**Research Article**

# Prediction of early pregnancy failure by use of first trimester ultrasound screening

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**ABSTRACT**

**Background:** Spontaneous miscarriage is defined as an involuntary termination of pregnancy before 20th week of gestation or spontaneous expulsion of fetus below a fetal weight of 500 gm. The introduction of ultrasound into the obstetrical practice has been extremely useful in providing better understanding of the etiology of the first trimester spontaneous abortion and a basis for its clinical classification and management. The aims and objective of this study is to assess the early pregnancy developmental changes in first trimester ultrasound screening, identify abnormal ultrasound parameters and correlate the ultrasonic findings with the clinical outcomes and also to analyze the success of conservative management on patients.
**Methods:** The study included 150 patients attending OPD/emergency within 5-12 weeks of gestation fulfilling the exclusion and inclusion criteria.
**Results:** The abortion rate in our study was 16%. Seventy two percent of abortion occurred at 8-12 weeks of gestation. Threatened abortion was noted in 10% of the patients. Sixteen percent of patients had abnormal USG findings in terms of large yolk sac, abnormal mean sac diameter, crown rump length, embryonic bradycardia, increased resistive index and intrauterine hematoma.
**Conclusions:** This study emphasizes the role of ultrasound in prediction of early pregnancy failure in first trimester. It also stresses on the importance of learning obstetric ultrasound and performing obstetric practice in the community with precision and perfection.

**Keywords:** Early pregnancy failure, Spontaneous abortion, First trimester ultrasonographic screening

## INTRODUCTION

Spontaneous miscarriage is involuntary termination of pregnancy before 20th week of gestation or spontaneous expulsion of fetus below fetal weight of 500 gram.[1] Approximately 12-24% of all pregnancies suffer miscarriages and most of the early miscarriages are caused by chromosomal abnormalities, and the risk of which increases with maternal age.[2] Antenatal ultrasonography (USG) has revolutionized the management of early pregnancy failure.[3] First trimester of

pregnancy is the most important period of human development in which single cell transforms into a recognizable human being.[4] USG plays an important role in assessing establishment and evaluation of early pregnancy.[5] It also helps in diagnosing any untoward events in early pregnancy and may guide its appropriate management.[6] Therefore, USG is an easily available tool to differentiate normal from abnormal pregnancy.[7]

This study is aimed to assess the accuracy of first trimester USG markers as mean gestational sac diameter

(MGSD), Yolk sac diameter (YS), crown rump length (CRL), MGSD-CRL, embryonic heart rate (EHR) and 1st trimester decidual artery Doppler in first trimester of pregnancy to predict the risk of early pregnancy failure (EPF).

Also to assess the early pregnancy developmental changes in first trimester ultrasound screening, to identify any abnormal ultrasound parameters, to correlate abnormal ultrasound findings with clinical outcome measured in terms of spontaneous or missed abortion. This study also aims to analyze the success of conservative management on patients presented with threatened abortion on the basis of early ultrasound findings and to analyze the outcome of pregnancy up to 20 weeks and any later sequel as pregnancy advances.

## METHODS

The study was approved by ethical committee and an informed consent was taken from all participants.

This was a prospective observational study conducted in the department of obstetrics and gynecology, ESIC-PGIMSR, JOKA, from May 2012 to April 2013. The study included 150 patients attending outpatients department or admitted in the hospital within 5-12 weeks of gestation fulfilling inclusion and exclusion criteria.

### Inclusion criteria

All age, any parity, single intrauterine pregnancy, pregnant women with estimated gestational age of 5-12 weeks, subjects with accurate last menstrual period (LMP) with previous history of regular cycle and any subject of threatened abortion.

### Exclusion criteria

Patient's refusal, multiple pregnancies, known fetal or uterine abnormalities, chronic diseases in pregnant women like; heart disease, diabetes, chronic hypertension, renal diseases, bronchial asthma, etc. Also patients who terminated their pregnancy electively or who lost to follow up were excluded from our study.

