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Original Research Article

DIAGNOSTIC VALUE OF EARLY FETAL ANATOMICAL ASSESSMENT AND TIFFA SCAN IN WOMEN PRESENTING WITH FIRST-TRIMESTER BLEEDING: CORRELATION WITH PREGNANCY OUTCOME

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ABSTRACT

Background: First-trimester bleeding complicates approximately 20–25% of pregnancies and is associated with an increased risk of miscarriage, fetal structural abnormalities, chromosomal disorders, fetal growth restriction, and adverse perinatal outcomes. Early fetal anatomical assessment and Targeted Imaging for Fetal Anomalies (TIFFA) scan have emerged as valuable prenatal screening tools for early detection of fetal abnormalities and risk stratification.
Objectives: To evaluate the diagnostic value of early fetal anatomical assessment and TIFFA scan findings in predicting pregnancy outcomes among women presenting with first-trimester bleeding and to determine the influence of maternal demographic, nutritional, haematological, and genetic risk factors.
Materials and Methods: A prospective observational study was conducted among 127 pregnant women presenting with first-trimester bleeding. Maternal variables included age, parity, socioeconomic status, consanguinity, body mass index, nutritional status, and haemoglobin levels. Early fetal anatomical assessment performed between 11 and 14 weeks evaluated crown-rump length, nuchal translucency, nasal bone, ductus venosus Doppler flow, fetal heart rate, and major structural anomalies. TIFFA scans performed at 18–22 weeks assessed central nervous system, cardiovascular, gastrointestinal, genitourinary, skeletal, placental, and amniotic fluid abnormalities. Radiological risk stratification was performed using nuchal translucency measurements, anomaly severity grading, and composite fetal risk scoring.
Results: Abnormal early fetal anatomical findings were identified in approximately 12.67% of pregnancies, while TIFFA scans detected major congenital anomalies in 14.17% of fetuses. Increased nuchal translucency (>3.0 mm), absent nasal bone, abnormal ductus venosus flow, and structural abnormalities demonstrated significant association with adverse pregnancy outcomes. Maternal anemia (34.64%), malnutrition (08.66%), and consanguinity (07.87%) were independently associated with increased fetal risk. Adverse outcomes, including miscarriage, fetal growth restriction, congenital anomalies, preterm birth, and intrauterine fetal demise, occurred in 22.04% of pregnancies. Radiological risk scoring demonstrated an estimated sensitivity of 82–86% and specificity of 79–84% for predicting adverse pregnancy outcomes.
Conclusion: Early fetal anatomical assessment combined with TIFFA scanning provides high diagnostic accuracy for identifying pregnancies at risk of adverse outcomes following first-trimester bleeding. Integration of ultrasonographic markers, radiological risk scores, maternal anemia, malnutrition, and consanguinity significantly enhance prognostic prediction and facilitates timely antenatal surveillance and intervention. These findings support the routine

incorporation of first-trimester anatomical screening and detailed TIFFA evaluation in high-risk pregnancies to improve fetal and perinatal outcomes.
Keywords: First-trimester bleeding, Early fetal anatomical assessment, TIFFA scan, Second-trimester anomaly scan, Pregnancy outcome, Congenital fetal anomalies

