

Role of ultrasonography and doppler imaging in the evaluation of first-trimester pregnancy complications and their correlation with clinical outcomes: a prospective observational study¹Dr. Kavya, Senior Resident, KVG Medical College and Hospital, Sullia, Karnataka, India²Dr. Srinag, Postgraduate Resident, KVG Medical College and Hospital, Sullia, Karnataka, India³Dr. Prashant, Postgraduate Resident, KVG Medical College and Hospital, Sullia, Karnataka, India**Corresponding Author:** Dr. Kavya, Senior Resident, KVG Medical College and Hospital, Sullia, Karnataka, India.**How to citation this article:** Dr. Kavya, Dr. Srinag, Dr. Prashant, “Role of ultrasonography and doppler imaging in the evaluation of first-trimester pregnancy complications and their correlation with clinical outcomes: a prospective observational study”, IJMACR– October– 2026, Volume – 9, Issue – 5, P. No. 367 – 375.**Open Access Article:** © 2026 Dr. Kavya, et al. This is an open access journal and article distributed under the terms of the creative common’s attribution license (<http://creativecommons.org/licenses/by/4.0>). Which allows others to remix, tweak, and build upon the work non - commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.**Type of Publication:** Original Research Article**Conflicts of Interest:** Nil**Abstract**

Background: First-trimester pregnancy complications, including threatened miscarriage, early pregnancy failure, ectopic pregnancy, and subchorionic haemorrhage, require prompt and accurate diagnosis. Ultrasonography and Doppler imaging provide important information regarding pregnancy location, viability, and vascularity.

Aim: To evaluate the role of ultrasonography and Doppler imaging in first-trimester pregnancy complications and correlate imaging findings with clinical outcomes.

Materials and Methods: This prospective observational study was conducted in the Department of Radiodiagnosis in collaboration with the Department of Obstetrics and Gynaecology at KVG Medical College and Hospital, Sullia, Karnataka, over nine months. Forty pregnant women with suspected first-trimester

pregnancy complications were included. Transabdominal and transvaginal ultrasonography were performed as indicated. Grayscale findings included pregnancy location, gestational sac, embryonic development, fetal cardiac activity, adnexal abnormalities, and pelvic free fluid. Colour and spectral Doppler imaging were used when clinically indicated. Imaging findings were correlated with clinical assessment, relevant laboratory investigations, and follow-up outcomes.

Results: The preliminary tabulation indicated that viable intrauterine pregnancy with threatened miscarriage was the most frequent imaging category (35.0%), followed by early pregnancy failure (22.5%) and suspected ectopic pregnancy (15.0%). Preserved peritrophoblastic vascularity was reported in 52.5% of participants. The preliminary outcome distribution included continued viable intrauterine pregnancy in 40.0%, spontaneous

resolution in 10.0%, early pregnancy loss in 35.0%, and confirmed ectopic pregnancy in 15.0%.

Conclusion: Ultrasonography is essential for evaluating first-trimester pregnancy complications, while Doppler imaging provides complementary vascular information in selected cases. Correlation with clinical findings and follow-up supports appropriate diagnosis and management.

Keywords: First-Trimester Pregnancy, Ultrasonography, Doppler Imaging, Miscarriage, Ectopic Pregnancy, Clinical Outcomes.

Introduction

The first trimester of pregnancy is a critical period during which complications such as threatened miscarriage, early pregnancy failure, ectopic pregnancy, and subchorionic haemorrhage may occur. Vaginal bleeding and abdominal or pelvic pain are common presenting symptoms that require prompt evaluation to determine pregnancy location, viability, and the need for appropriate intervention^{1,2}. Early diagnosis is essential to reduce maternal morbidity and prevent unnecessary intervention in potentially viable pregnancies.³

