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Evaluation of 2D Placental Parameters in Relation with Pregnancy Outcome A Prospective Study

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Abstract: Background and Objectives: A significant number of women experience adverse pregnancy outcome related to placental insufficiency and there is a need to accurately prediction of these adverse outcome by simple reproducible method. The aim of this study was to investigate possible value of assessing placental volume by two-dimensional (2D) ultrasonography in the prediction of adverse pregnancy outcomes. **Methods:** Prospective observational study carried out in obstetrics and Gynecology Department and included 122 pregnant women at 18-24 week gestation presented for antenatal care attending Zagazig University Hospitals then divided into 2 groups according to complication during pregnancy till time of delivery group **(A):** control group and group (B): Involve 30 pregnant women with complicated pregnancy **Results:** significant high placental thickness, height, width, volume in group A compared to group B but insignificant difference in placental site between both groups. The observation of, significant high difference in neonatal weight and Apgar score in group A compared to group B is correlated with difference in placental parameters between both groups.
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Key Words: two-dimensional ultrasonography - adverse pregnancy outcome – placental volume.

1. Introduction

Despite improved antenatal monitoring involving careful examination, however, there is considerable disappointment that may delay determination of most LBW infants may still be of great concern. Hypoxia, fetal distress, long-term disability and fetal death are possible consequences for LBW infants. Determining fetal failure to reach its potential to grow, although its bio-measure may exceed the criterion to the mean is of paramount importance. This indicates that early determination of intrauterine growth retardation will be useful in obstetric care and neonatal care. Reduced placental size occurs before fetal growth handicap **(Wolf et al., 1989).**

The average term infant at birth weights about 3000 to 3600 gm. During the second half of pregnancy, the fetal weight increases in a linear manner with time until about the37th week of gestation and then the rate slows variably. A related term is Low birth weight (LBW), it is an infant its birth weight lower than 2500 g (5 lb 8 oz), regardless of gestational age at the time of birth. Related definitions include Very Low Birth Weight (VLBW) which is less than1500 g, and Extremely Low Birth Weight (ELBW) which is less than 1000 g **(Farah et al., 2009).**

Intrauterine growth restriction (IUGR) is a condition that the fetus is incapable of acquiring its genetically confirmed potential size. Exclusion of small gestational age (SGA) fetuses that were not growth restricted aiming at detection of fetuses at risk for modifiable but otherwise poor outcomes is very evident in this pathology oriented definition **(Ashworth et al, 2010).**

Moderate and severe fetal growth restrictions (FGR) are defined as: birth weight in the third to tenth percentile and less than third percentile, respectively. Normal term infants Fetal weight more than 2500 g is typical in term infants by 37 weeks gestation **(Blackwell et al, 2001)**

Adverse pregnancy outcome including IUFD and IUGR is closely linked with abnormally low placental weight **(Gilbert and Danielsen, 2003)**. Routinely ordered prenatal obstetric ultrasound (US) is used for screening intent at 11 to 14 weeks for nuchal translucency in rating of Down syndrome, at 18 – 20 weeks for an anatomic survey Also at 32 – 36 weeks it could be used for estimating fetal size and location. Lack of assessing placental volume on such USs, in spite of the fact that it is directly accountable for the growth and well-being of the developing fetus is a great pitfall **(Arleo et al., 2013)**

Despite key role played by placenta in assisting fetal growth, prenatal placental measurement is quite restricted. Failure to yield clinically useful tools and Poor reproducibility are limitation facing early efforts to classify placenta by sonographic appearance aiming at prediction of adverse pregnancy outcomes (**Moran et al., 2011)**.

Hafner et al. (2003) studied three dimensional (3D) placental measures especially placental volume as a predictor of reverse pregnancy outcome. Despite being possibly predictive of small-for-gestational-age (SGA). Limitations include technical complexity, need for specialized training (**Schwartz et al., 2010**).

Azpurua et al. (2010) ascertained the feasibility of accurate prediction of placental weight utilizing routine two-dimensional (2D) ultrasound to get placental width, height and thickness, that in conjugation is used to estimate the convex – concave shell volume of the placenta. Being delicate, simple, rapid, and practical for routine prenatal care, routine use or selective use for high-risk patients with reduced fetal movement and IUGR is very valuable. Routine surveillance of estimated placental volume (EPV) may aid more vigilant prenatal care and decrease incidence of unexpected IUFD.

