Gynecology and Obstetrics Open Access Open Journal

SOAOJ PUBLISHING

Research

Early Ultrasound Fetal Parameters as a Predictor for Pregnancy Outcome: A Prospective Observational Cohort Study

Al Darwish AG, MD; Mahmoud Fouad, MD; Ahmed Ali M. Nasr, MD*; Abd Elhalim Mohammed, MD; Selim Ahmed Selim, MD;

Hanaa Abd Elsabour, MSc

Department of Obstetrics and Gynecology, Al Azhar University, Assiut, Egypt

Correspondence to: Ahmed Ali M. Nasr, MD; Assistant Professor of Obstetrics and Gynecology, Al Azhar University, Assiut, Egypt; E-mail: aam_nasr@yahoo.com

Received: February 9th, 2019; **Revised:** February 13th, 2019; **Accepted:** February 12th, 2019; **Published:** March 4th, 2019

Citation: Al Darwish AG, Fouad M, Nasr AAM, Mohammed AE, Selim SA, Elsabour HA. Early ultrasound fetal parameters as a predictor for pregnancy outcome: A prospective observational cohort study. *Gyne and Obste Open A Open J.* 2019; I(1): 7-12

Background

Ongoing technological advancements have allowed the resolution of ultrasound imaging in the first trimester to evolve to a level at which early fetal development can be assessed and monitored in detail.

Objective

To find a relation between first-trimester ultrasound fetal measurements and adverse pregnancy outcomes.

Subjects and Methods

A prospective observational cohort study conducted on 500 pregnant women at 1st trimester attending ANC clinic of obs& gyne. department of Al-Azhar university hospital (Assiut -Egypt). Ultrasound measurements of early fetal parameter GSD, CRL and YSD at 5-12 weeks of gestation were done. Results of measurements were classified into three classes, class A<10th centile, class B 10th-90th centile and Class C>90th centile. Patients were followed up throughout pregnancy to determine normal and abnormal outcomes in each class. Comparison between different classes was made to show association with abnormal pregnancy outcomes.

Results

Early fetal ultrasonographic parameters class A & C were significantly associated with 1st, 2nd-trimester abortions, IUFD, APH and PROM ($p<0.001$) with no significant association between these parameters and other pregnancy outcomes ($p>0.05$).

Conclusion

Our study emphasizes the role of early ultrasound in predicting abnormal pregnancy outcomes it could be useful to obstetricians to anticipate adverse outcomes and being warned to manage prenatal care and delivery more appropriately.

Recommendation

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

Keywords: *Ultrasound fetal parameters, Pregnancy outcomes.*

INTRODUCTION

Ultrasonography has an essential role in determining the progress of pregnancy and predicting prognosis. 1st trimester of pregnancy is defined as 12 weeks after the last menstrual period is now a mean of predicting an abnormal fetal outcome not only in the presence of a live embryo but also before visualization of the embryo itself.[1] Ongoing technological advancements, including high-frequency transvaginal scanning, have allowed the resolution of ultrasound imaging in the 1st trimester to evolve to a level at which early fetal development can be assessed and monitored in detail.[2] Ultrasonography does not use ionizing radiation, and the power levels used for imaging are too low to cause adverse heating or pressure effects in tissue. Although the long-term effects due to ultrasound exposure at diagnostic intensity are still unknown, currently most doctors feel that the benefits to patients outweigh the risks.[3] Many investigators have tried to find some useful sonographic markers in early pregnancy in order to anticipate the prognosis of the ongoing pregnancy. These include gestational sac diameter (GSD), crown-rump length (CRL), yolk sac diameter (YSD) and fetal heart rate (FHR).[4] CRL provides a more accurate estimation of gestational age because GSD shows greater variability of age prediction.[5] In early pregnancy, it is important to confirm viability, establish gestational age accurately, determine the number of fetuses and, in the presence of multiple pregnancies, assess chorionicity and amnionicity.[2]

The objective of this study was to find a relation between 1st trimester ultrasound fetal measurements and adverse pregnancy outcomes to provide accurate information regarding outcomes of pregnancy that facilitate the delivery of optimized ANC with the best possible outcomes for mother and fetus.

SUBJECTS AND METHODS

This study is a prospective observational cohort study conducted on 500 pregnant women fulfilled the inclusion criteria from attendants of ANC clinic of obstetrics and gynecology department of Al-Azhar University (Assiut - Egypt) from 1st November 2016 to the end of November 2017.

