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Comparison of TVS and MRI for Evaluating Adenomyosis in the Dhaka Metropolitan Area, Bangladesh

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ABSTRACT

Adenomyosis is a significant gynecologic cause of infertility, particularly in developing countries, where early diagnosis and accurate assessment of myometrial involvement are critical for appropriate risk categorization and surgical planning. While transvaginal ultrasound (TVS) is commonly used for pre-operative diagnosis, magnetic resonance imaging (MRI) is often considered superior for early and precise detection of adenomyosis. This cross-sectional study, conducted in the Department of Radiology and Imaging at BSMMU, Dhaka, aimed to evaluate the effectiveness of TVS and MRI in assessing myometrial invasion in adenomyosis. Both imaging techniques were performed on patients diagnosed with adenomyosis, and the results were compared with histopathology reports, which served as the gold standard. Statistical analysis was conducted using SPSS version 25.0. The study revealed that the majority of patients (56.7%) were aged 36-45 years, with a mean age of 41.15 years, and pelvic pain was the most common symptom, reported by 63.3% of patients. Adenomyosis was detected in 61.7% of patients using TVS and in 68.3% using MRI, with histopathology confirming the condition in 65% of cases. Among these, 53.8% had diffuse adenomyosis, while 46.2% had focal adenomyosis. MRI demonstrated a higher diagnostic accuracy with a sensitivity of 87.2%, specificity of 66.7%, positive predictive value (PPV) of 82.9%, and negative predictive value (NPV) of 73.7%, compared to TVS, which had a sensitivity of 71.8%, specificity of 57.1%, PPV of 75.7%, and NPV of 52.2%. These findings suggest that MRI is more reliable than TVS for detecting adenomyosis, though further studies are needed to confirm these results.

Keywords: Adenomyosis, MRI, TVS, Myometrial invasion, and Histopathology.

INTRODUCTION:

Uterine adenomyosis was initially identified by Rokitansky in 1860, which referred to it as "cystosarcoma adenoids uterinum." Later, in 1896, Von Recklinghausen provided a more precise definition. This condition is prevalent among women, particularly during their reproductive years (Amira T, 2019). Adenomyosis occurs when endometrial glands and stroma, which are normally found lining the uterus, are found within the muscle wall of the uterus (myometrium). These misplaced tissues are surrounded by an overgrowth of the uterine muscle, which becomes thickened and enlarged (Ahmed Hamimi, 2015).

Adenomyosis is a common gynecologic disease in women of reproductive age, leading to various clinical sequelae such as abnormal uterine bleeding, heavy menstrual bleeding, dysmenorrhea, and chronic pelvic pain (Hiroshi Kobayashi, 2020). The exact cause of adenomyosis remains unclear, but several theories have been suggested. Factors that

may increase the risk include estrogen exposure, having given birth, and previous surgeries involving the uterus. The most widely accepted theories suggest that adenomyosis results either from the invasion of the endometrial basalis layer into the myometrium or from embryologically misplaced pluripotent Müllerian remnants (Leyendecker, G *et al.,* 2015). To date, no studies have been conducted on the natural history of adenomyosis, and information regarding its prevalence and characteristics in adolescent girls and postmenopausal women is still limited (Benagiano *et al.,* 2015). Recent advancements in imaging technology have revealed that adenomyosis, once thought to primarily affect women, can also be detected in younger, asymptomatic individuals. This discovery has sparked debate over whether adenomyosis, or certain forms of it, should be classified as a disease or if it might instead represent a normal process that worsens with uterine aging (Athanasios Protopapas, 2020).

Recent studies suggest that adenomyosis may adversely affect fertility and contribute to obstetrical complications such as preterm labor, fetal growth restriction, and preeclampsia (G. Younes, *et al.,* 2017). Clinical diagnosis of adenomyosis is often challenging due to the nonspecific nature of its symptoms and the confounding presence of coexistent pelvic diseases (Horton J. *et al.,* 2019). Traditionally, the diagnosis of adenomyosis was made histologically from hysterectomy specimens. However, the evolution of imaging tools, particularly ultrasound and MRI, now allows for accurate non-invasive diagnosis using well-described morphological myometrial alterations, measurement of the thickness, assessment of the outline of the junctional zone (JZ), or a combination of these parameters (Bazot and Darai *et al.,* 2001). Recent advancements in gynecologic imaging techniques, such as transvaginal sonography (TVS) and magnetic resonance imaging (MRI), aim to improve the identification of this pathology (Leyendecker G., 2015). MRI seeks to enhance the objectivity, reproducibility, and interpretability of TVS studies. Subsets of adenomyosis can be discerned based on MRI patterns of anatomical localization and the content of adenomyotic lesions. Additionally, Adenomyosis frequently occurs alongside other gynecological conditions, like endometriosis and uterine fibroids, which adds to the complexity and variation in the data available (Vannuccini S., 2019).

