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Original article

Transvaginal Ultrasound vsMagnetic Resonance Imaging Optimum Modality for the Diagnosis of Endometriosis and Adenomyosis Phenotype

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Abstract

Background: Endometriosis is a chronic, painful gynecological disorder that results in pain of the pelvis and infertility. **Aim:** To compare transvaginal ultrasound to MRI optimum modality for diagnosis of adenomyosis and endometriosis phenotype. **Patients and methods:** This research was Prospective observational research has been performed on 60 subjects in the Radiology clinics of Benha University Hospitals. Cases have been separated into 2 groups: Group A: 30 Cases with endometriosis and Group B: 30 cases with adenomyosis. **Results:** TVS and MRI have different sensitivity and specificity in diagnosing adenomyosis. TVS has a sensitivity of 72.5% and specificity of 92.5%, whereas MRI has a sensitivity of 85% and specificity of 72.5%. TVS is better in diagnosing endometriosis, with a sensitivity of 72.5% and a specificity of 80%. Magnetic resonance imaging, on the other hand, has a sensitivity of 77.5% and a specificity of 87.5%, with a PPV of 78.4% and NPV of 74.4%. MRI is better in diagnosing adenomyosis than endometriosis. **Conclusion:** Elevated accuracy for MRI both and TVUS in diagnosing adenomyosis and endometriosis. TVUS is cost-effective, widely accessible, and likely the first imaging modality. Further research is needed to evaluate other ultrasound modalities, elastography, and 3D TVUS, and adopt standardized reporting guidelines.

Key words: Magnetic resonance imaging, Transvaginal ultrasound, Diagnosis, Endometriosis

Introduction

Endometriosis is a chronic gynecological disorder that results in pain in the pelvis and infertility. Despite being a benign condition, it remains a significant economic, social, and medical problem due to its chronic nature and associated symptoms. Endometriosis was associated with more severe results during gestation, including preterm delivery, placental conditions and preeclampsia [(1)].

Endometriosis is an estrogen-dependent condition marked by existence of ectopic tissue (stroma and endometrial glandular cells) outside uterus. In terms of its functional characteristics, the ectopic endometrium is comparable to eutopic endometrium. Approximately 10% of females of childbearing age are adversely impacted by this disorder [(2)].

Diagnostic imaging is crucial for confirming endometriosis, because clinical and physical examinations have little value. Various minimally invasive methods have been established for detecting endometriosis, like transrectal ultrasound, magnetic resonance imaging (MRI), transvaginal ultrasound (TVUS) transabdominal ultrasound, and, less frequently, computed tomography (CT) and positron emission tomography (PET) [(3)].

Both MRI and transvaginal ultrasound are commonly used imaging modalities for diagnosing endometriosis and adenomyosis. However, the choice between them depends on various factors, including the clinical presentation, availability of equipment, expertise of the operator, and patient preferences [(4)].

This study aimed to compare transvaginal ultrasound to magnetic resonance imaging optimum modality for diagnosing endometriosis and adenomyosis phenotype.

Patients and methods

This research was Prospective observational research has been performed on 60 subjects in the Radiology clinics of Benha University Hospitals from April 2024 to April 2025. **Cease have been separated into 2 groups: Group A:** 30 cases with endometriosis and **Group B:** 30 cases with adenomyosis. The ethical committee approval code (MS 26-8-2024).

Sample size

This investigation is based on research conducted by [(5)], utilizing Epi Info STATCALC to determine the size of the sample under the following assumptions: - A two-sided confidence level of ninety-five percent accompanied with a power of eighty percent. An error of five percent in the estimated odds ratio is 1.115. The final maximum sample size obtained from the Epi-Info output was fifty-three. Consequently, the sample size has been elevated to sixty cases to account for potential dropout cases throughout monitoring. (Statistical Package for the

Social Sciences; SPSS Inc., Chicago, IL, united states of America) version 7.

Inclusion criteria: Aged 18-45 years, women presenting with symptoms suggestive of endometriosis (diagnosed by clinical characteristics that indicate the existence of endometriosis, as symptoms like dyspareunia or dysmenorrhea, in addition to results from examinations of the vagina that suggest the existence of a tender enlarged adnexal mass or uterosacral ligament or palpable tender retrocervical nodules) and women with adenomyosis.

Exclusion criteria: Pregnancy, Patients with active pelvic inflammatory disease, Patients with a known allergy to contrast agents used in MRI or those with renal impairment and Patients with contraindications to MRI, such as those with metallic implants, severe claustrophobia, or inability to lie still for an extended period.