Inclusion Criteria

Any maternal age, any parity, singleton pregnancy, 1st trimester pregnancy (5-12 weeks) with a reliable date.

Exclusion Criteria

Chronic medical disorders (heart disease, DM, chronic hypertension, renal diseases, etc.), multiple pregnancies, smokers, and drug abusers, known uterine abnormalities, uncertain gestational age.

The following was done for all participants, detailed history, general, abdominal and local examinations, gestational age calculation according to modified Naegele's rule, routine investigations (CBC, ABO and Rh typing, urine analysis, RBS, and transabdominal or transvaginal sonography at 5-12 weeks of gestation for assessment of:

a) Gestational sac diameter (GSD) is the average of the three orthogonal measurements of the fluid-filled space within the gestational sac measured from inside of the sac to the inside of the decidual reaction; excluding the latter in the measurement.[2]

b) Crown-rump length (CRL) is the midline sagittal section of the whole embryo or fetus, ideally with the embryo or fetus oriented horizontally on the screen. An image should be magnified sufficiently to fill most of the width of the ultrasound screen so that the measurement line between crown and rump is at about 90° to the ultrasound beam. Electronic linear calipers should be used to measure the fetus in a neutral position (i.e. neither flexed nor hyperextended). The endpoints of crown and rump should be defined clearly. Care must be taken to avoid inclusion of structures such as the yolk sac; amniotic fluid should be visible between the fetal chin and chest in order to ensure that the fetus is not flexed. An average of three measurements in the sagittal plane of the embryo is obtained. CRL >8 mm in TAS who fail to demonstrate heartbeat was judged non-viable and CRL <8 mm without a visible heartbeat returned for repeat ultrasound after one week.[2]

c) Yolk sac diameter (YSD) and morphology measured by placing calipers on the inner limits of the longer diameter. YS having a diameter between 3-6 mm, rounded shape, an absence of degenerative changes, the presence of echogenic rim and hypoechoic center were considered normal.[7]

Results of ultrasound parameters (GSD, CRL, and YSD) were classified into three classes according to fetal charts:

- Class (A): measurements below the10th centile
- Class (B): average measurements between 10th-90th centile and
- Class (C): measurements above the 90th centile

Patients were followed throughout pregnancy to determine normal and abnormal outcomes (mother and fetus) in each class. Comparison was then made between pregnancy outcomes that are associated with normal measurements (class B) and abnormal measurements (class A & C).

Statistical Analysis

Data was analyzed using SPSS version 22. Qualitative data, quantitative data, frequency, mean, standard deviation (SD), and percent distribution were calculated. Chi square and t test were used to compare groups. $p<0.05$ was considered as the level of significance.

RESULTS

Table (1) shows the socio-demographic and clinical characteristics of the studied population.

Table 1. Socio-demographic and clinical characteristics of participants

Variables	Mean±SD
Age	26.54±4.71
Parity	2.0±1.4
Mode Of Delivery	
• Cesarean section	2.1±0.93
• Vaginal delivery	2.15±1.1
Abortion	1.44±0.62
Smoking (no. %)	
• No	340(68%)
• Yes	160(32%)
Consanguinity (no. %)	
• No	381(76.2%)
• Yes	119(23.8%)
Folic acid intake (no. %)	
• No Intake	45(9%)
• Preconception Intake	50(10%)
• 1st Trimester Intake	405(81%)
Body Mass Index(BMI)	26.42±3.43
Hb%	10.52±0.74

Table (2) shows the distribution of participants according to classes of early pregnancy parameters (CRL, Y.S & GSD) classified as class A<10th centile, class B 10th-90th centile, and class C>90th centile.

Table 2. Distribution of participants according to early ultrasonography parameters

Classes/ Parameter	Class A (<10th %)	Class B (10th–90th %)	Class C (>90th %)	Total
CRL	42	410	48	500
Y.S	18	459	23	500
GSD	49	409	42	500
CRL: crown rump length - Y.S: yolk sac- GSD: gestational sac diameter				

Table (3) shows pregnancy outcome (maternal and fetal) for participants. Proportions of different outcomes were calculated according to the total number (500). On the other hand proportions of AFI, NICU admission, Apgar score, and average fetal weight were estimated in relation to the total number of live births (402) after exclusion of pregnancies ended by abortions and IUFD.

