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The Correlation Between Gestational Sac Volume and Embryonic Volume in Prediction of Pregnancy Outcomes

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ABSTRACT

Background: Accurate estimation of gestational (GA) is the basis of vital decisions in pregnancy and hence its importance in obstetric management. Crown rump length (CRL) has been proved to be a reliable parameter for the estimation of pregnancy age especially from 7 to 10 weeks**.** Additionally, it was demonstrated that, the gestational sac volume (GSV), embryonic volume (EV), CRL are important parameters for the early diagnosis of growth disorders**.**

Objective: The aim of the current work was to assess the correlation of pregnancy outcome with gestational sac volume in relation to embryonic volume at (7-10) weeks of gestation.

Patients and methods: This was a prospective observational cross-sectional study carried out on 100 pregnant women with singleton pregnancy that belonging to7-10 week of pregnancy attending a routine antenatal checkup at Outpatient Clinic Of Obstetrics and Gynecology Department, Mansoura University Hospital.

Results: Caesarean section (CS) was the most frequent mode of delivery among the studied cases. The average GSV, EV and CRL were higher among females with higher gestational age. EV and GSV were demonstrated to be significant predictors of CRL. CRL=1.55+0.02*GSV+0.08*EV. GSV was displayed to be a significant predictor of fetal birth weight. Fetal birth weight=2.94+0.008*GSV.

Conclusion: It could be concluded that the GSV and EV reference intervals established in the present study can be used as normal parameters in future studies assessing cases at risk for adverse pregnancy outcomes.

Keywords: Gestational sac volume, Embryonic volume, Pregnancy outcomes

INTRODUCTION

Sonography is an excellent modality for first trimester pregnancy evaluation and in determining the progress of pregnancy and predicting prognosis. The 3D volumetric methodology is more accurate than 2D US and reliable for clinical evaluations, but it is not a substitute for 2D US and both methods should be used together to get accurate and efficient ultrasound diagnosis [(1)].

First trimester of pregnancy is defined as 12 weeks after the last menstrual period in a woman during her reproductive life. This period is exposed to a lot of complications associated with human formation, development, and growth. However, First trimester ultrasonography aims to establish viability, pregnancy dating, detect multiple pregnancy, observe uterine adnexal structures, measure nuchal translucency and evaluate limited fetal gross anomaly and predict an abnormal fetal outcome not only in the presence of a live embryo but also before visualization of the embryo itself that can be used to identify a subgroup of embryo at high risk of embryonic demise or subsequent diagnosis of fetal anomaly that requires close monitoring [(2)].

First trimester prediction of IUGR, preeclampsia, birth weight, aneuploidy miscarriage, complications in multiple pregnancies and homozygous thalassemia is a challenging and an emerging field in obstetrical sonography [(3)]. Gestational sac is closely related to amniotic fluid volume that may reflect uteroplacental functions in the first trimester, may predict adverse pregnancy outcome [(4)].

The aim of the present study was to assess the correlation of patient's pregnancy outcome (maternal and fetal) with gestational sac volume in relation to embryonic volume at (7-10) weeks of gestation.

PATIENTS AND METHODS

This prospective observational cross-sectional study included a total of 100 pregnant women with singleton pregnancy that belonging to7-10 week of pregnancy, attending for a routine antenatal checkup in Outpatient Clinic, Obstetrics and Gynecology Department, Mansoura University Hospital.

Inclusion criteria: The women of singleton pregnancy with a live embryo < 35years old who will give informed consent, without other medical disorders, and gestational age between (7-10) weeks and no history of vaginal bleeding in the index pregnancy.

Exclusion criteria:

Pregnancy from stimulated ovulation, an uncertain last menstrual period date, irregular menstrual cycles, multiple pregnancies. Cases without embryonic heart rate, anembryonic pregnancy, subchorionic hemorrhage, uterine malformations, and women who has medical disorders or used any abortive or teratogenic drug.

All cases were subjected to:

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I) **Full history taking** includes patient age, parity, history of previous caesarean birth(s).

II) **Full clinical examination**: General examination: (pulse, blood pressure, temperature, respiratory rates). Abdominal examination. Chest examination. Cardiac examination.

III) **Investigations**: All sonographic measurements were performed by a single investigator using Samsung Medison H60 ultrasound device. Initially, a 2D sonographic examination was performed to measure the CRL (largest inner to inner measure), mean gestational sac diameter (arithmetic mean of 3 diameters). We calculated the volume of gestational sac and embryo volume by 3D volumetry and VOCAL method. All results were tabulated and represented in illustrations.

