

*Research Article***A logistic model of early pregnancy ultrasound measurements and prediction of first-trimester outcome****Maha M. Hassan¹, Emad M. Ibrahim¹, Ameer A. AbdAllah¹ and Ayman M. Yousif¹**¹ Department of Obstetrics and Gynecology, Faculty of medicine Minia University, Egypt**Abstract**

Background: In early pregnancy, it is essential to emphasize viability and gestational age precisely. Researchers tried to discover some useful sonographic indicators in early pregnancy so as to expect the outcome of the ongoing pregnancy. The aim of this study is to assess first-trimester ultrasound measurements for the prediction of early pregnancy loss. **Method:** This is a prospective observational cohort study done in the outpatient clinic of obstetrics and gynecology of El Minia maternity university hospital from 1st February-31st August 2021. A random sample of 143 pregnant women selected, 7 were lost to follow up. For the 136 pregnant women followed 9(6.6%) had early pregnancy loss, and 127(93.4%) continue pregnancy after 12 weeks. **Results:** 136 pregnant women examined by using transvaginal ultrasonography. The readings at 6th week of gestation for the (GSD, YSD, CRL, and FHR) were (13.05 ± 1.17), (2.88 ± 1.62), (2.79 ± 0.72), & (94.5 ± 9.54) respectively, lower among those with first trimester loss than those continue pregnancy (28.71 ± 5.72), (4.29 ± 0.33), (5.61 ± 0.55), and (130.9 ± 3.3). The readings at 12th week of gestation for the (GSD, YSD, CRL, and FHR) were as follows; [22.59 ± 3.15], [3.24 ± 0.27], [11.7 ± 1.59]. & [148.5 ± 0.9)] were lower among with first trimester loss group than those continue pregnancy [65.12 ± 4.51], (4.95 ± 0.77), (55.77 ± 6.27)& (188.1 ± 5.5)]. **Conclusions:** The current study found that lower Gestational Sac Diameter, Yolk Sac Diameter, Crown-Rump Length, and Fetal Heart Rate may indicate early pregnancy loss.

Keywords: Early pregnancy loss, crown rump length, yolk sac, gestational sac diameters, fetal heart rate.

Introduction

Spontaneous abortion is specified to end a pregnancy without medical or mechanical means before a fetus is sufficiently established to be able to survive. In other words, its fetus loss before the twenty week of gestation ⁽¹⁾

Spontaneous miscarriage may be the outcome in 15% of confirmed pregnancies. The recurrent loss is confirmed if loss occurs in ≥ 3 pregnancies, with the prevalence of 2% of pregnancies ⁽²⁾

Ultrasonography has an important function in defining the proceeding of pregnancy and foreseeing outcome. 1st trimester of pregnancy is known as twelve weeks next to

the last menstrual period is now a method of predicting an abnormal fetal outcome in both cases where a live embryo is present and even before visualization of the embryo itself ⁽³⁾

With continuous technological achievements; high-frequency transvaginal scanning, has permitted the resolution of ultrasound imaging in the 1st trimester to develop to a level at which early fetal development can be estimated and watched in detail ⁽⁴⁾

Ultrasonography is a safe method because it does use too low power levels and not use ionizing radiation, so not cause adverse heating or pressure effects in tissue. Generally Ultrasonography advantages to

patients outweigh the risks⁽⁵⁾

Researchers have tried to discover some useful sonographic indicators in early pregnancy so as to expect the outcome of the ongoing pregnancy. These are as

follows; gestational sac diameter (GSD), yolk sac diameter (YSD), crown-rump length (CRL), and fetal heart rate (FHR)⁽⁶⁾ CRL gives a more precise assessment of gestational age because GSD shows higher variability of prediction of age⁽⁷⁾

In early pregnancy, it is essential to emphasize viability, set up gestational age precisely, and define the number of fetuses and, in the case of multiple pregnancies, estimate amnionicity & chorionicity. This study was conducted to assess first-trimester ultrasound measurements role for the prediction of early pregnancy loss

Subjects and Method

Study design

This is a prospective observational cohort study done in El Minia city in outpatient clinic of obstetrics and gynecology department of El Minia maternity university hospital from 1st February-31st August 2021. Study carried out on a convenient, randomly selected sample of 143 pregnant women who were attendants this hospital. The study was approved by the Minia maternity university hospital ethical Committee.

All methods were performed in accordance with the relevant guidelines and regulations. All patients gave informed, written consent to participate in the study. Inclusion Criteria include Mothers at any age, any parity, Singleton pregnancy, 1st trimester pregnancy with a reliable date. Exclusion criteria include The mothers with chronic medical disorders (heart disease, DM, chronic hypertension, renal diseases, etc.), multiple pregnancies, smokers, and drug abusers, known uterine abnormalities, uncertain gestational age, and extra uterine pregnancy. The data collection tools included Designed closed and open-ended questionnaire, By using direct interviewing, Physical examination by the researcher And

transvaginal sonography assessment. The information collected through the questionnaire related to: Demographic questions, (e.g age, sex, residence), and questions related to obstetrical and gynecological history, Previous medical history.

Physical Examination was done for the mothers in order to assess the general condition, abdominal and local examinations, and gestational age calculation according to modified Naegele's rule. Routine investigations (CBC, ABO and Rh typing, urine analysis, RBS also was done for each mother.

Sonography assessment using 2 Dimensions transvaginal ultrasound imaging, The crown rump length (CRL), Yolk sac (YS) and Gestational sac (GS) diameters, & fetal heart rates (FHR) are recording.

All patients were followed till the end of the 12th week of gestation.

Timeline of First-Trimester Sonographic Findings

Gestational Sac

Conventionally, gestational age is initially calculated from the first day of the LMP. Ovulation typically occurs mid-cycle, at about day 14 of the menstrual cycle, at which point fertilization (conception) is most likely to occur.

Thus, by the time of the first missed menstrual period, fertilization and implantation of the fertilized ovum have occurred. During the first 3 weeks following conception, the developing gestational sac is below the limit of detection by TVUS⁽²⁾

The growth rate of the gestational sac is approximately 1.1 mm/day and the gestational sac first becomes apparent on TVUS at approximately 4.5-5 weeks of gestational age, appearing as a round anechoic structure located eccentrically within the echogenic decidua (Fig. 1A, B)⁽³⁾

Decidual Sac Sign:

Subsequent to the appearance of the gestation sac, two concentric echogenic rings encircling the central anechoic collection develop:

The outer ring represents the decidua parietalis, while the inner ring represents the decidua capsularis and chorion (Fig. 2A, B).

Furthermore, the DDS sign can be difficult to demonstrate sonographically. For this reason, the possibility of a gestational sac should be considered for any round or ovoid fluid collection within the endometrium (Fig. 3A, B) ^[4]. Gestational sac size is measured in 3 dimensions and the mean sac diameter (MSD) is used to help estimate the early gestational age.

