e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2023; 13(1); 46-54

Original Research Article

Role of Two-Dimensional Ultrasonographic Placental Biometry in Prediction of Small for Gestational Age Fetuses

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Received: 25-11-2022 / Revised: 25-12-2022 / Accepted: 15-1-2023

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Conflict of interest: Nil

Abstract

Background: Placental insufficiency is a major contributor to the pathophysiology in small for gestational age babies. Small for gestational age refers to those foetuses whose birth weight is less than tenth centile for gestational age Early prediction and detection of foetal growth restriction is important for increased foetal surveillance. The objectives of this study were to assess the placental biometry (placental diameter and placental thickness) between 18 weeks to 22 weeks 6 days gestation and compare with birth weight centiles and to analyse whether placental biometry can be used as a predictor for the development of small for gestational age babies.

Objectives:

1. To assess the placental biometry (placental diameter and placental thickness) between 18 weeks to 22 weeks 6 days gestation and compare with birth weight centiles.
2. To analyse whether placental biometry can be used as a predictor for the development of small for gestational age babies.

Methods: Prospective study was conducted at the Department of Radiodiagnosis, Government Medical College, Thrissur from January 2019 to January 2020 in singleton pregnancies at 18-22 weeks of gestation, placental biometry (in two dimensions) was performed. Maximal placental diameter (Max PD) and Maximal placental thickness (Max PT) was recorded in two orthogonal planes. Mean placental diameter (MPD) and mean placental thickness (MPT) was calculated. At the time of delivery, as per the birth weight the neonate was classified into appropriate for gestational age (AGA) / small for gestational age (SGA) / large for gestational age (LGA). MPD and MPT were analysed as predictors of SGA.

Results: Both the Max PDs and MPD were significantly smaller in SGA pregnancies (all with p values <0.001) and Max PT and MPT also were significantly smaller (p values <0.001) in SGA babies. ROC curve plotted for MPD and MPT showed significant area under curve (AUC) 0.87 and 0.80 respectively.

Conclusion: Placental measurements taken in mid-gestation are a valuable predictor of SGA. Measurement of placental diameter and thickness is quick and simple. This approach should be explored in future to develop a predictive model for growth restricted foetuses.

Keywords: placental insufficiency, small for gestation, placental biometry.

Background

Small for gestational age (SGA) refers to foetuses with birth weight less than tenth centile for gestational age. Worldwide, the prevalence of SGA is 27% of live births, whereas it is 46.9% in India alone. [1] It has been estimated that only 50% of cases of foetal growth restriction (FGR) are correctly diagnosed in the antenatal period.[2] Early prediction would allow improved patient counselling and appropriate triage to a regimen of increased foetal surveillance.[2]

The placenta is a materno-foetal organ which is formed a little later than the foetus. It provides the physiological link between a pregnant women and the foetus and is important for the metabolic, endocrine and immunologic functions besides being responsible for nutrition, respiration and excretion for the foetus. Size of the placenta is reflection of health and size of fetus. [3] The placenta exerts its effects on the growth of the foetus from the beginning of pregnancy via metabolic and endocrine mechanisms. To achieve this, the placenta exchanges a wide array of nutrients, endocrine signals, cytokines and growth factors with the mother and the fetus. [4]

Placental insufficiency is a major contributor to the pathophysiology in SGA pregnancy Foetal growth restriction is significantly associated with perinatal mortality and morbidity and foetal distress in labour. Because of its association with adverse outcomes, the prenatal diagnosis of SGA has a significant impact in clinical practice. Sonographically detectable placental growth restriction precedes foetal growth restriction by several weeks.[5] Decreased placental size precedes the onset of IUGR and makes placental thickness abnormalities with the corresponding gestational age one of the early warning signs of development of growth restriction.[6] Intrauterine growth restriction (IUGR) is associated with many adverse outcomes like prematurity, intraventricular haemorrhage, necrotising enterocolitis, respiratory distress syndrome and longer stay in hospital. [7] If the IUGR is detected prenatally and the foetus is closely followed up using various foetal monitoring techniques such as non-stress test, biophysical profile and umbilical artery Doppler, a better foetal outcome can be obtained compared to those cases where there was no prenatal detection of IUGR. Hence an earlier detection of IUGR will be beneficial to improve the foetal outcome and survival. [8]