Aim of the work

The aim of this study was to investigate possible value of assessing placental volume by two-dimensional (2D) ultrasonography in the prediction of adverse pregnancy outcomes.

Patients and Methods

Type of study: Prospective observational study.

This study was conducted in obstetrics and Gynecology Department (Outpatient Clinic and Inpatient Ward in Emergence Unit), Zagazig University Hospitals.

Duration of the study: The study was from January 2017 to January 2018.

Study included: The study include 122 pregnant women at 18-24 week gestation presented for antenatal care attending Zagazig University Hospitals. (Outpatient Clinic)

Sample size justification: The sample size was estimated to be 122 patients calculated by open EPI (**Schwartz et al., 2012**).

- Occurrence of adverse pregnancy outcomes in normal expected placental volume (EPV) 1%.
- Occurrence of adverse pregnancy outcomes in abnormal expected placental volume (EPV) 14.4%.
- Confidence level 95%.
- Power 80 %

Inclusion criteria:

- Singleton viable pregnancy.
- Gestational age 18-24 wks. By sure of date or documented 1sttrimestric u/s to insure gestational age.

Exclusion criteria:

- Patient younger than 18 years.
- Patient older than 35 years.
- Multiple pregnancies.
- premature rupture of membrans.
- Presence of fibroid related to placental site of insertion.
- Retroplacental hematoma.
- Placental anomalies as abnormalities in size and shape (Diffuse, accessory, bidiscoid and placenta accreta), and abnormalities in position as low lie placenta or placental choriangioma.

Ethical Considerations

Proposal acceptance was taken from the Institutional Review Board (IRB) of the faculty of medicine, Zagazig University. Informed consent was taken from all patients.

Methodology:

Each pregnant woman was subjected to:

1. Complete history taking: Thorough history with special emphasis on:

- **Personal history.**
- **Obstetric history including Menstrual history**:
  - 1st day of last menstrual period check regularity and reliability of date.
  - Gestational age.
  - Expected date of delivery.
- **History of the present pregnancy: presence of risk factor:**
  - Presence of hypertension, Presence of diabetes mellitus, Presence of renal disease, Alcoholic intake, Cigarette smoking and Drug intake.

2. Examination:

A. General examination:

- Assessment of vital data (blood pressure, pulse).
- Estimation of blood sugar level.

B. Abdominal examination to asses the fundal height.

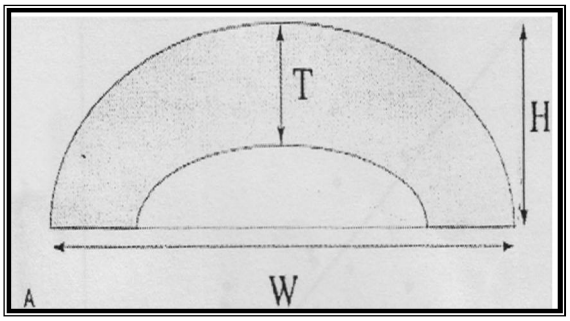
C. Maternal weight and height.

Methods:

- Singleton gestations were presented for anatomic survey between 18-24 weeks' gestation were involved in this investigation.
- Placental location and shape was estimated using standard (2D) ultrasound techniques.
- Placental thickness was calculated at the level of the cord insertion thus preserving close proximity to the perpendicular of the placental surface.
- Maximal width and height were obtained in an image of the placental. Visualization of both placental edges simultaneously can be achieved by slight anglulation of The probe.

♦ Placental volume was estimated using the convex – concave, shell formula: v = (π T / 6)* [4 H (W-T) + W (W-4 T) + 4 T2]

(Where v = volume; w = maximal width; h = height at maximal height; T = thickness at maximal height).



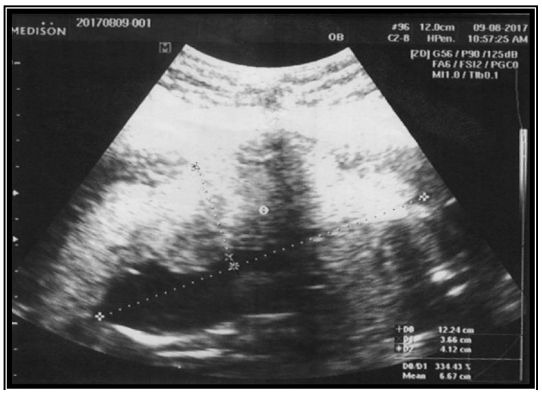


Fig. (1): (A) Diagram presenting parameters evaluated to estimate calculated placental volume (EPV). (B) Representative scan used to generate (EPV). W (D0): Maximal width, H (D2): Height at maximal height, T (D1): Thickness at Maximal height.