Yolk Sac

At around 5.5 weeks of gestation, the developing yolk sac becomes visible. Initially appearing as two echogenic parallel lines at the periphery of the gestational sac, the yolk sac eventually acquires its typical round appearance by the end of 5.5 weeks ^[2]

Embryo

The embryo (sometimes referred to as the fetal pole early on) becomes apparent at 6 weeks of gestation as a relatively featureless echogenic linear or oval structure adjacent to the yolk sac, initially measuring 1-2 mm in length. At this point, the MSD is approximately 10 mm.

The crown-rump length (CRL) is the measurement between the cranial and caudal ends of the embryo and is the most accurate measure of the gestational age in the first trimester. The CRL gradually increases, measuring 10 mm at 7.0 weeks. The lack of a visible embryo on TVUS once the MSD reaches at least 25 mm is diagnostic of pregnancy failure (Fig. 4) ^[2,5].

These findings are diagnostic of early pregnancy loss. While the fetal pole begins as a featureless structure, some fetal anatomic structures become visible as the first-trimester progresses. The spine appears at 7-8 weeks, and the hindbrain (rhombencephalon) is evident at 8-10 weeks ^[6]. Amniotic Membrane The amniotic membrane becomes visible around 7 weeks, and the CRL closely corresponds to the amniotic sac diameter between 6.5 and 10 weeks of gestation (Fig. 5) ^[7]

After fetal urine production commences at about 10 weeks, there is a disproportionate enlargement of the amniotic sac relative to the chorionic cavity. The amnion and chorion fuse after the first trimester at 14-16 weeks ^[8]. Cardiac Activity Cardiac activity is seen as early as the sixth week of gestation, when the embryo is 1-2 mm in size. The current guidelines of the Society of Radiologists in Ultrasound (SRU) establish a CRL cutoff of 7 mm, above which one should definitively visualize fetal cardiac activity. The absence of a detectable heartbeat once the embryo measures greater than 7 mm in length is diagnostic of pregnancy failure (Fig. 6A, B) ^[7].

First-Trimester Abnormalities

First-trimester TVUS is routinely performed in patients presenting with pelvic/abdominal pain or vaginal bleeding. Once pregnancy is established with urine or serum β -hCG tests, the utility of TVUS for evaluation of these patients is multifactorial: (1) to determine the presence and multiplicity of an IUP, (2) to determine the viability of an IUP, (3) to determine the stage of spontaneous abortion in the case of a nonviable pregnancy, and (4) to identify probable reasons why an IUP is not identified on TVUS. Confirming an IUP The detection of an eccentrically-located, anechoic collection in the orthogonal planes and averaged (Fig. 1A).

The YS largest diameter was measured placing the calipers endometrium of a patient with elevated serum β -hCG levels represents an IUP in 99.5% of cases ⁽⁴⁾ The presence of two or more gestational sacs surrounded by thick echogenic chorion, or sonographic features of the inter-twin membrane and "twin-peak" sign, confirm a multiple-gestation pregnancy ⁽¹¹⁾ Evaluating Viability Once an IUP is identified, the viability and presence or absence of abnormal features must be evaluated. The timeline of visualization of the gestational sac, yolk sac, and embryo at 5, 5.5, and 6 weeks, respectively, are accurate and consistent ⁽⁵⁾ Deviations from the normal chronological appearance of these structures are highly suspicious for pregnancy failure.

The SRU has presented specific guidelines for diagnosing pregnancy failure based on certain characteristics: namely, (1) the CRL measurement by which an embryonic heart rate must be identified (7 mm), (2) the MSD by which an embryo should be identified (25 mm), and (3) the absence

Subchorionic Hematoma:

Subchorionic hematoma (SCH) is a relatively common finding in the first trimester and has been reported to occur in 18%-22% of IUPs in patients presenting with vaginal bleeding^[12, 13]. On TVUS, SCH appears as a crescent-shaped, heterogeneous avascular collection between the gestational sac and decidua basalis (Fig. 7A, B)

For the scans we used two ultrasound machines: VOLLUSON with a 7.5MHz Transvaginal probe:

All measurements were obtained on a magnified, frozen section (sagittal and/or transverse) of the parameter to be evaluated. Measurements of the GS were obtained in three dimensions (length, height, width). The YS diameter was measured from one inner rim to the opposite inner rim. If not spherical, the three dimensions were measured and averaged.

THE CRL was measured once and the FHR was measured once with M mode. Both parameters' measurements were repeated in different sections if the first measurement did not meet the expected value for gestational age.

The ultrasound machine provides the expected gestational age for each variable measured based on standardized algorithms, except for YS. For YS, we used the previously established nomogram of YS growth from 5 until 10 weeks of GESTATION.

Figure 1 shows the correct cursor position for the measurement of the parameters under investigation.

The GS largest diameter was measured in the three orthogonal planes and averaged (Fig. 1A).

The YS largest diameter was measured placing the calipers at the inner rim of the

organ. CRL was measured placing the calipers in the most cephalad and most caudal extremities of the embryo's longitudinal image.

HR was automatically calculated by the machine, averaging the distance between one, or two, systolic spikes.

All the clinic patients with a positive pregnancy test were invited to come to the clinic for an initial Transvaginal ultrasound at 5–6 weeks of gestation, depending of the patient's history.

All the clinic patients with a positive pregnancy test were invited to come to the clinic for an initial Transvaginal ultrasound at 5–6 weeks of gestation, depending of the patient's history.

Most patients had weekly ultrasounds from 5 to 11 weeks of gestation, for an average of 4 scans per patient.

To maintain consistency, a single examiner performed all of the sonographic exams of this study. If at the initial scan the embryo had no cardiac activity, all parameters were measured to confirm the gestational age and a second scan was performed one week later to confirm the outcome.

If no gestational sac was present, and an ectopic pregnancy was excluded, or the mean gestational sac diameter measured more than 20mm without a visible YS or embryonal pole, these were classified as a nonviable pregnancy and were excluded from the analyses

Statistical analysis.

Variables, even if continuous, were expressed as Median and quartiles (Q1, Q3) because the Median is not skewed so much by a small proportion of extremely large or small values and it is more representative of a typical value. All analyses were performed using SAS/STAT V14.1 (Cary, North Carolina, USA). Mann-Whitney U test and Pearson correlations were used for comparisons between the ongoing pregnancy and pregnancy loss groups. The GS and YS diameters, CRL and FHR were plotted relatively to gestational age. Descriptive statistics including medians and quartiles for GS, YS, CRL and HR for each

gestational week were calculated by pregnancy loss status. If a patient had a loss before and a continuing pregnancy after, she was allocated to the group which identified the outcome at the time of her pregnancy. If the patient had twins, or triplets, with one or two losses within the same pregnancy (=vanishing twin), to balance the results she was allocated to both groups.