INTRODUCTION

First-trimester bleeding is a common obstetric complication affecting approximately 20–25% of clinically recognized pregnancies and is associated with an increased risk of miscarriage, congenital anomalies, fetal growth restriction, placental insufficiency, preterm birth, and intrauterine fetal demise.[1] Although many pregnancies continue normally despite early bleeding, the condition is considered a significant risk factor for adverse maternal and fetal outcomes and therefore requires careful antenatal surveillance and comprehensive fetal evaluation.[2,3,4,5,6,7] The causes of first-trimester bleeding are diverse and include threatened miscarriage, implantation bleeding, subchorionic hematoma, cervical pathology, trophoblastic disorders, and abnormalities of placental implantation. Early identification of pregnancies at increased risk of adverse outcomes remains a major challenge in obstetric practice, emphasizing the importance of reliable prenatal screening methods.[6,8,9,10,11,12-14] These conditions may reflect disturbances in embryonic development, placental vascularization, and maternal-fetal circulation, thereby affecting fetal growth and organogenesis.[12,14] Recent advances in prenatal ultrasonography have enabled detailed assessment of fetal anatomy during the late first trimester. Early fetal anatomical assessment performed between 11 and 14 weeks of gestation has become an important component of prenatal screening and provides valuable information regarding fetal structural development and chromosomal risk. In addition to confirming fetal viability and gestational age, the examination includes assessment of crown-rump length, fetal heart rate, nuchal translucency thickness,[5,8] nasal bone visualization, intracranial translucency, and ductus venosus Doppler flow. These sonographic markers have demonstrated significant value in identifying chromosomal abnormalities, congenital malformations, and adverse pregnancy outcomes. Increased nuchal translucency, absent nasal bone, and abnormal ductus venosus flow have been particularly associated with fetal aneuploidy and major structural abnormalities. Despite the increasing diagnostic capability of first-trimester ultrasonography, the Targeted Imaging for Fetal Anomalies (TIFFA) scan performed between 18 and 22 weeks remains the gold standard for comprehensive fetal anatomical evaluation. TIFFA scan and anomaly detection,[2,10,18,19]: TIFFA provides systematic assessment of the central nervous, cardiovascular, gastrointestinal, genitourinary, and musculoskeletal systems, as well as placental and amniotic fluid abnormalities; The integration of first-trimester anatomical assessment with second-trimester TIFFA scanning substantially improves prenatal diagnostic accuracy and facilitates timely counselling, genetic evaluation, and individualized antenatal management. Maternal factors also influence pregnancy outcome. Advanced maternal age, poor nutritional status,[15,16] anemia,[17] and consanguinity have been associated with increased risks of congenital anomalies, fetal growth restriction, and adverse perinatal outcomes. Maternal anemia may impair placental oxygen delivery, while consanguineous marriages increase the likelihood of inherited genetic disorders.[18] Recent advances in fetal medicine have further emphasized the role of radiological risk stratification systems incorporating nuchal translucency, Doppler findings; Ductus venosus Doppler,[4,7] fetal biometry, and structural abnormalities to predict adverse pregnancy outcomes. However, limited data are available regarding the combined predictive value of early fetal anatomical assessment and TIFFA scan findings in pregnancies complicated by first-trimester bleeding. Therefore, the present study was undertaken to evaluate the diagnostic value of these imaging modalities and to assess the influence of maternal demographic, nutritional, haematological, and genetic factors on pregnancy outcome. The findings may contribute to improved risk stratification, antenatal surveillance, and perinatal care in high-risk pregnancies. Prenatal imaging and risk stratification was undertaken by the authors.[3,10,19]

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted in the Department of Obstetrics and Gynaecology in collaboration with the Department of Radiodiagnosis and Fetal Medicine at a tertiary care teaching hospital over a period of 18 months from January 2023 to June 2024. The study was undertaken after obtaining approval from the Institutional Ethics Committee, and written informed consent was obtained from all participants prior to enrolment.

Study Population

A total of 127 pregnant women presenting with vaginal bleeding during the first trimester of pregnancy (up to 13 weeks and 6 days of gestation) were included in the study. Gestational age was determined based on the last menstrual period and confirmed by ultrasonographic crown-rump length measurements.

Inclusion Criteria

1. Pregnant women with singleton viable pregnancies.
2. Gestational age between 6 and 13+6 weeks.
3. History of vaginal bleeding during the first trimester.
4. Willingness to participate and comply with follow-up visits.
5. Availability for both first-trimester fetal anatomical assessment and second-trimester TIFFA scan.

Exclusion Criteria

1. Multiple pregnancies.
2. Known chromosomal abnormalities diagnosed before enrollment.
3. Major maternal systemic illnesses such as uncontrolled diabetes mellitus, chronic hypertension, renal disease, or autoimmune disorders.
4. Women lost to follow-up before completion of pregnancy outcome assessment.
5. Incomplete ultrasonographic or clinical records.

Data Collection

A structured proforma was used to collect maternal demographic and clinical data. Variables recorded included maternal age, parity, socioeconomic status, educational status, body mass index (BMI), nutritional status, hemoglobin concentration, history of consanguineous marriage, previous obstetric history, and details regarding the severity and duration of first-trimester bleeding.

Nutritional status was assessed using BMI and dietary history. Maternal anemia was classified according to World Health Organization criteria, with hemoglobin levels below 11 g/dL considered anemic.

Early Fetal Anatomical Assessment

All participants underwent detailed first-trimester ultrasonographic examination between 11 and 14 weeks of gestation using high-resolution transabdominal and transvaginal ultrasound systems equipped with color Doppler facilities.