Table (4) shows the relationship between mean GSD and pregnancy outcomes. It was found that GSD below normal (class A) was associated significantly with PTL, 1st & 2nd mid-trimester abortions (p<0.001), also GSD above normal (class C) was associated significantly with 1st trimester abortion (p<0.001), on the other hand, no significant association was found between GSD diameter and other fetal or maternal outcomes (p>0.05).

Table 3. Distribution of participants according to early ultrasonography parameters

Pregnancy outcomes	No.	%
MATERNAL OUTCOMES (n=500)		
Term pregnancy	344	68.8
Preterm labour (PTL)	58	11.6
Bleeding in early pregnancy	82	16.4
Antepartum hemorrhage	19	3.8
Pre labour rupture of membrane (PROM)	29	5.8
Amniotic Fluid Index (AFI)	(n=402)	
• Average	351	70.2
• Oligohydramnios	41	8.2
• Polyhydramnios	10	2
FETAL OUTCOME (n=500)		
1st trimester abortion	48	9.6
2nd trimester abortion	22	4.4
Intrauterine fetal death (IUFD)	14	2.8
Live births	372	74.4
Early neonatal death	30	6
Admission To NICU	(n=402)	
• Yes	75	18.7
• No	327	81.3
Fetal weight(gm) (Mean±SD)	2735±250	
Apgar score (Mean±SD)	(n=402)	
• 1 minute	7.5±1.2	
• 5 miniutes	8.1±1.1	

Table 4. Association between G.S.D and pregnancy outcomes

Classes/Outcomes		Class A (<10th %) (n=49)	Class B (10th–90th %) (n=409)	Class C (>90th %) (n=42)	P1	P2
Maternal outcome						
Term pregnancy		33(67.3%)	282(68.9%)	29(69 %)	0.57	0.19
PTL		3(6.1%)	50(12.2%)	5(11.9%)	<0.001**	0.79
early pregnancy Bleeding		7(14.3%)	68(16.6%)	7(16.7%)	0.30	0.88
APH		2(4.1%)	15(3.7%)	2(4.8%)	0.93	0.16
PROM		2(4.1%)	25(6.1%)	2(4.8%)	0.81	1.00
AFI	Average	34(69.4%)	288(70.4%)	29(69%)	0.68	0.83
	Oligohyd	3(6.1%)	33(8.1%)	5(11.9%)	0.83	0.58
	Polyhyd	1(2.0%)	8(2.0%)	1(2.4%)	0.61	0.64
Fetal outcome						
Abortion	1st trimester	8(16.3%)	16(3.9%)	24(57.1%)	0.001**	<0.001**
	2nd trimester	9(18.4%)	11(2.7%)	1(2.4%)	<0.001**	0.58
IUFD		1(2.0%)	12(2.9%)	1(2.4%)	0.92	0.76
neonatal death		3(6.1%)	25(6.1%)	2(4.8%)	0.75	1.00
NICU Admission		7(14.3%)	61(14.9%)	7(%)16.7	0.26	0.70
Fetal weight(gm)#		2694.0±413.71	2691.97±460.93	2723.4±451.22	0.98	1.00
APGAR Score#		8.0±1.48	7.72±1.47	7.83±1.47	0.79	1.00

# Values are given as Mean±SD **=very high significance
P1=p- value between group A&B P2=p- value between group B&C
PTL: preterm labour- APH: antepartum hemorrhage- PROM: pre-labour rupture of membranes- AFI: amniotic fluid index- IUFD: intrauterine fetal death- NICU: neonatal intensive care unit- GSD: gestational sac diameter

Table (5) shows association between classes of CRL and pregnancy outcomes. It was found that abnormal CRL (class A & C) was associated significantly with 1st trimester abortion and IUFD (p<0.001), also CRL more than normal (class C) was associated significantly with 2nd trimester abortion (p<0.001), on the other hand, no association was found between mean CRL and other fetal or maternal outcomes (p>0.05).