♦ In addition to placental measurements, other variables were involved.

- Date of scan (working gestational age)
- Estimated date of delivery.
- Fetal biometric measurements (head circumference, biparietal diameter, abdominal circumference, femur length, estimated fetal weight)

♦ The parameters of labor and delivery were queried for these singleton deliveries during study period.

So collected variables: included:

1. Placental measurements:

- Thickness, height, width.
- Placental volume calculation.

1. **Fetal biometric measurements.**
2. **Gestational age.**
3. **Expected date of delivery.**

Then the patient was follow up until the date of delivery and the following was recorded:

4. **Date of delivery.**
5. **Gestational age at delivery**
6. **Maternal age at delivery.**
7. **Birth weight.**
8. **Infant gender.**
9. **1 min & 5 min APGAR score.**
10. **Admission to NICU**

Fig. (2): To avoid observer variation: all ultrasonographic examination was performed by the same sonographer using a medison x5 ultrasound machine trans-abdominal 4.0 MHZ probe (Outpatient Clinic), Zagazig University Hospitals.

3. Results

The current study is prospective cohort study which was carried out at Zagazig University Hospital (out patient clinic)

The study include 122 pregnant women at 18-24 week gestation presented for antenatal care and then followed till delivery 10 cases were lost to followed up.

The residual 112 patients were notice d for the correlation of placental measurements and their outcome was divided into 2 groups according to complication during pregnancy till time of delivery and there outcome into:

- **Group (A):** Involve 82 apparently normal pregnant women with uncomplicated pregnancy till time of delivery and present as a control group.
- **Group (B):** Involve 30 pregnant women with complicated pregnancy.

Table (1): Placental evaluation and Neonatal birth weight in studied groups.

Placenta	Group A	Group B	*P*
	Mean ± SD	Mean ± SD	
♦ Thickness (cm)	3.5±0.6	2.7±0.4	0.0001*
♦ Height (cm)	4.4±0.7	3.3±0.6	0.0001*
♦ Width (cm)	11.6±1.2	10.7±1.1	0.003*
♦ Volume	260±70.8	176.4±39.5	0.0001*
♦ Neonatal birth weight (gm)	3183.4±407.3	2567.8±517.1	<0.0001*

Table (1) show significant high placental thickness, height, width, volume in group A compared to group B.

Table (2): Placental evaluation in studied groups according to placental site.

Placenta		Group A		Group B		*P*
		No.	%	No.	%	
Site	♦ Anterior	33	40.2	8	26.7	0.273
	♦ Posterior	30	36.6	13	43.3	
	♦ Fundal and anterior	8	9.8	3	10	
	♦ Fundal and posterior	6	7.3	4	13.3	
	♦ Fundal	5	6.1	2	6.7	

There is insignificant difference in placental site between both groups.

Table (3): Show the outcome between the 2 different groups represented by Neonatal Birth weight (NBW) Apgar Score (At 1 min), (At 5 min).

Neonatal	Group A	Group B	*P*
	Mean ± SD	Mean ± SD	
♦ Weight	3192±431	2555±522	0.0001*
♦ Apgar 1min	7.1±2.2	3±1.9	0.0001*
♦ Apgar 5min	8.6±2.1	5.1±2.7	0.0001*

Table (3): Show significant high neonatal weight and Apgar score in group A compared to group B.

Table (4): Comparison of Duration of NICU admission/day in studied groups.

Neonatal		Group A		Group B		*P*
		No.	%	No.	%	
NICU admission	♦ No	0	0	14	46.7	0.0001*
	♦ Yes	82	100	16	53.3	

Table (5): Fetal outcome between the 2 studied groups.

