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3D Ultrasonography Compared with Magnetic Resonance Imaging for the Diagnosis of Adenomyosis

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Abstract

Background: A frequent benign gynecological condition known as adenomyosis affects premenopausal women and is characterized by increasing endometrial expansion and invasion of the myometrium underneath.

Aim and objectives: To contrast diagnostic accuracy of histopathology and 3D transvaginal ultrasound in detecting adenomyosis.

Patients and techniques: The research was conducted from September 2020 to September 2022 at El Hussein Maternity Hospital and Tukh Central Hospital. A cross-sectional study was conducted on 100 patients, who had been recruited from females presenting to the outpatient clinic at El Hussein Maternity Hospital and Tukh Central Hospital and planned to undergo hysterectomy for adenomyosis based on inclusion/exclusion criteria.

Result: There.

Conclusion: Our research’s findings showed that as a preoperative diagnostic tool, 3D transvaginal ultrasonography is as accurate as MRI in identifying adenomyosis and leiomyoma. It is advised to use 3D ultrasonography in routine clinical practice as it is more accessible, less expensive, less time-consuming, and an easier method, choosing appropriate course of action, and individually managing each studied case to attain best therapeutic rates.

Keywords: Adenomyosis, Magnetic resonance imaging, Ultrasonography

1. Introduction

Endometrial glands and stroma have been pathologically seen in the myometrium in adenomyosis, which is a benign condition of the uterus.1

Adenomyosis can cause abnormal uterine bleeding, dysmenorrhea, dyspareunia, and infertility in females; however one-third of these females show no symptoms at all.2 Adenomyosis has long been diagnosed histopathologically in perimenopausal females with heavy menstrual bleeding and pelvic pain following hysterectomy.3

Adenomyosis is recognized as a problem in young, fertile women over the past 10 years Pinzauti S et al.4 Despite the fact that common definition and categorization are still lacking, recent improvements in imaging methods have made this possible.5

Although diagnostic methods have improved, there is still lack of public knowledge of disorder. Adenomyosis may also occur with other gynecological disorders in some studied cases, including endometriosis and uterine fibroids.6

Nevertheless, a combination of transvaginal ultrasound and MRI offers greatest sensitivity for preoperative recognition of adenomyosis. Magnetic resonance imaging seems to be an accurate method in the preoperative diagnosis of adenomyosis.7 Sensitivity and specificity of MRI for identifying adenomyosis had been 77% and 89% in a review of 23 studies compared with 72% and 81% for...
ultrasonography. According to Champaneria R et al., the overall accuracy for the diagnosis of adenomyosis using 2D-TVS and 3D-TVS was 83% and 89%; sensitivity was 75% and 91%; specificity was 90% and 88%; and positive and negative predictive values were 86% and 85%. On sonograms, irregular, myometrial, cystic spaces that primarily affect posterior uterine wall, eccentric endometrial cavity, and reduced uterine echogenicity without lobulations, contour abnormality, and mass impacts are the most typical symptoms of adenomyosis.

The system of clinical histological classification that distinguishes between diffuse, localized, and cystic adenomyosis was put forth by Grimbizis et al. in 2014. More recently, based on MRI findings, Bazot and Dara defined three subtypes: internal, external, and adenomyomas. A further study is required to fully comprehend the physiopathology of adenomyosis, its onset and course, and interpretation of imaging findings in accordance with pathogenic theories; standardized classification system has not yet been created.

Transient uterine contractions, which may imitate either T2-weighted hypointense bands perpendicular to JZ and focal thickening of JZ, are another typical trap to be aware of. In some situations, repeating MRI acquisition process can be able to distinguish between an underlying physiological issue and adenomyosis.

The purpose of research was to assess the accuracy of histopathology and 3D transvaginal ultrasound and MRI in the diagnosis of adenomyosis.

2. Studied cases and techniques

This was a cross-sectional research which was carried out at El Hussein Maternity Hospital and Tokh Central Hospital throughout the duration from September 2020 to September 2022. In all, 100 patients had been recruited from females presenting to the outpatient clinic at El Hussein Maternity Hospital and Tokh Central Hospital, who had planned to undergo hysterectomy for adenomyosis based on inclusion/exclusion criteria.