Methods

All cases have been exposed to the following:

Complete history taking: Personal history, complaint & its duration, Current history, history of sensitivity to medications, Previous Surgical history and Previous Medical history, **Physical examinations:** Local examination and General examination, **abdominal Examination:** inspection of the abdomen, palpation of the abdomen: deep abdominal palpation, Light abdominal palpation, abdominal auscultation and abdominal percussion and listen for bruits and **Investigational Studies:** Routine laboratory investigations and radiological investigation.

Transvaginal ultrasound (TVUS)

All cases had transvaginal ultrasound examinations performed by a gynecologist utilizing a 7.5-megahertz vaginal probe (Voluson E8 Expert, GE Healthcare). Evaluations were conducted on non-menstrual days with a partially filled bladder, following IDEA group guidelines. The evaluation started with the central compartment, encompassing the ovaries and uterus, to detect adenomyosis or endometriomas. The posterior and anterior compartments were subsequently evaluated for endometriosis nodules, while adnexal mobility and the "sliding sign" have been assessed. Transvaginal ultrasound identifies endometrial implants and adhesions by detecting alterations in organ density and shape, with anomalies like cysts, nodules, hypoechoic solid lesions, or peritoneal thickening indicating the existence of deep infiltrating endometriosis (DIE).

Magnetic Resonance Imaging

Magnetic Resonance Imaging is frequently utilized after Transvaginal Ultrasound for accurate anatomical evaluation of the pelvic organs, providing the utmost accuracy in identifying deep infiltrating endometriosis. To improve visualization, 40 mcm^3 of lubricating gel has been introduced into the vagina and rectum, enhancing the visibility of pelvic walls and endometriosis nodules

for more accurate assessment of infiltration. Imaging comprised axial, coronal, and sagittal T1- and T2-weighted sequences, as well as T1 axial and sagittal fat saturation methods, executed with & without contrast to precisely illustrate anatomical structures and pathological characteristics.

Outcome Measurements and Follow-up

We were compared the findings of both techniques in both groups and detect the optimum modality for diagnosing adenomyosis and endometriosis phenotypes.

Ethical Consideration

The data acquired from participants are confidential. The names of the participants in the investigation weren't mentioned in any of the reports or publications that were related to this research. Prior to the participants' admission to the research, the research's aim, nature, and risk-benefit evaluation had been explained to them. Informed consent has been acquired.

Statistical Analysis

All statistical analyses were conducted utilizing Microsoft Excel version 7 (Microsoft Corporation, NY, the United States of America) and SPSS for Windows. SPSS (Statistical Package for the Social Sciences; SPSS Inc., Chicago, IL, united states of America)

Descriptive statistics: Standard deviation (± SD), Mean, percentage and frequency of non-numerical data, paired T-test, student T Test. To compare categorical data, the Chi-square ($\chi 2$) test has been conducted, utilizing the likelihood ratio, Fisher's exact test, continuity correction, and linear by linear association-value: degree of significance; p-value above 0.05: Non-significant (NS); P-value below 0.05: Significant (S); P-value below 0.01: Highly significant (HS).

Results

According to general characteristics, the mean age was 33.58 with SD 7.7. mean of BMI was 28.2 with SD 3.21. **(Table 1)**

TVS had sensitivity of 72.5% and specificity of 92.5% with highly significance. Magnetic resonance imaging had sensitivity of 85% and specificity of 72.5% with high significance in diagnosis of Endometriosis. TVS was better than MRI in diagnosis of Endometriosis. **(Table 2)**

Transvaginal sonography had sensitivity of 72.5% and specificity of 80%, PPV was 78.4%, NPV was 74.4% and accuracy of 76.3% in detecting adenomyosis. **(Table 3)**

According to this table, magnetic resonance imaging had sensitivity of 77.5% and specificity of 87.5%, PPV was 86%, NPV was 79.5% and accuracy of 82.5% in detecting adenomyosis**. (Table 4)**

TVS had sensitivity of 72.5% and specificity of 80% with high significance. Magnetic resonance imaging had sensitivity of ٧٧.٥% and specificity of ٨٧.٥% with high significance in diagnosis of Endometriosis. MRI was better than TVS in diagnosis of Uterine adenomyosis. **(Table 5)**

According to comparison between accuracy of TVS in detecting adenomyosis and endometriosis, TVS is better detecting endometriosis than adenomyosis. And according to comparison between accuracy of MRI in detecting adenomyosis and endometriosis, MRI is better in diagnosis of adenomyosis than Endometriosis. **(Table 6)**

A) Shows Ultrasound (TVUS) examination of Endometriosis and B) Shows MRI examination of Endometriosis. **Figure 1**

A) Shows Ultrasound (TVUS) examination of Adenomyosis and B) MRI examination of Adenomyosis. **Figure 2**

Table (1): Distribution of general characteristics and specimen among the examined patients.