Most commonly encountered form of foetal growth restriction is the one that is secondary to uteroplacental insufficiency and sometimes the term placental foetal growth restriction (PFGR)is used. PFGR implies a structurally and genetically normal baby that has the potential for a normal life ex- utero, but has very specific perinatal problems and risks associated with placental insufficiency, potential therapies exist for PFGR, all of which aim to maximize the uteroplacental circulation. But accurate prognostication relies on accurate

diagnosis, and good outcome depends on attentive management.[9]

Many researches have emphasised the importance of three-dimensional sonographic placental volumetry as an indicator of SGA. However, in comparison to the two-dimensional placental measurements, three dimensional measurements are more complex, time consuming, require greater expertise and not widely available thus making the

clinical utility limited. Hence it is important to consider available two dimensional sonographic techniques.

This study aims to evaluate the role of two dimensional ultrasonographic placental measurements in early and timely prediction of SGA foetuses and studies in these areas are less.

Relevance of study:

To improve foetal outcome and to prevent neonatal complications there is a need for better detection and early prediction of foetal growth restriction.

Methodology

This Observational study was conducted on 120 pregnant women who were referred for routine antenatal scan between 18 wks. to 22 wks. of gestation at Government medical college, Thrissur ,Kerala during the period of 2019-2020. The ethics committee of our institute approved this observational study and an informed consent obtained from all antenatal women included in it. However women with fetal anomalies, multiple pregnancies and Placental anomalies were excluded. All the pregnant women underwent a detailed clinical examination. They were evaluated with a GE LOGIQ S8 machine equipped with a 3.5 MHz convex array and 3.5 – 5.0 MHZ curvilinear transducer using 2D grey scale and colour real time ultrasonography of abdomen. Foetal and placental biometry was performed on all patients by trans abdominal sonography. No financial burden was incurred on the patient.

Scanners and Transducers Used

The grey scale real time ultrasonographic examinations were performed using a GE LOGIQ S8 machine(GE healthcare, Milwaukee, USA) equipped with a 3.5 MHz convex array transducer with colour and power doppler facility. The patients were examined using 2D grey scale real time ultrasonography of abdomen using a curvilinear probe of 3.5 – 5.0 MHZ with colour Doppler. Foetal and placental biometry was performed on all patients by trans abdominal sonography.

The Sonographic Technique of Placental Measurement

The patient was scanned in supine position. The curvilinear transducer was placed on maternal abdomen after applying the ultrasound gel. The placental thickness, in mm, was measured at the level of cord insertion site. Umbilical artery colour Doppler was used for further reconfirmation of the site of umbilical cord insertion. The transducer was oriented to scan perpendicular to both the chorionic and basal plates, as tangential scan will distort the measurement of the placental thickness. The uterine myometrium and retroplacental veins were excluded from the measurement.

Placenta was scanned from various angles to obtain largest diameter possible – Maximal placental diameter (Max. PD) Diameter will be measured along foetal surface using a linear or bilinear approach(whichever is deemed a better fit). Then the ultrasound probe was rotated 900 and above measurements were repeated in the orthogonal plane. Using the two values obtained the mean placental diameter (MPD)and mean placental thickness (MPT)were calculated. After the delivery, gestational age at delivery, and the birth weight of the neonate was recorded. The neonates were classified into AGA (appropriate for gestational age) SGA (small for gestational age)with birth weight <10th centile for gestational age and LGA (large for gestational age) with birth weight >90th centile for gestational age. The placental measurements of the foetuses were analysed and studied.