We applied Wilcoxon 2-sample tests by gestational week for univariate comparison of distributions/ medians for GS, YS, CRL, and HR, between the pregnancies that were lost and those that were not.

For YS, we also performed a median split analysis using Wilcoxon 2-sample tests by gestational week both above and below the YS median, to compare the YS medians by pregnancy loss status.

We calculated the gestational age in weeks, rather than in days, because it is the standard method to measure the gestational age in clinical practice. We extended the univariate analysis into multivariate logistic regression models in order to retain multiple significant predictors of pregnancy loss by gestational week. Non-significant variables were omitted from the model unless contributing to the overall fit of the model.

We estimated optimal sensitivity and specificity of each model along with area under the receiver operating characteristic curve (AUC).

All associations were considered significant at alpha level 0.05.

Results

This study was conducted on 143 women who were pregnant and examined by using early trans-vaginal US in the first trimester. During follow up 7 were lost due to the condition of COVID19 pandemic, therefore outcome of first trimester of the 136 pregnancies were recorded.

For the 136 pregnant women followed 9(6.6%) had an early pregnancy loss, and 127(93.4%) continue the pregnancy after 12 weeks. Of the 127 pregnancies included in this study, twenty-two pregnancies (17.3%)

had a 1st US examination between 4–5 weeks of gestation due to ectopic pregnancy, recurrent pregnancy loss, pelvic pain, or vaginal bleeding history.

As regard the demographic data, There was no significant difference between the 2 groups. In the first trimester pregnancy loss group, the median age was 34 years, the median gravidity was 2, the median parity was 0 and the median BMI was 26.1 kg/m². In the continuing pregnancy group, the median age was 32 years, the median gravidity was 2, the median parity was 0 and the median BMI was 25 kg/m². (table 1)

As regard the gestational sac diameter at the first trimester. There was significant difference between the 2 groups (P-Value<0.05). In the continuing pregnancy, the largest GSD (65.12) was in the 12th and the least GSD (22.55) was in the 5th week. In the pregnancy loss group, the largest GSD (25.29) was in the 9th and the least GSD (12.33) was in the 5th week. In the pregnancy loss group, the mean gestational sac diameter at the 6th week of gestation was 13.05± 1.17 while it was 28.71± 5.72 in the continuing pregnancy group. In the pregnancy loss group, the mean gestational sac diameter at the 9th of gestation week was 25.29± 3.42 while it was 41.85± 2.75 in the continuing pregnancy group. In the pregnancy loss group, the mean gestational sac diameter at the 12th of gestation week was 22.59± 3.15 while it was 65.12± 4.51 in the continuing pregnancy group. (table 2)

As regards the Yolk sac diameter during the first trimester, there was a significant difference between the 2 groups (P-Value< 0.05). In the continuing pregnancy, the largest YS (6.49) was in the 10th and the least YS (4.07) was in the 5th week. In the pregnancy loss group, the largest YS (4.77) was in the 9th and the least YS (2.61) was in the 5th week. In the pregnancy loss group, the mean yolk sac diameter at the 6th week of gestation was 2.88±1.62 while it was 4.29± 0.33 in the continuing pregnancy group. In the pregnancy loss group, the mean yolk sac diameter at the 9th week of gestation was 4.77± 0.81 while it was 6.38± 0.66 in the continuing pregnancy group. In the pregnancy loss group, the mean yolk sac

diameter at the 12th week of gestation was 3.24 ± 0.27 while it was 4.95 ± 0.77 in the continuing pregnancy group. There was slower increase in the diameter of the yolk sac followed by a decrease from the 9th week of gestation in the 2 groups. (Table 3)

As regard the gestational crown rump length (CRL) during the first trimester, there was a significant difference between the 2 groups (P-Value $e < 0.05$). In the continuing pregnancy, the largest CRL (55.77) was in the 12th and the least CRL (4.51) was in the 5th week. In the pregnancy loss group, the largest CRL (15.75) was in the 9th and the least CRL (2.25) was in the 5th week. In the pregnancy loss group, the mean CRL at the 6th week of gestation was 2.79 ± 0.72 while it was 5.61 ± 0.55 in the continuing pregnancy group. In the pregnancy loss group, the mean CRL at the 9th week of gestation was 15.75 ± 1.53 while it was 30.58 ± 3.96 in the continuing pregnancy group. In the pregnancy loss group, the mean CRL at the 12th week of gestation was 11.7 ± 1.59 while it was 55.77 ± 6.27 in the continuing pregnancy group. (table 4)

As regards the gestation fetal heart Rate (FHR) during the first trimester, there was a significant difference between the 2 groups (P-Value < 0.05). In the continuing pregnancy, the highest FHR (188.1) was in the 12th and the lowest FHR (115.5) was in the 8th week. In the pregnancy loss group, the highest FHR (148.5) was in the 11th and 12th and the lowest FHR (92.7) was in the 5th week. In the pregnancy loss group, the mean FHR at the 6th week of gestation was 94.5 ± 9.54 while it was 130.9 ± 3.3 in the continuing pregnancy group. In the

pregnancy loss group, the mean FHR at the 9th week of gestation was 145.8 ± 8.1 while it was 140.58 ± 3.96 in the continuing pregnancy group. In the pregnancy loss group, the mean FHR at the 12th week of gestation was 148.5 ± 0.9 while it was 188.1 ± 5.5 in the continuing pregnancy group. (table 5)

Gestational week was used to perform the regressions with the loss of pregnancy as an outcome variable. The models were used for estimation of Sensitivity and specificity. for the measurement of the model fir, the AUC was presented. The univariate findings were confirmed by the adjusted models. Large YS was associated with 3-6 folds increase in the pregnancy loss chance from the 5th week to the 8th week. At the 10th week of gestation, large YS was associated with a reduction in the pregnancy loss chance. This gave evidence that only 1 pregnancy was lost after 10 gestational weeks with large YS. Small YS was in all losses at this gestational age.

The YS pregnancy loss group was smaller than that in the continuing pregnancy group after the 1st trimester. Pregnancy loss chance was even reduced in large GS meaning that small GS can be an evidence for pregnancy loss. There was a steady association direction during the investigation with a significance in the 6th, 7th and 9th weeks. Also, large CRL had low pregnancy loss chance, thus, small CRL can be an evidence of pregnancy loss at 8th and 9th weeks. The models performed with reasonable predictive accuracy and goodness of fit. Sensitivity ranged from 60–86% and specificity from 78–91%. (table 6)

Table (1): Demographics of the patient population divided by pregnancies that resulted in a first trimester loss and those that progressed beyond the first trimester (continuing pregnancy).