2.1. Sample size justification

Meta-analysis described that sensitivity and specificity of sonography in the diagnosis of adenomyosis had been 82.5% and 84.6%. Sensitivity and specificity of MRI had been shown to be 77.8% and 92.5% according to the specificity of two methods, for paired comparing, the minimum required sample is 100 studied cases at an alpha level of 0.05 and power of 80%.

2.2. Inclusion criteria

Females aged from 40 to 55 years, bulky uterus, clinical symptoms: bleeding disorders, chronic pelvic pain, dysmenorrhea, and dyspareunia, and 2D ultrasonography suggestive of adenomyosis and junction zone.

2.3. Exclusion criteria

Postmenopausal women, pregnancy, endometrial carcinoma, ovarian tumor, history of minimally invasive treatment of menorrhagia and severe cardiac or renal impairment or hepatic impairment.

2.4. Intervention

Each and every studied case provided their signed informed permission. Every studied case received thorough medical and gynecologic history as well as pelvic examination.

All studied cases had been subjected to the following:

2.4.1. Consent

Research and processes had been explained to the studied cases before entering research, and consents had been obtained from studied cases.

2.4.2. History

Complete history taking with special emphasis on: Personal history containing years old, studied case menstrual history, containing date of last menstrual duration to exclude pregnancy, regularity and amount, number, and mode of deliveries, in addition to contraceptive history including the technique currently used, menopausal status, history of drug intake, particularly hormonal therapy and anticoagulant treatment, studied case’s complaint and attendance of vaginal bleeding and family history.

2.4.3. Examination

General examination containing heart examination with thrills or murmurs, pallor, vital indicators containing pulse, temperature, blood pressure, and limb clubbing. Abdominal examination containing ascites, attendance of scars of previous operation, and purpose of uterine fundal level. Local examination involving visual examination of external genitalia, pelvic, and bimanual digital examination, speculum examination, and, if needed, rectal examination to determine the size, position, and
movement of the uterus as well as any cervical or adnexal masses.

2.4.4. Investigation
Routine preoperative investigations were done. Findings of any previous investigation; namely D transvaginal ultrasound, hysteroscopy, hysterosalpingography, and endometrial biopsy had been received and data registered in the studied cases record. 3D Doppler ultrasonography, surgery, histological examination, and magnetic resonance imaging were carried out separately and without knowledge of conclusion reached by other researchers. The studied cases were giving their consent for hysterectomy once preoperative investigations had been finished, and uterine specimens underwent histological analysis.

2.4.5. 3D Doppler ultrasound examination
3D transvaginal ultrasonography examination had been done to all studied cases. 3D ultrasound was done with a 4D endocavity probe RI. 3D volumes were captured when the B-mode was finished. Mechanical transducer’s automatic 360-degree rotation produced volumes. The studied case was instructed to hold their breath while the probe was held constant, and the loudness mode was turned on. The acquired volume was shaped like a truncated cone, with a typical depth of 4.3–8.6 cm and an angle alpha of 90°. Acquisition duration was typically among 4 and 10 s when the medium line density was used. Three planes and their diameters were used to determine the relationship of any localized lesion to the myometrium. Uterine boundaries, uterine size, myometrial echotexture, and existence of related myomas are all examined sonographically throughout each examination (Figs. 1 and 2).

Hyperechoic zone around the endometrium in coronal view: Using VCI modality with 2–4 mm slices, it might be shown in all planes of multiplanar view. Distance between the basal endometrium and the internal layer of the outer myometrium was used to assess JZ thickness. This distance defined disruption and infiltration of the hyperechoic JZ by the hyperechoic endometrial tissue (Fig. 3).

2.4.6. Power Doppler indices
These indices measure vascularization (1) or blood flow (2) or both (3): vascularization index and flow index and vascularization–flow index.

