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Hanaa Abd El-Moniem Younis

Department of Obstetrics and Gynecology, Faculty of Medicine for Girls, Al-Azhar University, Cairo, Egypt.

Reda Tawfik Mohamed

Department of Obstetrics and Gynecology, Faculty of Medicine for Girls, Al-Azhar University, Cairo, Egypt.

Aliaa Hussein Abd El-Aziz

Department of Obstetrics and Gynecology, Faculty of Medicine for boys, Al-Azhar University, Cairo, Egypt,
aliaahussein81@gmail.com

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Gestational Sac Size, Yolk Sac Size, and Embryonic Cardiac Activity as Prognostic Factors of First-Trimester Pregnancy Outcomes

Hanaa Abd El-Moniem Younis, Reda Tawfik Mohamed, Aliaa Hussein Abd El-Aziz*

Department of Obstetrics and Gynecology, Faculty of Medicine for Girls, Al-Azhar University, Cairo, Egypt

Abstract

Background: The accurate difference between normal pregnancy and abnormal pregnancy in early gestation remains a challenge clinically. Different studies have previously described the association between fetal well-being and gestational sac characteristics. Yolk sac first appears at 5 weeks gestation and becomes visible by ultrasound, while the fetal heart rate appears at 6 weeks gestation and these can be used as prognostic parameters for first-trimester outcomes in pregnancy.

Study aim: Relation of the ultrasound parameters in early pregnancy (gestational sac size, yolk sac, and embryonic cardiac activity) to early fetal demise.

Patients and methods: This was a hospital-based cross-sectional study conducted in the outpatient clinic and Emergency Department – Obstetrics and Gynecology Department – El Monera General Hospital on 100 pregnant women in their first trimester. Patients were subjected to general examination and abdominal and local clinical examination.

Result: Gestational sac diameter at different gestational ages was significantly higher among the ongoing pregnancy group compared with the pregnancy loss group.

Conclusion: Based on our findings we concluded that yolk sac diameter, gestational sac diameter, Crown-rump length in different gestational ages, and cardiac activity at sixth and seventh weeks were significantly higher among the ongoing pregnancy group; yolk sac diameter, gestational sac diameter, and fetal heart rate were significant predictors for pregnancy loss.

Keywords: Embryonic heart rate, Gestational sac diameter, Yolk sac diameter

1. Introduction

Ultrasound has been used in early pregnancy to determine whether the fetus is healthy or not, identify the location and number of pregnancies, detect viability, and to detect fetal malformations.¹

The gestational sac with its thickened decidua is the first evidence of pregnancy seen by the ultrasound. It is possible to identify the gestational sac by 4 weeks and 3 days gestation by transvaginal ultrasound when the mean sac diameter is 2–3 mm.²

The embryo is visualized by the transvaginal ultrasound between the fifth and seventh week of pregnancy when its length is 1–2 mm.³

The heart is a vital organ in the human body. It is developed in the embryo between 3 and 6 weeks of gestation. A functional heart that can be visualized by Doppler ultrasound is the first sign of cardiac activity.⁴

Several studies have been elucidated concerning severe embryonic bradycardia with the subsequent fetal loss.⁵

Multiple studies have evaluated the value of demographic features and sonographic elements in determining the pregnancies at risk of miscarriage showing the association between the high risk of miscarriage and previous history of miscarriage, vaginal bleeding, fetal bradycardia, small gestational

sac size, large-sized yolk sac, early-onset fetal growth restriction, and advanced maternal age.⁶

The aim of study was to assess the relation between ultrasound parameters in early pregnancy to early fetal demise.

2. Patients and methods

The is a hospital-based cross-sectional study that was carried out in the outpatient clinic and Emergency Department – Obstetrics and Gynecology Department – El Monera General Hospital on a total of 100 pregnant women after very early detection of pregnancy. Ten of these cases had a history of recurrent pregnancy loss, while pregnant women above 8 weeks gestation and women with multifetal pregnancy or with symptoms of threatened abortion at the initial antenatal visit.

2.1. Methods

Informed consent (oral and written) was taken from all participants in this study explaining the benefits and the absence of risks.

