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Radiology & Imaging

Role of Transvaginal Ultrasound in Differentiating Tubal Ectopic Pregnancy from Other Adnexal Masses

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Abstract	**Original Research Article**

Background: Ectopic pregnancy remains a significant obstetric complication with the potential for severe morbidity and mortality if not identified and managed promptly. The purpose of the study is to evaluate the diagnostic accuracy of transvaginal ultrasound in distinguishing tubal ectopic pregnancy from other adnexal masses. ***Methods:*** This cross-sectional study at the Department of Radiology and Imaging, Uttara Adhunik Medical College Hospital, Dhaka, Bangladesh (June 2024–July 2025) included 80 patients with suspected ectopic pregnancy or adnexal masses. All underwent transvaginal ultrasound (TVUS), diagnoses were confirmed by surgery, histopathology, or follow-up, and TVUS diagnostic performance was assessed using sensitivity, specificity, PPV, NPV, and overall accuracy. ***Results:*** Among 80 patients (mean age 29.8 ± 4.6 years), 62.5% had tubal ectopic pregnancy and 37.5% other adnexal masses, mainly corpus luteum (46.7%) and hemorrhagic cysts (30%). TVUS showed empty uterus (92%), adnexal mass separate from ovary (88%), tubal ring (64%), and free fluid (52%) in ectopic cases, while non-ectopic masses had cystic lesions without tubal ring (90%) and lesions inseparable from ovary (83.3%). Diagnostic performance was high (sensitivity 94%, specificity 86.7%, PPV 92.2%, NPV 89.7%, accuracy 91.3%). ***Conclusion:*** Transvaginal ultrasound is a reliable and accurate tool for differentiating tubal ectopic pregnancy from other adnexal masses, facilitating early diagnosis and appropriate management.
Keywords: Transvaginal Ultrasound, Tubal Ectopic Pregnancy, Adnexal Masses.

INTRODUCTION

Ectopic pregnancy represents a severe obstetric complication that can result in substantial morbidity and, in extreme cases, mortality if not identified and managed at an early stage [1]. It occurs when implantation of the developing blastocyst takes place outside the endometrial cavity, and it remains one of the leading contributors to maternal mortality worldwide [2]. When left undiagnosed or untreated, ectopic pregnancy constitutes a medical emergency with the potential for catastrophic outcomes, including tubal rupture and massive intra-abdominal hemorrhage. Approximately 95% of ectopic pregnancies are located within the fallopian tubes. Prompt and precise diagnosis during the first trimester plays a critical role in minimizing maternal morbidity and reducing the risk of mortality [3].

Achieving an early and dependable diagnosis of ectopic pregnancy continues to pose a significant clinical challenge; however, timely identification is crucial to prevent life-threatening hemorrhage and long-term

sequelae such as infertility [4]. Over time, sonography has emerged as a central diagnostic tool in the evaluation of patients with suspected ectopic pregnancy [5]. Ultrasonography is a cost-effective, widely accessible, rapid, and noninvasive modality that enables early determination of both the presence and anatomical location of pregnancy. It is regarded as the first-line imaging technique, and with transvaginal pelvic sonography, an intrauterine pregnancy can be reliably visualized as early as five weeks of gestation [6].

The advent of transvaginal sonography (TVS) has significantly enhanced diagnostic accuracy in a wide range of early pregnancy–related and gynecological conditions. Compared to the transabdominal approach, vaginal ultrasonography offers superior image resolution because the transducer is positioned closer to the pelvic structures and operates at higher frequencies [7]. This improved spatial resolution allows more accurate assessment of early gestational structures. TVS plays a vital role in diagnosing ectopic pregnancy by confirming the absence of an intrauterine pregnancy and by directly

detecting an ectopic mass. Additionally, confirmation of intrauterine gestation is achievable at earlier gestational ages and at lower serum human chorionic gonadotropin (HCG) levels with TVS than with transabdominal sonography (TAS) [3].

The diagnosis of ectopic pregnancy is often complicated by its ability to clinically and sonographically resemble a variety of other gynecological and non-gynecological conditions. Both typical and atypical presentations may mimic early intrauterine pregnancy, spontaneous abortion, salpingitis, ovarian cyst torsion or rupture, bleeding corpus luteum, endometriosis, appendicitis, and other pelvic pathologies. Furthermore, corpus luteal cysts are frequently encountered in early pregnancy, increasing the likelihood that an ovarian ectopic pregnancy may be mistaken for a benign cystic lesion. The presence of a "ring of fire" on Doppler imaging lacks sufficient specificity, as similar vascular patterns can be observed in corpus luteal cysts [8-10]. Echogenic free fluid within the Pouch of Douglas or Morison's pouch may indicate hemoperitoneum due to a ruptured ectopic pregnancy or tubal abortion; however, comparable findings may also result from rupture of a hemorrhagic ovarian cyst.