Results

Out of 120 included in the study, most number of study population belonged to the 20-30 years age group, accounting for 85.8% of the study population. Gestational age of patients enrolled in study was

ranging from 18 weeks to 22 weeks. Maximum number of cases was in 20 weeks gestational age which was 34(28.3%). Based on the birth weight centiles of the neonate according to gestational age, the study group was divided into 3 groups: AGA, SGA and LGA. Amongst 120 women; 97(80.8%) delivered AGA neonates, 19 (15.8%) delivered SGA neonates and 4 (3.3%) delivered LGA neonates.

120 patients were studied and the placental thickness ranged from 16 mm to 39 mm. The mean placental thickness among the patients was 25.65±4.07 mm. 120 patients were studied and the placental diameter ranged from 8 cm to 18 cm. The mean placental thickness among the patients was 13.7±1.66 cm. Placental thickness was studied among the subgroups-AGA, SGA, LGA-two placental thickness measurements PT 1 and PT 2 was measured and MEAN PT was calculated .The average MEAN PT among AGA group was 25.89± 3.31 mm, SGA group 22.07 ± 3.09 mm was LGA group was 36.69 ± 1.68 mm.

Table 1: Comparison of Placental Biometry (PT) among Groups

Placental Biometry	Groups	N	Mean(mm)	SD	Median (IQR)	Kruskal Wallis Value	p Value
PT 1	AGA	97	25.84	3.40	26.0 (24-28)	25.76	<0.001
	SGA	19	22.13	3.32	22 (19-25)		
	LGA	4	36.75	1.66	36.5 (35.38-38.38)		
PT 2	AGA	97	25.94	3.37	26 (24-28)	28.71	<0.001
	SGA	19	22.01	2.93	21.5 (19.6-24.5)		
	LGA	4	36.63	1.89	37.25 (34.63-38.0)		
MEAN PT	AGA	97	25.89	3.31	26 (23.84-27.5)	27.24	<0.001
	SGA	19	22.07	3.09	21.75 (19.3-24.75)		
	LGA	4	36.69	1.68	36.88 (35.0-38.19)		
MAX PT	AGA	97	26.51	3.40	27 (24-28)	28.94	<0.001
	SGA	19	22.51	2.98	22 (19.6-25)		
	LGA	4	37.13	1.75	37.25 (35.38-38.75)		

Kruskal Wallis test was performed to compare the placental thickness among the different subgroups, placental thickness showed statistically significant difference (p value <0.001) among different subgroups. Placental diameter was studied among the subgroups-AGA, SGA, LGA-two placental diameter measurements PD 1 and PD 2 was measured and MEAN PD was calculated. The average MEAN PD among AGA group was 14.02±1.37 cm, SGA group 11.78±1.42 cm was LGA group was 16.35 ±0.41 cm.

Table 2: Comparison of Placental Biometry (PD) among Groups

Placental Biometry	Groups	N	Mean(cm)	SD	Median (IQR)	Kruskal Wallis Value	p Value
PD 1	AGA	97	13.97	1.51	14 (13-15)	30.624	<0.001
	SGA	19	11.77	1.58	12 (10.6-13)		
	LGA	4	16.70	1.25	16.9 (15.45-17.75)		
PD 2	AGA	97	14.07	1.37	14.15 (13.25-15.0)	34.689	<0.001
	SGA	19	11.79	1.36	12 (10.5-13.0)		

	LGA	4	16.00	0.41	16 (15.63-16.38)		
MEAN PD	AGA	97	14.02	1.37	14.15 (13.25-15.0)	34.905	<0.001
	SGA	19	11.78	1.42	11.8 (10.75-12.75)		
	LGA	4	16.35	0.67	16.45 (15.66-6.94)		
MAX PD	AGA	97	14.37	1.46	14.5 (13.5-15.5)	34.303	<0.001
	SGA	19	12.11	1.38	12 (11-13)		
	LGA	4	16.95	0.82	16.9 (16.2-17.75)		

Kruskal Wallis test was performed to compare the placental diameter among the different subgroups ,placental diameter showed statistically significant difference (p value <0.001) among different subgroups.