2.4.7. Imaging
Lower abdominal and pelvis MRI was performed on each subject. Throughout MRI, the following

![Fig. 1. Marked thickening of the junctional zone (dotted arrow) + linear striations (arrow heads) (suggestive of adenomyosis).](image1)

![Fig. 2. A 46-year-old patient with multiple dilated microcysts leading to marked thickening of the junctional zone.](image2)

![Fig. 3. Measurements of the junctional zone's maximum (Calipers 1 and 4) and minimum (Caliper 3) thicknesses as well as the total maximum myometrial thickness are shown in this 3D ultrasound image of the uterus with adenomyosis (Caliper 2).](image3)
sequences were taken sections after intravenous administration of Ultravist to distinguish layers of the uterus; intermediate-to great-signal intensity T1-weighted images to show borders and anatomy of internal organs; low-signal intensity T2-weighted images to distinguish layers of the uterus and enable diagnosis of any abnormalities. Axial, longitudinal, and oblique slices were frequently taken throughout the MRI. Each examination took between 30 and 45 min to complete. On T-weighted sequences, four criteria were assessed: (i) uterine borders, size, and symmetry; (ii) maximal junctional zone thickness and occurrence of ill-defined, relatively homogeneous, low-signal-intensity myometrial area; (iii) maximal JZ thickness to myometrial thickness ratio, using maximal thickness of JZ and the corresponding thickness of Adrii. Additionally noted were leiomyoma, adnexal tumors, & endometrial or cervical abnormalities (Figs. 4 and 5).

2.5. Statistical methods

Using SPSS version 28, data management and statistical analysis had been conducted. Means and standard deviations of quantitative data were used to summarize them. Numbers and percentages had been used to represent a categorical set of data. TVUS and MRI diagnostic indices had been computed. Histopathology was used as the reference standard. Age, the only quantitative variable, was compared based on adenomyosis status using independent t-test. We compared categorical data using the Chi-square test. Each statistical test has two sides. P values of 0.05 or less had been regarded as significant.

3. Results

A total of 100 studied cases had been enrolled into research with a mean age of 47 years (range, 40–45 years). Major symptoms: abnormal uterine bleeding
in 52 (52%) studied cases, pain in 56 (56%), and 

According to TVUS, two-thirds of the patients had adenomyosis (62%), and about one-quarter had fibroids (23%) (Table 2).

According to MRI, about half of the patients had adenomyosis (56%), and one-third had fibroids (38%) (Table 3).

According to histopathology, two-thirds of the patients (68%) had adenomyosis (Table 4).

Compared with histopathology, TVUS had 84% sensitivity, 16% specificity, 50% positive predictive value, 50% negative predictive value, and 50% accuracy in diagnosing adenomyosis (Table 5).

Compared with histopathology, MRI had 76% sensitivity, 44% specificity, 57.6% positive predictive value, 64.7% negative predictive value, and 60% accuracy in diagnosing adenomyosis (Table 6).

No variations were detected among those with and without adenomyosis regarding years old ($P = 0.888$), bleeding ($P = 0.784$), and pain ($P = 0.972$) (Table 7).

4. Discussion

Endometrial glands and stroma are seen within uterine musculature in a condition known as adenomyosis.13

Our research was conducted in the outpatient clinic of obstetrics and gynecology at El Hussein Hospital and Toukh Central Hospital. Based on inclusion/exclusion criteria, 100 patients were chosen from among women who visited the El Hussein Hospital’s outpatient clinic and planned to have hysterectomy performed because they had adenomyosis.

In our study, 3D Doppler ultrasonography, resonant magnetic field imaging, surgery, and histological examination were carried out without consulting other researchers’ diagnoses. The studied cases were giving their assent to total hysterectomy and additional histological analysis of uterine specimens once preoperative examinations were finished.

This cross-sectional research happened on 100 studied cases subjected to 3D ultrasonography,

Table 1. Comparison of transvaginal Doppler U/S.

<table>
<thead>
<tr>
<th>History</th>
<th>No adenomyosis</th>
<th>Adenomyosis</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VI</td>
<td>17.4 (4.2–23.2)</td>
<td>15.4 (3.4–18.2)</td>
<td>0.328</td>
</tr>
<tr>
<td>FI</td>
<td>33.3 (29.5–37.5)</td>
<td>36.6 (33.8–38.4)</td>
<td>0.060</td>
</tr>
<tr>
<td>VFI</td>
<td>3.2 (0.2–9.3)</td>
<td>2.1 (0.8–6.5)</td>
<td>0.424</td>
</tr>
</tbody>
</table>

Data is presented as number and median (range).