Patients were subjected to complete history taking: personal history including name, age, marital state, address, demographic data, menstrual history including menstrual disturbance, dysmenorrhea, related symptoms, obstetric history, the method used to confirm pregnancy, symptoms of the current pregnancy, complete medical and surgical history, history of hypertension (HTN), diabetes mellitus (DM), autoimmune disease, for example, systemic lupus or rheumatoid arthritis, family history, for example, autoimmune disease, HTN and DM and history of allergy to any medication, and blood transfusion.

2.2. Examination (general, abdominal, and local)

Investigation for cases with recurrent pregnancy loss: anticardiolipin antibodies, lupus anticoagulants, anti-B2 glycoprotein (IgG and IgM) antibodies, thyroid-stimulating hormone, T4, antithyroid antibodies, HbA1c, FBS, prolactin.

Procedure: a first ultrasound scan: after early diagnosis with a pregnancy test between 5 and 7 weeks of gestation that included the following: gestational sac measurement in longitudinal and transverse views and their diameters were averaged. The yolk sac diameter (YSD) is measured from the inner edges of the longitudinal diameter of the sac. Crown-rump length (CRL) measurement was done according to (Pexsters methods 2011) by placing the calipers correctly on the embryo between the crown

(top of the head) and the rump (end of the trunk). Fetal heart rate measurement was obtained transvaginally using M-mode sonography. Examination of both adnexae was carried out to exclude extrauterine pregnancy; the presence of fluid or blood in the Douglas pouch was documented. Assessments were done using transvaginal ultrasound or/and transabdominal ultrasound. Miscarriage is diagnosed when the gestational sac size is more than 25 mm with no fetal pole or if a fetal pole more than 10 mm with no fetal cardiac activity. In cases of an empty gestational sac less than 25 mm in size, the scan was repeated after 1 week. B-HCG follow-up is requested in cases with a history of recurrent pregnancy loss, among which six had doubling B-HCG within 48 h while four of them did not have.

Ethical considerations: the study protocol was approved by the Institutional Review Board, Al-Azhar University. An informed consent (oral and written) was obtained from each participant in this study.

2.3. Statistical analysis

The data were collected, tabulated, and analyzed using IBM SPSS statistics (Statistical Package for Social Sciences) software version 22.0, IBM Corp., Chicago, USA, 2013 and Microsoft Office Excel 2007, for Windows. Data were tested for normal distribution using the Shapiro–Walk test. Qualitative data were represented as frequencies and relative percentages. χ^2 test and Fisher's exact were used to calculate the difference between the qualitative variables as indicated. Quantitative data were expressed as mean \pm SD for parametric data. The optimal cutoff point was established at the point of maximum accuracy.

3. Results

Table 1.

Table 2 shows that there is no statistically significant difference between groups as regards age, parity, and BMI.

Table 1. Distribution of demographic characteristics between the two groups.

Variables	Ongoing pregnancy (N = 85)	Pregnancy loss (N = 15)	t	P
Age (years)				
Mean \pm SD	26.43 \pm 4.91	27.46 \pm 4.65	0.755	0.452
Parity			Z	
Mean \pm SD	1.29 \pm 1.01	1.37 \pm 0.992	254	0.836
BMI (kg/m ²)				
Mean \pm SD	26.45 \pm 2.29	27.88 \pm 2.68	1.94	0.056

Table 3 shows that there is significant difference between the groups regarding the history of previous abortion and PCOS.

Table 4 shows that there is a highly significant difference between the groups regarding yolk sac abnormality.

Table 5 shows that gestational sac diameters at different gestational ages were significantly higher among the ongoing pregnancy group compared with the pregnancy loss group.

Table 6 shows that the YSD at 6th and 7th weeks was significantly lower among the ongoing pregnancy group compared with the pregnancy loss group. However, the YSD at the 5th week was significantly higher among the ongoing pregnancy group compared to the pregnancy loss group.

Table 2. Comorbidities and history distribution among the studied groups.

	Ongoing pregnancy (N = 85) [n (%)]	Pregnancy loss (N = 15) [n (%)]	χ^2	P
History of abortion	6 (7.1)	4 (26.7)	5.45	0.020
HTN	3 (3.5)	1 (6.7)	0.327	0.568
DM	5 (5.9)	3 (20)	3.453	0.063
PCOS	16 (18.8)	8 (53.3)	8.325	0.004

Table 3. Yolk sac distribution among the studied groups.

