

ROLE OF TRANSABDOMINAL AND TRANSVAGINAL ULTRASONOGRAPHY IN EARLY DIAGNOSIS OF ECTOPIC GESTATION

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Abstract

Objective: To evaluate transabdominal versus transvaginal ultrasonography (TAUS vs TVUS) for early identification of ectopic gestation and to offer recommendations for selection of diagnostic methods in clinical practice, using laparotomy as gold standard.

Study design: Comparative accuracy study.

Place and Duration of Study: Department of Diagnostic Radiology, Islamabad Diagnostic Center, F8, Islamabad, Pakistan, from Sep 2024 to Feb 2025 (6 months).

Methodology: This study included 130 clinically suspected cases of early ectopic gestation. Women aged 15 to 45 years underwent sonography in early pregnancy. Patients were assessed by both TVUS and TAUS. Ultrasound findings were compared with laparotomy findings which were taken as gold standard. Diagnostic performance of both modalities was evaluated in terms of sensitivity, specificity, positive and negative predictive values and overall diagnostic accuracy.

Results: Among 130 suspected cases, mean age was 31.15 ± 7.67 years. Compared with TAUS, TVUS detected more adnexal masses, fetal cardiac activity, tubal ring appearance and pelvic free fluid. Using laparotomy as gold standard, TVUS showed higher sensitivity (97.32%), specificity (94.44%) and overall diagnostic accuracy (96.92%) than TAUS which showed sensitivity of 93.75%, specificity of 83.33% and overall diagnostic accuracy of 92.31%. TVUS revealed a higher sensitivity and specificity for early diagnosis of ectopic gestation.

Conclusions: Transvaginal ultrasonography (TVUS) was more accurate than transabdominal ultrasonography (TAUS) for early ectopic gestation diagnosis. Meanwhile TAUS remained useful for initial screening and complementary assessment to early diagnosis of ectopic gestation.

INTRODUCTION

Ectopic pregnancy remains a leading cause of first-trimester maternal morbidity and mortality globally, accounting for about 1-2% of all pregnancies.¹ Early presentation is often non-specific, with complains of abdominal pain and

vaginal bleeding, which makes reliance on clinical signs alone hazardous. Modern diagnosis depends on combined use of serial β -hCG measurement and pelvic ultrasonography.²

Transvaginal sonography (TVUS) has emerged, over past two decades, as a potentially more

sensitive modality for detection of small adnexal masses, tubal ring sign and yolk-sac/embryonic structures outside uterine cavity. It routinely identifies intrauterine pregnancy at lower hCG thresholds and elucidates features that distinguish ectopic implantation.^{3, 4} In contrast, transabdominal ultrasound (TAUS) remains widely used as first-line, noninvasive scan, particularly where TVUS is unavailable, contraindicated or poorly tolerated. However, TAUS has lower spatial resolution for adnexal pathology and can miss early or small ectopic implants.⁵

Recent literature has also highlighted advancements that refine sonographic diagnosis, from standardized first-trimester lexicons to contrast-enhanced and Doppler techniques that improve lesion characterization, and emphasizes special considerations for non-tubal and cesarean-scar implantations where early TVUS interpretation can be decisive in avoiding catastrophic outcomes.^{6,7}

Nisar *et al.* reported that TVUS had sensitivity of 93.8% while TAUS showed lower sensitivity of 78.6% for diagnosis of ectopic gestation.⁸ Given evolving evidence and population differences in access and expertise, a comparative accuracy study that quantifies sensitivity, specificity and predictive values of TAUS and TVUS in early ectopic gestation, remains highly relevant. This study aimed to compare sensitivity, specificity and diagnostic accuracy of TAUS and TAVS in patients presenting with suspected early ectopic pregnancy.

Methodology

A comparative accuracy study was conducted at Islamabad Diagnostic Center F-8, Islamabad, Pakistan, from September 2024 to February 2025. Before initiation of current study, ethical approval was taken from Institutional Review Board and Ethical Committee (IRB & EC): no. IRB # 001-

02-2026. For estimating sample size, WHO sample size calculator was used. Sample size of 130 with suspected ectopic gestation was calculated by using estimating TVUS sensitivity of 93.8%, TAUS sensitivity of 78.6%.⁸

Non-probability purposive sampling technique was used for inclusion of patients, after obtaining informed consent. Patient flow can be seen in Figure-1.

Inclusion Criteria: Pregnant women aged 15-45 years in first trimester with symptoms suggestive of ectopic pregnancy and beta-hCG levels of at least 25 mIU/mL, were included.