Despite the widespread use of transvaginal ultrasound in the evaluation of suspected ectopic pregnancy, diagnostic uncertainty persists when distinguishing tubal ectopic pregnancy from other adnexal masses that share overlapping sonographic and clinical features. Many benign adnexal conditions encountered in early pregnancy can closely mimic ectopic gestation, increasing the risk of misdiagnosis and potentially leading to delayed treatment or unnecessary surgical intervention. Furthermore, reported diagnostic performance of transvaginal ultrasound varies across studies and clinical settings, and local data assessing its effectiveness in differentiating tubal ectopic pregnancy from other adnexal pathologies remain limited. The purpose of the study is to evaluate the diagnostic accuracy of transvaginal ultrasound in distinguishing tubal ectopic pregnancy from other adnexal masses.

Objective
- To evaluate the diagnostic accuracy of transvaginal ultrasound in distinguishing tubal ectopic pregnancy from other adnexal masses.

METHODOLOGY & MATERIALS

This cross-sectional study was conducted at the Department of Radiology and Imaging, Uttara Adhunik Medical College Hospital, Dhaka, Bangladesh, from June 2024 to July 2025. A total of 80 patients presenting with suspected ectopic pregnancy or adnexal masses were included, selected based on predefined inclusion and exclusion criteria. Data were collected to evaluate the role of transvaginal ultrasound (TVUS) in differentiating tubal ectopic pregnancy from other adnexal masses.

Inclusion Criteria:
- Women of reproductive age presenting with suspected ectopic pregnancy or adnexal masses.
- Positive pregnancy test and/or clinical signs suggestive of ectopic gestation.
- Willingness to undergo TVUS and follow-up.

Exclusion Criteria:
- Confirmed intrauterine pregnancy.
- History of previous adnexal or pelvic surgery affecting adnexal anatomy.
- Contraindications to TVUS (e.g., patient refusal or active vaginal infection preventing probe insertion).
- Incomplete clinical or ultrasound data.

All participants underwent TVUS using a high-frequency transvaginal probe. Findings were recorded for features suggestive of tubal ectopic pregnancy—such as empty uterine cavity, adnexal mass separate from the ovary, tubal ring sign, free pelvic fluid, and yolk sac or embryo visualization—as well as for other adnexal masses, including cystic lesions without a tubal ring, lesions inseparable from the ovary, internal echoes suggestive of hemorrhage, and presence or absence of free fluid. The final diagnosis was confirmed by surgical findings, histopathology, or follow-up TVUS as appropriate. The diagnostic performance of TVUS in differentiating tubal ectopic pregnancy from other adnexal masses was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy. Data were analyzed using SPSS version 25.0, with continuous variables presented as mean ± standard deviation and categorical variables as numbers and percentages.

RESULTS

Table 1: Age Distribution of the Study Population (n = 80)

Age Group (years)	Number of Patients	Percentage (%)
≤ 20	6	7.5
21–25	18	22.5
26–30	24	30.0
31–35	18	22.5
> 35	14	17.5
Total	**80**	**100.0**

The majority of patients were aged 26–30 years (24 patients, 30.0%), followed by 21–25 years (18 patients, 22.5%) and 31–35 years (18 patients, 22.5%). Patients older than 35 years accounted for 17.5% (14 patients), while those aged 20 years or younger represented 7.5% (6 patients). The mean age of the study population was 29.8 ± 4.6 years.
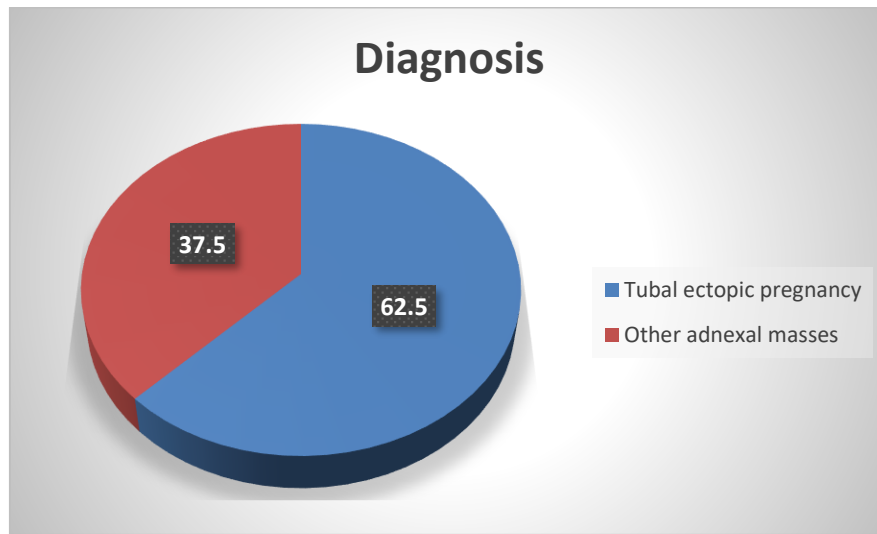

Figure 1: Final Diagnosis of Study Participants (n = 80)

Among the study participants, 50 patients (62.5%) were diagnosed with tubal ectopic pregnancy, whereas 30 patients (37.5%) were diagnosed with other adnexal masses.