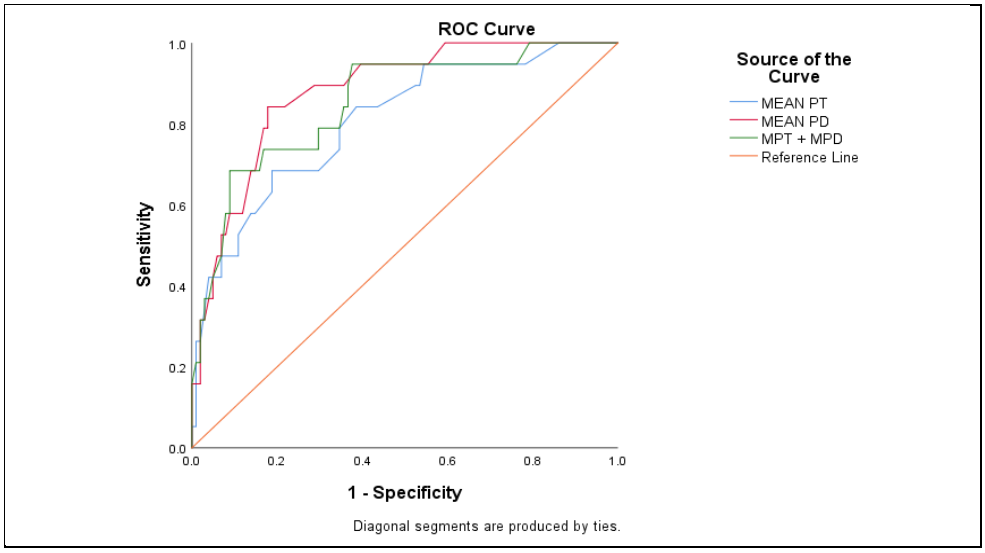

Figure 1: ROC curve

Table 3: Sensitivity Specificity, Positive Predictive Value (PPV) and Negative Predictive Value (NPV) for Prediction of SGA

Test	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
MPT ≤ 25.25	84.2	61.4	29.1	95.4
MPD ≤ 12.95	84.2	82.2	47.1	96.5
MPT + MPD	84.2	64.4	30.8	95.6

Based on the ROC curve, for mean placental diameter a cut off value of ≤ 12.95 cm at which maximum sensitivity of 84.2 % and maximum specificity of 82.2%, has been set. For mean placental thickness a cut off value of ≤ 25.25 mm has been decided, with maximum sensitivity of 84.2% and maximum specificity of 61.4%. Based on the MPT (mean placental thickness) cut off calculated from ROC curve the observed results were analysed with chi square test to test the statistical significance and the results were found to be statistically significant (p value <0.001) based on the calculated cut off. Based on the ROC curve, for mean placental diameter a cut off value of ≤ 12.95 cm at which maximum sensitivity of 84.2 % and maximum specificity of 82.2%, has been set. For mean placental thickness a cut off value of ≤ 25.25 mm has been decided, with maximum sensitivity of 84.2% and maximum specificity of 61.4%. Based on the MPD (mean placental diameter) cut off calculated from ROC curve the observed results were analysed with chi square test to test the statistical significance and the

results were found to be statistically significant (p value <0.001) based on the calculated cut off. Combined parameters MPD and MPT obtained from the ROC curve were analysed with chi square test to test the statistical significance and the results were found to be statistically significant (p value <0.001).

Table 4: Area Under Curve (AUC)

Tests	AUC	95% CI for AUC		p Value
		Lower	Upper	
MEAN PT	0.807	0.699	0.916	<0.001
MEAN PD	0.879	0.803	0.954	<0.001
MPT + MPD	0.851	0.755	0.946	<0.001

The AUC for each of these curves was found to be significant.