Exclusion Criteria: Patients with confirmed intrauterine or molar pregnancy, or known non-gestational tubo-ovarian masses were excluded.

After obtaining written informed consent agreement from patients in outpatient department, we proceeded with their enrollment if they exhibited symptoms indicative of suspected EP. Each patient underwent TVUS and TAUS conducted by single radiologist with minimum five years of experience. Recorded ultrasound findings included tubal ring appearance, free fluid in Douglas pouch, fetal heart activity and adnexal mass. Subsequent to ultrasound, obstetrics specialist conducted laparotomies to confirm diagnosis of ectopic pregnancy. Laparotomy findings were used for comparison.

Statistical Package for Social Sciences (SPSS) version 25 was used for data analysis. Mean and standard deviation (mean±SD) were used to present quantitative variables, and qualitative variables were presented percentages and frequencies. Both TVUS and TAUS were evaluated using 2 x 2 tables to determine specificity, sensitivity, diagnostic accuracy (DA), negative predictive values (NPVs), positive predictive values (PPVs) and area under the receiver operating curve (ROC).

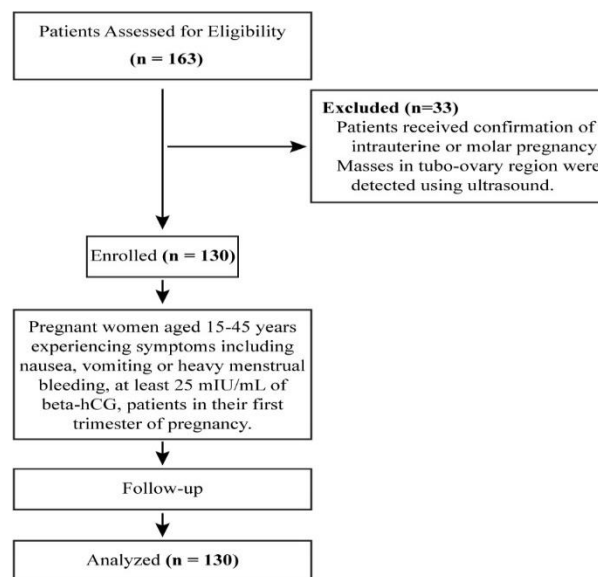


Figure-1. Patient Selection Flow Diagram

Results

Total 130 patients with suspected early ectopic gestation were evaluated. Mean age of patients was 31.15 ± 7.67 years. Most patients belonged to urban areas, accounting for 80 (61.54%) while 50 (38.46%) were from rural areas. Mean parity was recorded as 1.58 ± 0.66 in study population. On ultrasonographic assessment, transvaginal ultrasonography identified greater number of abnormal findings compared with transabdominal ultrasonography. Adnexal masses were detected in 114 (87.69%) cases by TVUS while TAUS detected 96 (73.85%). Fetal cardiac activity was demonstrated in 24 (18.46%) cases on TVUS and in 12 (9.23%) cases on TAUS. Free fluid in pouch of Douglas was noted in 67 (51.53%) patients by TVUS compared with 38 (29.23%) by TAUS. Similarly, tubal ring appearance was observed in 60 (46.15%) cases on TVUS whereas TAUS detected this sign in only 32 (24.61%) cases (Table-I).

When compared with laparotomy findings, TVUS showed superior diagnostic performance. Among 130 patients, TVUS diagnosed ectopic gestation as present in 109 true positive cases and 1 false positive case, while it missed only 3 false negative cases and correctly identified 17 true negative cases. Based on these findings, sensitivity of TVUS was 97.32%, specificity was 94.44%, positive

predictive value (PPV) was 99.09%, negative predictive value (NPV) was 85% and overall diagnostic accuracy was 96.92%. These results indicated high reliability of TVUS in confirming ectopic gestation and also demonstrated better performance (Table-II).

TAUS also showed good diagnostic utility, although its performance remained lower than TVUS. TAUS identified 105 true positive cases and 3 false positive cases while 7 cases were false negative and 15 were true negative on comparison with laparotomy. Sensitivity of TAUS was 93.75%, specificity was 83.33%, PPV was 97.22%, NPV was 68.18% and diagnostic accuracy was 92.31%. Although TAUS performed well in detecting several cases of ectopic gestation but it was less accurate than TVUS. (Table- III).

Receiver operating characteristic (ROC) curve analysis further supported superior performance of TVUS. Area under the curve (AUC) for TVUS was 0.959 (95% CI: 0.895-1.00) while TAUS showed AUC of 0.885 (95% CI: 0.781-0.990), as shown in Figure-2. Overall, both modalities were useful, but TVUS demonstrated better sensitivity, specificity and diagnostic accuracy for early diagnosis of ectopic gestation.