	Ongoing pregnancy (N = 85) [n (%)]	Pregnancy loss (N = 15) [n (%)]	χ^2	P
Normal	82 (96.5)	1 (6.7)	81	0.000
Large	1 (1.2)	5 (33.3)		
Absent	0	7 (46.7)		
Echogenic	1 (1.2)	0		
Small	1 (1.2)	2 (13.3)		

Table 4. Gestational sac diameters between the two groups.

GCD	Ongoing pregnancy (N = 85)	Pregnancy loss (N = 15)	t	P
5th week				
Mean ± SD	10.14 ± 1.56	8.72 ± 1.73	3.2	0.002
6th week				
Mean ± SD	15.52 ± 1.98	9.87 ± 1.79	10.3	0.000
7th week				
Mean ± SD	23.34 ± 1.81	15.64 ± 2.57	14.2	0.000

Table 5. Yolk sac diameters between the two groups.

YCD	Ongoing pregnancy (N = 85)	Pregnancy loss (N = 15)	t	P
5th week				
Mean ± SD	2.29 ± 0.196	2.06 ± 0.391	3.51	0.001
6th week				
Mean ± SD	2.55 ± 0.210	2.87 ± 0.733	3.38	0.001
7th week				
Mean ± SD	3.05 ± 0.191	3.72 ± 0.734	7.27	0.000

Table 7 shows that CRL at different gestational ages was significantly higher among the ongoing pregnancy group compared with the pregnancy loss group.

Table 7 shows that cardiac activity at the 6th and 7th weeks was significantly higher among the ongoing pregnancy group compared with the pregnancy loss group. However, cardiac activity at the 5th week was significantly lower among the ongoing pregnancy group compared with the pregnancy loss group.

4. Discussion

This study demonstrates the parameters for early diagnosis of a healthy pregnancy from an unhealthy pregnancy.

The findings of this study demonstrate no significant difference between groups as regards age, parity, and BMI; P values were 0.452, 0.836, and 0.056, respectively. The mean age was 26.43 ± 4.91 years in the ongoing pregnancy group and 27.46 ± 4.65 years in the pregnancy loss group; the mean parity was 1.29 ± 1.01 in the ongoing pregnancy group and 1.37 ± 0.992 in the pregnancy loss group; the mean BMI was 26.45 ± 2.29 kg/m² in the ongoing pregnancy group and 27.88 ± 2.68 kg/m² in the pregnancy loss group.

Similarly, 72 pregnant women in their early pregnancy were enrolled in a study by Ghali et al.⁷ aimed to know the pregnancy outcome by assessing the role of ultrasonographic evaluation of yolk sac characteristics in early pregnancy, in pregnant women at 6–11 weeks of pregnancy. The mean age was 26.9 ± 3.9 years. It was found that there was no significant relationship between maternal age and pregnancy outcome.

Table 6. Crown-rump length between the two groups.

CRL	Ongoing pregnancy (N = 85)	Pregnancy loss (N = 15)	t	P
5th week				
Mean ± SD	2.61 ± 0.779	2.19 ± 0.511	2.01	0.047
6th week				
Mean ± SD	4.98 ± 0.612	3.36 ± 0.761	9.1	0.000
7th week				
Mean ± SD	11.72 ± 0.771	5.04 ± 0.470	32	0.000

Table 7. Embryonic cardiac activity distribution between the two groups.

Cardiac activity	Ongoing pregnancy (N = 85)	Pregnancy loss (N = 15)	t	P
5th week				
Mean ± SD	105.71 ± 9.43	111.53 ± 6.31	2.3	0.024
6th week				
Mean ± SD	118.42 ± 3.53	112.92 ± 9.75	3.99	0.000
7th week				
Mean ± SD	137.15 ± 4.81	114.86 ± 14.67	11.2	0.000

Our results expressed a significant difference between the groups regarding previous abortion; it was six (7.1%) in the ongoing pregnancy group and four (26.7%) in the pregnancy loss group ($P = 0.020$).