Table 2: Distribution of Other Adnexal Masses (n = 30)

Type of Adnexal Mass	Number of Cases	Percentage (%)
Corpus luteum cyst	14	46.7
Hemorrhagic ovarian cyst	9	30.0
Endometrioma	4	13.3
Paraovarian cyst	3	10.0
Total	**30**	**100.0**

Of the 30 patients with other adnexal masses, corpus luteum cysts were the most frequent, seen in 14 patients (46.7%). This was followed by hemorrhagic ovarian cysts in 9 patients (30.0%), endometriomas in 4 patients (13.3%), and paraovarian cysts in 3 patients (10.0%).

Table 3: Transvaginal Ultrasound Findings in Tubal Ectopic Pregnancy (n = 50)

Sonographic Finding	Number of Cases	Percentage (%)
Empty uterine cavity	46	92.0
Adnexal mass separate from ovary	44	88.0
Tubal ring sign	32	64.0
Free pelvic fluid	26	52.0
Yolk sac / embryo visualized	9	18.0

In patients with tubal ectopic pregnancy, the most common ultrasound finding was empty uterine cavity, observed in 46 patients (92.0%), followed by adnexal mass separate from the ovary in 44 patients (88.0%). Tubal ring sign was seen in 32 patients (64%), free pelvic fluid in 26 patients (52.0%), and yolk sac or embryo visualized in 9 patients (18.0%).

Table 4: Transvaginal Ultrasound Findings in Other Adnexal Masses (n = 30)

Sonographic Finding	Number of Cases	Percentage (%)
Lesion inseparable from ovary	25	83.3
Cystic lesion without tubal ring	27	90.0
Internal echoes (hemorrhage)	11	36.7
Minimal or no free pelvic fluid	24	80.0

Among patients with other adnexal masses, cystic lesions without a tubal ring were most frequently observed (27 patients, 90%), followed by lesions inseparable from the ovary in 25 patients (83.3%).

Minimal or no free pelvic fluid was seen in 24 patients (80%), while internal echoes suggestive of hemorrhage were present in 11 patients (36.7%).

Table 5: Diagnostic Performance of Transvaginal Ultrasound in Differentiating Tubal Ectopic Pregnancy from Other Adnexal Masses

Parameter	Value
Sensitivity	94.0%
Specificity	86.7%
Positive Predictive Value (PPV)	92.2%
Negative Predictive Value (NPV)	89.7%
Overall Diagnostic Accuracy	91.3%

Transvaginal ultrasound demonstrated high diagnostic performance in differentiating tubal ectopic pregnancy from other adnexal masses. The sensitivity was 94.0%, specificity 86.7%, positive predictive value (PPV) 92.2%, negative predictive value (NPV) 89.7%, and the overall diagnostic accuracy was 91.3%.

DISCUSSION

Tubal ectopic pregnancy is a significant obstetric condition that can result in life-threatening complications if not promptly identified and managed. Transvaginal ultrasound (TVUS) serves as a critical diagnostic tool, allowing early detection of ectopic gestation and differentiation from other adnexal masses. The findings of this study demonstrate that TVUS can reliably distinguish tubal ectopic pregnancy from other adnexal pathologies, as evidenced by characteristic sonographic signs such as empty uterine cavity, adnexal mass separate from the ovary, and the tubal ring sign. These results emphasize the clinical value of TVUS in guiding timely diagnosis and appropriate management, ultimately reducing maternal morbidity and preventing adverse outcomes.

The age distribution of our study population showed that the highest proportion of patients with suspected ectopic pregnancy were aged 26–30 years (30.0%), followed by 21–25 years (22.5%) and 31–35 years (22.5%), while those ≤20 years accounted for 7.5% and those >35 years for 17.5%. This pattern aligns with previously published literature, reflecting the higher incidence of tubal ectopic pregnancy during the mid-reproductive years. For example, Naznin et al., [11] reported that the majority of ectopic pregnancy cases were aged 26–30 years (51.7%), with an overall range of 20–40 years, while Joshi et al., [12], in a cohort of 123 ectopic cases, observed the highest frequency in women aged 26–30 years (37.4%), followed by 31–35 years (25.2%). These findings indicate that tubal ectopic pregnancy predominantly affects women in their mid- to late twenties and early thirties, highlighting reproductive age as a major risk factor.