Several minimally invasive treatment methods, including uterine-sparing options, are available. Various pharmacological alternatives, hysteroscopic resection or ablation, conservative surgical options, uterine artery embolization, and high-intensity focused ultrasound may provide comparable benefits to the majority of women with adenomyosis (Dessouky R., 2019). Therefore, MRI can aid more accurately in the early diagnosis of adenomyosis than TVS.

Research Question

Is MRI better than TVS in the assessment of adenomyosis?

Objectives of the Study

General Objective

To evaluate the role of TVS and MRI in the assessment of adenomyosis.

Specific Objectives

- To diagnose adenomyosis using TVS.
- To diagnose adenomyosis using MRI.
- To diagnose adenomyosis using histopathology.
- To compare TVS and MRI findings of adenomyosis with those of the gold standard histopathological findings.
- To calculate the sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of TVS and MRI in the diagnosis of adenomyosis.

MATERIALS AND METHODS:

This study involved women aged 25 to 55 with newly diagnosed adenomyosis, who were referred to the radiology department of a hospital in Dhaka, Bangladesh. All participants met the study's inclusion and exclusion criteria. The study received approval from the Institutional Review Board, and written informed consent was obtained from all participants.

A total of 60 participants underwent both transvaginal ultrasound (TVS) and magnetic resonance imaging (MRI) scans. Following surgical treatment, their tissue samples were examined in the pathology department. The results from the TVS and MRI were then compared with the pathology findings, which served as the gold standard for diagnosis. MRI images were assessed based on

signal characteristics across different sequences (T1W1, T2W2, and STIR), the depth of myometrial involvement, junctional zone thickness, and the presence of myometrial cysts and other pathologies. All MRI analyses were conducted by consensus using a picture archiving and communication system (PACS) workstation. TVS examinations were carried out with a Philips Affiniti 30 machine equipped with a transvaginal probe. Prior to the TVS, a lower abdominal ultrasound was performed. During the TVS procedure, patients emptied their bladder and then lay on an examination table in a pelvic exam position with knees bent. A covered and lubricated probe was gently inserted into the vagina to capture images of the pelvic organs, which were displayed on a screen for evaluation. Three primary scanning techniques were utilized for comprehensive imaging: sagittal imaging with side-to-side movements, rotation for coronal images, and adjustments in probe depth to focus on different areas. TVS images were interpreted based on myometrial heterogeneity, poor definition of the endometrial-myometrial interface, subendometrial linear echogenic striations, myometrial cysts, and other pathologies. As with the MRI, all TVS interpretations were performed by consensus on a PACS workstation.

RESULTS:

Table 1: Age distribution of the study subjects (n=60).

Age in years	Frequency	Percentage (0%)	Mean ± SD
27-35	9	15.0	41.15± 7.23
36-45	34	56.7	
46-55	17	28.3	

The table reveals that the highest proportion (56.7%) of individuals fell within the age group of 36-45 years, followed by 28.3% in the age group of 46-55 years, and 15% in the age group of 25-35 years. The mean age ± standard deviation was calculated to be 41.15 ± 7.25 years.

Table 2: Body mass index of the study subject (n=60).

BMI	Frequency	Percentage (%)
Under weight (< 18.5 kg/m$^{2)}$	6	10
Normal (18.5-24.9 kg/m$^{2)}$	18	30
Overweight (25-29.9 kg/m$^{2)}$	22	36.7
Obese (> 30 kg/m$^{2)}$	14	23.3

Table shows maximum (36.7%) were overweight followed by 30% were normal weight, 23.3% were obese and 10% were underweight.

Table 3: Distribution of parity of the study subjects (n=60).

Parity	Number	Percentage (%)
0	6	10.0
1-2	15	25.0
3-4	28	46.7
>4	11	18.3

Table shows maximum 46.7% respondent had 3 or 4 children.