Table (6) shows an association between mean YSD and pregnancy outcomes. It was found that Y.S above normal (class C) was associated significantly with APH (p<0.001), on the other hand, Y.S less than normal (class A) was associated significantly with PROM and 1st trimester abor-

Table 5. Association between CRL and pregnancy outcomes

Classes/Outcomes		Class A (<10th %) (n=42)	Class B (10th–90th %) (n=410)	Class C (>90th %) (n=48)	P1	P2
Maternal outcome						
Term pregnancy		29(69.1%)	281(68.5%)	34(70.8%)	0.28	0.26
PTL		4(9.5%)	52(12.7%)	2(4.2%)	0.7	0.1
early pregnancy Bleeding		7(16.8)	66(16.1%)	9(18.6%)	0.91	0.76
APH		2(4.8%)	15(3.7%)	2(4.2%)	0.95	0.82
PROM		3(7.1%)	25(9%)	1(2.1%)	0.94	0.42
AFI	Average	29(69.1%)	289(70.5%)	33(68.8%)	0.09	0.22
	Oligohyd	1(2.4%)	37(9%)	3(6.3%)	0.24	0.72
	Polyhyd	1(2.4%)	8(1.9%)	1(2.1%)	0.69	0.62
Fetal outcome						
Abortion	1st trimester	23(54.8%)	1(0.2%)	24(50%)	<0.001**	<0.001**
	2nd trimester	1(2.4%)	10(2.4%)	11(22.9%)	0.60	<0.001**
IUFD		4(9.5%)	5(1.2%)	5(10.4%)	<0.001**	<0.001**
neonatal death		2(4.8%)	26(6.3%)	2(4.2%)	0.96	0.80
NICU Admission		3(7.1%)	68(16.6%)	4(8.3%)	0.17	0.20
Fetal weight(gm)#		2718.29±405.55	2679.02±468.12	2809.30±371.33	0.60	0.06
APGAR Score#		7.83+1.38	7.73+1.50	7.93+1.35	0.68	0.38

# Values are given as Mean±SD **=very high significance
P1=p- value between group A&B P2=p- value between group B&C
PTL: preterm labour- APH: antepartum hemorrhage- PROM: pre-labour rupture of membranes- AFI: amniotic fluid index- IUFD: intrauterine fetal death- NICU: neonatal intensive care unit- GSD: gestational sac diameter

Table 6. Association between YSD and pregnancy outcomes

Classes/Outcomes		Class A(<10th %) (n=42)	Class B (10th–90th %) (n=410)	Class C (>90th %) (n=48)	P1	P2
Maternal outcome						
Term pregnancy		13(72.2%)	315(68.6%)	16(69.6%)	0.70	0.85
PTL		2 (11.1%)	53(11.6%)	3(13%)	0.76	0.91
early pregnancy Bleeding		6(33.3%)	73(15.9%)	3(13%)	0.10	0.94
APH		1(5.6 %)	12(2.6%)	6(26.1%)	0.37	<0.001**
PROM		7(38.9%)	21(4.6%)	1 (4.4%)	<0.001**	0.72
AFI	Average	13(72.2%)	321(69.9%)	2(8.7%)	0.74	0.77
	Oligohyd	1(5.6%)	38(8.3%)	2(8.7%)	0.98	0.75
	Polyhyd	1(5.6%)	8(1.7%)	1(4.4%)	0.70	0.12
Fetal outcome						
Abortion	1st trimester	16(88.9%)	30(6.5%)	2(8.7%)	<0.001**	0.53
	2nd trimester	1(5.6%)	20(4.4%)	1(4.4%)	0.84	0.9
IUFD		1(5. 6%)	12(2.6%)	1(4.4%)	0.68	0.92
neonatal death		1(5. 6%)	28(6.1%)	1(4.4%)	0.68	0.92
NICU Admission		4(22.2%)	69(15%)	2(8.7%)	0.62	0.60
Fetal weight(gm)#		2712.50±499.17	2696.14±456.30	2659.52±417.92	0.88	0.71
APGAR Score#		7.50±1.75	7.76±1.47	7.90±1.25	0.47	0.65

# Values are given as Mean±SD **=very high significance
P1=p- value between group A&B P2=p- value between group B&C
PTL: preterm labour- APH: antepartum hemorrhage- PROM: pre-labour rupture of membranes- AFI: amniotic fluid index- IUFD: intrauterine fetal death- NICU: neonatal intensive care unit.

tion ($p<0.001$), on the other hand no association was found between mean Y.S diameter and other fetal or maternal outcomes ($p>0.05$).

DISCUSSION

In the present study, abnormal ultrasound parameters were found to be significantly associated with the following abnormal outcomes (1st and 2nd trimester abortions, IUFD, APH, and PROM). On the other hand, no significant association was found between abnormal fetal ultrasound parameters and other fetal or maternal outcomes mentioned in this study ($p>0.05$).