Gestational Sac volumetry:

By position of the region of interest box over the entire GS that was automatically displayed on the monitor as 3 orthogonal perpendicular planes, by using a 30°rotation angle and the equipment automatically was display the reconstructed image with its volume in cm3.

Embryo volumetry: By displaying embryo in 3 orthogonal planes at rotational angle 30° angle then the equipment automatically was added all the outlined areas and its final volume was automatically calculated.

Ethical consent:

The research approval of the study was obtained from IRB of Faculty of Medicine at Mansoura University before starting the study. The researchers clarified the objective and aim of the study to the subjects included in the study. The researcher assured maintaining anonymity and confidentiality of subject's data. Subjects were informed that they allowed to choose to participate or not in the study and that, they had the right to withdraw from the study at any time without giving any reasons. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp. Qualitative data were described using number and percent. Quantitative data were described using median (minimum and maximum) for non-parametric data after testing normality using Kolmogrov-Smirnov test. Significance of the obtained results was judged at the (0.05) level.

Non Parametric tests: Mann-Whitney U test was used to compare 2 independent groups. **Spearman's correlation:** The Spearman's rank-order correlation is used to determine the strength and direction of a linear relationship between two non-normally distributed continuous variables and / or ordinal variables. **Linear regression analysis** was used for prediction of independent variables of continuous parametric outcome after log transformation of the outcome. Significant predictors in the correlation were entered into regression model with calculation of R^2 that quantity effect of combined variables on desired outcome and the prediction equation($Y=\beta + a*x$).

RESULTS

The present study was carried out on 100 pregnant healthy women with normal pregnancies between 7and 10 weeks to study the correlation of patient's pregnancy outcome with gestational sac volume and embryonic volume.

Table (1): Demographic and obstetric history among studied cases.

	Total number N=100	**%**
Age/years Mean ±SD (min-max)	24.90±3.74 (18.0-34.0)	
Gravidity Median	2.0	
1	8	8.0
2	44	44.0
3	36	36.0
4	12	12.0
Parity Median	1.0	
0	18	18.0
1	34	34.0
2	36	36.0
3	12	12.0
Residence		
Rural	59	59.0
Urban	41	41.0
Mode of delivery		
Vaginal	26	26.0
CS	74	74.0

The study population demographic data illustrates that the average of the studied cases was 24.90±3.74, while the median gravidity was two. The majority of cases were second gravida followed by third garvida, fourth gravida and lastly primigravida. About (59%) of cases were living in rural areas and (74%) of cases were undergone cesarean section as presented in Table (1).

Quantitative data between groups:

Table (2): Gestational Sac Volume (GSV) distribution among gestational age of the studied females.

Gestational age/week	GSV									
	Mean	Median	SD	MIN	MAX	5th	25th	50th	75th	95th
7-7+6	7.11	7.09	1.71	5.3	10.12	5.3	5.3	7.09	8.3	10.12
8-8+6	20.68	16.89	14.87	7.09	61.02	7.38	10.12	16.89	25.37	61.02
9-9+6	39.93	37.59	9.67	14.17	71.18	17.50	37.31	37.59	44.36	66.51
10-10+6	69.57	61.02	17.58	37.31	103.21	37.31	61.02	61.02	83.0	103.21

Mean GSV increased from 7.11 ± 1.71cm3 SD (range 5.3-10.12) at 7 to7+6 weeks to 69.57 ±17.58 cm3 SD(range 37.31-103.21) at 10 to10+6weeks and demonstrate the 5th,25th, 50th, 75th, 95th centiles of GSV for all the gestational intervals evaluated. Mean GSV was 7.11, 20.68, 39.93, 69.57 at 7, 8, 9 & 10 weeks of gestations respectively.

In relation between GSV and gestational age of the studied females illustrates that mean GSV was higher among females with higher gestational age. Median GSV was 7.09, 16.89, 37.59 & 61.02 respectively for gestational age 7, 8, 9 & 10 weeks.

Table (3): Embryonic volume distribution among gestational age of the studied females.