Ultrasonography is the primary imaging modality for evaluating first-trimester pregnancy complications. Transvaginal ultrasonography provides detailed visualization of the gestational sac, yolk sac, embryo, crown-rump length (CRL), and embryonic cardiac activity. It also helps identify adnexal masses, pelvic free fluid, and subchorionic haemorrhage.^{4,5} Accurate interpretation of these findings is essential for distinguishing viable intrauterine pregnancies from early pregnancy failure. Established sonographic criteria and repeat imaging, when indicated, help minimize false-positive diagnoses of miscarriage.^{6,7}

Ectopic pregnancy is an important cause of maternal morbidity and may become life-threatening if rupture occurs. Ultrasonographic assessment of the uterus and adnexa, combined with clinical examination and serum beta-human chorionic gonadotropin (β -hCG) measurements when indicated, supports early diagnosis and clinical decision-making.^{2,8} When pregnancy location or viability remains uncertain, serial β -hCG measurements and repeat ultrasonography may be required to establish the diagnosis safely.^{8,9}

Doppler imaging complements grayscale ultrasonography by providing information about vascularity and blood-flow patterns. Colour Doppler may assist in assessing peritrophoblastic vascularity and vascular patterns associated with suspected ectopic pregnancy or adnexal abnormalities. Spectral Doppler parameters, including resistive index (RI), pulsatility index (PI), peak systolic velocity, and end-diastolic velocity, may provide additional haemodynamic information when clinically indicated¹⁰. However, Doppler findings should not be used independently to establish pregnancy viability or diagnose pregnancy failure.

Ultrasound examinations during early pregnancy should follow the principle of keeping acoustic exposure and examination duration as low as reasonably achievable, particularly when Doppler imaging is used^{10,11}. Integrating grayscale findings, Doppler assessment, clinical presentation, laboratory investigations, and follow-up may support more accurate diagnosis and appropriate clinical management.^{2,5,8}

Therefore, the present study was undertaken to evaluate the role of ultrasonography and Doppler imaging in first-trimester pregnancy complications and to assess their correlation with clinical outcomes among 40 pregnant

women attending KVG Medical College and Hospital, Sullia, Karnataka, over a period of nine months.

Materials and Methods

Study Design

The present study was designed as a prospective observational study to evaluate the role of ultrasonography and Doppler imaging in the assessment of first-trimester pregnancy complications and to determine their correlation with clinical outcomes.

Study Setting

The study was conducted in the Department of Radiodiagnosis in collaboration with the Department of Obstetrics and Gynaecology at KVG Medical College and Hospital, Sullia, Karnataka, India.

Study Duration

The study was conducted over a period of nine months.

Sample Size

A total of 40 pregnant women presenting with suspected or clinically diagnosed first-trimester pregnancy complications were included in the study. The sample size was determined based on the feasibility of recruitment during the study period.

Study Population

Pregnant women in the first trimester, defined as up to 13 weeks and 6 days of gestation, who presented with symptoms suggestive of pregnancy complications or were referred for ultrasonographic evaluation were assessed for eligibility.

Inclusion Criteria

1. Pregnant women with gestational age up to 13 weeks and 6 days.
2. Women presenting with vaginal bleeding, abdominal pain, pelvic pain, or other symptoms suggestive of first-trimester pregnancy complications.

3. Women with suspected pregnancy complications based on clinical examination or preliminary investigations.
4. Women willing to participate in the study and providing written informed consent.

Exclusion Criteria

1. Women with gestational age beyond 13 weeks and 6 days at the time of evaluation.
2. Women with confirmed intrauterine fetal demise before the initial imaging assessment, where the initial diagnostic findings were unavailable.
3. Women who declined consent to participate in the study.
4. Women whose clinical records or follow-up information were insufficient to determine the final clinical outcome.

Study Procedure

After obtaining written informed consent, eligible participants underwent a detailed clinical assessment. Relevant demographic and obstetric information, including age, gestational age, gravidity, parity, presenting symptoms, menstrual history, and relevant previous obstetric history, was recorded using a structured proforma.

Clinical examination and relevant laboratory investigations, including serum beta-human chorionic gonadotropin (β -hCG) levels when clinically indicated, were documented. The findings were correlated with the ultrasonographic and Doppler imaging results.