Table 4: Distribution of patients according to clinical findings (n=60).

Clinical Findings	Number	Percentage
Pelvic pain	38	63.3
Abnormal vaginal bleeding	22	36.7
Vaginal discharge	19	31.7
Intermenstrual bleeding	6	10.0
Perimenopasusal bleeding	5	8.3
Infertility	4	6.7

According to the table, the most common clinical finding was pelvic pain, reported by 63.3% of the participants, followed by abnormal vaginal bleeding at 36.7%, vaginal discharge at 31.7%, and intermenstrual bleeding at 10%.

Table 5: Findings of Adenomyosis in Transvaginal Ultrasound, MRI and Histopathology.

Findings	Number	Percentage (%)
TVS		
Present	37	61.7
Absent	23	38.3
MRI		
Present	41	68.3
Absent	19	31.7
Histopathology		
Present	39	65.0
Absent	21	35.0

Table 6: Distribution of types of adenomyosis in histopathology (n=39).

Type of Adenomyosis on Histopathology	Number	Percentage (%)
Diffuse	21	53.8%
Focal	18	46.2%

Table 7: Distribution of TVS diagnosed patients with adenomyosis according to variable (n=37).

TVS Variables	Number	Percentage (%)
Globular uterine configuration	25	67.6
Poor definition of the endometrial myometrial interface	26	70.3
Subendometrial echogenic linear striations	34	91.9
Myometrial cysts	20	54.1
Heterogeneous myometrial echotexture	32	86.5

Table shows sub endometrial echogenic linear striations are the most common (91.9%) TVS variable for adenomyosis.

Table 8: Distribution of MRI diagnosed patients with adenomyosis according to variables (n=41).

MRI Variables	Number	Percentage (%)
Junctional zone thickening (> 12 mm)	34	82.9
Myometrial cysts	27	65.9
Heterogenous myometrium usually heterogeneously hyperintense	32	78.0

Table shows junctional zone thickening (> 12 mm) is the most common (82.9%) MRI variable for adenomyosis.

Table 9: Diagnostic validity for magnetic resonance imaging keeping histopathology as gold standard.

MRI	Histopathology		Total
	Present	Absent	
Present	True Positive (n=34)	False Positive (n=7)	41
Absent	False Negative (n=5)	True Negative (n=14)	19
Total	39	21	60

Statistics

Sensitivity 87.2% (95% of CI: 72.5% to 95.7%)
Specificity 66.7% (95% of CI: 43.1% to 85.4%)
PPV 82.9% (95% of CI: 67.9% to 92.8%)

NPV 73.7% (95% of CI: 48.8% to 90.8%)
Accuracy 80.0% (95% of CI: 67.7% to 89.2%)

In histological staging, 87.2% were sensitivity, 66.7% were specificity, 82.9% were PPV, 73.7% were NPV and 80% were accuracy.

Table 10: Diagnostic validity for transvaginal ultrasound keeping histopathology as gold standard.

TVS	Histopathology		Total
	Present	Absent	
Present	True Positive (n=28)	False Positive (n=9)	37
Absent	False Negative (n=11)	True Negative (n=12)	23
Total	39	21	60

Statistics
Sensitivity 71.8% (95% of CI: 55.1% to 85%)
Specificity 57.1% (95% of CI: 34.1% to 78.1%)
PPV 75.7% (95% of CI: 58.8% to 88.2%)
NPV 52.2% (95% of CI: 30.6% to 73.2%)
Accuracy 66.7% (95% of CI: 53.3% to 78.3%)

In histological staging, 71.8% were sensitivity, 57.1% were specificity, 75.7% were PPV, 52.2% were NPV and 66.7% were accuracy.

Table 11: Comparison of diagnostic validity of TVS and MRI in adenomyosis with histopathology as gold standard.

	Sensitivity (%)	Specificity (%)
MRI	87.2%	66.7%
TVS	71.8%	57.1%

This table shows both sensitivity and specificity of MRI is more than TVS in case of adenomyosis.

Table 12: Comparison of diagnostic accuracy of TVS and MRI in adenomyosis with histopathology as gold standard.