	Studied patients N=80	
	mean	±SD
Age	33.58	7.7
BMI	28.2	3.21

SD: standard deviation.

Table (2): ROC analysis for TVS and MRI in diagnosis of Endometriosis.

Test Result Variable(s)	**Area**	**Sensitivity**	**Specificity**	**Std. Error**	**Asymptotic Sig.**	**Asymptotic 95% Confidence Interval**	
						Lower Bound	Upper Bound
TVS	0.825	72.5%	92.5%	0.049	0.001	0.728	0.922
MRI	0.788	85%	72.5%	0.053	0.001	0.683	0.892

NPV: Negative Predictive Value; PPV: Positive Predictive Value

Table (3): Cross tabs of TVS in diagnosis of adenomyosis among the studied patients.

	Uterine adenomyosis	
TVS	Positive	Negative
Positive	22	6
Negative	8	24
Sensitivity	72.5%	
Specificity	80%	
PPV	78.4%	
NPV	74.4%	
Accuracy	76.3%	

Table (4): Cross tabs of MRI in diagnosis of adenomyosis between the studied patients.

MRI	Uterine adenomyosis	
	Positive	Negative
Positive	23	4
Negative	7	26
Sensitivity	77.5%	
Specificity	87.5%	
PPV	86%	
NPV	79.5%	
Accuracy	82.5%	

Table (5): ROC analysis for TVS and MRI in diagnosis of Uterine adenomyosis**.**

Test Result Variable(s)	Area	Sensitivity	Specificity	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
						Lower Bound	Upper Bound
TVS	0.763	72.5%	80%	0.055	0.001	0.654	0.871
MRI	0.825	77.5%	87.5%	0.049	0.001	0.728	0.922

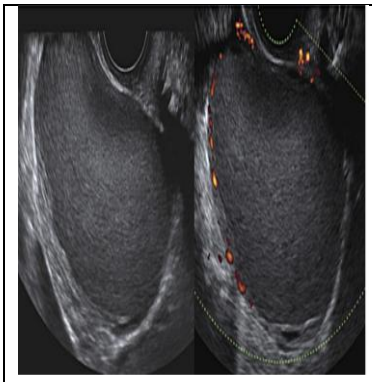
Table (6): Comparison between accuracy of TVS in diagnosis of adenomyosis and Endometriosis. & Comparison between accuracy of MRI in detecting endometriosis and adenomyosis

Test Result Variable(s)	Area	Sensitivity	Specificity	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
						Lower Bound	Upper Bound
Endometriosis	0.825	72.5%	92.5%	0.049	0.001	0.728	0.922
adenomyosis	0.763	72.5%	80%	0.055	0.001	0.654	0.871

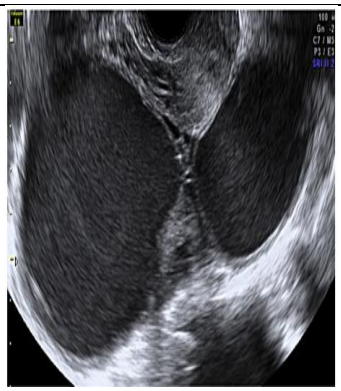
Comparison between accuracy of MRI in detecting endometriosis and adenomyosis

Test Result Variable(s)	Area	Sensitivity	Specificity	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
						Lower Bound	Upper Bound
Endometriosis	0.788	85%	72.5%	0.053	0.001	0.683	0.892
adenomyosis	0.825	77.5%	87.5%	0.049	0.001	0.728	0.922

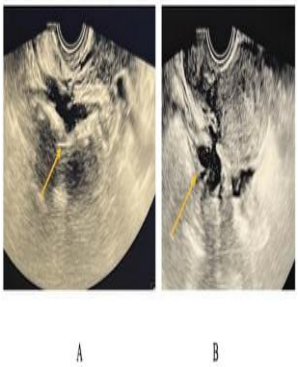
Cases



A1. Ultrasound typically shows an ovarian endometrioma as a unilocular cyst with a ground-glass appearance and mild to moderate vascularity, with normal ovarian tissue visible around it.