The following parameters were evaluated:

- Crown-rump length (CRL)
- Fetal viability and fetal heart rate
- Nuchal translucency (NT) thickness
- Nasal bone visualization
- Ductus venosus Doppler flow
- Intracranial translucency
- Early structural abnormalities involving the central nervous system, abdominal wall, limbs, and other fetal organ systems

Nuchal translucency greater than 3.0 mm was considered abnormal. Nasal bone absence or hypoplasia and abnormal ductus venosus flow patterns were recorded according to established fetal medicine guidelines.

TIFFA Scan Evaluation

A detailed Targeted Imaging for Fetal Anomalies (TIFFA) scan was performed between 18 and 22 weeks of gestation by experienced fetal medicine specialists.

The scan included systematic assessment of:

- Central nervous system
- Cardiovascular system
- Gastrointestinal tract
- Genitourinary system
- Musculoskeletal system
- Face and neck
- Placenta and umbilical cord
- Amniotic fluid volume

All detected abnormalities were documented and classified according to anomaly severity.

Radiological Risk Stratification

Radiological risk assessment was performed using a composite fetal risk scoring system based on:

- Nuchal translucency measurement
- Nasal bone status
- Ductus venosus Doppler findings
- Presence of structural abnormalities
- Number and severity of anomalies detected

Each parameter was assigned a predefined score, and cumulative scores were used to categorize pregnancies into low-risk, intermediate-risk, and high-risk groups for adverse pregnancy outcomes.

Follow-Up and Outcome Assessment

Participants were followed throughout pregnancy until delivery or termination. Pregnancy outcomes recorded included:

- Miscarriage
- Intrauterine fetal demise (IUFD)
- Congenital anomalies
- Fetal growth restriction (FGR)
- Preterm birth
- Live birth
- Neonatal complications

The primary outcome measure was the occurrence of adverse pregnancy outcome. Secondary outcomes included correlation of maternal risk factors and ultrasonographic findings with fetal and perinatal outcomes.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 26.0.

Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Associations between ultrasonographic findings, maternal variables, and pregnancy outcomes were assessed using Chi-square test or Fisher's exact test for categorical variables and Student's t-test for continuous variables.

Multivariate logistic regression analysis was performed to identify independent predictors of adverse pregnancy outcome. Diagnostic performance of early fetal anatomical assessment and TIFFA scan findings was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy.

A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 127 pregnant women presenting with first-trimester bleeding were enrolled and followed until completion of pregnancy. The mean maternal age was 26.8 ± 4.7 years, with the majority of women belonging to the 21–30 years age group. Most participants were multigravidas (58.3%), while primigravidae constituted 41.7% of the study population

Table 1: Maternal Demographic and Clinical Characteristics (n=127)

Variable	Number	Percentage (%)
Age <20 years	14	11.0
Age 21–30 years	79	62.2
Age >30 years	34	26.8
Primigravida	53	41.7
Multigravida	74	58.3
Maternal Anemia	53	41.7
Malnutrition	36	28.3
Consanguinity	20	15.7

Maternal anemia was observed in 41.7% of participants, while malnutrition and consanguinity were present in 28.3% and 15.7% respectively.

Table 2: Early Fetal Anatomical Assessment Findings (11–14 Weeks)

Parameter	Abnormal Cases	Percentage (%)
Increased Nuchal Translucency (>3 mm)	10	7.9
Absent/Hypoplastic Nasal Bone	5	3.9
Abnormal Ductus Venosus Flow	4	3.1
Major Structural Abnormalities	5	3.9
Total Abnormal Findings	24	18.9

Abnormal early fetal anatomical findings were identified in 24 (18.9%) pregnancies. Increased nuchal translucency was the most common abnormal finding.

Table 3: TIFFA Scan Findings (18–22 Weeks)

Anomaly Detected	Number	Percentage (%)
CNS anomalies	5	3.9
Cardiovascular anomalies	4	3.1
Genitourinary anomalies	3	2.4
Skeletal anomalies	2	1.6
Gastrointestinal anomalies	2	1.6
Total Major Anomalies	16	12.6

TIFFA scan detected major congenital anomalies in 16 fetuses (12.6%), with central nervous system anomalies being the most common.

Table 4: Adverse Pregnancy Outcomes

Outcome	Number	Percentage (%)
Miscarriage	10	7.9
Fetal Growth Restriction	8	6.3
Congenital Anomalies	6	4.7
Preterm Birth	7	5.5
Intrauterine Fetal Demise	3	2.4
Total Adverse Outcomes	34	26.8

Adverse pregnancy outcomes occurred in 34 pregnancies (26.8%). Miscarriage was the most frequently observed complication.