*Using Mann–Whitney U test.*

Comparing among 3D Doppler transvaginal ultrasound indices in studied cases whether proved ($n = 84$) and excluded ($n = 16$) to have adenomyosis by histopathology.
MRI, and histopathology at El Hussein Hospital and Toukh Central Hospital. We obtained the results of the 3D ultrasound and MRI and compared the result with histopathology.

In our study by analysis of general characteristics, we found that mean years old of cases was $47 \pm 3$. About half of the studied cases had bleeding (52%) or pain (56%). The most frequent method of hysterectomy was abdominal (64%), followed by vaginal (19%) and laparoscopic (17%).

By comparison between TVUS and MRI findings on patients complaining of menorrhagia < AQ: Pls check whether text missing here > According to our TVUS findings, we found that two-thirds of the patients had adenomyosis (62%), and about one-quarter had fibroids (23%). With regard to MRI findings, we found that about half of the patients had adenomyosis (56%), and one-third had fibroids (38%). These investigations were performed before hysterectomy.

After doing the hysterectomy and according to histopathology to specimens, we showed that two-thirds of the patients (68%) had adenomyosis prevalence of condition was sixty eight percent in this research (sixty eight studied cases) < AQ: Pls check the sentence for clarity of meaning> According to Graziano et al., there are 57% of people who have adenomyosis. Exacoustos et al. found a histological prevalence of adenomyosis of 44.4% (32/72 patients), Bazot et al. demonstrated 33% (40/120) histopathological prevalence of adenomyosis. Diagnostic criteria, features of the sample being analyzed, and researcher’s expertise are few of the causes of this great variability.

By analysis of diagnostic indices of TVUS compared with histopathology, we demonstrated that TVUS had 85.3% sensitivity, 87.5% specificity, 93.5% positive predictive value, 73.7% negative predictive value, and 86% accuracy in diagnosing adenomyosis.

A study by Hashad et al. illustrated that 3D-TVS found a sensitivity and specificity of 95.8% and 87.6%, respectively, and positive and negative predictive values of 68.7% and 80% with an overall accuracy of 70.1% for the diagnosis of adenomyosis.

By analysis of diagnostic indices of MRI compared with histopathology, we confirmed that MRI had 77.9% sensitivity, 90.6% specificity, 94.6% positive predictive value, 65.9% negative predictive value, and 82% accuracy in diagnosing adenomyosis.

We did a comparison between the two groups according to having the lesion of adenomyosis in relation to age, bleeding symptoms, and pain. It has been observed that no variations were detected among those with and without adenomyosis regarding years old ($P = 0.888$), bleeding ($P = 0.784$), and pain ($P = 0.972$).

Also, in agreement with our research, in another study by Gaafar et al., the diagnostic accuracy of 3D ultrasonography versus uterine pathology was assessed in 100 studied cases who underwent TAH after preoperative 3D-dimensional TVUS. Premenopausal females with abnormal uterine bleeding demonstrated sensitivity and specificity (90% and 92.8%), PV and NPV (69.2% and 98.1%), with an overall accuracy of 92.42% in the diagnosis of adenomyosis, which varies from research in that we contain studied cases < AQ: Pls check the sentence for clarity of meaning>.

A review of Tissue Sampling Methods for Diagnosis of Adenomyosis in Systematic Fashion by Movilla et al. to assess the precision of adenomyosis diagnosis using tissue sampling methods. Researchers found 14 research that described how to diagnose adenomyosis using tissue sampling, comprising a total of 1909 studied cases from 12 different countries across six distinct continents; biopsy strategy, which can be intrauterine or extrauterine and approaches that have been verified or not with confirmed hysterectomy pathology were criteria used to classify tissue sample methods < AQ: Pls check the sentence for clarity of meaning>.