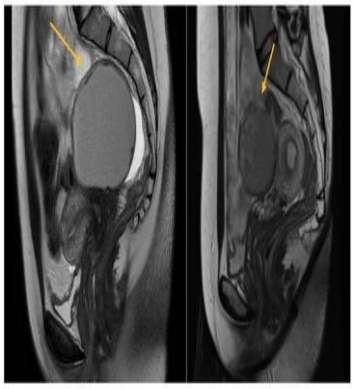


A2. Bilateral endometriomas on ultrasound appear as both ovaries adherent to each other ("kissing ovaries") and to the posterior aspect of the uterus.



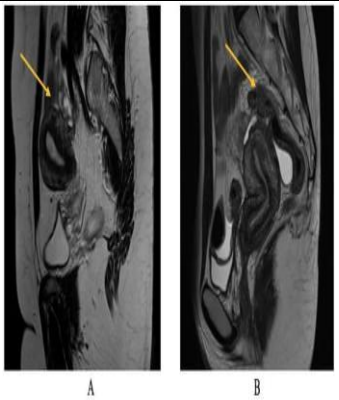
A B

A3. Transvaginal ultrasound (TVS) shows (A) a rectal endometriosis lesion and (B) the same lesion adherent to an endometriotic lesion on the uterine torus.



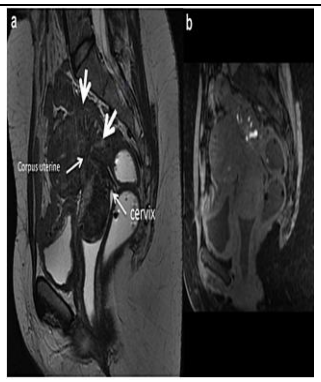
(a) (b)

B1. On sagittal T2-weighted MRI, (a) a left-sided endometrioma is seen with the ovary firmly attached to the back of the uterus, while (b) a separate endometrioma is visible on the right ovary.



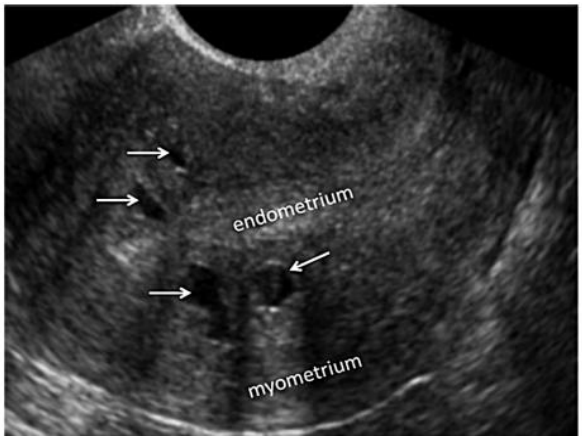
A B

B2. Sagittal T2-weight MRI images demonstrate (A, B) a rectosigmoid endometriotic nodule that is tethered to the uterine fundus via an underlying adenomyotic lesion.

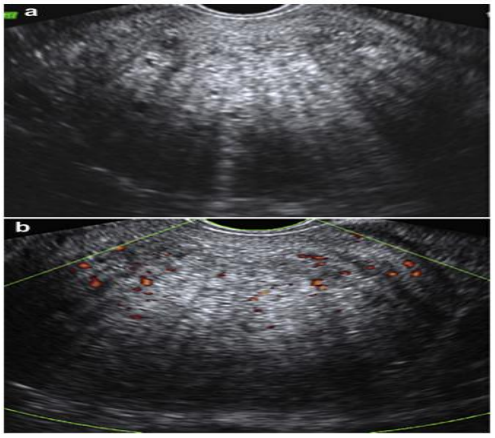


B3. MRI assessment of bowel endometriosis shows (a) on sagittal T2-weighted imaging, complete loss of the posterior cul-de-sac and irregular thickening of the lower sigmoid colon wall due to a deeply infiltrating endometriotic lesion that also involves the posterior uterine wall, resulting in adhesion between the colon and uterus; and (b) on sagittal T1-weighted fat-saturated imaging, the same lesion appears with bright foci, suggestive of methaemoglobin deposits typical of endometriotic tissue.

