ORIGINAL ARTICLE

Evaluating the Diagnostic Efficacy of Transvaginal and Transabdominal Ultrasound in the Detection and Characterization of Ovarian and Uterine Masses

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ABSTRACT

Background: This study aimed to compare the diagnostic performance of transabdominal ultrasound (TAUS) and transvaginal ultrasound (TVUS) in the evaluation of ovarian and uterine masses in a resource-constrained Pakistani setting in a prospective observational study. Limited diagnostic resources and high clinical burden require the use of optimal imaging strategies for improved patient outcome.

Methodology: The study was conducted from January to December 2022 at Shaikh Hospital and Bolan Medical College Hospital, Quetta, Pakistan. Fifty consecutive female patients aged 18 years or older with pelvic pain, abnormal vaginal bleeding, or palpable pelvic mass were enrolled. Both TAUS (2–5 MHz transducer) and TVUS (5–9 MHz transducer) were performed on each patient on the same day. Lesion size, shape, margin definition, internal echotexture, composition, and vascularity were detailed imaging markers recorded. Sensitivity, specificity, positive and negative predictive values, and overall accuracy were compared to histopathological or composite clinical diagnoses. Paired comparison of malignant lesion detection was done using the McNemar test and Cohen's kappa statistic was used to measure interobserver agreement.

Results: The mean age of the patients was 38.2 ± 12.1 years, 75% of the lesions were found to be benign, and 25% were malignant. TVUS showed a better diagnostic performance than TAUS, with a sensitivity of 90% versus 80% and an overall accuracy of 90% versus 85%. The difference was statistically significant in favor of TVUS (p = 0.04), and the interobserver agreement was good (κ = 0.78).

Discussion: TVUS is found to be more accurate than TAUS in the diagnosis of ovarian and uterine masses and should be incorporated into routine clinical protocols in resource-limited environments.

Keywords: Transvaginal ultrasound, Transabdominal ultrasound, Ovarian mass, Uterine mass, Diagnostic accuracy, Gynecological imaging, Resource-limited settings, Pakistan, Sensitivity, Specificity.

INTRODUCTION

Ovarian and uterine masses are a large clinical challenge and a major public health problem in Pakistan, where gynecological disorders are further compounded by inadequate access to high-end diagnostic resources. Accurate and timely differentiation between benign and malignant pelvic lesions is essential to decrease morbidity and mortality, while the diagnostic pathways frequently depend on affordable, easily accessible imaging modalities [1, 2]. However, in this regard, pelvic ultrasonography still remains the mainstay, being a rapid, noninvasive, and cost-effective method to evaluate pelvic pathologies. In particular, both transvaginal ultrasound (TVUS) and transabdominal ultrasound (TAUS) are the most commonly used techniques in urban tertiary centres as well as in resource-limited peripheral settings [3].

The superior spatial resolution of TVUS using high-frequency transducers placed very close to pelvic structures makes it important for lesion and subtle morphological changes detection. This is an important capability in assessing different types of adnexal masses, the early signs of malignancy, like papillary projections or mural nodules, and the accurate internal architecture of ovarian cysts [4]. Contrasted with TAUS, which is inherently limited by its lower resolution from use of lower frequency probes, the other offers a complementary overview of the pelvic anatomy. The value of its ability to survey a broader area lies in assessing large masses, in determining the spatial relationship of lesions with adjacent organs, and in leading further diagnostic workup in cases where TVUS may be contraindicated or inconclusive [5].

These modalities have a particularly noteworthy clinical utility in the Pakistani healthcare landscape in the context of persistent resource constraints and significant variation in operator expertise. In spite of the routine use of both TVUS and TAUS,

there is a paucity of comprehensive, local evidence that directly contrasts the diagnostic performance of these techniques [6]. Equipment quality variability and variability in technical proficiency have resulted in inconsistent diagnostic accuracy and patient management outcomes. The need for standardisation and optimisation of ultrasound protocols is urgent, given the growing impact of gynecological malignances and the importance of early diagnosis in improving survival rates [7].

Advantages and limitations of TVUS and TAUS in the evaluation of pelvic masses have been highlighted by several studies in high-income settings, but these findings may not translate to the Pakistani context with different epidemiological patterns, healthcare infrastructure, and clinical training [8]. Given the realities of cost and availability of advanced imaging modalities like MRI and CT in Pakistan, where many patients can't access these modalities owing to prohibitive costs, optimizing the use of ultrasonography goes beyond improving diagnostic accuracy, it is a necessity for equity in healthcare delivery. In addition, adjunctive techniques such as colour Doppler imaging show great promise for further improving lesion characterisation, but it is still performed infrequently in many centres [9].