This is in agreement with a prospective observational study conducted on 280 pregnant women with a low-risk single fetus in early gestation at the antenatal clinics. Adiga et al.⁸ showed that according to the history of previous abortions, there were statistically significant differences between the ongoing pregnancy group and the pregnancy loss group.

This was in contrast to a study carried out on 100 pregnant females during the first trimester by Abd Ellatif et al.,⁹ which reported no significant difference between the groups [fetal loss ($n = 8$) and ongoing pregnancy ($n = 85$)] regarding the history of previous abortion ($P < 0.05$).

However, there were no significant differences between the groups as regards HTN and DM; the P values were 0.568 and 0.063, respectively.

It was found in this study that there is a highly significant difference between the groups regarding yolk sac abnormality ($P = 0.000$). Among 15 women in the pregnancy loss group, there were seven (46.7%) absent, five (33.3%) large, two (13.3%) small, and one (6.7%) normal yolk sac.

YSD at the 6th and 7th weeks was significantly lower among the ongoing pregnancy group (2.55, 3.03 mm) compared with the pregnancy loss group (2.87, 3.73 mm). However, YSD at the 5th week was significantly higher among the ongoing pregnancy group (2.29 mm) compared with the pregnancy loss group (2.06 mm).

In a separate retrospective study by Bae and Karnitis,¹⁰ it has been shown that when the YSD was 2–6 mm, pregnancy was likely to continue.

However, the study by Moradan and Forouzeshfar,¹¹ found that the largest normal YSD was 6.6 mm.

Aseri¹² showed that the YSD correlated significantly to early pregnancy sequel (t -test $P = 0.002$).

Lebda et al.¹³ reported that regarding the distribution of YSD in the studied groups, there was a normal sac diameter in the majority of the studied groups (86.5%).

However, Ghali et al.⁷ noted that regarding the size of the yolk sac, the YSD mean ± SD was 3.7 ± 1.8 mm as seen in GA from 6 to 9 weeks and no significant difference between the studied groups as regards YSD.

Also, we found that gestational sac diameter at different gestational ages was significantly higher among the ongoing pregnancy group (10.14 at the 5th week, 15.52 at the 6th week, and 23.34 at the 7th week) compared with the pregnancy loss group (8.72 at the 5th week, 9.87 at the 6th week, and 15.64 at the 7th week) ($P = 0.000$).

Ghali et al.,⁷ showed that there is a significant difference between the groups as regards gestational sac diameters in the 8th week but no statistically significant difference between the groups regarding gestational sac diameters in the 7th or 6th week.

Our results showed that CRL at different gestational ages were significantly higher among the ongoing pregnancy group (2.61 ± 0.779 at the 5th week, 4.98 ± 0.612 at the 6th week, and 11.72 ± 0.771 at the 7th week) compared with (2.19 ± 0.511) at the 5th week, 3.36 ± 0.761 at the 6th week, and 5.04 ± 0.470 at the 7th week in the pregnancy loss group; p values were 0.047, 0.000, and 0.000, respectively.

Regarding embryonic cardiac activity distribution between the two groups, it was clear that cardiac activity in the 6th and 7th weeks was significantly higher among the ongoing pregnancy group (119–138 bpm) compared with the pregnancy loss group (113–115 bpm). However, cardiac activity in the 5th week was significantly lower among the ongoing pregnancy group (105 bpm) compared with the pregnancy loss group (111 bpm).

A study by Lebda et al.,¹³ reported that a continuous decrease in the fetal heart rate activity may be associated with miscarriage.

4.1. Conclusion

Early ultrasound assessment is the cornerstone in evaluating the potential of the ongoing pregnancy. It is crucial to assess the viability, the location of the pregnancy, the gestational age, and whether it is singleton or multiple pregnancies. Measurement of gestational sac diameter, YSD, fetal heart rate, and CRL together provides better prediction of the first-trimester prognosis than when either parameter is used alone. This study observed that the sonographic finding of a smaller-for-date CRL, small gestational sac size, abnormal yolk sac characteristic, and fetal bradycardia indicate a poor outcome of early pregnancy. Also combining these parameters with the demographic data of the pregnant proved to be an even greater predictor of the first-trimester outcome.

Conflict of interest

There are no conflicts of interest.

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