All USG were done and reviewed by a single radiologist experienced in obstetric sonography to reduce the observational bias.

Following parameters were measured by transabdominal sonography (TAS) at 5-12 weeks of gestation:

a) Mean gestational sac diameter,
b) Yolk sac diameter, morphology of yolk sac,
c) Crown rump length,
d) MGSD-CRL difference,
e) Embryonic heart rate,
f) 1st trimester decidual artery Doppler.

Gestational age was calculated by modified Naegele's rule. LMP derived gestational age was compared with ultrasound derived gestational age using CRL and marked discrepancy of one or more weeks led to exclusion of participants from the study.

MGSD was assessed by averaging three dimensions (longitudinal, anteroposterior and transverse). Sac was measured from inside of the sac to the inside of the decidual reaction; excluding the latter in the measurement.

YS were determined by placing calipers on the inner limits of the longer diameter. Size of the sac, shape, echogenicity of the rim and centre of sac, its number and degenerative changes such as calcification were evaluated. YS having diameter between 3-6 mm, rounded shape, absence of degenerative changes, presence of echogenic rim and hypoechoic centre were considered normal. Any deviation from above parameters was considered abnormal.

CRL was measured in sagittal plane of the embryo avoiding inclusion of YS. This was recorded as an average of three measurements. CRL >9 mm in TAS who fail to demonstrate heart beat was judged non-viable and CRL <9 mm without a visible heart beat returned for repeat USG after one week. MGSD-CRL of less than 5mm was associated with poor outcome. EHR of less than 100 beats per minute at 8 weeks or earlier was classified as slow. First trimester decidual artery Doppler was assessed and RI of 0.55 or above for any site was considered abnormal. Patients were then followed up until delivery for any complication including miscarriage, gestational hypertension (GH), intrauterine growth restriction (IUGR), abruption or preterm delivery. Patients with abnormal initial study were scanned every week. Volume of intrauterine hematoma (IUH) was estimated by measuring the maximum transverse, anteroposterior and longitudinal diameters and multiplying these values by constant of 0.52 as a correction for crescent shape of hematoma. Outcome of pregnancy was evaluated according to initial hematoma volume (milliliters), gestational age and maternal age at the time of diagnosis.

Outcome of pregnancy was defined as adverse if there was spontaneous abortion at 20 weeks of gestation. EPF is said when abortion occurred at ≤12 weeks and late when abortion occurred after 12 weeks of gestation. IUGR was defined as birth weight of less than tenth percentile for gestational age according to the population norms; delivery before 37 weeks of gestation was defined as the preterm. Placental abruption was defined after noting any retro-placental clot. GH was defined as blood pressure of ≥140/90 mm Hg at least two readings taken 6 hours apart at any gestational age after 20 weeks.

## RESULTS

We included 150 patients in this study fulfilling the predefined inclusion and exclusion criteria. On the basis of outcome of pregnancy, assessment of prediction value of early USG parameters on pregnancy outcome was observed and analyzed statistically.

## DISCUSSION

Spontaneous abortion accounts for approximately 17-22% of pregnancies and approximately 12-15% of recognized pregnancies undergo miscarriage.[8,9] This imposes a serious physical, psychological and social distress in both patient and their relatives. In our study majority of the individuals were young i.e.; in the age group of 20-25 years whereas 16.66% of the individuals were found to be above 30 years of age. Thirty percent of patients in our study were primigravida and rests were parous (Table 1). 16.66% of pregnancies suffered spontaneous abortion in our study, out of which 32% were more than 30 years of age. There is an increasing tendency of early miscarriage (40%) among those who had previous history of one or more miscarriage (Table 1) which points towards the increasing risk of recurrence and hence imposes the importance of close follow up in these individuals. Initial period of conception is most vital as majority of the abortions occur before 12 weeks gestational age and fewer than 5% occur after identification of fetal heart activity.[10] Second trimester loss, between 12-24 weeks, occurs less frequently and constitutes <4% of pregnancy outcomes.[11] In our series of observation amongst 150 cases studied, out of 16.66% spontaneous abortion cases, 72% occurred at 8-12 weeks of gestation (Table 1).