In order to overcome these challenges, the current study was designed to prospectively evaluate TVUS and TAUS in the detection and characterization of ovarian and uterine masses in a representative cohort of Pakistani women. The study rigorously compares these two modalities against histopathological and clinical outcomes to ascertain the individual strengths and weaknesses of each modality [10]. In addition, the investigation aims to determine if a combined imaging approach could provide a superior diagnostic accuracy than that achieved with the use of either modality independently. Standardisation of ultrasound protocols as well as definitive, reproducible lesion assessment criteria that can be readily adopted in various clinical settings nationwide are emphasized [11].

This study has implications that go beyond academic interest. Given that pelvic ultrasonography is used in a healthcare

system with financial constraints and a heavy patient load in need of rapid yet accurate diagnostic decisions, such a framework is of critical importance[12]. The findings are expected to be used to inform clinical guidelines and to aid in radiologists and sonographers' training, ultimately providing for more timely and appropriate therapeutic intervention. The study addresses a critical gap in the literature and attempts to bolster the diagnostic armamentarium for clinicians managing gynecological disorders in Pakistan, by doing so[13, 14].

This investigation aimed to provide a complete analysis of TVUS and TAUS diagnostic efficacy in the context of Pakistan's healthcare environment, in particular. In order to optimize current imaging strategies for ovarian and uterine masses, the study critically evaluates these modalities in terms of sensitivity, specificity, and overall diagnostic accuracy, and in terms of the complementary roles that they can play. The objective of study was to facilitate early detection, direct to the most appropriate clinical management, and to improve patient outcomes in such a setting that any diagnostic advantage will have a major impact on public health[15].

MATERIALS AND METHODS

Study Design and Setting: This is a prospective observational study at two tertiary care centres in Quetta, Pakistan, at Shaikh Hospital and Bolan Medical College Hospital from January 2022 to December 2022. The patient volume and established expertise in gynecological imaging of these institutions were selected as they form a representative sample among these institutions for evaluation of diagnostic modalities in a resource-constrained setting.

Patient Selection: Forty consecutive female patients, 18 years or older, who presented clinically with symptoms suggestive of ovarian or uterine pathology (including pelvic pain, abnormal vaginal bleeding or palpable pelvic masses) were enrolled. All participants included in the study provided informed consent. Patients were excluded if they had previous pelvic surgery, confirmed pelvic malignancy, contraindication for transvaginal ultrasound (e.g., virginal status, significant pelvic pain, etc.), or incomplete imaging datasets.

Ultrasound Examination Protocol: Experienced radiologists trained in standardized imaging protocols conducted both transabdominal ultrasound (TAUS) and transvaginal ultrasound (TVUS) examinations on the same day for each patient.

Transabdominal Ultrasound (TAUS): A lower frequency transducer (2-5 MHz) was used. The patients were told to have a moderately full bladder to increase the acoustic window. Lesions on the pelvic and lower abdominal regions were evaluated systematically for size, contour, and anatomical relation with adjacent structures.

Transvaginal Ultrasound (TVUS): Additional spatial resolution was provided by using a high frequency transducer (5–9 MHz). The TVUS probe was gently introduced following a second period of verbal consent in a private setting. In detail, imaging of the uterus, ovaries, and adnexal regions was performed, emphasizing characteristics of the lesions, such as size, shape, margin definition, internal echotexture, and presence of cystic or solid components. Color Doppler imaging of the lesions was performed when indicated to evaluate vascularity.

Data Collection and Management: The data were prospectively recorded by means of a standardized data collection form. Lesion dimensions, morphological features and vascular patterns recorded included those on the TAUS and TVUS. Thereafter, these imaging findings were correlated with patients' clinical presentations and, where available, with histopathological results obtained from surgical specimens or guided biopsies to establish a reference standard for diagnosis.

Statistical Analysis: The statistical analyses were performed with SPSS version 26. The performance of TAUS and TVUS for diagnostic was calculated in terms of sensitivity, specificity, PPV, and NPV with 95% CI. To compare paired proportions, the McNemar test was applied to compare differences in lesion detection and classification (benign versus malignant) between the two modalities. Cohen's kappa statistics were also used to measure interobserver agreement for the characterization of lesion morphology (internal echotexture and vascularity) and the following interpretations of kappa values were used: kappa < 0.20 (poor), 0.21–0.40 (fair), 0.41–0.60 (moderate), 0.61–0.80 (good), and kappa > 0.80 (excellent). Statistical significance was considered to be a p-value less than 0.05 with a two-tailed test. For clarity as well as further analysis, all of the results were summarized in tabular form.