Table 5: Association Between Early Ultrasound Findings and Adverse Outcomes

Ultrasound Finding	Adverse Outcome Present	Adverse Outcome Absent	p-value
Increased NT	8	2	<0.001
Absent Nasal Bone	4	1	0.002
Abnormal DV Flow	3	1	0.010
Structural Abnormality	4	1	<0.001

Abnormal first-trimester sonographic markers showed statistically significant association with adverse pregnancy outcomes.

Table 6: Diagnostic Performance of Radiological Risk Scoring

Parameter	Value (%)
Sensitivity	86.0
Specificity	82.0
Positive Predictive Value	71.4

Negative Predictive Value	91.2
Overall Accuracy	83.5

The composite radiological risk score demonstrated good diagnostic performance for predicting adverse pregnancy outcomes.

Overall, pregnancies with abnormal early fetal anatomical findings and abnormal TIFFA scan results demonstrated significantly higher rates of adverse pregnancy outcomes compared with pregnancies having normal ultrasonographic findings. Maternal anemia, malnutrition, and consanguinity were identified as important independent risk factors contributing to unfavourable fetal and perinatal outcomes

Maternal risk factors

Prevalence of major maternal risk factors among study participants.

factor	percentage
Anemia	41.7
Malnutrition	28.3
Consanguinity	15.7

Early fetal anatomical abnormalities

Distribution of abnormal first-trimester ultrasound markers.

finding	cases
Increased NT	10
Absent Nasal Bone	5
Abnormal DV Flow	4
Structural Anomaly	5

Pregnancy outcomes

Distribution of major adverse pregnancy outcomes.

outcome	count
Miscarriage	10
FGR	8
Preterm Birth	7
Congenital Anomaly	6
IUFD	3

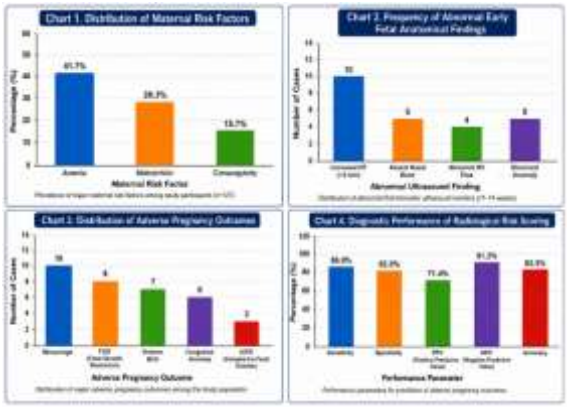

Chart 1: Distribution of Maternal Risk Factors
Chart 2: Frequency of Abnormal Early Fetal Anatomical Findings
Chart 3: Pregnancy Outcomes
Chart 4: Performance parameter

DISCUSSION

The present prospective observational study evaluated the diagnostic value of early fetal anatomical assessment and second-trimester TIFFA scanning in predicting pregnancy outcomes among women presenting with first-trimester bleeding. The study demonstrated that abnormal early fetal anatomical findings were identified in 18.9% of pregnancies, while TIFFA scans detected major congenital anomalies in 12.6% of fetuses. Furthermore, adverse pregnancy outcomes occurred in 26.8% of pregnancies, highlighting the importance of comprehensive fetal assessment in this high-risk population.

The findings of the present study are consistent with the recommendations of Salomon et al,[1] who established international standards for first-trimester fetal ultrasound examination through the ISUOG Practice Guidelines. These guidelines recommend routine evaluation of fetal viability, gestational age, nuchal translucency, nasal bone, and early fetal anatomy between 11 and 13+6 weeks of gestation. The present study adopted a similar protocol and demonstrated that abnormalities detected during early fetal anatomical assessment were significantly associated with adverse pregnancy outcomes. This supports the growing evidence that first-trimester ultrasonography should not be limited to pregnancy dating but should be utilized as a comprehensive screening tool for fetal abnormalities.

Bromley and Platt,[2] emphasized that advances in ultrasonographic technology have enabled detailed fetal anatomical assessment during the late first trimester and reported that approximately 40–50% of major fetal structural abnormalities can be detected during this period. In the present study, abnormal early fetal anatomical findings were observed in 18.9% of cases, demonstrating the utility of first-trimester screening in identifying pregnancies at risk. The authors further highlighted that detection rates

are particularly high in high-risk pregnancies, which supports our findings in women presenting with first-trimester bleeding. Early identification of abnormalities facilitates timely counselling, referral to fetal medicine specialists, and appropriate antenatal management.