Demographics	First Trimester Pregnancy Loss N = 9	Continuing Pregnancy N = 127	p-value
Age (years) [Median	34.0 (31.0, 36.3)	32.0 (29.0, 35.0)	0.067a
Gravidity (N) [Median	2.0 (1.0, 3.0)	2.0 (1.0, 3.0)	0.440a
Parity (N) [Median	0 (0, 1.0)	0 (0, 1.0)	0.324a
BMI (kg/m ²) [Median	26.1 (22.0, 30.5)	25.0 (22.0, 31.0)	0.785a

Table (2): Relation between Gestational Sac Diameter at Different Gestational Age Period and Pregnancy Outcome:

Week	Gestational days	Pregnancy loss		Continuing Pregnancy		p value
		Mean	SD	Mean	SD	
5	35-41	12.33	0.99	22.55	5.39	<0.05S
6	42-48	13.05	1.17	28.71	5.72	<0.05S
7	49-55	16.02	1.89	34.43	1.98	<0.05S
8	56-62	22.05	2.61	37.95	1.43	<0.05S
9	63-69	25.29	3.42	41.58	2.75	<0.05S
10	70-76	23.85	3.33	44.55	3.08	<0.05S
11	77-83	23.31	3.33	54.01	4.18	<0.05S
12	84-90	22.59	3.15	65.12	4.51	<0.05S

Table (3): Relation between Yolk Sac at Different Gestational Age Period and Pregnancy Outcome

Week	Gestational days	Pregnancy loss		Continuing Pregnancy		p value
		Mean	SD	Mean	SD	
5	35-41	2.61	1.53	4.07	0.33	<0.05S
6	42-48	2.88	1.62	4.29	0.33	<0.05S
7	49-55	3.42	0.99	4.62	0.44	<0.05S
8	56-62	4.23	0.9	5.61	0.55	<0.05S
9	63-69	4.77	0.81	6.38	0.66	<0.05S
10	70-76	4.41	0.72	6.49	0.66	<0.05S
11	77-83	3.42	0.63	5.39	0.66	<0.05S
12	84-90	3.24	0.27	4.95	0.77	<0.05S

Table (4): Relation between Gestational Crown-Rump Length (CRL) At Different Gestational Age Period and Pregnancy Outcome

Week	Gestational days	Pregnancy loss		Continuing Pregnancy		p value
		Mean	SD	Mean	SD	
5	35-41	2.25	0.54	4.51	0.44	<0.05S
6	42-48	2.79	0.72	5.61	0.55	<0.05S
7	49-55	7.65	1.35	15.4	0.99	<0.05S
8	56-62	12.15	1.17	23.54	1.32	<0.05S
9	63-69	15.75	1.53	30.58	3.96	<0.05S
10	70-76	14.31	1.17	27.83	3.08	<0.05S
11	77-83	10.08	1.17	48.07	2.31	<0.05S
12	84-90	11.7	1.89	55.77	6.27	<0.05S

Table (5): Relation between Gestational Fetal Heart Rate (FHR) At Different Gestational Age and Pregnancy Outcome

Week	Gestational days	Pregnancy loss		Continuing Pregnancy		p value
		Mean	SD	Mean	SD	
5	35–41	92.7	9.36	126.5	9.35	<0.05S
6	42–48	94.5	9.54	130.9	3.3	<0.05S
7	49–55	118.8	8.37	155.1	7.37	<0.05S
8	56–62	130.5	10.53	115.5	11.66	<0.05S
9	63–69	145.8	8.1	140.58	3.96	<0.05S
10	70–76	144.9	7.74	173.8	4.29	<0.05S
11	77-83	148.5	8.64	184.8	10.67	<0.05S
12	84-90	148.5	0.9	188.1	5.5	<0.05S

Table (6): Models of Multivariate logistic regression with pregnancy loss significant predictors, and their sensitivity and specificity

Gestational Week	Gestational days	Variables	Odds Ratio	(95% CI)	p-value	Sens. (%)	Spec. (%)	AUC
5th	35–41	Yolk Sac	<0.001	(<0.001 5.34)	0.0881	79	67	0.95
		Heart Rate	0.97	(0.86 1.10)	0.6482			
6th	42–48	Yolk Sac	3.36	(1.53 7.34)	0.0025	74	78	0.86
		Gestational Sac	0.01	(0.00 0.09)	<0.0001			
7th	49–55	Yolk Sac	6.52	(2.32 18.33)	0.0004	79	73	0.90
		Gestational Sac	0.10	(0.02 0.52)	0.0063			
		Heart Rate	0.96	(0.92 1.00)	0.0376			
8th	56–62	Yolk Sac	6.28	(1.21 32.73)	0.0291	86	83	0.92
		Crown-rump Length	0.59	(0.48 0.73)	<0.0001			
9th	63–69	Gestational Sac	0.10	(0.02 0.41)	0.0016	82	85	0.86
		Crown-rump Length	0.85	(0.71 1.02)	0.0806			
10th	70–76	Yolk Sac	0.05	(0.08 0.33)	0.0018	60	79	0.92
		Gestational Sac	0.57	(0.24 1.35)	0.1975			

Multivariate Logistic Regression; 95% CI = 95% Confidence Interval; Sens. = Sensitivity; Spec. = Specificity; AUC = Area under the Curve; N = Number of cases in each group.

(Fig. 1A, B) [3]

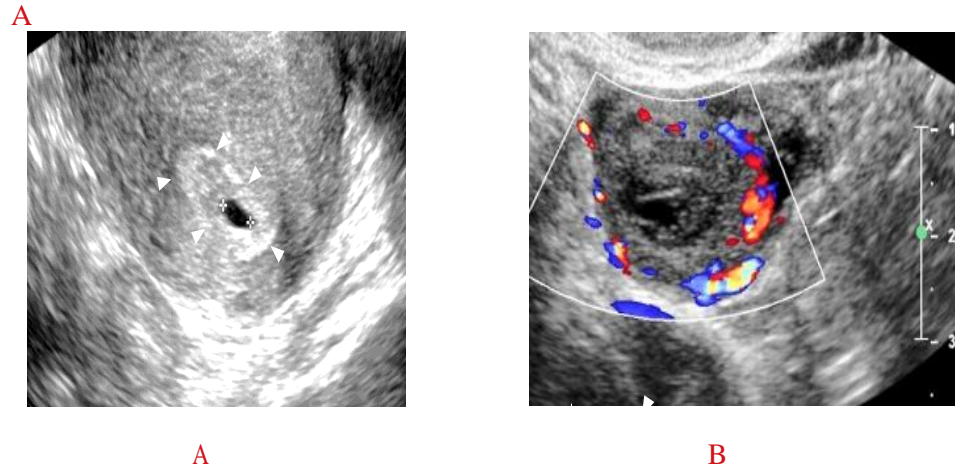


Fig. 1. Normal early gestational sac and corpus luteum.