### Table 1: Total number of patients (n=150).

| | Age (years) | | | |
|---|---|---|---|---|
| **Age distribution** | **<20** | **21-25** | **26-30** | **>30** |
| | 20 (13.33%) | 60 (40%) | 45 (30%) | 25 (16.66%) |
| Parity distribution | Parity | | | |
| | P0+0 | P0+1-P0+3 | P 1+0-P2+0 | P3+0 |
| | 45 (30%) | 50 (33.3%) | 40 (26.7%) | 15 (10%) |
| Total number of abortion in relation to maternal age (n=25) | Age (years) | | | |
| | <20 | 21-25 | 26-30 | >30 |
| | 5 (20%) | 6 (24%) | 6 (24%) | 8 (32%) |
| Total number of abortion in relation to parity (n=25) | Parity | | | |
| | P0+0 | P0+1-P0+3 | P 1+0-P2+0 | P3+0 |
| | 4 (16%) | 10 (40%) | 6 (24%) | 5 (20%) |
| Total number of abortion in relation to period of gestation (n=25) | Period of gestation (weeks) | | | |
| | <8 | 8-12 | 12-20 | |
| | 4 (16%) | 18 (72%) | 3 (12%) | |

### Table 2: Incidence of abnormal USG parameters in total 150 patients.

| Parameters | Number | Percentage |
|---|---|---|
| Yolk sac size >6 mm | 4 | 2.66 |
| Mean sac diameter >25 mm with yolk sac but no embryo | 3 | 2 |
| Mean sac diameter >25 mm with large embryo | 4 | 2.66 |
| Mean sac diameter: crown rump length <5 mm | 4 | 2.66 |
| Mean sac diameter: crown rump length <5 mm, no cardiac activity | 3 | 2 |
| Crown rump length >9 mm, no cardiac activity | 10 | 6.66 |
| Embryonic heart rate <100/minute | 2 | 1.33 |
| Resistive index >0.55 | 8 | 5.33 |
| Intrauterine hematoma | 4 | 2.66 |
| Intrauterine hematoma with resistive index >0.55 | 2 | 2.66 |

Increasing maternal age has been found to be a risk factor for miscarriage.[12] We also found that out of 25 abortion cases, majority (32%) of abortions were noted among mothers more than 30 years of age (Table 1). The incidence of abnormal USG parameters amongst 150 cases (Table 2) and the incidence of individual parameters among the total abnormal parameters (n=35) were studied (Table 3).

The findings of our study demonstrate that prediction of subsequent miscarriage in singleton pregnancies presenting with a live embryo is provided by a combination of maternal factors, including age, parity, history of vaginal bleeding and ultrasound measurements of MGSD, YS, CRL, EHR, RI and IUH.

Gestational sac (GS) is the first definitive landmark of pregnancy which is consistently visible by 5 weeks of gestation, even with TAS, GS should be at least 10 mm larger than the CRL.[13] Higher rate of pregnancy loss is noted with a difference of less than 5 mm between GS

and CRL.[13] We found 50% of miscarriages in association with small MSD or, MSD-CRL <5 mm. YS should be seen by 7 weeks gestation. Abnormal size of YS leads to spontaneous miscarriage.[14] Our study showed that 50% of EPF occurred with abnormally large YS (Table 3) (Figure 1). Embryo should be present where MSD is >25 mm. Approximately 94% of EPF occur in MSD >25 mm without an embryo.[15] Our study showed 100% abortion rate with MSD >25 mm without an embryo which signifies a very high positive correlation between MSD >25 mm without an embryo and incidence of early abortion (Table 3).