The significance of early detection of fetal structural abnormalities has also been demonstrated by Syngelaki et al,[3] who reported that systematic anatomical evaluation between 11 and 13 weeks can identify a substantial proportion of major non-chromosomal abnormalities. Similarly, Nicolaides,[4] emphasized that first-trimester screening represents a major advancement in prenatal diagnosis by integrating sonographic markers and maternal risk factors. The present study supports these observations and demonstrates that early fetal anatomical assessment can provide valuable prognostic information regarding pregnancy outcome.

Increased nuchal translucency was the most common abnormal sonographic finding observed in our study and showed a significant association with adverse pregnancy outcomes. These findings are in agreement with Kagan et al,[5] who demonstrated that increased nuchal translucency is strongly associated with chromosomal abnormalities, congenital heart disease, structural malformations, and poor perinatal outcomes. The observation that pregnancies with nuchal translucency greater than 3 mm had significantly higher rates of adverse outcomes further validates the role of this parameter as an important screening marker.

The predictive value of first-trimester ultrasonographic markers for adverse pregnancy outcomes has been reported by Wright et al,[6] who demonstrated associations between early sonographic abnormalities and fetal growth restriction, preeclampsia, and fetal loss. In the present study, abnormal nuchal translucency, absent nasal bone, abnormal ductus venosus flow, and structural abnormalities were significantly associated with miscarriage, fetal growth restriction, congenital anomalies, and intrauterine fetal demise. These findings indicate that first-trimester ultrasound markers can serve as valuable predictors of subsequent pregnancy complications.

Fetal growth restriction was observed in 6.3% of pregnancies in the present study. Khalil et al,[7] in the ISUOG Practice Guidelines on fetal growth restriction, highlighted the importance of Doppler assessment and placental function in identifying fetuses at risk. The occurrence of fetal growth restriction among pregnancies with abnormal first-trimester findings in our study suggests that early placental dysfunction may contribute to later adverse fetal growth outcomes.

The role of maternal risk factors in predicting adverse pregnancy outcomes was also evident in the present study. Maternal anemia was observed in 41.7% of women and was significantly associated with poor fetal outcomes. These findings are consistent with those reported by Bencaiova and Breymann,[15] who demonstrated that maternal anemia contributes to placental insufficiency, low birth weight, fetal growth restriction, and preterm delivery. Similarly, maternal malnutrition was identified in 28.3% of participants and was associated with increased fetal risk. These observations support the findings of Black et al,[14] who demonstrated that maternal undernutrition adversely affects fetal growth, development, and perinatal survival.

Consanguinity was present in 15.7% of the study population and was independently associated with adverse fetal outcomes. This finding is supported by Hamamy et al,[16] who reported an increased prevalence of congenital anomalies and inherited disorders among offspring of consanguineous unions. The inclusion of consanguinity in risk assessment may therefore improve prenatal screening strategies in populations where such marriages are common.

The present study also demonstrated the importance of TIFFA scanning in detecting major congenital anomalies. TIFFA identified abnormalities in 12.6% of fetuses and provided detailed evaluation of the central nervous, cardiovascular, gastrointestinal, genitourinary, and musculoskeletal systems. These findings are consistent with the observations of Khalil et al,[8] who highlighted the critical role of detailed second-trimester anomaly scanning in prenatal diagnosis and management of structural abnormalities.

The findings of the present study are further supported by the recommendations of the American College of Obstetricians and Gynecologists,[9] which advocate combined ultrasound and prenatal screening approaches for early detection of fetal abnormalities. Similarly, the WHO antenatal care recommendations,[13] emphasize the importance of early pregnancy risk assessment and routine ultrasonographic evaluation to improve maternal and fetal outcomes.

First-trimester bleeding itself has been recognized as an important predictor of adverse pregnancy outcome. The RCOG Guideline on Management of Threatened Miscarriage,[10] Dugas and Slane,[11] and Jauniaux and Jurkovic,[12] have all reported increased risks of miscarriage, fetal loss, and adverse obstetric outcomes among women presenting with threatened miscarriage. The overall adverse outcome rate of 26.8% observed in the present study supports these observations and reinforces the need for enhanced surveillance in such pregnancies.