- A.** Transvaginal ultrasonography (TVUS) demonstrates an anechoic structure with peripheral echogenic tissue (arrowheads) representing a gestational sac in the uterine cavity of a woman with a positive urine pregnancy test. **B.** TVUS shows a circumscribed heterogeneous structure with peripheral vascularity in the right ovary compatible with a corpus luteum (arrowheads).

(Fig. 2A, B).

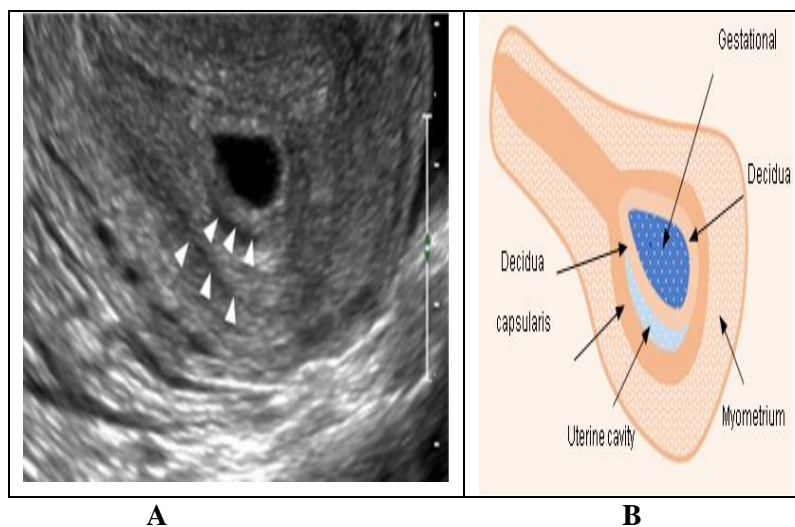


Fig. 2. The double decidual sac sign.

- A.** Transvaginal ultrasonography demonstrates two concentric echogenic rings (arrowheads) with intervening trace hypoechoic material, known as the double decidual sac sign.
- B.** Graphical representation of the double decidual sign is shown. This is known as the double decidual sac sign (DDS), which is a definitive sign of an intrauterine pregnancy (IUP). While the presence of the DDS sign confirms an IUP, its absence does not exclude an IUP [4].

(Fig. 3A, B) [4].

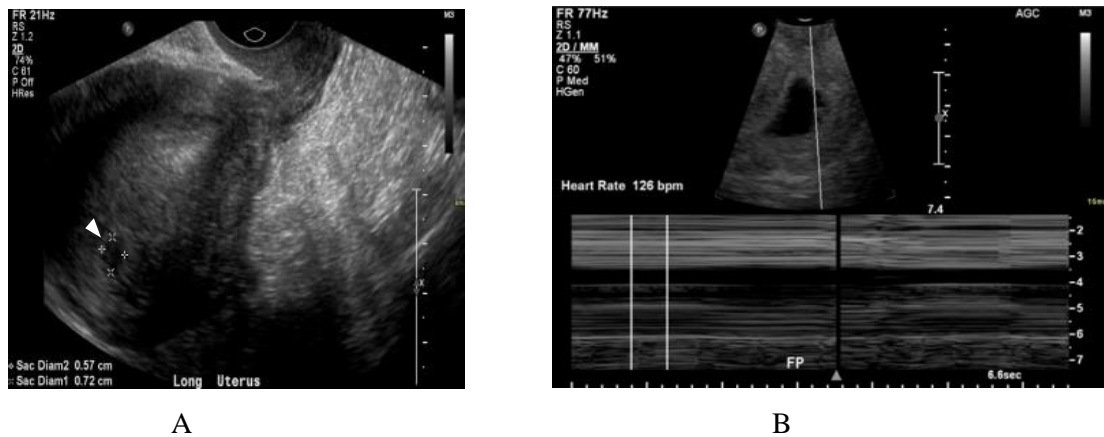


Fig. 3. A 19-year-old woman with vaginal bleeding and a positive beta-human chorionic gonadotropin test.

A. Initial transvaginal ultrasonography (TVUS) shows a vague hypoechoic collection measuring 7 mm in the uterine fundus (arrow). The morphology was not typical for an intrauterine pregnancy.

B. Subsequent TVUS 2 weeks later demonstrates an intrauterine gestational sac with an embryo with heart rate of 126 bpm.

(Fig. 4) [2,5].

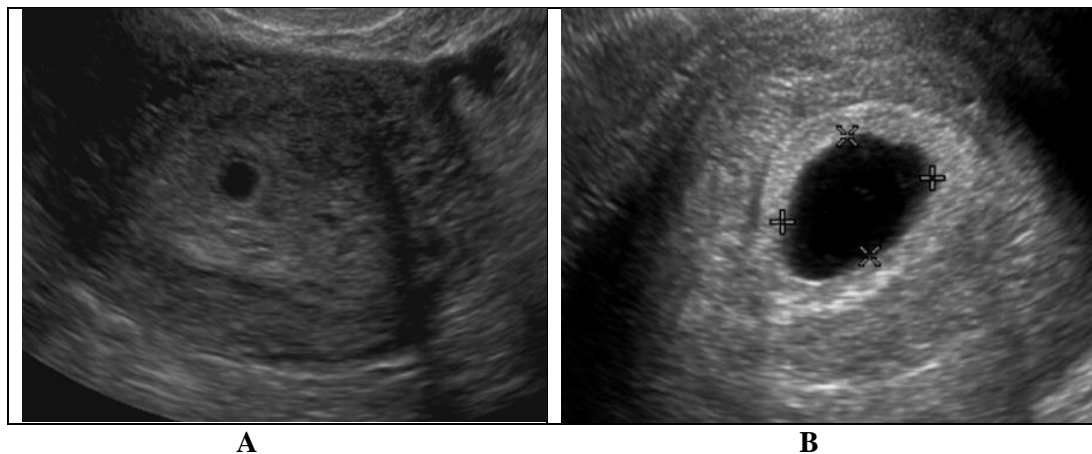


Fig. 4. Transvaginal ultrasonography in a pregnant woman presenting with abdominal pain and cramping.

A. Initial ultrasonography shows a gestational sac without a yolk sac or embryo.

B. Follow-up ultrasonography 2 weeks later shows a gestational sac measuring greater than 25 mm in diameter without evidence of a yolk sac or embryo.

(Fig. 5) [7].