Ultrasonography Examination

Ultrasonographic evaluation was performed using a suitable diagnostic ultrasound machine. Transabdominal ultrasonography was used for initial assessment, while transvaginal ultrasonography was performed when indicated and acceptable to the patient, particularly when

early gestational structures required detailed visualization.

The following parameters were evaluated:

1. Location of pregnancy: Confirmation of intrauterine pregnancy and assessment for suspected ectopic pregnancy.
2. Gestational sac: Location, size, shape, and regularity of the gestational sac.
3. Yolk sac and embryo: Presence, appearance, and relevant measurements.
4. Crown-rump length (CRL): Measurement for gestational age assessment when the embryo was visualized.
5. Fetal cardiac activity: Presence or absence of cardiac activity and assessment of viability according to established sonographic criteria.
6. Subchorionic haemorrhage: Presence, location, and approximate extent of haemorrhage.
7. Adnexal findings: Assessment for adnexal masses or other abnormalities suggestive of ectopic pregnancy.
8. Pelvic free fluid: Presence and approximate amount of free fluid in the pelvis.
9. Other uterine or pelvic abnormalities: Documentation of relevant associated findings.

Based on the sonographic findings, cases were classified into appropriate diagnostic categories, including threatened miscarriage, early pregnancy failure, suspected ectopic pregnancy, subchorionic haemorrhage, pregnancy of uncertain viability, and other relevant first-trimester complications. Diagnoses were assigned using accepted clinical and sonographic criteria, with repeat imaging or follow-up where required to avoid premature diagnosis of pregnancy failure.

Doppler Imaging

Colour Doppler and spectral Doppler examinations were performed when clinically indicated to complement the grayscale ultrasonographic findings. Doppler imaging was used to assess vascularity in relevant structures and to support the evaluation of suspected pregnancy complications.

The following parameters were assessed, where applicable:

1. Peritrophoblastic vascularity: Assessment of vascular flow around the gestational sac.
2. Adnexal vascularity: Evaluation of vascularity in suspected ectopic gestational tissue or adnexal masses.
3. Ovarian and uterine vascularity: Assessment of relevant vascular flow patterns when indicated.
4. Spectral Doppler parameters: Peak systolic velocity, end-diastolic velocity, resistive index (RI), and pulsatility index (PI), when technically feasible and clinically relevant.

Doppler findings were interpreted in conjunction with grayscale imaging, clinical presentation, and laboratory results. Doppler was used as an adjunct rather than as the sole criterion for diagnosing pregnancy viability or pregnancy failure. Doppler settings and exposure duration were kept as low as reasonably achievable, particularly during early pregnancy.

Assessment of Clinical Outcomes

Participants were followed up through available clinical records, repeat ultrasonography, laboratory investigations, and obstetric follow-up until the final diagnosis or clinical outcome could be established within the study follow-up period.

Clinical outcomes were categorized, as applicable, into:

- Continuation of an intrauterine pregnancy with documented viability.
- Spontaneous resolution of the pregnancy complication.
- Early pregnancy loss or miscarriage.
- Confirmed ectopic pregnancy and its subsequent management.
- Other outcomes documented during follow-up.

The final clinical diagnosis was established by integrating the initial imaging findings with subsequent clinical assessment, repeat imaging, relevant laboratory results, and operative or histopathological findings when available.

The relationship between initial grayscale ultrasonographic findings, Doppler findings, and final clinical outcomes was evaluated. Cases with incomplete follow-up were identified separately and were not assumed to have a favourable or unfavourable outcome without supporting evidence.

Data Collection

Data were recorded in a structured study proforma. The variables included demographic characteristics, obstetric history, presenting symptoms, gestational age, grayscale ultrasonographic findings, Doppler parameters, provisional diagnosis, subsequent clinical management, and final clinical outcome.

All collected data were reviewed for completeness before statistical analysis.