As regard to abortion: Abnormal GSD (class A & C), low YSD (class A) and abnormal CRL (class A & C) were significantly associated with 1st trimester abortion ($p<0.001$). On the other hand, 2nd trimester abortion was associated significantly with small GSD (class A) and large CRL (class C) ($p<0.001$)

Findings of our study were in agreement with Christiansen et al., 2017[7] they showed in their study that pregnancies that will end in abortion after 6 weeks' gestation may be predicted by the measures of YS and GS. In addition, they identified 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.[7] Also similar to our finding Odeh et al, 2009[8] compare gestational sac volume (GSV) between normal pregnancies, missed abortion and anembryonic pregnancies they concluded that GSV in missed abortion and anembryonic pregnancies are significantly smaller than normal pregnancies, starting at 7-weeks of gestational age.[8] Also finding of Batmaz et al, 2016 in their study agreed with the present study, they stated that GS measurements can help to distinguish between normal and abnormal pregnancies.[9]

Also Jauniaux et al 2005 confirmed that in pregnancies with a live fetus at 6-10-weeks' gestation the rate of subsequent fetal loss is related to maternal age, cigarette smoking, history of vaginal bleeding and the ultrasound findings of small GSD and fetal bradycardia, relative to CRL.[10] Also, our study is in agreement with many other studies as Balsane et al, 2017, Agarwal et al, 2017 and Abu Elghar et al, 2013[11-13]

In contrast to our study, Oh et al, 2002 found no significant relationship between gestational sac and normal and abnormal pregnancy outcome.[14] Also Abdallah et al, 2011 found that slow or absent gestational sac growth is not necessarily associated with miscarriage.[15]

As regard to IUFD, we found in our study that small or large CRL (class A&C) were significantly associated with IUFD ($p<0.001$). On the other hand, no statistically significant association could be found between abnormal YSD or GSD and IUFD ($p>0.05$). This result is in accordance to Sabour et al, 2017 who evaluate the association between the small crown-rump length (CRL) and IUFD ≤22 weeks in IVF pregnancies he found that rate of fetal loss was significantly higher than in pregnancies with CRL> tenth percentile.[16]

In the present study we did not find a significant association between early ultrasound fetal measurements and fetal birth weight however our results were against Benítez et al 2017 who study ultrasound and biochemical first trimester markers as a predictive factors for IUGR and small for gestational age (SGA) they concluded that biochemical markers, CRL, maternal weight, smoker status, hypertension conditions, and parity, was a good model for predicting the risk of IUGR and SGA.[17] Also Sedehi and Morteza; 2014 found in their study that CRL in the first trimester is significantly correlated with fetal weight, fetal length, and HC at birth and can be used in screening.[18] Vafaei et al, 2012 found in their study that low (<2500 g) and high (>4000 g) birth weights were correlated with the difference between actual and expected CRL, but they did not find a correlation between the difference between actual and expected CRL and premature delivery($p=0.005$). They also stated that routine measuring of CRL during the first trimester to detect CRLs shorter than expected for gestational age could be useful to obstetricians to anticipate a low birth weight and being warned to manage prenatal care and delivery more appropriately.[19]

In the present study no significant association was found between early fetal parameters and PTL, this result is in accordance with Vafaei et al, 2012 and KAZEMIER et al, 2012.[19,20] However in contrary to our study Smeets et al, 2013 revealed that there is a strong relationship between early fetal measurements and fetus at risk for preterm birth and low birth weight for gestational age[21]

In the current study, large YSD (class C) was associated significantly with APH ($p<0.001$) while small YSD and abnormal CRL and GSD have no significant association to APH ($p>0.05$). Also regarding PROM, only small YSD (class A) was associated significantly with PROM ($p<0.001$) while large YSD, CRL or GSD has no significant association ($p>0.05$). To our knowledge, this study is the first to find such association between early pregnancy fetal measurements and PROM and APH. Further large studies are needed to evaluate this finding.

CONCLUSION

Finding of the present study showed that early fetal measurements can predict to some extent pregnancy outcome. Abnormal GS measurements significantly related to abortion, CRL is considered an important predictor for 1st & 2nd trimester abortion and IUFD, abnormal YSD strongly related to 1st trimester abortion, PROM and APH.

RECOMMENDATIONS

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

CONFLICT OF INTERESTS

Authors declare that no conflict of interest is present.