Neonatal			Group A		Group B		*P*
			No.	%	No.	%	
Fetal outcome	♦	Normal	80	97.6	0	0	0.0001*
	♦	Still birth	0	0	1	3.3	
	♦	SGA	0	0	7	23.3	
	♦	IUFD	0	0	4	13.3	
	♦	IUGR	0	0	14	46.7	
	♦	Preterm delivery	2	2.4	4	13.3	

4. Discussion

Disturbed gas and nutrients exchange and diminished placental size are possible consequences of placental insufficiency **(Toal et al, 2008).** Higher incidence of small for gestational age (SGA) fetuses and adverse pregnancy outcome (APO) was closely correlated with small placental volume **(Law et al, 2009 and Proctor et al, 2009).**

Nowadays, considerable importance was paid to early prediction and detection of high risk pregnancies e.g. SGA and preeclampsia. Timely recognition of fetal growth restriction (FGR) and fetal surveillance result in better pregnancy outcome and lower morbidity **(Schwartz et al, 2012).**

Convenient perfusion of uterine artery and exchange of nutrients via placenta and umbilical artery is of ultimate importance for appropriate fetal growth An incidence of 4-8% and 6-30% of the newborns in developed and developing countries was estimated to suffer from FGR. **(Kliman, 2000; Baschat and Hecher, 2004)**

Normal birth weight and consequently formation of a healthy fetus is the ultimate result of normal placental function and structure. Precise arrangement of prenatal care aiming at early detection of any fetoplacental unit pathology helps obstetrician to check placental bed and villi changes. (**Afrakhteh and her co-workers, 2013**).

Sonographic evaluation of the placenta seems to be useful in early APO survillance. Development of a screening tool to diagnose placental insufficiency aiming at prediction of abnormal fetal growth including uterine artery Doppler (UAD) indices and placental volumetric assessment using two-(2D) and three-dimensional (3D) sonographic measurements **(Baschat and Hecher, 2004).**

Evaluating placental weight utilizing (3D) sonography is time-consuming and demands expensive technology and expertise. Evaluation of estimated placental volume (EPV) by two-dimensional sonography and actual placental weight after delivery was noticed to be significantly correlated. Besides providing immediate estimation of placental volume, this method is quick, simple, and precise that makes it a good choice for both routine and selective use. Hopefully, routine EPV monitoring may reduce the rates of unexpected IUFD and other potential perinatal complications. (**Azpurua et al, 2009).**

This study was conducted to examine potential advantage of two-dimensional (2D) volumetric study in the prediction of adverse pregnancy outcomes. A potential cohort study which was carried out at Zagazig University Hospital (out patient clinic) on122 pregnant women at 18-24 week gestation presented for antenatal care and then followed till delivery. Drop out ratio of 10 cases were lost to follow up. The residual 112 patients were recognized for the correlation of placental measurements and their outcome and was divided into 2 groups according to complication during pregnancy till time of delivery and there outcome into: Group (A) involve 82 apparently normal pregnant women with uncomplicated pregnancy till time of delivery and present as a control group while, Group (B) involve 30 pregnant women with complicated pregnancy.

In this study, a significant high placental thickness, height, width, volume were detected in group A compared to group B. while, There was insignificant difference in placental site between both groups. Also, a significant high neonatal weight and Apgar score in group A compared to group B were detected. 16 (53.3%) newborns were admitted in NICU in group B, while 2(2.4%) newborns in group A were admitted in NICU.

In group B; fetal complications were 1(3.3%) still birth baby, 4(13.3%) IUFD babies as well as preterm babies, 7(23.3%) SGA babies and 14(46.7%) IUGR babies. Maternal complications were 4(13.3) preeclampsia, preterm and anemia, 3(10%) eclampsia, HTN and uncontrolled DM, 2(6.6) PIH, 5(16.6%) gestational DM, 1(3.3) SLE and Sudden accidental hemorrhage.

These results are in agreement with study done by **(Khazardoost et al., 2014)** that detected significant correlation of placental height and volume with neonatal weight. Mean placental thickness and height was lower in adverse pregnancy outcome group (APO) than the normal outcome group.

In this study, a significant positive correlation was observed in both groups between placental thickness, placental volume and neonatal birth weight. Reduced placental volume and vascularization associated with uterine artery Doppler velocimetry changes is noticed in severe fetal growth restriction **(Abulé et al, 2016)**

It was recorded that there were smaller, volume, length, width, weight and disc area in placentas by about ~25% percentage from pregnancies ending in adverse outcome **(Higgins et al, 2015)**. Also, significant positive correlation between placental thickness and birth weight in the second and third trimesters were detected by **Afrakhteh and her co-workers (2013)**.