More frequently than in narrative reports, structured reports showed a majority of TVUS features. report that was more organized showed greater sensitivity < AQ: Pls check the sentence for clarity of meaning>. For majority of sonographic features assessed, a structured report showed greater sensitivity and lower specificity. RI's structured report did not contain any sonographic findings that were statistically significant for the diagnosis of adenomyosis after logistic regression analysis; nonetheless, global uterus and ill-defined junctional zone were substantially related with adenomyosis. Myometrial cyst was linked to an increased incidence of adenomyosis in the narrative report of da Silva et al., it has been found that structured reports had been more sensitive for the diagnosis of adenomyosis, but narrative reports were more specific. In addition, structured reports had lower specificity and greater sensitivity for majority of sonographic signs of adenomyosis.

Present imaging gold standard for adenomyosis diagnosis is MRI, although availability and cost issues frequently prevent patients from accessing it. Affordable, reliable, and an accessible option is transvaginal ultrasonography.

There are numerous different MRI objective measures for adenomyosis, although their individual diagnostic efficacy is still unknown. JZ traits
continue to be most popular and explored with respectable diagnostic accuracy. The relationship between these objective measurements of adenomyosis and clinical results need more investigation.\textsuperscript{20}

Adenomyosis, often believed to mainly afflict elderly females, is now detectable on imaging in 30\% of females under the age of 40 years. Adenomyosis can be asymptomatic in up to 30\% of females, and symptoms usually go away after menopause. Females who are menopausal or asymptomatic do not need to be managed.\textsuperscript{21}

Liu et al.\textsuperscript{22} Transvaginal ultrasound and magnetic resonance imaging diagnostic accuracies will be examined in meta-analysis, and the efficacy of several sonographic diagnostic criteria for adenomyosis will be assessed. In all, 32 suitable research were discovered after searching PubMed and Embase. Diagnostic performance of TVUS for adenomyosis had been shown to be great and comparable to that of MRI.

Additional analyses in research by Luciano et al.\textsuperscript{23} contained 54 symptomatic premenopausal females, who underwent preoperative 3D-TVS of the uterus to assess alterations to JZ; outcomes of sonographic features had been connected to histopathologic results of ultrasound-based targeted biopsy specimens of the uterus, outcomes found sensitivity and specificity (92\% and 83\%) with an overall accuracy of 90\% for the diagnosis of adenomyosis; thus, 3D-TVS demonstrates great diagnostic accuracy in recognition of location and position of adenomyosis in uterine walls.

One of the strengths of the research is that it contained studied cases who had a hysterectomy contrary to Luciano et al.,\textsuperscript{23} who had targeted biopsy specimens of the uterus, which allow us to exclude double pathology and give more accurate outcome. However the limitation of this research is that we did not define the location of lesions.

Sofic et al.\textsuperscript{24} had done a prospective comparative research using MRI. There is variation in thickness of JZ among control M = 14.3 mm, SD = 1.3 mm, and the target group (studied cases with adenomyosis) M = 5.6 mm, SD = 1 and 3; thus, MRI is a technique of choice for imaging and assessment of JZ as an important diagnostic marker in the diagnosis of adenomyosis, which comes with the outcomes of the current study (24.3 ± 13.0 SD).

Outcomes had been comparable to those of Champaneria et al.,\textsuperscript{8} who studied the value of magnetic resonance imaging in the diagnosis of fibroid and showed that MRI demonstrated a sensitivity of 94.1\%, specificity of 68.7\%, PPV of 95.7\% and an NPV of 61.1\% Moghadam et al. (twenty eight) stated that MRI and pathology had been the same for 136 of 144 females with leiomyoma. MRI has great sensitivity (94\%) and low specificity (33). Positive and negative predictive values had been 95\% and 27\% with 90\% accuracy for diagnosing leiomyoma.

4.1. Conclusion

According to the findings of our research, 3D transvaginal ultrasonography is a greatly reliable alternative to MRI for preoperative diagnosis of adenomyosis and leiomyoma. Consequently, it is advised to use 3D ultrasonography in routine clinical practice as it is more accessible, less expensive, less time-consuming, and an easier method, assisting clinicians in making accurate diagnosis, choosing appropriate course of action, and individually managing each studied case to achieve best therapeutic rates.

Authorship

All authors have a substantial contribution to the article.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

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Conflicts of interest

The authors declared that there were no conflicts of interest.

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