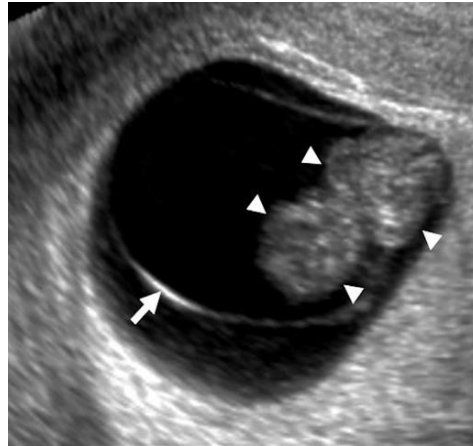
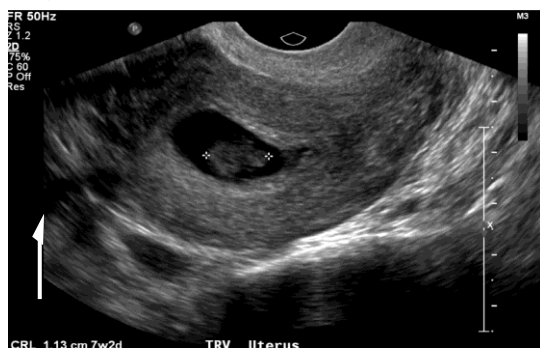
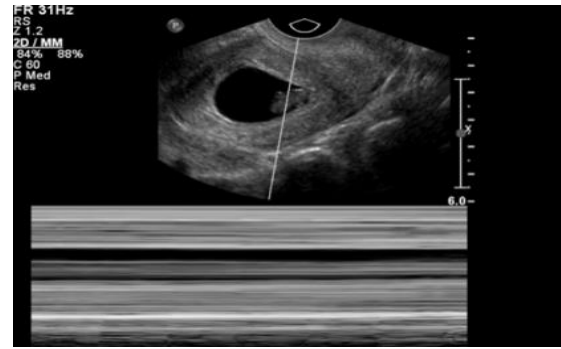


Fig. 5: Transvaginal ultrasonography in a patient with a previously confirmed intrauterine pregnancy (IUP) and vaginal bleeding, showing an IUP with a fetal pole (arrowheads). A curvilinear echogenic membrane is noted around the embryo, corresponding to the amniotic membrane (arrow).

(Fig. 6A, B) [7].



A



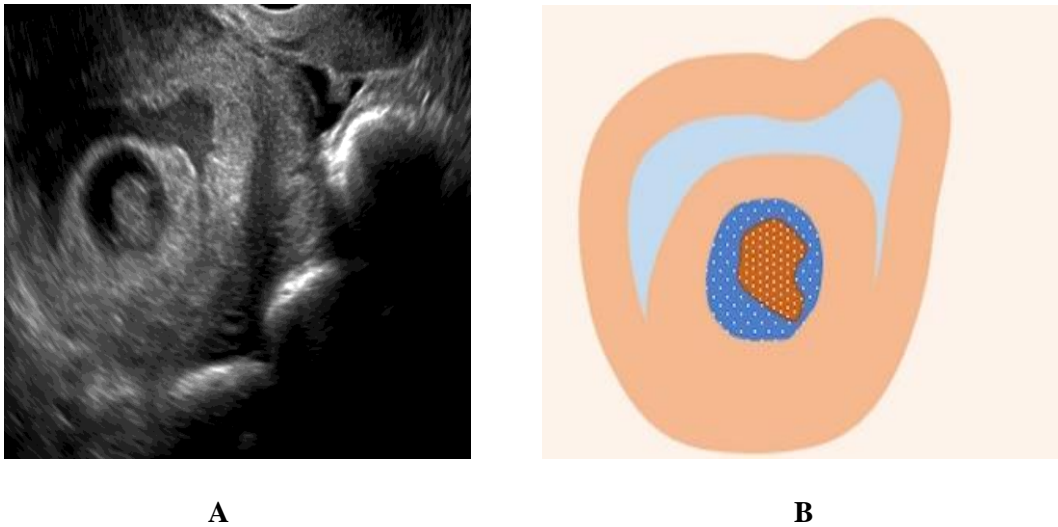
B

Fig. 6: Early pregnancy failure.

A. Transvaginal ultrasonography shows an intrauterine pregnancy with an embryo (arrow) with a crown-rump length of 1.1 cm, corresponding to a gestational age of 7 weeks, 2 days.

B. No fetal heart rate was identified; compatible with intrauterine embryonic demise. The fetal heart rate gradually increases with gestational age from approximately 110 beats per minute (bpm) at 6.2 weeks to approximately 159 bpm at 7.6-8.0 weeks

Fig. 7A, B):

**Fig. 7: Subchorionic hemorrhage.**

A. Transvaginal ultrasonography in a pregnant woman shows a gestational sac with an embryo and a heterogeneous subchorionic collection (arrowheads) encircling approximately 180° of the gestational sac.

B. Graphic depiction of the findings in A is shown. Larger subchorionic hematomas are associated with an increased risk of pregnancy loss, especially if the hematoma is greater than two thirds of the chorionic circumference ^[13, 14].

(Figure 8):