Adegoke et al., (2013), stated that 2D prenatal ultrasound measurement of placental thickness is an accurate indicator of the genuine placental weight and volume and a positive prospective of the birth weight. Low birth weight is statistically correlated with decreased placental thickness notably less than 20 mm. Ultrasonic estimation of placental thickness and grading can strictly predict the actual placental weight and volume and also predict recurrent occurrence of placental insufficiency related complication.

In the late second and third trimester, Results indicate presence of correlation of ultrasonographic gestational age in FGR pregnancies and 2D placental thickness, and when compared to group B, group A in 26th and 27th weeks and 30th and 31th weeks clearly demonstrate statistically significant lower thickness of placenta. **(Betty et al, 2013).** A study concluded that measuring placental thickness at umbilical cord insertion level may be considered as an accurate sonographic indicator in assessment of gestational age there was a trend towards positive correlation and linear equations of relationship was noticed between ultrasonographic gestational age and placental thickness in two groups. (**Betty et al, 2013).**

Cooley et al, (2013) stated that antenatal detection of placental disease may be facilitated by 2D Ultrasonography of the placenta. Decreased second trimesteric placental thickness in pregnant patients complicated by chorioamnionitis **(Cooley et al, 2013).** A rapid, simple and clinical beneficial procedure to predict early warning signs is 2D Ultrasonographic assessment of placental thickness which could be done virtually by any obstetrician center**.**

Placental volume measured at mid-pregnancy was correlated to birth weight **(Kinare et al., 2000). Karthikeyan et al., (2012)** showed that placental thickness correlation of with fetal growth and gestational age was demonstrated**.** Although growth-restricted fetuses demonstrate lower positive correlation, this correlation still exists with increasing placental volume with rising gestational age, **(Damodaram et al, 2010).**

It was noticed that significant positive correlation exists among placental thickness and evaluated fetal weight in both second and third trimesters in a non-IUGR group **(Abu et al, 2009).**

A study investigated the relationship between growth parameters and placental thickness clearly demonstrated that the earliest allusion of fetal growth retardation may be suboptimal placental thickness for gestational age. **(Ohagwu et al, 2009).**

Elchalal et al. (2000) noticed correlation of gestational age throughout pregnancy with linear increase of placental thickness. The authors showed that expansion of placental thickness is a useful tool assisting management of at risk feti but not diagnostic of any specific disorder. Also, they observed at term both in fetal weighting above 4,000 g or less than 2,500 g there is a higher percentage of thick placentae. Nevertheless, they did not find any difference between patients with thick placenta and control group in terms of coexistent medical disorders diabetes and hypertension. Also, Ultrasonographic placental diameter and thickness measurements appeared to be of prognostic value in identifying the subsequent occurrence of fetal growth retardation. Cut off value of a placental diameter of 18 cm and placental thickness of 2 cm at 36 weeks gestation was proposed to predict low birth weight infants **(Habib 2000).**

Our results are in disharmony with a study by **Miwa et al., (2014),** who detected that gestational age at delivery was earlier and birth weight was smaller in the women with thick placenta than in patients without thick placenta.

Odibo et al., 2011 detected preeclampsia in 7.7%, gestational hypertension in 9.0% and SGA in 38.0% in studied cases. Lack of significant difference regarding placental volume was observed between pregnancies with adverse outcomes and those without. Also, earlier studies detected that women with ITP or preeclampsia had thicker placenta in comparison with normal pregnant women **(Jauniaux, 1992; Dombrowski, et al, 1992).** Moreover**, Raio et al., 2004** stated that abnormally thick placentas have been correlated with adverse pregnancy outcome.

5. Conclusion

The routine assessment of placental parameters especially placental volume during routine obstetric ultrasound at 18-14 weeks represent a valuable inexpensive tool for prediction of adverse pregnancy outcome.