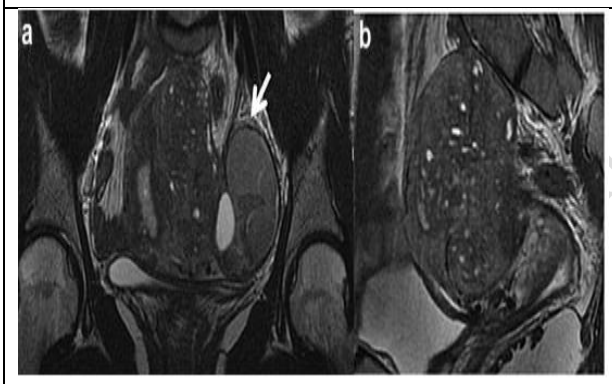
Figure (1): A) Shows Ultrasound (TVUS) examination of Endometriosis and B) Shows MRI examination of Endometriosis.



A1. Sonographic view of adenomyosis shows multiple small, round, fluid-filled spaces (arrows) located within the inner muscle layer of the uterus, directly beneath the endometrial lining in the junctional zone.



A2. Transverse ultrasound images of the uterus affected by adenomyosis show: (a) grayscale imaging with an uneven and patchy appearance of the myometrium, including bright foci and radial streaks; (b) color Doppler revealing widespread distribution of fine-caliber blood vessels within the uterine wall.



B1. T2-weighted MRI scans illustrate the typical features of adenomyosis as follows: (a) coronal view and (b) sagittal view both demonstrate ill-defined regions of low signal intensity, along with scattered bright spots suggesting the presence of displaced endometrial glands or small cysts; additionally, a dilated fallopian tube containing dark fluid—likely representing blood—is noted on the left (white arrow).of blood (white arrow).

B2. On sagittal T2-weighted MRI, superficial internal adenomyosis is shown as numerous tiny cystic areas located just under the endometrial surface, symmetrically affecting both the anterior and posterior uterine walls, without any thickening of the junctional zone.

Figure (2): A) Shows Ultrasound (TVUS) examination of Adenomyosis and B) MRI examination of Adenomyosis

Discussion

Endometriosis is a chronic, painful gynecological disorder that leads to pain in the pelvis and infertility. Despite being in a benign condition, it remains a significant economic, social, & medical problem due to its chronic nature and associated symptoms. Endometriosis has been associated with more severe outcomes during gestation, including preterm delivery, placental conditions and preeclampsia [(6)].

Our results showed that the mean age was 33.58 with SD 7.7. mean of BMI was 28.2 with SD 3.21. Our results showed that TVS had sensitivity of 72.5% and specificity of 92.5%, PPV was 90.6%, NPV was 77% and accuracy of 82.5% in detecting Endometriosis.

Menakaya and co-authors [(7)] found that the sliding sign was more effectively identified in retrocervix region compared to posterior upper uterine fundus. They additionally determined that the cut-off of two hundred conducted TVS enhances the diagnosis of endometriosis nodules. Operators with expertise in 2500 scans get proficiency in executing the sliding sign method and identifying obliteration of the pouch of Douglas. Except for rectovaginal septum (RVS) DE, TVS is an accurate & dependable technique for the non-invasive detection of DE.

Our results showed that magnetic resonance imaging had sensitivity of 72.5% and specificity of 75.5%, PPV was 75.5%, NPV was 82.8% and accuracy of 78.8% in detecting Endometriosis.

Our results showed that TVS had sensitivity of 72.5% and specificity of 92.5% with high significance. Magnetic resonance imaging had sensitivity of 85% and specificity of 72.5% with high significance in diagnosis of Endometriosis. TVS was better than MRI in diagnosis of Endometriosis.

Our findings align with those of **Hernández and co-authors** [(8)]**,** who reported that TVU exhibited elevated accuracy compared to magnetic resonance imaging for recto-vaginal (seventy-seven percent versus sixty-nine percent) and vaginal (ninety-four percent versus eighty-nine percent) endometriosis. The MRI demonstrated elevate accuracy (ninety-six percent) compared to TVU (ninety-two percent) for diagnosing bladder endometriosis.

Zhang and co-authors [(9)] conducted research on the diagnostic accuracy of endometriosis, demonstrating that magnetic resonance imaging and TVS have an elevated diagnostic efficacy in assessing DE. The diagnostic accuracy of transvaginal sonography has been assessed in twenty-one investigations, with a sensitivity of seventy-six percent and a specificity of ninety-four (ninety-five percent CI, eighty-eight to ninety-seven percent). The diagnostic accuracy of MRI has been assessed in thirteen studies, with a sensitivity of

eighty-two percent (ninety-five percent CI, seventy to ninety percent) and a specificity of eighty-seven percent (ninety-five percent CI, seventy-eight to ninety-two percent).

endometrioses are as follows: 88.2 percent and 71 percent for transvaginal sonography; 87.5 percent & 71 percent for magnetic resonance imaging.