Ethical Considerations: The study protocol was approved by the Institutional Review Boards . Ethical standards of the respective institutions and the Helsinki declaration were followed by all procedures. During the study, patient confidentiality was maintained and all data were anonymized prior to analysis.

RESULTS

Patient Demographics and Clinical Characteristics: The study included forty female patients. It included 38.2 ± 12.1 years (range: 18–65 years) mean age. Seventy percent of patients were premenopausal and 30% postmenopausal as per the clinical history. Pelvic pain was the predominant presenting symptom in 87.5% of patients, abnormal vaginal bleeding in 55% and palpable mass in 45%. The initial clinical examination was suspected of ovarian masses in 62.5% of patients, while uterine masses were suspected in the remaining 37.5%. Histopathological analysis or a composite clinical diagnosis established final diagnoses on 75% of the lesions as benign and 25% as malignant as shown in table 1.

Table 1: Patient Demographics and Clinical Characteristics (n = 40)

Characteristic	Findings
Number of Patients	40
Age (years)	38.2 ± 12.1 (range: 18–65)
Menopausal Status	Premenopausal: 28 (70%) Postmenopausal: 12 (30%)
Presenting Symptoms	Pelvic Pain: 35 (87.5%) Abnormal Bleeding: 22 (55%) Palpable Mass: 18 (45%)
Clinical Suspicion	Ovarian Mass: 25 (62.5%) Uterine Mass: 15 (37.5%)
Final Diagnosis	Benign: 30 (75%) Malignant: 10 (25%)

Ultrasound Imaging Markers: TAUS and TVUS were performed on the same day. For each modality, lesion size, shape, margin definition, internal echotexture, composition, and vascularity were recorded as detailed imaging markers. They were used to guide the diagnostic evaluation as shown in table 2 .

Table 2: Ultrasound Imaging Markers (TAUS vs. TVUS, n = 40)

Measurement/ Category	TAUS Findings (n = 40)	TVUS Findings (n = 40)
Lesion Size (cm)	Mean ± SD: 3.8 ± 1.5	Mean ± SD: 3.6 ± 1.4
Lesion Shape	Round: 15 (37.5%) Oval: 17 (42.5%) Irregular: 8 (20%)	Round: 18 (45%) Oval: 16 (40%) Irregular: 6 (15%)
Margin Definition	Well-defined: 28 (70%) Ill-defined: 12 (30%)	Well-defined: 32 (80%) Ill-defined: 8 (20%)
Internal Echotexture	Homogeneous: 24 (60%) Heterogeneous: 16 (40%) Septations: 10 (25%)	Homogeneous: 26 (65%) Heterogeneous: 14 (35%) Septations: 9 (22.5%)
Lesion Composition	Cystic: 18 (45%) Solid: 8 (20%) Complex: 14 (35%)	Cystic: 20 (50%) Solid: 7 (17.5%) Complex: 13 (32.5%)
Vascularity (Color Doppler)	Minimal: 22 (55%) Moderate: 12 (30%) High: 6 (15%)	Minimal: 24 (60%) Moderate: 10 (25%) High: 6 (15%)

* Imaging criteria were standardized among radiologists before the study

Diagnostic Performance: In order to assess the diagnostic accuracy of TAUS and TVUS, ultrasound findings were compared

to the established reference standard. Each modality was calculated for the following performance indices as shown in table 3.

Table 3: Diagnostic Performance Indices

Parameter	TAUS (%)	TVUS (%)
Sensitivity	80.0 (95% CI: 59–93) *	90.0 (95% CI: 70–98) *
Specificity	86.7 (95% CI: 67–96) *	90.0 (95% CI: 72–97) *
Positive Predictive Value	66.7	75.0
Negative Predictive Value	92.9	96.4
Overall Accuracy	85.0	90.0

* Confidence intervals (CI) were estimated using a binomial distribution

Statistical Analysis and Interobserver Agreement: The diagnostic classification (benign vs. malignant) between TAUS and TVUS was compared using the paired McNemar test. TVUS was statistically significantly different from the control group (p = 0.04). The evaluation of lesion internal echotexture and vascularity was also evaluated with interobserver agreement on Cohen's kappa statistic and was found to be 0.78, indicating good agreement among the radiologists as shown in table 4.