**Table 3: Inter-relationship of different USG parameters with pregnancy outcome and prediction value (PV) (n=35).**

| Size of yolk sac | Live | Dead | PPV | NPV | P value |
|---|---|---|---|---|---|
| >6 mm, n=4 | 2 (50%) | 2 (50%) | 50% | 50% | 0.0083 |
| <6 mm, n=115 | 112 (97.4%) | 3 (2.60%) | 97.4% | 2.6% | |
| **MSD >25 mm and embryo** | **Live** | **Dead** | | | |
| Absent embryo, n=3 | 0 | 3 (100%) | 100% | 0 | 0.0001 |
| Embryo present, n=115 | 112 (97.4%) | 3 (2.60%) | 97.4% | 2.6% | |
| **CRL >9 mm and cardiac activity** | **Live** | **Dead** | | | |
| Absent , n=10 | 0 | 10 (100%) | 100% | 0 | 0.0001 |
| Present , n=115 | 112 (97.4%) | 3 (2.60%) | 97.4% | 2.6% | |
| **MSD-CRL N=150** | **Live** | **Dead** | | | |
| <5 mm, n=4 | 2 (50%) | 2 (50%) | 50% | 50% | 0.0083 |
| Present >5 mm, n=115 | 112 (97.4%) | 3 (2.60%) | 97.4% | 2.6% | |
| **Embryonic heart rate** | **Live** | **Dead** | | | |
| <100/min, n= 2 | 0 | 2 (100%) | 100% | 0 | 0.0015 |
| >100/min, n=115 | 112 (97.4%) | 3 (2.60%) | 97.4% | 2.6% | |
| **Resistive index** | **Live** | **Dead** | | | |
| >0.55, n=8 | 6 (75%) | 2 (25%) | 25% | 75% | 0.0037 |
| <0.55, n=115 | 112 (97.4%) | 3 (2.60%) | 97.4% | 2.6% | |
| **Intrauterine hematoma** | **Live** | **Dead** | | | |
| Present, n=4 | 3 (75%) | 1 (25%) | 25% | 75% | 0.1294 |
| Absent, n=115 | 112 (97.4%) | 3 (2.60%) | 97.4% | 2.6% | |

The single most important feature for confirmation of embryonic and fetal life is identification of cardiac activity. The cutoff CRL for detecting cardiac activity by TVS is 4 mm and by TAS is 9 mm.[15,16] Our observation is in concordance with the above observation (Table 3). Fetal cardiac activity is the earliest proof of a viable pregnancy.[17]



**Figure 1: Size of yolk sac (YS>9 mm).**



**Figure 2: Embryonic heart rate less than 100 bpm.**

Several studies documented that a slow EHR at 7-9 weeks gestation is associated with high rate of first trimester pregnancy demise.[18] We found two patients with embryonic bradycardia (<100 beats/min) and both cases suffered EPF (Table 3) (Figure 2). So, we firmly consider evaluation of EHR as soon as possible in all pregnancies because regardless of the presence of symptoms, it is a consistent parameter in the outcome of pregnancy.
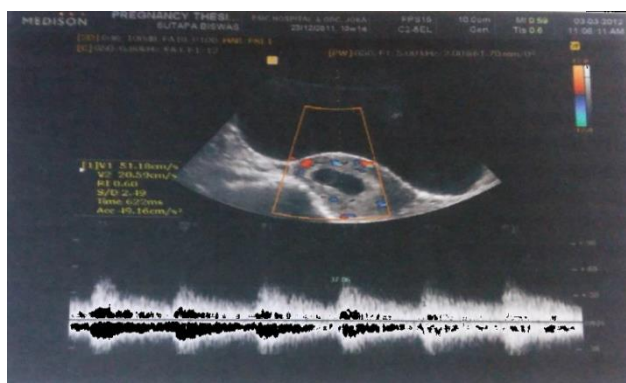
**Figure 3: Raised RI (>0.55) of spiral arteries.**



**Figure 4: Subchorionic collection.**

There is an association between incidence of first trimester miscarriage and women with abnormal RI (>0.55).[19] Our study demonstrated loss of 25% of pregnancy in women having abnormal RI (Table 3) (Figure 3).