Table-I. Patients Parameters and Ultrasound Findings for Early Diagnosis of Ectopic Gestation (n = 130)

Parameters	Values	
Age (years); Mean±SD	31.15±7.67	
Urban; n (%)	80 (61.54)	
Rural; n (%)	50 (38.46)	
Parity; Mean±SD	1.58±0.66	
Ultrasound Findings	TVUS	TAUS
Adnexal Masses	114 (87.69%)	96 (73.85%)
Fetal Cardiac Activity	24 (18.46%)	12 (9.23%)
Free Fluid in Pouch of Douglas	67 (51.53%)	38 (29.23%)
Tubal Ring Appearance	60 (46.15%)	32 (24.61%)

SD = Standard Deviation; TVUS = Transvaginal Ultrasound; TAUS = Transabdominal Ultrasound

Table-II. Performance of TVUS, for Early Diagnosis of Ectopic Gestation, taking Laparotomy as gold standard (n = 130)

TVUS	Laparotomy	
	EG Present (n)	EG Absent (n)
EG Present (n)	109	1
EG Absent (n)	3	17
Sensitivity	97.32% (95% CI, 92.42 - 99.08)	
Specificity	94.44% (95% CI, 74.24 - 99.01)	
PPV	99.09% (95% CI, 95.03 - 99.84)	
NPV	85% (95% CI, 63.96 - 94.76)	
DA	96.92% (95% CI, 92.36 - 98.8)	

EG = Ectopic Gestation; TVUS = Transvaginal Ultrasound; PPV = Positive Predictive Value; NPV = Negative Predictive Value; DA = Diagnostic Accuracy

Table-III. Performance of TAUS, for Early Diagnosis of Ectopic Gestation, taking Laparotomy as gold standard (n = 130)

TAUS	Laparotomy	
	EG Present (n)	EG Absent (n)
EG Present (n)	105	3
EG Absent (n)	7	15
Sensitivity	93.75% (95% CI, 87.66 - 96.94)	
Specificity	83.33% (95% CI, 60.78 - 94.16)	
PPV	97.22% (95% CI, 92.15 - 99.05)	
NPV	68.18% (95% CI, 47.32 - 83.64)	
DA	92.31% (95% CI, 86.42 - 95.77)	

EG = Ectopic Gestation; TAUS = Transabdominal Ultrasound; PPV = Positive Predictive Value; NPV = Negative Predictive Value; DA = Diagnostic Accuracy

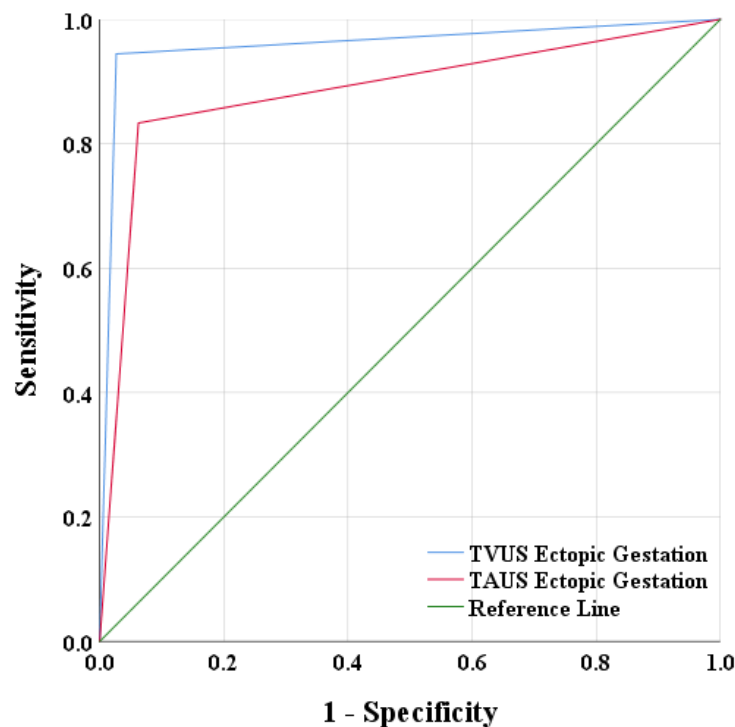


Figure-2. ROC curve of Transvaginal Ultrasound (TVUS) in blue line and Transabdominal Ultrasound (TAUS) in red line.