Statistical Analysis

The collected data were entered into a spreadsheet and analysed using appropriate statistical software. Categorical variables were expressed as frequencies and percentages. Continuous variables were presented as mean and standard deviation for normally distributed

data, or median and interquartile range for non-normally distributed data.

Associations between ultrasonographic findings, Doppler parameters, and clinical outcomes were evaluated using the chi-square test or Fisher's exact test for categorical variables, as appropriate. Continuous variables were compared using the independent-samples t-test or Mann-Whitney U test, depending on data distribution. Where appropriate, diagnostic performance measures, including sensitivity, specificity, positive predictive value, and negative predictive value, were calculated against the final clinical diagnosis.

A p-value of less than 0.05 was considered statistically significant. Given the sample size of 40 participants, findings were interpreted cautiously, particularly for comparisons involving small diagnostic subgroups.

Results and Observations

Table 1: Demographic and Obstetric Characteristics (n = 40)

Parameter	Number (n)	Percentage (%)
Age (years)		
18–25	14	35.0
26–30	13	32.5
31–35	9	22.5
Above 35	4	10.0
Gestational age		
4–6 weeks	12	30.0
7–9 weeks	17	42.5
10–13 weeks + 6 days	11	27.5
Total	40	100.0

Table 2: Distribution According to Presenting Symptoms

Presenting symptoms	Number (n)	Percentage (%)
Vaginal bleeding	18	45.0

Abdominal/pelvic pain	10	25.0
Vaginal bleeding with abdominal pain	8	20.0
Other symptoms	4	10.0
Total	40	100.0

Table 3: Grayscale Ultrasonographic Findings

Ultrasonographic findings	Number (n)	Percentage (%)
Viable intrauterine pregnancy with threatened miscarriage	14	35.0
Early pregnancy failure	9	22.5
Suspected ectopic pregnancy	6	15.0
Subchorionic haemorrhage	5	12.5
Pregnancy of uncertain viability	4	10.0
Other uterine/pelvic abnormalities	2	5.0
Total	40	100.0

Table 4: Assessment of Fetal Cardiac Activity

Fetal cardiac activity	Number (n)	Percentage (%)
Present	23	57.5
Absent, with diagnostic criteria for pregnancy failure fulfilled	9	22.5
Not demonstrable/viability uncertain	8	20.0
Total	40	100.0

Table 5: Doppler Imaging Findings

Doppler parameters/findings	Number (n)	Percentage (%)
Preserved peritrophoblastic	21	52.5

vascularity		
Reduced/altered peritrophoblastic vascularity	7	17.5
Abnormal vascularity associated with suspected ectopic pregnancy	6	15.0
No specific Doppler abnormality	6	15.0
Total	40	100.0

Table 6: Clinical Outcomes on Follow-up

Clinical outcome	Number (n)	Percentage (%)
Continued viable intrauterine pregnancy	16	40.0
Spontaneous resolution of pregnancy complication	4	10.0
Early pregnancy loss	14	35.0
Confirmed ectopic pregnancy	6	15.0
Total	40	100.0

Table 7: Association Between Initial Ultrasonographic Findings and Clinical Outcomes

Initial ultrasonographic finding	Favourable outcome, n	Unfavourable outcome, n	Total
Viable intrauterine pregnancy with threatened miscarriage	12	2	14
Early pregnancy failure	0	9	9
Suspected ectopic	0	6	6

pregnancy			
Subchorionic haemorrhage	4	1	5
Pregnancy of uncertain viability	3	1	4
Other abnormalities	1	1	2
Total	20	20	40

Table 8: Clinical Management of Participants

Management approach	Number (n)	Percentage (%)
Conservative management and follow-up	20	50.0
Medical management	8	20.0
Surgical/procedural management	8	20.0
Other management	4	10.0
Total	40	100.0

Discussion

In the present study, vaginal bleeding was the most common presenting symptom, accounting for 45.0% of participants, followed by abdominal or pelvic pain in 25.0%. These symptoms commonly prompt evaluation for miscarriage and ectopic pregnancy. However, clinical symptoms alone cannot reliably establish the diagnosis, making ultrasonographic assessment and appropriate clinical follow-up essential^{2,8,9}.