Accuracy (%)	
MRI	80.0
TVS	66.7

This table shows the diagnostic accuracy of MRI is more than TVS in case of adenomyosis. Accuracy of TVS and MRI for the diagnosis of adenomyosis was calculated by following formula,

Accuracy= $\frac{a+d}{N}$ x 100

DISCUSSION:

Adenomyosis commonly affects multiparous women of late reproductive age and presents clinically with menorrhagia and pelvic pain. It has a 10% association with endometrial adenocarcinoma. Accurate diagnosis is essential and typically begins with transvaginal ultrasonography (TVS) as a first-line investigation. If TVS results are inconclusive or other associated pathologies are found, MRI is recommended. However, the gold standard remains histopathology. An ideal diagnostic test should be inexpensive, minimally invasive, and widely available. It should also be well accepted by patients and exhibit high accuracy, sensitivity, and specificity (Alvi *et al.,* 2021). This study aimed to evaluate the roles of TVS and MRI in the assessment of adenomyosis, comparing the findings with previous studies.

The study revealed that the largest age group was between 36-45 years, accounting for 56.7% of the sample (34 subjects). The second largest group was 46-55 years, with 28.3% (17 subjects), and the smallest group was 25-35 years, with 15% (9

subjects). The mean age of participants was 41.15 years, with a standard deviation of 7.25. These findings are consistent with previous studies (Anwar *et al.,* 2022). In contrast, Rubab *et al.* (2022) reported a mean patient age of 44.2 ± 5.12 years. (Hashad *et al.,* 2017) studied 77 patients with a mean age of 46 years (range 40-55 years). (Dueholm *et al.,* 2001) found a mean age of 44.7 ± 6.52 years (range 28-58 years). The results also indicated that the majority of patients were overweight or obese, with 36.7% being overweight (BMI 25-29.9 kg/m²) and 23.3% obese (BMI > 30 kg/m²). In contrast, 30% had a normal weight (BMI 18.5-24.9 kg/m²) and 10% were underweight (BMI < 18.5 kg/m²). This suggests a potential association between being overweight or obese and adenomyosis, aligning with previous research (Goyal *et al.,* 2020; Alvi *et al.,* 2021; Anwar *et al.,* 2022; Rubab *et al.,* 2022). Regarding parity, the largest group had three or more children, reported by 46.7% of patients, followed by those with one or two children (25%) and those with more than four children (18.3%). These findings are consistent with other studies showing an increased risk of adenomyosis with higher parity (Rubab *et al.,* 2022).

Pelvic pain was the most common symptom, reported by 63.3% of patients. This aligns with previous research indicating that pelvic pain is a frequent symptom of adenomyosis (Haq *et al.,* 2009; Puliyathinkal *et al.,* 2017; Shankar *et al.,* 2019; Goyal *et al.,* 2020; Hussein *et al.,* 2021; Alvi *et al.,* 2021; Anwar *et al.,* 2022; Rubab *et al.,* 2022). Abnormal vaginal bleeding was the second most common symptom, reported by 36.7% of patients. Other common symptoms included vaginal discharge (31.7%), intermenstrual bleeding (10%), perimenopausal bleeding (8.3%), and infertility (6.7%). These findings indicate that adenomyosis can present with various clinical symptoms affecting women's reproductive health and quality of life, consistent with other studies (Haq *et al.,* 2009; Puliyathinkal *et al.,* 2017; Shankar *et al.,* 2019; Goyal *et al.,* 2020; Hussein *et al.,* 2021; Alvi et *al.,* 2021; Anwar *et al.,* 2022; Rubab *et al.,* 2022). In this study, adenomyosis was detected in 61.7% of patients via TVS and 68.3% via MRI, suggesting that MRI may be more sensitive than TVS in detecting adenomyosis. Histopathology, performed on all patients, detected adenomyosis in 65%, confirming it as the most accurate diagnostic technique. Among those with adenomyosis, 53.8% had diffuse adenomyosis and 46.2% had focal adenomyosis, consistent with previous research indicating that diffuse adenomyosis is the most common type (Ying-Lung Sun *et al.,* 2010; Shankar *et al.,* 2019; Goyal *et al.,* 2020; Hussein *et al.,* 2021; Alvi *et al.,* 2021; Anwar *et al.,* 2022). TVS findings showed that the most common indicators of adenomyosis were subendometrial echogenic linear striations (91.9%), followed by heterogeneous myometrial echotexture (86.5%), poor definition of the endometrial-myometrial interface (70.3%), globular uterine configuration (67.6%), and myometrial cysts (54.1%). These findings are consistent with previous studies (Ying-Lung Sun *et al.,* 2010; Goyal *et al.,* 2020; Anwar *et al.,* 2022).