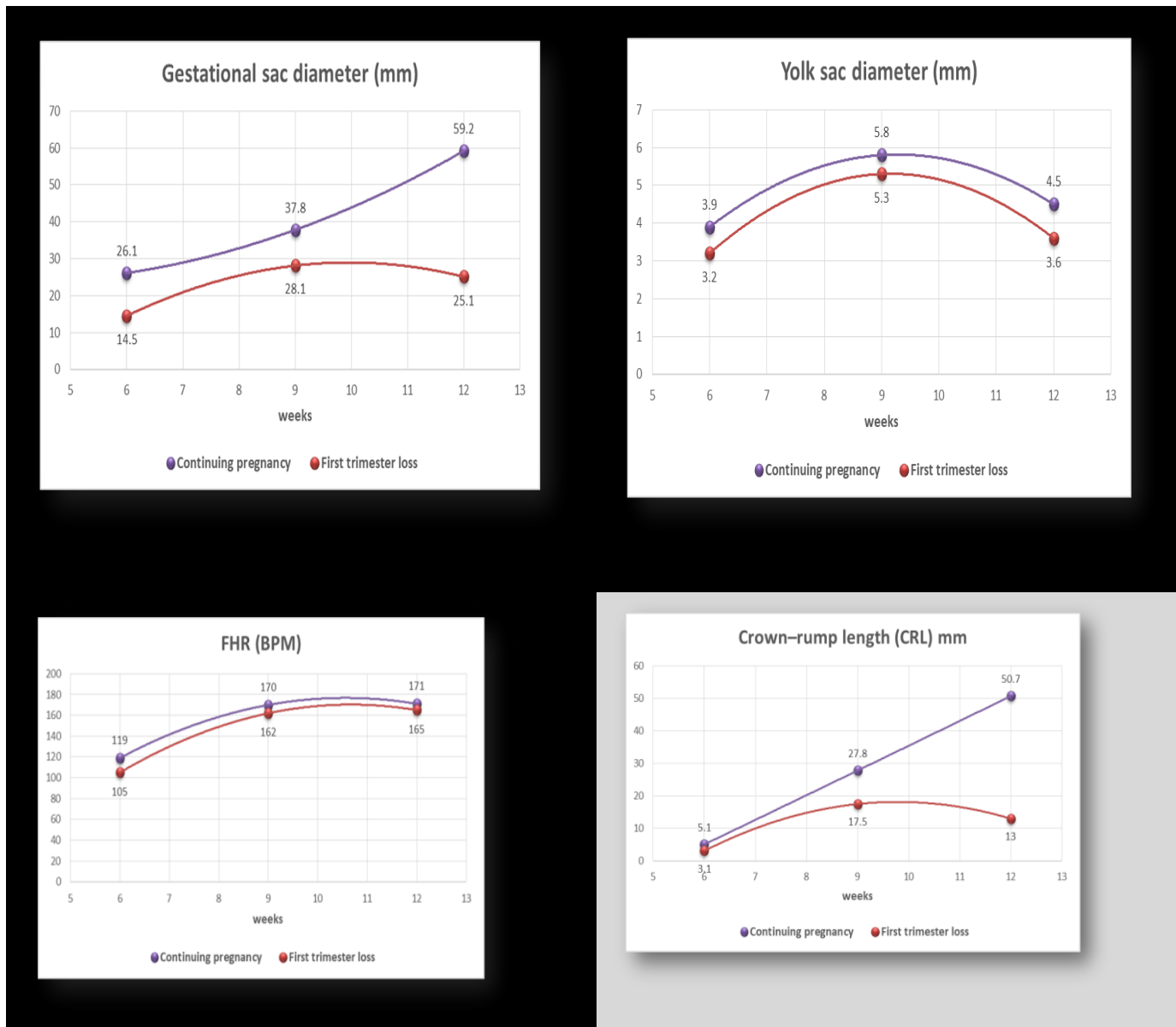


Figure 8: Median measurements of the parameters under investigation in the two groups, pregnancy loss and continuing pregnancy, plotted against the gestational age: (A). Gestational sac (GS); (B). Yolk sac (YS); (C).Crown-rump length (CRL); (D). Heart Rate (HR).

Discussion

Spontaneous abortion is specified to end a pregnancy without medical or mechanical means before a fetus is sufficiently established to be able to survive. In other words, its fetus loss before the twenty week of gestation.⁽¹⁾ spontaneous miscarriage may be the outcome in 15% of confirmed pregnancies. The recurrent loss is confirmed if loss occurs in ≥ 3 pregnancies, with

prevalence of 2% of pregnancies⁽²⁾ Ultrasonography has an important function in defining the proceeding of pregnancy and foreseeing outcome. 1st trimester of pregnancy is known as twelve weeks next to the last menstrual period is now a method of predicting an abnormal fetal outcome in both cases where a live embryo is present and even before visualization of the embryo itself.⁽³⁾

With continuous technological achievements; high-frequency transvaginal scanning, have permitted the resolution of ultrasound imaging in the 1st trimester to develop to a level at which early fetal development can be estimated and watched in detail. ⁽⁴⁾

Ultrasonography is a safe method because it does use too low power levels and not use ionizing radiation, so not cause adverse heating or pressure effects in tissue. Generally Ultrasonography advantages to patients outweigh the risks ⁽⁵⁾

Researchers have tried to discover some useful sonographic indicators in early pregnancy so as to expect the outcome of the early identification of pregnancies at increased risk for early loss is important issue for health personnel and for the mother herself.

The current study revealed that readings of GSD at 6th week of gestation (13.05 ± 1.17) was lower among with first trimester loss group than those continue pregnancy (28.71 ± 5.72) GSD at 9th week of (25.29 ± 3.42) was lower among with first trimester loss group than those continue pregnancy (41.85 ± 2.75) GSD at 12th week of gestation (22.59 ± 3.15) was lower among with first trimester loss group than those continue pregnancy (65.12 ± 4.51).

This agrees with Al Darwish AG et al., who found that GSD below normal (< 10th percentile) was associated significantly with PTL (preterm Labor), 1st & 2nd mid-trimester abortions ⁽⁸⁾

This agrees with Al Darwish AG et al., who found that abnormal CRL (<10th percentile), >90th percentile) was associated significantly with 1st trimester abortion and intrauterine fetal death (IUFD). ⁽⁸⁾

This agrees with Al Darwish AG et al., who found that Y.S less than normal (< 10th percentile) was associated significantly with PROM and 1st trimester abortion. ⁽⁸⁾

This agrees with Al Darwish AG et al., who found that abnormal GS measurements significantly related to abortion, CRL is considered an important predictor for 1st & 2nd trimester abortion and intrauterine fetal death IUFD, abnormal YSD strongly related

to 1st trimester abortion, PROM and APH ⁽⁸⁾

The current study results were in agreement with Christiansen et al., 2017 ⁽⁹⁾ they found that pregnancies that will end in abortion after 6 weeks' gestation may be predicted by the measures of YS and GS.

Additionally, they determined that abortion is predicted at least 7-days prior to occurrence.

The other parameters also became abnormal prior to spontaneous abortion, but at a later time in pregnancy and closer to the event. ⁽⁹⁾ Also similar to the current study results, Odeh et al., 2009 compare gestational sac volume (GSV) between normal pregnancies, missed abortion and anembryonic pregnancies they found that GSV in missed abortion and anembryonic pregnancies are considerably smaller than normal pregnancies, starting at 7-weeks of gestational age. ⁽¹⁰⁾

Also results of Batmaz et al., 2016 in their research agreed with the current study, they found that GS readings can help to distinguish between normal and abnormal pregnancies ⁽¹¹⁾

Also Jauniaux et al., 2005 proved that in pregnancies with a live fetus at 6-10-weeks' gestation the rate of subsequent fetal loss is associated to maternal age, and the ultrasound findings of small GSD and fetal bradycardia (FHR bradycardia), relative to CRL. ⁽¹²⁾

Also, the current research is in accordance with many other researches as Balsane et al., 2017 ⁽¹³⁾, Agarwal et al., 2017 ⁽¹⁴⁾ and Abu Elghar et al., ^[15] 2013, S Abdulkadhim et al., 2017 ⁽¹⁶⁾ found that with majority of patients with embryonic heart rate <100 BPM ended up with poor outcome.

Regarding the FHR, Most of the patients who had poor first trimester outcome had EHR below 150 BPM.

This finding came in agreement with those of Doubilet et al., 1995 ⁽¹⁷⁾ who found that an FER below 90 beats per minute at 6-8 weeks of gestation have been found to be related with a high probability of subsequent 1st trimester demise.

Another similar research by Benson et al.,

2013⁽¹⁸⁾ identify the survival rate according to the FHR in 6.3-7 gestational weeks to be nearly 52% when the FHR between 100-119 bpm and this drop to 0% when the heart rate drop to less than 100 bpm.