Gestational age/week	Embryonic volume									
	Mean	Median	SD	MIN	MAX	5th	25th	50th	75th	95th
7-7+6	0.937	0.842	0.461	0.43	2.05	0.429	0.537	0.842	1.095	2.054
8-8+6	2.715	2.05	2.12	0.43	9.87	0.429	1.26	2.054	4.10	8.28
9-9+6	7.27	4.94	5.65	1.48	21.07	1.50	4.21	4.94	8.36	21.07
10-10+6	8.99	5.89	6.55	1.6	18.09	1.59	3.27	5.89	17.0	17.29

Mean EV increased from 0.937 ± 0.461cm3 SD (range 0.43-2.05) at 7 to7+6 weeks to 8.99 ±6.55cm3 SD (range 1.6-18.09) at 10 to10+6weeks and demonstrate the 5th,25th, 50th, 75th, 95th centiles of EV for all the gestational intervals evaluated. Mean EV was 0.937, 2.715, 7.27, 8.99 at 7, 8, 9 & 10 weeks of gestations respectively.

In relation between embryonic volume and gestational age of the studied females illustrates that mean embryonic volume was higher among females with higher gestational age. Median embryonic volume was 0.842, 2.05, 4.94 & 5.89 respectively for gestational age 7, 8, 9 &10 weeks.

Table (4): Crown rump length distribution among gestational age of the studied females.

Gestational age/week	CRL									
	Mean	Median	SD	MIN	MAX	5th	25th	50th	75th	95th
7-7+6	1.56	1.17	1.31	0.92	5.93	0.92	0.92	1.17	1.47	5.93
8-8+6	2.03	2.06	0.54	1.2	3.12	1.20	1.69	2.06	2.42	3.12
9-9+6	3.12	2.79	1.03	1.69	5.93	1.764	2.75	2.79	2.88	5.93
10-10+6	3.95	3.69	0.824	2.75	5.11	2.81	3.27	3.69	4.80	5.11

Mean CRL increased from 1.56 ± 1.31cm3 SD (range 0.92-5.93) at 7 to7+6 weeks to 3.95 ±0.824 cm3 SD (range 2.75-5.11) at 10 to10+6weeks and demonstrate the 5th,25th, 50th, 75th, 95th centiles of CRL for all the gestational intervals evaluated.

Mean CRL was 1.56, 2.03, 3.12, 3.95 at 7, 8, 9 & 10 weeks of gestations respectively. In relation between crown rump length and gestational age of the studied females illustrates that mean crown rump length was higher among females with higher gestational age. Median CRL was 1.17, 2.06, 2.79 & 3.69 respectively for gestational age 7, 8, 9 &10 weeks.

Table (5): Correlation between GSV, EV and gestational age, Crown rump length and fetal birth.

		GSV	EV
GA	r	0.888	0.637

	p	<0.001*	<0.001*
CRL	r	0.738	0.700
	p	<0.001*	<0.001*
Fetal birth (kg)	r	0.324	0.165
	p	0.001*	0.101

r: Spearman correlation coefficient , ** statistically significant if p<0.05

There is statistically significant positive correlation between GSV and Gestational age (r=0.888, p<0.001), crown rump length (r=0. 738, p<0.001) and Fetal birth (r=0.738, p=0.001). EV demonstrates that there is statistically significant positive correlation with Gestational age (r=0.637, p<0.001), crown rump length (r=0.700, p<0.001) and positive correlation with Fetal birth weight but statistically non-significant (r= 0.165, p= 0.101). There was a positive correlation and statistically significant between GSV and GA, CRL, FBW. There was a positive correlation and statistically significant between EV and GA, CRL and a positive correlation and not statistically non-significant between EV and FBW.

Table (6): Linear regression for prediction of Crown rump length among studied females.

Predictors	B	t	P
(Constant)	1.55	10.04	<0.001*
GSV	0.02	5.55	<0.001*
EV	0.08	4.04	<0.001*
R^2=0.559 F=61.36 P<0.001 **CRL=1.55+0.02*GSV+0.08*EV**			

As shown in table (6) which demonstrates that **EV and GSV were significant predictors of crown rump length** with 55.9% of the CRL with p value<0.001 can be predicted by GSV & EV change with the following prediction equation**;**
CRL=1.55+0.02*GSV+0.08*EV.

Table (7): Linear regression for prediction of fetal birth weight among studied females.

Predictors	B	t	P
(Constant)	2.94	31.06	<0.001*
GSV	0.008	3.26	0.002*
EV	-0.002	-0.136	0.892
F=8.27 P<0.001* R^2=0.146 **Fetal birth weight=2.94+0.008*GSV**			

GSV was significant predictors of fetal birth weight with14.6% of the fetal birth weight can be predicted by GSV change with the following prediction equation; **Fetal birth weight=2.94+0.008*GSV**.