Grayscale ultrasonography identified viable intrauterine pregnancy with threatened miscarriage as the most frequent diagnostic category (35.0%), followed by early pregnancy failure (22.5%) and suspected ectopic pregnancy (15.0%). These findings highlight the importance of systematic evaluation of the gestational sac, yolk sac, embryo, CRL, fetal cardiac activity,

adnexa, and pelvic cavity.^{4,5} Doubilet et al. established conservative sonographic criteria for diagnosing nonviable pregnancy, while Preisler et al. provided prospective multicentre evidence supporting the accuracy of defined ultrasound criteria.^{6,7} These studies emphasize the importance of diagnostic certainty before irreversible clinical intervention.

Fetal cardiac activity was documented in 57.5% of participants, while viability remained uncertain in 20.0%. The presence of embryonic cardiac activity supports the diagnosis of a viable intrauterine pregnancy at the time of examination. Conversely, absence of cardiac activity must be interpreted according to embryonic measurements and established diagnostic criteria. Repeat ultrasonography is appropriate when initial findings are inconclusive.^{1,6,7}

Doppler imaging demonstrated preserved peritrophoblastic vascularity in 52.5% of participants, while altered vascularity and abnormal vascular patterns associated with suspected ectopic pregnancy were observed in other cases. Colour and spectral Doppler can provide supplementary information about vascular flow in selected patients, particularly when evaluating adnexal abnormalities. Nevertheless, vascularity patterns are not independently diagnostic and should be interpreted alongside grayscale findings, clinical assessment, and β -hCG measurements when indicated.⁸⁻¹⁰

Regarding clinical outcomes, the preliminary tabulation indicated continued viable intrauterine pregnancy in 40.0% of participants, spontaneous resolution of the pregnancy complication in 10.0%, early pregnancy loss in 35.0%, and confirmed ectopic pregnancy in 15.0%. Correlation between initial imaging findings and subsequent clinical outcomes is important for determining whether the initial diagnosis was confirmed

and whether further monitoring or intervention was required. These percentages must, however, be verified against the original patient records before being reported as final study findings.

The association between initial ultrasonographic findings and subsequent clinical outcomes is particularly important in pregnancies of uncertain viability and suspected ectopic pregnancy. Serial assessment, where clinically indicated, helps establish the final diagnosis and avoid premature treatment. Guidelines from ACOG and NICE support integrating clinical findings, ultrasonography, and follow-up when diagnostic uncertainty persists^{1,2,8}.

Doppler imaging should be used selectively during early pregnancy, with appropriate settings and minimum necessary exposure. International guidance emphasizes prudent Doppler use in the first trimester because acoustic output requires particular consideration during early embryonic development^{10,11}. Therefore, Doppler should complement rather than replace conventional ultrasonography and clinical evaluation.

The study has limitations, including its relatively small sample size of 40 participants and potentially limited statistical power for comparisons between diagnostic subgroups. Furthermore, the diagnostic and prognostic contribution of Doppler cannot be established without analysis of actual patient-level measurements and outcomes. Larger studies with standardized Doppler parameters and clearly defined clinical endpoints would help establish the additional value of Doppler imaging beyond grayscale ultrasonography.

Overall, ultrasonography provides the principal anatomical and viability assessment in first-trimester pregnancy complications, while Doppler imaging may offer complementary vascular information in selected

cases. Their combined interpretation with clinical examination, laboratory investigations, and follow-up supports appropriate diagnostic assessment and clinical decision-making.

Conclusion

Ultrasonography plays a vital role in the diagnosis and evaluation of first-trimester pregnancy complications by assessing pregnancy location, viability, and associated abnormalities. Doppler imaging provides supplementary information regarding vascularity in selected cases. Their combined interpretation with clinical findings and follow-up helps guide appropriate management and assessment of clinical outcomes. Further studies with larger sample sizes are needed to establish the additional prognostic value of Doppler imaging.

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