Concerning the diagnostic accuracy of TVS and magnetic resonance imaging in identifying ovarian endometriomas, the two techniques exhibited comparable sensitivity and specificity. TVS demonstrated a sensitivity ranging from 70.86 percent to 96 percent and a specificity between 71 percent and 96 percent. In contrast, magnetic resonance imaging showed a sensitivity of 63.5 percent to 92.6 percent and a specificity of 71 percent to 93.9 percent **(10).**

About **Alborzi and co-authors (11),** the specificity and sensitivity for ovarian endometriosis are 92.77 percent and 70.86 percent for TVS, and 63.58 percent and 93.98 percent for magnetic resonance imaging.

Concerning the diagnostic accuracy of transvaginal sonography and magnetic resonance imaging in identifying ovarian endometriomas, the two techniques exhibited comparable sensitivity and specificity. TVS demonstrated a sensitivity ranging from 70.86 percent to 96 percent and a specificity between 71 percent and 96 percent. In contrast, MRI showed a sensitivity of 63.5 percent to 92.6 percent and a specificity from 71 percent to 93.9 percent **(12).**

Our results showed that TVS had sensitivity of 77.5% and specificity of 87.5%, PPV was 86%, NPV was 79.5% and accuracy of 82.5% in detecting adenomyosis.

Numerous ultrasonographic criteria have been used for diagnosing adenomyosis, encompassing asymmetry in posterior and anterior uterine wall thickness, uterine enlargement, the existence of heterogeneous myometrial regions, identification of anechoic areas within the myometrium (termed myometrial cysts), sub-endometrial echogenic nodules, the existence of echogenic striations in the sub-endometrium, an irregular endometrial–myometrial interface, and poor definition along with thickening of the JZ**(13).**

Our results showed that magnetic resonance imaging had sensitivity of 77.5% and specificity of 87.5%, PPV was 86%, NPV was 79.5% and accuracy of 82.5% in detecting adenomyosis.

Our results showed that TVS had sensitivity of 72.5% and specificity of 80% with high significance. Magnetic resonance imaging had sensitivity of 77.5% and specificity of 87.5% with high significance in diagnosis of Uterine adenomyosis. MRI was better compared to TVS in diagnosis of Uterine adenomyosis.

Our findings agree with those of **Alborzi and co-authors (14),** who reported that the accuracy of ultrasound in diagnosing adenomyosis was 72.1 percent, with a sensitivity of 77.6 percent & a specificity of 40.0

percent. The diagnostic accuracy, sensitivity, and specificity of magnetic resonance imaging for adenomyosis in this group were 49.2 percent, 41.5 percent, and 90.0 percent, correspondingly.

Our results showed that according to comparison between accuracy of TVS in detecting adenomyosis and Endometriosis, TVS is better in diagnosis of Endometriosis than adenomyosis.

TVS is more effective for the diagnosis of endometriosis cysts, but magnetic resonance imaging is preferable for identifying torus, uterosacral ligaments, and bladder and intestinal DE lesions **(15).**

Our results showed that comparison between accuracy of MRI in diagnosis of adenomyosis and Endometriosis, MRI is better in diagnosis of adenomyosis than Endometriosis.

Our findings align with those of **Alborzi and co-authors (14),** who determined that transvaginal sonography is a reliable 1st-line diagnostic method for adenomyosis, but magnetic resonance imaging exhibited more specificity compared to TVS. A significant correlation exists between endometriosis and adenomyosis, particularly the diffuse type. The association has been evaluated based on the degree of endometriosis. However, we identified an insignificant correlation between the existence of OMA, uterosacral ligaments deep infiltrating endometriosis (US DIE), rectocervical deep infiltrating endometriosis (RC DIE), & the absence or existence of adenomyosis and its subtypes (P-value more than 0.05). Therefore, the hypothesis that posterior compartment endometriosis lesions invading uterus and resulting in adenomyosis will be deemed weak.

Conclusion

Both MRI and transvaginal ultrasound exhibit high accuracy in the diagnosis of adenomyosis and endometriosis. Transvaginal ultrasound is a cost-effective, broadly accessible, and probably the first imaging modality. Additional research is required to assess other ultrasound modalities, elastography, and 3D TVUS, and adopt standardized reporting guidelines.

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