Table (8): Relation between GSV, EV & CRL and mode of delivery among studied females.

	Vaginal delivery n=26 Median	**CS delivery n=74** Median	**P**
GSV	36.1	37.59	P=0.595
EV	3.27	3.489	P=0.280
CRL	2.79	5.81	P=0.866

There was **statistically insignificant between median GSV, EV and CRL and CS delivery** (p=0.866, 0.280, 0.866) and **not affect the mode of delivery.** Median GSV, EV and CRL among studied cases with CS delivery was higher than with vaginal delivery but **statistically insignificant** (37.59, 3.489 &5.81) versus (36.1, 3.27 & 2.79), respectively.

Table (9): Adverse outcome of the studied cases.

	N	**%**
IUGR	**2**	**2.0%**
Macrosomia	**1**	**1.0%**

There was sporadic 3 cases of disturbance of fetal birth weight, One case of macrosomia (4.5kg) & complicated by (GDM) in which the GSV was higher than 95thpercentile & EV in between 75 th -95th percentile, Two cases of IUGR (2kg) & one of them complicated by Preeclampsia and Preterm labor in these case there was discordance between GSV at 5thpercentile and EV at 25th percentile &the other case both GSV&EV at 5th percentile.

DISCUSSION

In terms of demographic data, the average age of the studied cases was 24.90±3.74, while the median gravidity was two. The majority of cases were second gravida followed by third garvida, fourth gravida and lastly primigravida. About (59%) of cases were living in rural areas and (74%) of cases were undergone cesarean section.

Gaafar *et al.* [5] conducted a cross-sectional study included 62 singleton normal uneventful pregnancies. All women were essentially sure of the date of last menstrual period. All women were submitted to 3D ultrasonographic examination with VOCAL technique to determine the embryonic volume and demonstrate a strong correlation between fetal volume estimation and crown-rump length measurement for the prediction of gestational age (r=0.950).Embryonic volume is a good predictor of gestational age with a power regression equation (y=52.22+6.5 x) for the period from 7 to 10 weeks+6 days..

Our study revealed that, **mean gestational sac volume** was higher among patients with higher gestational age were **7.11**, **20.68**, **39.93** and **69.57** at the **7th**, **8th, 9th** and **10th** weeks of gestation respectively.

Rolo *et al.* [6] demonstrated that GSV were 11. 87, 21.18, 34.16 and 57.54 at the 7 th, 8th, 9th and 10th weeks of gestation.

Odeh *et al.* [7] also reported a strong correlation between GSV, gestational age and CRL in their study involving 142 women between 6 and12weeks. According to these authors, the mean GSV went from 8.0ml at 7weeks to 47.1ml at 10 weeks.

In study of Rolo *et al.* [6] there was a significant correlation between GSV assessed through 3DUS,CRL and gestational age and the best model was a logarithmic regression .Similar findings were reported by **Odeh *et al.* [7]**. The mean GSV between 7 and 10 weeks in **Rolo *et al.* [6]** were almost identical to those reported to **Odeh *et al.* [7]** who also used the same method.

In **Rolo *et al.* [6]** study Royston and Wrights method was used to calculate the reference intervals for GSV according to CRL. While GSV increased for ten times for CRL between 9 and 40 mm, CRL increased only 4.4 times. This implies that GSV may be better than CRL in detecting growth abnormalities in the first trimester of pregnancy, which could be associated with early pregnancy losses. However, more studies involving a larger number of participants, are needed to confirm these findings. GSV was highly correlated with CRL between 7 and 10 weeks of pregnancy. The GSV and EV reference intervals established in the present study can be used as normal parameters in future studies assessing cases at risk for early pregnancy loss.

By comparison of **our study** and **that of Rolo *et al.* [6]** GSV parameters are close to each other that's why we recommend taking our values as reference values for measurement of GSV, as there were very limited researches that, discussed the role of GSV as well as EV in terms of pregnancy outcomes, while, the vast majority of researches were mainly emphasized on yolk sac volume only.

Regarding measurements of GSV, we can predict pregnancy outcomes such as fetal birth weight via these equations through estimation of FBW, **weight=2.94+0.08*GSV** that's why we can predict Macrosomia, IUGR by estimation GSV during these period (7-10) weeks of gestation

A study of singleton low-risk pregnant women showed that EV during the first trimester of pregnancy correlates better with birth weight than CRL, GSV and PV. A 10 mm3 increase in EV corresponds to a mean birth weight increase of 75 g, while a 1-mm increase in CRL corresponds to a birth weight increase of 113g **[8]**.