A study on the effects of IUH on pregnancy outcome showed that out of 92 (8.5%) patients with IUH, 20.70% patients aborted in the late first and early 2nd trimester of

pregnancy.[20] When outcome was assessed in relation to size of hematoma, 7 of 37 patients (19%) who had small hematoma (13.1cm$^2$) aborted, compared with 12 (21.8%) of 55 patients with large hematoma (13.2cm$^2$).[20] We found only four cases with IUH and one of them (25%) which had IUH volume >10 ml on USG ended in early miscarriage (Table 3) (Figure 4).

**Table 4: Comparison of association of pregnancy failure between normal and abnormal USG parameters in threatened abortion cases (n=16).**

| USG parameters | Dead | Live | PPV | NPV | P-value |
|---|---|---|---|---|---|
| Abnormal n=6 | 6 (100%) | 0 | 100% | 0% | 0.0070 |
| Normal n=10 | 2 (20%) | 8 (80%) | 80% | 20% | |

**Table 5: Different abnormal USG parameters observed (out of 6).**

| Parameters | Dead | Live | PPV | NPV | P-value |
|---|---|---|---|---|---|
| MSD-CRL <5mm, n=2 | 2 (100%) | 0 | 100% | 0% | 0.0909 |
| CRL >9 mm with no EHR, n=2 | 2 | 0 | 100% | 0% | 0.0909 |
| EHR <100/min, n=1 | 1 | 0 | 100% | 0% | 0.2727 |
| IUH, n=1 | 1 | 0 | 100% | 0% | 0.2727 |
| Normal USG parameters, n=10 | 2 (20%) | 8 (80%) | 80% | 20% | 0.0909 |

**Table 6: Spiral arteries RI in relation with late adverse pregnancy outcome.**

| Parameter | Normal outcome | Preterm delivery | Gestational hypertension | Abruption | IUGR |
|---|---|---|---|---|---|
| RI>0.55, n= 6 | 1 (16.66%) | - | 3 (50%) | - | 2 (33.33%) |
| RI<0.55,n= 115 | 79 (68.69%) | 13 (11.30%) | 12 (10.43%) | - | 11 (9.56%) |

Study indicates that out of six abnormal USG parameters amongst threatened abortion cases, 100% cases aborted in comparison to 20% abortions in patients with normal USG parameters (Table 4) and all the abnormal parameters were predictive of poor pregnancy outcome (Table 5).

The association of RI and late pregnancy complications were also studied (Table 6). 33.33% fetuses suffered IUGR and 50% women developed GH. In both cases RI was raised in first trimester which signifies a definite

relation among the above parameters. Significant association was seen in increased RI with GH but no significant association was found with IUGR.

This study also found an increased incidence of late adverse outcome like preterm delivery, hypertension, abruption and IUGR among the patients with IUH and pregnancy with otherwise normal USG parameters in first trimester (Table 7).

**Table 7: Incidence of late adverse outcome among the patients with IUH and pregnancy with normal USG parameters in first trimester.**

| Parameter | Normal outcome | Preterm delivery | Hypertension | Abruption | IUGR |
|---|---|---|---|---|---|
| IUH, n= 3 | - | 2 (66.66%) | 1 (33.33%) | - | - |
| Normal, n= 115 | 79(68.69%) | 13 (11.30%) | 12 (10.43%) | - | 11(9.56%) |

## CONCLUSION

USG plays a vital role in early stage of pregnancy. It gives an accurate diagnosis in majority of pregnant women in the first trimester and also defines a reliable differentiation between viable pregnancy and ongoing abnormal pregnancy. Being an easily available, quick, safe, reliable, and reproducible non-invasive investigation, USG plays an important role in differentiating normal from abnormal pregnancies and therefore in predicting its wellness accurately. The chronological development and growth of GS, timely appearance of YS, CRL, its cardiac activity and heart rate can be very well assessed by USG during the period of organogenesis and any later adverse outcome can therefore be very well predicted. It also stresses importance of obstetricians to get trained in obstetric sonology.

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