Among patients presenting with suspected adnexal masses, tubal ectopic pregnancy accounted for 62.5% (50/80), while 37.5% (30/80) were diagnosed with other adnexal masses, including corpus luteum cysts and hemorrhagic ovarian cysts (Figure 1). This distribution is consistent with Chowdary et al., [13], who reported that in patients with a positive pregnancy test and absent intrauterine pregnancy, the majority of TVUS-identified adnexal masses were ultimately confirmed as ectopic pregnancies, supporting the observation that ectopic pregnancy represents the predominant pathology in early pregnancy. These results underscore the clinical utility of TVUS in distinguishing tubal ectopic pregnancy from other adnexal lesions.

Among the 30 patients with non-ectopic adnexal masses, corpus luteum cysts were most frequent (46.7%), followed by hemorrhagic ovarian cysts (30.0%), endometriomas (13.3%), and paraovarian cysts (10.0%). These findings are consistent with prior literature indicating that most adnexal masses detected during early pregnancy are physiological or functional cysts. Hakoun et al., [14] reported that corpus luteum and hemorrhagic ovarian cysts are commonly observed on first-trimester ultrasound and may persist into early pregnancy, while Zucchini et al., [15] noted that endometriomas, although less frequent, are also detected and exhibit distinct echogenic features. These patterns highlight the predominance of functional ovarian cysts and endometriomas among non-ectopic adnexal masses and underscore the importance of TVUS in accurate characterization.

Transvaginal ultrasound demonstrated characteristic findings in patients with tubal ectopic pregnancy. Empty uterine cavity (92.0%) and adnexal mass separate from the ovary (88.0%) were the most common findings, followed by the tubal ring sign (64.0%), free pelvic fluid (52.0%), and yolk sac or embryo visualization (18.0%) (Table 3). These results align with previous studies, including Frates et al., [16], who reported adnexal abnormalities in nearly 95% of 231 confirmed ectopic pregnancies, and Richardson et al., [17], whose systematic review confirmed that the most common sonographic signs include empty uterus, adnexal mass, and free fluid, with adnexal mass separation from the ovary significantly contributing to

diagnostic accuracy. Among non-ectopic adnexal masses, the most frequent TVUS findings were cystic lesions without a tubal ring (90.0%) and lesions inseparable from the ovary (83.3%), while internal echoes suggestive of hemorrhage (36.7%) and minimal or no free pelvic fluid (80.0%) were also observed (Table 4). Smorgick *et al.,* [18] described that these masses typically present on pelvic ultrasound with cystic structure, low-level internal echoes, and close association with the ovary, supporting the ability of TVUS to differentiate benign adnexal masses from tubal ectopic pregnancies.

Finally, TVUS demonstrated high diagnostic performance in differentiating tubal ectopic pregnancy from other adnexal masses, with a sensitivity of 94.0%, specificity of 86.7%, PPV of 92.2%, NPV of 89.7%, and overall accuracy of 91.3% (Table 5). These results are consistent with Imtiaz *et al.,* [19], who reported sensitivity ≈93.98%, specificity ≈95.07%, PPV ≈96.15%, NPV ≈92.34%, and overall accuracy ≈94.45%, and with Nisar *et al.,* [20], who observed sensitivity 93.8%, specificity 82.4%, PPV 95.1%, and accuracy 91.4% in a large cohort. The close alignment with these studies underscores TVUS as a highly sensitive and accurate modality, reinforcing its pivotal role in the early diagnosis and management of tubal ectopic pregnancy.

Limitations of the study
The study had a few limitations:
- The sample size was relatively small, which may limit the generalizability of the findings.
- TVUS is an operator-dependent modality, and diagnostic accuracy can vary based on the sonographer's experience.
- Late presentation of some patients and variability in clinical follow-up could have influenced detection of certain adnexal masses.

CONCLUSION
Transvaginal ultrasound is a valuable imaging modality for evaluating women with suspected ectopic pregnancy, providing detailed characterization of adnexal masses and aiding early diagnosis. In our study, tubal ectopic pregnancy represented the majority of cases, while non-ectopic masses were primarily functional ovarian cysts. TVUS demonstrated characteristic features for ectopic gestation, such as empty uterine cavity, adnexal mass separate from the ovary, and tubal ring sign, whereas non-ectopic masses showed cystic lesions without a tubal ring and lesions inseparable from the ovary. Overall, transvaginal ultrasound proved to be a reliable, non-invasive, and accurate tool for differentiating tubal ectopic pregnancy from other adnexal masses, supporting timely and appropriate clinical management.

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