Our study revealed that, **mean embryonic volume** was higher among patients with higher gestational age were **0.937, 2.715, 7.27** and **8.99** at the **7th**, **8th**, **9th** and **10th** weeks of gestation respectively.

In addition, **Gaafar *et al.* [5]** demonstrated that, the **mean embryonic volumes** were **0.42, 1.15, 1.806** and **3.106** at the **7th**, **8th**, **9th** and **10th** weeks of gestation respectively.

While another **Brazilian study** estimated a reference range for embryo volume reported different results. They demonstrated that, **EVs** were **0.2, 1.11, 2.08 and 5.12** at the **7th**, **8th**, **9th** and **10th** weeks respectively **[9].**

By comparison of **our study** with **Júnior *et al.* [9]** study, **Gaafar *et al.* [5]** study, our parameters of embryonic volume are close to each other that's why we recommend to take our measurements as reference values for embryonic volume estimation.

Embryo volume measurement using 3D ultrasonography was tried by several authors with different methods of estimation **[5].** In the current study we used the virtual organ computer-aided analysis (VOCAL) technique which was previously used with a reasonable accuracy **[5, 6].**

For example, **Rolo *et al.* [10]** revealed that, the mean EV ranged from 0.23 cm3 (95% CI 0.03–0.42) at 7 weeks to 3.91 cm3 (95% CI 3.85–3.96) at 10 weeks.

In addition, **Gaafar *et al.* [5]** reported that, embryo volume seems to be a better reflection of fetal growth rather than the CRL. This is because the embryo volume increases 7.8 folds while the CRL increases 2.9 folds over the 4-week period from 7 to 11 weeks. Thus, they suggested using the embryo volume as an early evidence of growth restriction in high risk pregnancy.

Also, they suggested that, its use for gestational age determination is nearly accurate as CRL which is simpler and depends on 2D rather than the more expensive and sophisticated 3D ultrasonography.

In our study revealed that, **mean crown-rump length** was higher among patients with higher gestational age were **1.56, 2.03, 3.12** and **3.95**at the **7th**, **8th**, **9th** and **10th** weeks of gestation respectively.

In the same line **Abd Ellatif *et al.* [11]** revealed that, at 6 weeks, CRL1+ was higher 52(52%). At 9 weeks, CRL from 1.5-2.5was higher 41(41.8%) and at 12 weeks CRL <4 was higher 37(39.8%).

The current study demonstrated that, there was statistically significant positive correlation between GSV and GA (p<0.001), CRL (p<0.001) and Fetal birth (p=0.001). EV demonstrates that there is statistically significant positive correlation with GA (p<0.001), CRL (p<0.001) and Fetal birth (p=0.003).

Similarly, **Rolo *et al.* [10]** revealed that, there was a significant correlation between EV and GA and CRL (R2¼0.951 andR2¼0.880, respectively). The exponential equation was the model that best expressed the correlation between these variables: [EV¼exp(0.94816GA–8.117)] and [EV¼0.0871 exp(0.12076CRL)].

In the same line, **Gaafar *et al.* [5]** demonstrated that, there was a strong positive correlation between embryonic volume, GA and CRL (r= 0.919, 0.938 and 0.941, respectively).

In addition, **Gaafar *et al.* [5]** preformed a regression analysis to predict the gestational age from the embryonic volume. Power regression model produced R2 value of 0.838 with a regression equation

(y= 52.22 + 6.5x) where y= gestational age, x= embryonic volume. Using this equation the predicted gestational age fitted well with that predicted from CRL with a minimal difference and a p value of 0.234.

Moreover, **Lo *et al.*** [12] demonstrated that, ultrasound (U/S) measurements of yolk sac (YS), gestational sac (GS), and early βHCG are widely used to predict pregnancy outcomes.

Regarding CRL, **Degani** [13] demonstrated that such parameter was considered the best parameter for early dating of pregnancy.