References

1. Ashworth, M. D., Ross, J. W., Stein, D., White, F., & Geisert, R. D. (2010). Endometrial gene

expression of acute phase extracellular matrix components following estrogen disruption of pregnancy in pigs. Animal Reproduction Science,122, 215–221.
2. Abu PO, Ohagwu CC, Eze JC, et al., (2009): Correlation between placental thickness and estimated fetal weight in Nigerian women. Ibnosina J Med Biomed Sci.;1(3):80–5.
3. Abulé R, Bernardes L, Doro G, Miyadahira S, and Francisco R. (2016): Reduced placental volume and flow in severe growth restricted fetuses. Clinics (Sao Paulo); 71(6): 332–337.
4. Adegoke A, Olaboyede A and Abiodun A. (2013): Newborn birth weight and placental parameters in normalhuman pregnancies. BPMS J.;23-29.
5. Afrakhteh M, Moeini A, Taheri M and Haghighatkhah R. (2013): Correlation between placental thickness in the second and third trimester and fetal weight. Rev Bras Ginecol Obstet.; 35(7):317-22.
6. Arleo, G., Caccavale, F., Muscio, G., and Pierri, F. (2013). Control of quadrotor aerial vehicles equipped with a robotic arm. In *Proc. of 21th Mediterranean Conference on Control and Automation*, 1174–1180.
7. Azpurua H, Edmund F., Luisa M and Leo F. (2009): Doherty, Isaac E. Sasson. Determination of Placental Weight Using Two-dimensional Sonography and Volumetric Mathematic Modeling. Determination of Placental Weight Using Two-dimensional Sonography and Volumetric Mathematic Modeling; 33-42.
8. Azpurua H, Funai EF, Coraluzzi LM, Doherty LF, Sasson IE, Kliman M, Kliman HJ. (2010). Determination of placental weight using two-dimensional sonography and volumetric mathematic modeling. Am J Perinatol;27:151-155.
9. Baschat, A. A. and K. Hecher, (2004): Fetal growth restriction due to placental disease. Seminars in Perinatology, 28(1): 67-80.
10. Betty M. Singla Subhash C. Nittala Pramod P and Chakravarti Rajesh J. (2013): Toppo Julius N. Placental Thickness: Its Correlation with Ultrasonographic Gestational Age in Normal and Intrauterine Growth-Retarded Pregnancies in the Late Second and Third Trimester. The Journal of Obstetrics and Gynecology of India; 63 (4): 230–233.
11. Blackwell SC, Moldenhauer J, Redman M, Hassan SS, Wolfe HM, Berry SM (2001). Relationship between the sonographic pattern of intrauterine growth restriction and acid-base status at the time of cordocentesis. *Archives of Gynecology and Obstetrics*.;264(4):191–193.
12. Cooley SM, Donnelly JC, Walsh T, McMahon C, Gillan J and Geary MP. (2013): The correlation of ultrasonographic placental architecture with placental histology in the low-risk primigravid population. J Perinat Med.:1-5.
13. Damodaram M, Story L, Eixrach E, et al., (2010): Placental MRI in intrauterine fetal growth restriction. Placenta; 31(6):91–498.
14. Dombrowski MP, Wolfe HM, Saleh A, Evans MI and O'Brien J. (1992): The sonographically thick placenta: a predictor of increased perinatal morbidity and mortality. Ultrasound Obstet Gynecol; 2(4):252-5.
15. Elchalal U, Ezra Y, Levi Y, Bar-Oz B, Yanai N, Intrator O, et al., (2000): Sonographically thick placenta: a marker for increased perinatal risk a prospective cross-sectional study. Placenta;21(2-3):268-72.
16. Farah N, Maher N, Barry S, Kennelly M, Stuart B, Turner MJ. Maternal morbid obesity and obstetric outcomes. Obes Facts 2009;2:352-4.
17. Gilbert WM, Danielsen B. Pregnancy outcomes associated with intrauterine growth restriction Am J Obstet Gynecol. 2003;188:1596-9.
18. Habib F. (2002): Prediction of Low Birth Weight Infants from Ultrasound Measurement of Placental Diameter and Placental Thickness; 22 (5-6): 312-314.
19. Hafner, E., Metzenbauer, D., Hofinger, D., Munkel, M., Gassner, R., Schuchter, K., Dillinger-Paller, B. and Philipp, K. (2003). Placental growth from the first to the second trimester of pregnancy in SGA-foetuses and pre-eclamptic pregnancies compared to normal foetuses. *Placenta*; 24:336–342.
20. Higgins L, de Castro N and Naa A. (2015): Placental Features of Late-Onset Adverse Pregnancy Outcome. PLoS One; 10(6): e0129117.
21. Jauniaux E. (1992): Placental ultrasonographic measurement: what can we learn and is it worth doing routinely? Ultrasound Obstet Gynecol. 1992;2(4):241-2.
22. Karthikeyan T, Subramaniam RK, Johnson W and Prabhu K. (2012): Placental thickness & its correlation to gestational age & foetal growth parameters – a cross sectional ultrasonographic study. J Clin Diagn Res.; 6(10):1732-5.
23. Khazardoost, Maryam Noorzadeh, Khadije Rezaie, Sedigheh Hantoushzadeh, Sedigheh Borna, Kobra Shojaei, Khadijeh Nasri, Maryam Shafaat (2014). Second Trimester Two-Dimensional Sonographic Placental Measurement and Uterine Artery Doppler for Prediction of Adverse Pregnancy Outcome In