REFERENCES

1. Okeke TC, Agwuna KK, Agu PU. The application of first trimester volumetry in predicting pregnancy complications. *Journal of Basic and Clinical Reproductive Sciences*. 2014; 3(1): 8-14. doi: 10.4103/2278-960X.129272

2. Salomon LJ, Alfirevic Z, Bilardo CM, et al. ISUOG practice guidelines: Performance of first-trimester fetal ultrasound scan. *Ultrasound Obstet Gynecol*. 2013; 41(1): 102–113. doi: 10.1002/uog.12342

3. Harris, Gerald R. FDA regulation of clinical high intensity focused ultrasound (HIFU) devices. Engineering in Medicine and Biology Society. Annual International Conference of the IEEE. IEEE, 2009.

4. Altay MM, Yaz H, Haberal A. The assessment of the gestational sac diameter, crown–rump length, progesterone and fetal heart rate measurements at the 10th gestational week to predict the spontaneous abortion risk. *J Obstet Gynaecol Res*. 2009; 35(2): 287-292.

5. Chalouhi GE, Bernard JP, Benoist G, Nasr B, Ville Y, Salomon LJ. A comparison of first trimester measurements for prediction of delivery date. *J Matern Fetal Neonatal Med*. 2011; 24(1): 51-57. doi: 10.3109/14767051003728229

6. Kumari S, Roychowdhury J, Biswas S. Prediction of early pregnancy failure by use of first trimester ultrasound screening. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*. 2017; 5(7): 2135-2140. doi: 10.18203/2320-1770.ijrcog20161897

7. Christiansena M, Francillonb LI, Ikwuezunma GB, et al. Prediction of first trimester miscarriage by ultrasound. *Fertility and Sterility.* 2017; 108(3): e383-e384. doi: 10.1016/j.fertnstert.2017.07.1113

8. Odeh M, Tendler R, Kais M, et al. OP06. 04: Gestational sac volume in missed abortion compared to normal pregnancies. *Ultrasound in Obstetrics & Gynecology*. 2009; 34(S1): 79-80. doi: 10.1002/uog.6701

9. 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.

10. 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. doi: 10.1002/uog.1892

11. 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. doi: 10.18203/2320-1770.ijrcog20161656

12. 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. doi: 10.18203/2320-1770.ijrcog20161324

13. 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. doi: 10.1111/jog.12082

14. Oh JS, Wright G, Coulam CB. Gestational sac diameter in very early pregnancy as a predictor of fetal outcome. *Ultrasound Obstet Gynecol.* 2002; 20(3): 267-269. doi: 10.1046/j.1469-0705.2002.00774.x

15. Abdallah Y, Daemen A, Kirk E, et al. Limitations of current definitions of miscarriage using mean gestational sac diameter and crown–rump length measurements: A multicenter observational study. *Ultrasound Obstet Gynecol*. 2011; 38(5): 497-502. doi: 10.1002/uog.10109

16. Sabour, Siamak. Prediction of fetal loss by first-trimester crown-rump length in IVF pregnancies: Prediction rules to avoid misinterpretatiosn. *Archives of Gynecology and Obstetrics*. 2017; 295(5): 1297-1297. doi: 10.1007/s00404-017-4318-8

17. Benítez Martín A , Vargas Pérez M, Manzanares Galán S. Ultrasound and biochemical first trimester markers as predictive factors for intrauterine growth restriction. *Obstet Gynecol Cases Rev*. 2017; 4(2):109. doi: 10.23937/2377-9004/1410109

18. Sedehi, MoRteza. The relationship between fetal crown-rump length in the early first trimester and growth parameters at birth. *International Journal of Anatomy, Radiology and Surgery*. 2016; 5(3): RO47-RO51 doi: 10.7860/IJARS/2016/17869.2166

19. Vafaei H, Samsami A, Zolghadri J, Hosseini-Nohadani A. Correlation of first-trimester fetal crown–rump length with outcome of pregnancy and birth weight. *Int J Gynaecol Obstet*. 2012; 119(2): 141-144. doi: 10.1016/j.ijgo.2012.05.040

20. Kazemier BM, Kleinrouweler CE, Oudijk MA, et al. Is short first-trimester crown–rump length associated with spontaneous preterm birth? *Ultrasound Obstet Gynecol*. 2012; 40(6): 636-641. doi: 10.1002/uog.11148

21. Nicol AC, Smeetsa, Winkens B, Prudon M, et al. The predictive value of first trimester fetal volume measurements, a prospective cohort study. *Early Human Development*. 2013; 89(5): 321-326. doi: 10.1016/j.earlhumdev.2012.11.001