The current study revealed that YSD at 6th week of gestation was lower among with first trimester loss group (2.88 ± 1.62) than those continue pregnancy (4.29 ± 0.33), YSD at 9th week of gestation was lower among with first trimester loss group (4.77 ± 0.81) than those continue pregnancy (6.38 ± 0.66), and YSD at 12th week of gestation was lower among with first trimester loss group (3.24 ± 0.27) than those continue pregnancy (4.95 ± 0.77).

This result disagrees with research by Cho FN et al., 2006⁽¹⁹⁾ shown that the largest acceptable size of yolk sac was 8.1mm, and that the quality of the yolk sac is also an important predictor of the outcome of pregnancy. The poor quality and early regression of a yolk sac are more specific than the large size of a yolk sac in predicting pregnancy loss.

According to SinanTan et al., 2012,⁽²⁰⁾ evaluation of yolk sac should be part of a full 1st trimester sonographic examination as an abnormality in the sonographic appearance of a yolk sac can predict subsequent embryonic death. Another study made by Asim K et al,⁽²¹⁾ gave the criteria of subsequent first trimester demise depending on the quality of the yolk sac as 1-Absence of the yolk sac, 2-Too large yolk sac more than 6mm (sensitivity 16%, specificity 97%) and 3-Too small yolk sac less than 3mm (sensitivity 15%, specificity 95%). In the current study the 3rd point was found to have bad impact on the pregnancy outcome

Conclusions

The readings at 6th, 9th and 12th week of gestation for the (Gestational Sac Diameter, Youlk Sac Diameter, Crown–Rump Length, and Fetal Heart Rate) were lower among with first trimester loss group than those continue pregnancy.

The current study found that that those with early pregnancy loss the mean Gestational Sac Diameter, Youlk Sac Diameter, Crown–

Rump Length, and Fetal Heart Rate were lower than the value among those continue pregnancy.

This study proves the function of early ultrasound in predicting abnormal outcomes of pregnancy it could be useful to obstetricians to anticipate adverse outcomes and being warned to manage prenatal care and delivery more accurately.

Early fetal ultrasound should be used as a tool to predict pregnancy outcome so as to manage prenatal care and delivery more efficiently.

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Conflict of Interest: None to declare.

Ethical Clearance: All experimental protocols were approved under the El Minia university hospital Health Directorate and all experiments were carried out in accordance with approved guidelines.

References

1. Li L, Leung PC, Chung TK. Systematic review of Chinese medicine for miscarriage during early pregnancy. *Evid Based Complement Altern Med.* 2014; 2014:753856.
2. Ford HB, Schust DJ. Recurrent pregnancy loss: etiology, diagnosis, and therapy. *Rev Obstet Gynecol.* 2009; 2(2):76–83.
3. Kratochwil E, Eisenhut L. Der fruhestenachweis der fatalen herzaction durch ultrascall. *Geburtshilfe Frauenheilkd* 1967; 27: 176–180.
4. ISUOG Practice Guidelines: performance of first- trimester fetal ultrasound scan. *Ultrasound Obstet Gynecol.* 2013; 41: 102-113.
5. Jauniaux E, Gulbis B. Fluid compartments of the embryonic environment. *Hum Reprod Update* 2000; 6: 268–278.
6. Jauniaux E, Gulbis B. In vivo investigation of placental transfer early in human pregnancy. *Eur J Obstet Gynecol Reprod Biol* 2000; 92: 45–49.
7. Ziskin MC. Basic physics of ultra-

- sound. In: *The Principles and Practice of Ultrasonography in Obstetrics and Gynecology*, 4th ed, Fleischer AC, Romero R, Manning FA, et al., (eds), Appleton & Lange, Norwalk, CT 1991.
8. Al Darwish AG. Early Ultrasound Fetal Parameters as a Predictor for Pregnancy Outcome: A Prospective Observational Cohort Study. *Gynecology and Obstetrics Open Access Open Journal Research* 2019; 1(1): 7-12.
 9. Christiansena M, et al., Prediction of first trimester miscarriage by ultrasound. *Fertility and Sterility*. 2017; 108(3): e383-e384.
 10. Odeh M, Tendler R, Kais M. OP06. 04: Gestational sac volume in missed abortion compared to normal pregnancies. *Ultrasound in Obstetrics & Gynecology*. 2009; 34(S1): 79-80.
 11. Batmaz G, Aksoy A, Aydin S, Ozcan P, Dane C, Dane B. The early pregnancy volume measurements in predicting pregnancy outcome. *Clin Exp Obstet Gynecol*. 2016; 43(2): 241-244.
 12. Jauniaux E, Johns J, Burton GJ. The role of ultrasound imaging in diagnosing and investigating early pregnancy failure. *Ultrasound Obstet Gynecol*. 2005; 25(6):613-624.
 13. Balsane R, Vyas J, Rajoria L, Agarwal P, Gupta S. To study the association between initial fetal crown-rump length and subsequent abortion in a viable first trimester pregnancy. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*. 2017; 5(6): 1744-1747.
 14. Agarwal N, Sharma A. Miscarriage and early first trimester growth restriction by ultrasound. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*. 2017; 5(5): 1558-1561.
 15. Abuelghar WM, Fathi HM, Ellaithy MI, Anwar MA. Can a smaller than expected crown-rump length reliably predict the occurrence of subsequent miscarriage in a viable first trimester pregnancy? *J Obstet Gynaecol Res*. 2013; 39(10): 1449-1455.
 16. Abdulkadhim S et al., Predictors of poor first trimester outcome in asymptomatic women: the value of embryonic heart rate, mid sac diameter/ yolk sac ratio & mid sac diameter/crown rump length. *Al-Kindy College Medical Journal* 2017;13 (2):46-50.
 17. Doubilet PM. Ultrasound Evaluation of the First Trimester. *Radiol. Clin. North Am*. 2014; 52 (6): 1191-1199
 18. Benson CB, Doubilet PM, Peters HE, et al., Intrauterine fluid with ectopic pregnancy: a reappraisal. *J Ultrasound Med* 2013; 32: 389-93.
 19. Cho FN, Chen SN, Tai MH, Yang TL. The quality and size of yolk sac in early pregnancy loss. *Aust N Z J Obstet Gynaeco*. 2006; 46(5):413-8. 138-21 Sinan Tan. Sonographic evaluation of the yolk sac. *journal of ultrasound in medicine*, 2012;31:87-95
 20. Sinan Tan. Sonographic evaluation of the yolk sac. *journal of ultrasound in medicine* 2012; 31:87-95
 21. Asim K, Sanja K, Jose MC, Badreldeen A. Ultrasound evaluation of the abnormal early pregnancy. *Donald School journal of ultrasound in obstetrics & gynecology* 2008; 2(2):87-105.