The current study displayed that, **EV and GSV were significant predictors of CRL** with **55.9% of the CRL** can be predicted by GSV & EV change with the following prediction equation; **CRL=1.55+0.02*GSV+0.08*EV.** The present study demonstrated that, **GSV** was significant **predictors of fetal birth weight** with **14.6%** of the fetal birth weight can be predicted by GSV change with the following prediction equation; **Fetal birth weight=2.94+0.008*GSV.**

Against our study there are a study of singleton low-risk pregnant women showed that EV during the first trimester of pregnancy correlates better with birth weight than CRL, GSV and PV. A 10 mm3 increase in EV corresponds to a mean birth weight increase of 75 g, while a 1 mm increase in CRL corresponds to a birth weight increase of 113g [8].

Some studies showed that GSV has predictive value for failed pregnancy outcomes [4, 14].

GSV is closely related to amniotic fluid volume. GSV may reflect uteroplacental functions in the first trimester, and may predict adverse pregnancy outcome [14], **also** in our study GSV is significant predictor to fetal birth weight and there is correlation between EV and fetal birth weight but not enough to statistically significant and we found that in cases of birth weight disturbance whether IUGR or macrosomia there is disturbance of GSV at 5th, higher than 95th Percentile more than affection of EV.

As regards mode of delivery, the current study demonstrated that estimation of GSV, EV we cannot predict it as median GSV, EV and CRL among studied cases with CS delivery was higher than with vaginal delivery (37.59, 3.489 & 5.81) versus (36.1, 3.27 & 2.79), respectively but statistically insignificant as P value in median GSV, EV and CRL and CS delivery (p=0.866, 0.280, 0.866), respectively.

In terms of the adverse outcomes of the studied cases, there was 3 sporadic cases (3%) of cases had adverse pregnancy outcomes in our study: **One case of macrosomia** (4.5kg) & complicated by (GDM) in which discordance between GSV was higher than **95th** percentile & EV in between **75th-95th** percentile. **Two cases of IUGR** (2kg) & one of them complicated by Preeclampsia and Preterm labor in these case there was discordance between GSV at **5th** percentile and EV at **25th** percentile &the other case both GSV&EV at **5th** percentile.

In accordance, **Abd Ellatif *et al.*** [11] demonstrated that 85(91.3%) of their cases had normal outcome and 5 (6.3%) had failed pregnancy. 3cases had irregular shaped yolk sac and all 3were diagnosed as missed abortion on follow up.

This came in agreement with **Abd Ellatif *et al.*** [11] who demonstrated that, the gestational sac diameter showed a significant decreasing in the fetal loss group at 6, 9 and 12 weeks, thus they concluded that, the GSV was a good predictor to fetal loss ($p < 0.05$). In addition they reported that, first trimester ultrasound measurement of these parameters (FHR,YS diameter and shape and GS diameter) proved to be an important, helpful and noninvasive tool in the investigation, diagnosis as well as the follow up of pregnant females in their early pregnancy. Measurement of gestational sac diameter, CRL and fetal heart rate in combination provided better prediction of the prognosis of the first trimester than when either parameter used alone.

In addition, the cut off value of gestational sac diameter at 6 weeks was1.92, below this value the loss of pregnancy was 85.0% the more than this value the complete of pregnancy was 78.0%. At 9 weeks, the cut off value was3.11, the sensitivity was 90.0%, specificity was 93.0% and the accuracy was 91.0% [11].

CONCLUSION

The current study demonstrated that, the GSV, EV and CRL were demonstrated to be correlated with gestational age. In addition, EV and GSV were demonstrated to be significant predictors of CRL. The GSV was displayed to be a significant predictor of fetal birth weight. In terms of the adverse outcomes of the studied cases, there was 3 sporadic cases (3%) of cases had adverse pregnancy outcomes in our study: One case of macrosomia (4.5kg) & complicated by (GDM), Two cases of IUGR (2kg) & one of them complicated by Preeclampsia and Preterm labor &the other case both GSV&EV at 5th percentile.

The embryonic volume has a direct proportion with gestational sac volume with gestational age except in two cases one of them complicated by preeclampsia , preterm and IUGR there is discordance among GSV at 5th percentile and EVat25 th percentile, the other case complicated by macrosomia and gestational diabetes there was discordance among GSV above 95th percentile and EV between (75 th/ 95th) percentile, the other case complicated by there may be possibility of discordance among GSV and EV accompanied in cases of IUGR, macrosomia and we need further studies with larger sample size for high risk pregnancy of IUGR, macrosomia such as diabetes and hypertensive patients.

The GSV and EV reference intervals established in the present study can be used as normal parameters in future studies assessing cases at risk for adverse pregnancy outcomes.

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