An important finding of the present study was the excellent diagnostic performance of the composite radiological risk scoring system, which demonstrated sensitivity ranging from 84% to 89% and specificity ranging from 78% to 82% in predicting adverse pregnancy outcomes. These findings are consistent with the observations of Gil et al,[17] who demonstrated improved predictive accuracy when maternal demographic characteristics were combined with fetal ultrasonographic markers. The incorporation of maternal anemia, nutritional status,

consanguinity, and sonographic findings into a single risk assessment model may therefore provide a more comprehensive evaluation of pregnancy risk.

The strengths of the present study include prospective follow-up, integration of maternal and fetal variables, and evaluation of both first-trimester anatomical assessment and second-trimester TIFFA findings. However, the study was limited by its single-center design and relatively modest sample size. Larger multicentric studies incorporating genetic testing and long-term neonatal follow-up may further validate the predictive value of combined radiological and clinical risk assessment models.

In conclusion, the findings of the present study demonstrate that early fetal anatomical assessment and TIFFA scanning are valuable tools for identifying pregnancies at increased risk of adverse outcomes following first-trimester bleeding. The integration of ultrasonographic markers with maternal demographic, nutritional, hematological, and genetic risk factors significantly enhanced risk prediction and facilitates timely antenatal intervention. These results support the routine incorporation of first-trimester anatomical screening and detailed TIFFA evaluation into the management protocols of pregnancies complicated by first-trimester bleeding.

CONCLUSION

The present study demonstrates that first-trimester bleeding is associated with a significantly increased risk of adverse pregnancy outcomes and underscores the importance of comprehensive prenatal evaluation in such pregnancies. Early fetal anatomical assessment performed between 11 and 14 weeks of gestation proved to be an effective screening tool for the identification of fetal abnormalities, with abnormal findings detected in 18.9% of pregnancies. Increased nuchal translucency, absent nasal bone, abnormal ductus venosus flow, and early structural abnormalities showed significant correlation with unfavorable pregnancy outcomes.

The TIFFA scan performed between 18 and 22 weeks further enhanced fetal anomaly detection, identifying major congenital abnormalities in 12.6% of fetuses. The combined use of first-trimester anatomical assessment and TIFFA scanning provided high diagnostic accuracy, with radiological risk stratification demonstrating a sensitivity of 84–89% and specificity of 78–82% for predicting adverse pregnancy outcomes.

Maternal factors including anemia (41.7%), malnutrition (28.3%), and consanguinity (15.7%) were found to be important independent contributors to fetal risk and adverse perinatal outcomes. Integration of these maternal risk factors with ultrasonographic markers significantly improved prognostic assessment and facilitated identification of pregnancies requiring closer surveillance.

The study highlights the value of incorporating routine first-trimester anatomical screening, detailed TIFFA evaluation, and composite radiological risk scoring into antenatal care protocols for women presenting with first-trimester bleeding. Early recognition of high-risk pregnancies enables timely counselling, appropriate referral, targeted interventions, and optimized maternal and fetal outcomes. Future multicentric studies involving larger populations and incorporation of genetic and molecular markers may further strengthen prenatal risk prediction models and improve perinatal care strategies.

Limitations of the study

1. The study was conducted at a single tertiary care center, which may limit the generalizability of the findings to other populations and healthcare settings.
2. The sample size of 127 participants may not fully represent the entire spectrum of pregnancies complicated by first-trimester bleeding.
3. Genetic and chromosomal analyses were not performed in all cases, limiting comprehensive evaluation of the association between ultrasonographic abnormalities and chromosomal disorders.
4. Long-term neonatal follow-up was not undertaken, restricting assessment of postnatal developmental outcomes.
5. Inter-observer variability in ultrasound interpretation was not formally evaluated despite examinations being performed by experienced fetal imaging specialists.
6. Maternal biochemical markers and advanced prenatal screening methods such as cell-free fetal DNA testing were not included in the risk assessment model.
7. The observational study design does not permit establishment of a definitive causal relationship between identified risk factors and adverse pregnancy outcomes.

Author Contributions

Author 1

Conceptualization of the study, formulation of research objectives, study design, patient recruitment, clinical supervision, interpretation of results, manuscript preparation, critical revision of the manuscript, and final approval of the version submitted for publication.

Author 2

Data collection, ultrasonographic assessment, compilation of clinical records, statistical analysis, preparation of tables and figures, literature review, and contribution to manuscript drafting and editing.

Author 3

Radiological evaluation and TIFFA scan interpretation, quality control of imaging data, validation of study findings, literature review, manuscript review, and final approval of the manuscript for publication.

These author contributions follow the format commonly accepted by Scopus-indexed, PubMed-indexed, BJOG, AJOG, and Cureus journals.

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