suspected, or for presurgical planning.

REFERENCES:

1. Bulun S (2009): Endometriosis.The New England Journal Of Medicine, 360(3): 268-279.

2. Meuleman C, Vandenabeele B, Fieuws S et al. (2009):High prevalence of endometriosis in infertile women with normal ovulation and normo-spermicpartners. Fertility and Sterility, 92(1):68-74.

3. Chapron C, DubuissonJ,Pansini V et al. (2002): Routine clinical examination is not suffcient for diagnosing and locating deeply infiltrating endometriosis. The Journal of the American Association of Gynecologic Laparoscopists, 9(2):115-119.

4. Clement P (2007): The pathology of endometriosis: A survey of the many faces of a common disease emphasizing diagnostic pitfalls and unusual and newly appreciated aspects. Advances in Anatomic Pathology,14(4):241-60.

5. Bazot M, Bharwani N, Huchon C et al. (2016): European society of urogenital radiology (ESUR) guidelines: MR imaging of pelvic endometriosis. European Radiology, 27(7):2765-2775.

6. Coutinho A, Bittencourt L, Pires C et al. (2011): MR imaging in deep pelvic endometriosis: A pictorial essay. Radiographics, 31:549-567.

7. Bazot M, Darai E, Hourani R et al. (2004): Deep pelvic endometriosis: MR imaging for diagnosis and prediction of extension of disease. Radiology, 232(2):379-389.

8. Woodward P, Sohaey R and Mezzetti T (2001): Endometriosis: Radiologic-Pathologic Correlation. RadioGraphics, 21(1):193-216.

9. Bourgioti C, Preza O, Panourgias E et al. (2017): MR imaging of endometriosis: Spectrum of disease. Diagnostic and interventional imaging, 98(11):751-767.

10. Jill A, Courtney A, Lazarus E et al. (2009): Female infertility: a systematic approach to radiologic imaging and diagnosis. Radiographics, 29 (5):1353-1370.

11. Krüger K, Behrendt K, Niedobitek-Kreuter G et al. (2013): Location-dependent value of pelvic MRI in the preoperative diagnosis of endometriosis. European Journal of Obstetrics & Gynecology and Reproductive Biology, 169(1): 93-98.

12. Zanardi R, Del Frate C, Zuiani C et al.:Staging of pelvic endometriosis based on MRI findings versus laparoscopic classification according to the American Fertility Society. Abdominal imaging, 28(5):733-742.

13. Imaoka I, Wada A, Matsuo M et al. (2003):MR imaging of disorders associated with female infertility: use in diagnosis, treatment, and management. Radiographics, 23(6): 1401-1421.

14. IyerVand Lee S (2010): MRI, CT, and PET/CT for ovarian cancer detection and adnexal lesion characterization. American Journal of Roentgenology, 194(2): 311-321.

15. Choudhary S, Fasih N, Papadatos D et al. (2009): Unusual imaging appearances of endometriosis. American Journal of Roentgenology, 192(6): 1632-1644.

دور التصوير بالرنين المغناطيسي في تشخيص التهاب بطانة الرحم

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المقدمة: يشير بطانة الرحم إلى وجود غدد بطانة الرحم الوظيفية خارج تجويف الرحم. على الرغم من أن تنظير البطن هو المعيار الذهبي لتشخيص بطانة الرحم ، إلا أن التحديد الموثوق للمرض قبل تنظير البطن سيكون ذا قيمة لأخصائي أمراض النساء في اختيار النهج العلاجي المفضل ، الطبي أو الجراحي. الموجات فوق الصوتية هي التحقيق الأولي الذي تم إجراؤه ، لكن التصوير بالرنين المغناطيسي يستخدم بشكل متزايد، لاسيما عندما تكون الإشعاعات فوق الصوتية غير حاسمة ، أو عندما يكون هناك التهاب بطانة الرحم الحوض العميق أو عند الإشارة إلى الجراحة.

الهدف من البحث:هدفت هذه الدراسة إلى تقييم دقة التصوير بالرنين المغناطيسي في تشخيص بطانة الرحم.

المرضى والطرق والحالات: خضع ٤٠ مريضا قبل انقطاع الطمث مع الشك السريري و / أو التصوير فوق الصوتي من بطانة الرحم التصوير بالرنين المغناطيسي الحوض. وتمت مقارنة جميع نتائج التصوير الخاصة بنا أخيرًا ببيانات تنظير البطن مع التحقق من التشريح المرضي كمعيار ذهبي. تم حساب المعلمات النتيجة الرئيسية، والحساسية والنوعية والقيمة التنبؤية الإيجابية (PPV) ، القيمة التنبؤية السلبية (NPV) ودقة التصوير بالرنين المغناطيسي في تشخيص بطانة الرحم.

النتائج: الحساسية ، والنوعية ، والقيمة التنبؤية الإيجابية (PPV)، القيمة التنبؤية السلبية (NPV) ودقة التصوير بالرنين المغناطيسي في تشخيص بطانة الرحم كانت ٩٥,٦٥ ٪ ، ٥٧,١٤ ٪ ، ٨٨ ٪ ، ٨٠ ٪ ، ٨٦,٧ ٪ على التوالي.

الخاتمة:التصوير بالرنين المغناطيسى هو أفضل أداة لحل المشكلات في حالات تحديد الغدد التناسلية غير المحدد على التصوير فوق الصوتي ، عندما يكون عميقا في بطانة الرحم يشتبه ، أو لرسم الخرائط قبل الجراحة.