Low-Risk Pregnancy. Advances in Environmental Biology: (4):72-77.
24. Kinare AS, Natekar AS, Chinchwadkar MC, Yajnik CS, Coyaji KJ, Fall CH, Howe DT. Low midpregnancy placental volume in rural Indian women: A cause for low birth weight? Am J Obstet Gynecol. 2000 Feb;182(2):443-448.
25. Kliman, H.J., (2000): Uteroplacental blood flow. The story of decidualization, menstruation, and trophoblast invasion. The American journal of pathology, 157(6): 1759-68.
26. Law, L.W., T.Y Leung., D.S. Sahota, L.W. Chan, T.Y. Fung and T.K. Lau, (2009): Which ultrasound or biochemical markers are independent predictors of small-for-gestational age? Ultrasound in Obstetrics & Gynecology, 34(3): 283-7.
27. Miwa I, Sase M, Torii M, Sanai H and Nakamura Y. (2014): A thick placenta: a predictor of adverse pregnancy outcomes. Springer Plus; 3:353.
28. Moran, Mary; Ryan, John; Higgins, Mary; Brennan, Patrick; McAuliffe, Fionnuala M. (2011). Poor agreement between operators on grading of the placenta. ournal of Obstetrics and Gynaecology, 31 (1): 24-28.
29. Odibo A, Goetzinger K, Kristina M and Huster. (2011): Placental volume and vascular flow assessed by 3D power Doppler and Adverse pregnancy outcomes. Placenta. 2011 Mar; 32 (3): 230–234.
30. Ohagwu CC, Abu PO, Ezeokeke UO, et al., (2009): Relationship between placental thickness and growth parameters in normal Nigerian foetuses. Afr J Biotechnol; 8(2):133–8.
31. Proctor, L.K., M. Toal, S. Keating, D. Chitayat, N. Okun, R.C. Windrim, G.C. (2009): Placental size and the prediction of severe early-onset intrauterine growth restriction in women with low pregnancy-associated plasma protein-A. Ultrasound in Obstetrics & Gynecology, 34(3): 274-82.
32. Raio L, Ghezzi F, Cromi A, Nelle M, Dürig P and Schneider H. (2004): The thick heterogeneous (jellylike) placenta: a strong predictor of adverse pregnancy outcome. Prenat Diagn.; 24 (3): 182-8.
33. Schwartz N, Coletta J, Pessel C, (2010). Novel 3-dimensional placental measurements in early pregnancy as predictors of adverse pregnancy outcomes. J Ultrasound Med. 29:1203–12.
34. Schwartz, N., E. Wang and S. Parry, (2012): Two-dimensional sonographic placental measurements in the prediction of small-for-gestational-age infants. Ultrasound in Obstetrics & Gynecology, 40(6): 674-9.
35. Schwartz, N., E. Wang and S. Parry, (2012): Two-dimensional sonographic placental measurements in the prediction of small-for-gestational-age infants. Ultrasound in Obstetrics & Gynecology, 40(6): 674-9.
36. Toal, M., S. Keating, G. Machin, J. Dodd, S.L. Adamson, R.C. Windrim and J.C. Kingdom, (2008): Determinants of adverse perinatal outcome in high-risk women with abnormal uterine artery Doppler images. American journal of obstetrics and gynecology, 198(3): 330 e1-7.
37. Wolf, H., Oosting, H. & Treffers, P. E. (1989) A longitudinal study of the relationship between placental and fetal growth as measured by ultrasonography. Am J Obstet Gynecol, 161(5), 1140-5.

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