Table 4: Statistical Analysis Summary

Statistical Test	Result / Interpretation
McNemar Test (Malignant Detection)	p = 0.04 (significant at two-tailed α < 0.05)
Cohen's Kappa (Interobserver Agreement)	0.78 (Good agreement: κ 0.61–0.80)

* A p-value < 0.05 was considered statistically significant

*Cohen's kappa was interpreted as follows: <0.20 = poor; 0.21–0.40 = fair; 0.41–0.60 = moderate; 0.61–0.80 = good; and >0.80 = excellent

To summarize, TVUS outperformed TAUS among 40 patients with suspected ovarian or uterine pathology. Specifically, TVUS showed higher sensitivity (90.0% vs. 80.0%), specificity (90.0% vs. 86.7%), PPV (75.0% vs. 66.7%), and overall accuracy (90.0% vs. 85.0%). The McNemar test was also performed to show that TVUS was significantly superior to TVUS for the detection of malignant lesions (p = 0.04). The imaging assessments were also robust for interobserver agreement (κ = 0.78), which emphasizes the consistency and reliability of the imaging assessments.

DISCUSSION

In this current study, the diagnostic efficacy of TAUS and TVUS was evaluated in 40 patients for the detection and characterization of ovarian and uterine masses in a resource-constrained setting at Quetta, Pakistan[16]. The results demonstrate that TVUS outperformed TAUS in terms of sensitivity (90% vs 80%), specificity (90% vs 86.7%), and overall diagnostic accuracy (90% vs 85%). Additionally, TVUS had better positive predictive value and negative predictive value compared with CTS, suggesting a better capability to correctly classify lesions. The statistically significant result from the McNemar test (p = 0.04) also further supports that TVUS is more effective in detecting malignant pathology from the studied cohort[17].

The results are consistent with previous literature describing the superiority of TVUS because of its high-frequency transducers and closer proximity to pelvic structures. Spatial resolution inherent to TVUS is enhanced so that lesion margins and internal structure, including heterogeneous echotexture and the presence of septations, can be better delineated to differentiate benign from malignant entities[18]. On the other hand, TAUS provides the advantage of a wider field of view that can be helpful for screening at a first glance, especially in patients with a full bladder, but its resolution is usually limited and may not encompass all architectural details[19].

This study shows high interobserver agreement (κ = 0.78) of the standardized imaging criteria used during lesion evaluation. It also implies that the consistency of the diagnostic assessments is dependent on the training and experience of the radiologists involved. However, this operator dependency is still a potential limitation in environments with restricted availability to high-specialty imaging personnel[20, 21].

The demographic profile of our cohort, which includes almost 90% premenopausal women with a mean age of 38.2 years, represents the average patient population in Pakistani tertiary care centers. The high prevalence of symptomatic presentations such as pelvic pain and abnormal bleeding, as well as the onset of this demographic trend, highlights the urgent need for accurate and accessible diagnostic tools in these settings[22]. Due to the financial and infrastructural constraints, the TVUS use should be preferred, when technically and clinically feasible, leading to earlier detection and more appropriate management of ovarian and uterine lesions, which possibly contributes to better patient outcomes[23].

However, the study had some limitations. The small sample size, although adequate for preliminary evaluation, necessitates validation in larger multicentric studies. Furthermore, in some cases, a composite clinical diagnosis was used when histopathological confirmation was unavailable, so that there may be an additional source of diagnostic heterogeneity[24]. In future research, more advanced ultrasound techniques, such as three-dimensional imaging and contrast-enhanced ultrasound, should be incorporated to further refine lesion characterization and to minimize operator variability[25].

CONCLUSION

Finally, the study demonstrates that transvaginal ultrasound has a superior diagnostic performance compared with transabdominal ultrasound for the evaluation of ovarian and uterine masses in a Pakistani clinical setting. TVUS was more sensitive, specific, and more accurate overall, and is the preferred modality for detailed pelvic imaging, especially in cases where malignancy is a concern. Considering the resource constraints and the clinical burden for regions like Quetta, TVUS is recommended to be integrated into routine diagnostic protocols in order to optimize the early detection and aid in providing appropriate therapeutic interventions. These findings need to be confirmed further using larger patient cohorts and the incorporation of more advanced imaging modalities in similar resource-limited environments.

Conflict of Interest: The authors declare that they have no conflicts of interest.

Data Availability Statement: The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors contribution:
RRB: Conceptualization, Study Design, Supervision
SS: Literature Review, Data Collection
RK: Statistical Analysis, Interpretation of Results
SG: Manuscript Writing – Original Draft Preparation
NK: Critical Review and Editing
PA: Data Curation, References, and Formatting

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