Discussion

This study found that both TAUS and TVUS were helpful to establish early diagnosis of ectopic gestation. Greater sensitivity, specificity, NPV, diagnostic accuracy and AUC of TVUS demonstrated superior reliability in detection of early extra-uterine implantation.⁹ This is in line with recent studies, suggesting ultrasound remains a key diagnostic modality for evaluating suspected ectopic pregnancy. Transvaginal examination is better for small adnexal lesions and mild extra-uterine abnormalities.^{10, 11}

Our findings are consistent with a recent comparative study which indicated superior sensitivity, specificity and overall accuracy of TVUS compared to TAUS, ultimately concluding that TVUS serves more robust confirmatory function in ectopic pregnancy imaging.⁸ In a similar study, Zeb *et al.* reported diagnostic accuracy of TVUS as compared to laparotomy which supported its use in surgically confirmed tubal ectopic pregnancies.¹² Conversely, TAUS in our investigation demonstrated commendable

overall performance, affirming its ongoing diagnostic relevance as an initial screening tool.

This aligns with study conducted by Javed *et al.*, which showed that TAUS exhibited good diagnostic accuracy in comparison with surgical results, suggesting its continued utility in situations where TVUS is inaccessible or postponed.¹³

Another study also reported about superior TAUS sensitivity when compared to TVUS, while still concluding that TVUS performed better.⁵ Current study showed clear numerical advantage of TVUS over TAUS. Findings are comparable with those of Nisar *et al.* They reported higher sensitivity, specificity and accuracy of TVUS compared to TAUS. They evaluated sensitivity of TVUS to be 93.8% while TAUS showed sensitivity of 78.6%, and TVUS accuracy of 91.4% while TAUS accuracy of 72%.⁸ An important finding in this study was that TVUS identified greater number of adnexal masses, tubal ring appearances, fetal cardiac activity and free pelvic fluid than TAUS. These findings are clinically significant as they

directly impact prompt diagnosis and treatment. Another study noted that adnexal mass, empty uterus and free fluid were among most prevalent ultrasonographic characteristics of ectopic pregnancy in Pakistani patients.¹⁴ Malik *et al.* also showed that Doppler ultrasound can improve diagnostic confidence in difficult cases especially when conventional greyscale results are inconclusive.¹⁵

Diagnostic utility of TVUS was also further reinforced by ROC analysis in present study. Overall discriminatory ability of TVUS was better with AUC of 0.959 as compared to TAUS with AUC of 0.885. Lower specificity and NPV of TAUS indicate that it should not be employed alone if clinical suspicion remains high. This view is supported by recent studies that have shown that TVUS allows better imaging of early adnexal disease and increases diagnostic accuracy over TAUS. Hu *et al.* reported diagnosis accuracy of 97.40% for TVUS versus 88.89% for TAUS.³ Shakeel *et al.* stated that TAUS is still helpful but inferior to TVUS and preferably should be performed before TVUS.¹⁶

Al-Falaki *et al.* indicated superiority of TVUS in sensitivity and accuracy of ectopic gestation diagnosis than TAUS while also acknowledging simultaneous application of both modalities enhanced total detection.¹⁷ Houser *et al.* emphasized that accurate identification of tubal ring, adnexal morphology and prevalent diagnostic errors is crucial to enhance specificity in diagnosis of early ectopic pregnancy.¹⁰ Jeffers *et al.* emphasized ultrasonography results must be analyzed with clinical evaluation and serial beta-hCG levels to mitigate risk of missed or delayed diagnosis.¹⁸

Overall, our findings strongly supported protocol in which TAUS is used for initial triage although TVUS is superior in early diagnosis. Timely confirmation can reduce morbidity, guide prompt management and help preserve future reproductive outcomes.

Limitations

This study had some limitations. First, it was conducted at single diagnostic center, therefore,

findings may not be generalized to other hospitals, emergency settings or peripheral healthcare facilities. Second, only patients with suspected early ectopic gestation were included, therefore, diagnostic accuracy values may be higher than expected in unselected early-pregnancy population.

Conclusion

In conclusion, both transabdominal ultrasonography and transvaginal ultrasonography were helpful in early diagnosis of suspected ectopic gestation but transvaginal ultrasonography proved to be more accurate and reliable. It detected important signs earlier and showed better sensitivity, specificity and overall diagnostic accuracy than Transabdominal ultrasonography, which still remains useful in initial screening. Using both modalities in complementary way would improve timely diagnosis, support early management, reduce complications and help preserve future fertility.

Conflict of Interest: There is no conflict.

Author's Contribution:

MK and SK: Conception, study design, drafting the manuscript, approval of the final version to be published.

MK and AK: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

SK and ZA: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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