MRI findings indicated that the most common indicators were a widened junctional zone (82.9%), heterogeneously hyperintense myometrium (78%), and myometrial cysts (65.9%). These findings are consistent with previous research (Ying-Lung Sun *et al.,* 2010; Hamini, 2015; Shankar *et al.,* 2019; Amira *et al.,* 2019; Goyal *et al.,* 2020; Anwar *et al.,* 2022). The diagnostic accuracy of MRI in detecting adenomyosis, with histopathology as the gold standard, showed a sensitivity of 87.2%, specificity of 66.7%, positive predictive value (PPV) of 82.9%, negative predictive value (NPV) of 73.7%, and overall accuracy of 80.0%. These results indicate that MRI has high sensitivity for detecting adenomyosis, correctly identifying the condition in 87.2% of cases. The PPV of 82.9% suggests a high probability that a positive MRI diagnosis is correct, while the NPV of 73.7% suggests a moderate probability that a negative MRI diagnosis is correct. The overall accuracy of 80.0% is consistent with other studies evaluating MRI's diagnostic accuracy for adenomyosis (Ying-Lung Sun *et al.,* 2010; Alvi *et al.,* 2021; Anwar *et al.,* 2022). Anwar *et al.* (2022) reported a sensitivity of 86.7%, specificity of 81.5%, and accuracy of 83% for MRI. (Rubab *et al.,* 2017) reported a sensitivity of 82.5%, specificity of 81.5%, PPV of 79.3%, and NPV of 76.1%. The diagnostic accuracy of TVS for adenomyosis is critical, given its common use. This study found a sensitivity of 71.8%, specificity of 57.1%, PPV of 75.7%, NPV of 52.2%, and overall accuracy of 66.7%. These values suggest that TVS may not be as accurate as MRI for diagnosing adenomyosis. These findings are consistent with previous studies

reporting lower sensitivity and specificity of TVS compared to MRI (Haq *et al.,* 2009; Puliyathinkal *et al.,* 2017; Shankar *et al.,* 2019; Goyal *et al.,* 2020; Hussein *et al.,* 2021; Anwar *et al.,* 2022; Rubab *et al.,* 2022).

A systematic review by (Bazot *et al.,* 2018) reported a sensitivity of 72% and specificity of 85% for TVS, compared to 77% and 89% for MRI, respectively. (Novellas *et al.,* 2011) and (Shwayder *et al.,* 2014) found an 85% diagnostic accuracy for MRI. (Rasmussen *et al.,* 2019) reported a sensitivity and specificity of 72% and 69% for TVS, respectively.

CONCLUSION:

This study provides valuable insights into the comparative diagnostic performance of transvaginal ultrasound (TVS) and magnetic resonance imaging (MRI) for assessing adenomyosis in the Dhaka Metropolitan Area. The findings indicate that MRI surpasses TVS in terms of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy. Therefore, MRI should be prioritized as the imaging method of choice for diagnosing adenomyosis when accessible. Nevertheless, utilizing both TVS and MRI together may improve diagnostic accuracy, especially in complex cases with ambiguous clinical presentations. The combined application of these imaging techniques could facilitate earlier and more precise detection, ultimately leading to better patient outcomes. Further studies are encouraged to confirm these results in a broader population and to evaluate the cost-effectiveness of routinely incorporating MRI alongside TVS as a diagnostic approach.

ETHICAL CLEARANCE:

Ethical clearance was obtained from Bangladesh University of Health Sciences (BUHS), Dhaka, Bangladesh.

AUTHOR'S CONTRIBUTION:

F.F.R. and M.A.O. contributed to the conceptualization, methodology, data analysis, visualization, statistical analysis, and resource management. They also worked on the original draft, editing, and reviewing the manuscript. I.J.N. was responsible for data collection and supervision, while M.A.F. provided additional supervision. T.P. and S.M.M.M. were involved in data curation, investigation, validation, and gave final approval of the manuscript.

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CONFLICTS OF INTEREST:

The authors declare that there are no conflicts of interest regarding the publication of this work.

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