Discussion

Usually during obstetric ultrasound examination, the placenta is examined only for its location and position. But nowadays due to detailed ultrasonography, we can detect the morphological changes of the placenta as the placenta matures Many studies have been done in past regarding the importance of placenta in the growth of foetus. Initially most of studies concentrated upon the placental volume and foetal growth.[10,11] From these the relationship between foetal growth and placental weight were assessed. Abnormalities in placental volume was found to be predictor of foetal abnormalities.[12,13,14] However placental volumetric assessment was a complex procedure. Hence much easier parameters like placental thickness and diameter was taken into consideration. Many studies were done considering the same. In most of these positive correlation between placental thickness, gestational age and foetal growth was found. Early reliable predictors of placental dysfunction remain lacking in obstetric care. It is likely that no single test will achieve sufficient accuracy to be used in clinical practice as a stand-alone test in the prediction of SGA. Currently, only 50% cases of foetal growth restriction get diagnosed correctly in the antenatal period. Accurate identification of foetal growth impairment leads to four times reduction in neonatal complications and death.

Present study assessed placental biometry at 18-22 weeks of gestation (placental thickness and placental diameter) and its relation with foetal birth weight and analysis were made whether placental biometry can be used as a predictor in development of foetal growth restriction.

Total of 120 antenatal women were examined. Most women belonged to the group of 20- 30years(85.8%). Maximum number of cases belonged to 20 weeks of gestation(28.3%).

Based on the birth weight centiles of the neonate according to gestational age the study group was divided into 3 groups: AGA, SGA and LGA. Amongst 120 women; 97(80.8%) delivered AGA neonates, 19 (15.8%) delivered SGA neonates and 4 (3.3%) delivered LGA neonates. The ultrasound was performed in the second trimester at 18 weeks 0 days to 22 weeks 6 days of gestation. The timing of scan was based on the fact that a discrete placenta gets formed by 16 - 18 weeks with completion of vascular remodelling of uterine spiral arteries. The mean gestational age at the time of scan in AGA group was 20.57 ±1.13weeks, in SGA group was 20.11±1.15 weeks and in LGA group was 20.88±0.98 weeks. The mean gestational age at the time of scan between AGA and SGA group was comparable.

MPD among AGA group was 14.02 ±1.37 mm ,SGA group was 11.78 ±1.42 mm and in LGA group was 16.35 ±0.41 mm. The MPT in AGA group was 25.89± 3.31 mm, in SGA group was 22.07 ± 3.09 mm and in LGA group was 36.69 ± 1.68 mm . All the placental measurements i.e., both the MaxPDs ($p \leq 0.001$), MPD ($p \leq 0.001$), both the MaxPTs ($p = <0.001$) and MPT ($p < 0.001$) are statistically more in AGA group than in SGA group. Thus, the study showed definite association between simple two- dimensional placental measurements and subsequent delivery of SGA neonate. These results were similar to the findings of the study by Schwartz et al and Jindal et al according to which MPD ($p <0.001$ in Schwartz study and $p <0.000$ in Jindal study) and MPT ($p <0.006$ in Schwartz study and $p =0.000$ in Jindal study) were significantly smaller in SGA pregnancies.

ROC curves were generated for MPD and MPT for prediction of SGA, MPD (AUC =0.879) performed better than MPT (AUC=0.807) in the prediction of SGA which was similar to the findings of Jindal et al in which MPD yielded AUC(0.772) and MPT yielded AUC(0.712). Inclusion of MPD and MPT into a combined model to predict SGA yielded a AUC (0.851) which was similar to the findings of Jindal et al in which combined parameters yielded AUC(0.805).

Based on the ROC curve, for MPD a cut off value of 12.95 mm was chosen at which maximum sensitivity of 84.2 % and maximum specificity of 82.2 % were attained. Similarly, for MPT a cut off value of 25.25 mm was chosen at which maximum sensitivity of 84.2 % and maximum specificity of 61.4 % were attained. On combining MPD and MPT at the above-mentioned cut offs sensitivity of 84.2 % specificity of 64.4 %, PPV of 30.8 % and NPV of 95.6 % were attained. Though the PPV was less, but the high NPV of the placental biometry gives the advantage of reasonably ruling out an adverse outcome. These findings were similar to the study by Jindal et al in which based on the cut off they selected NPV was 97 % for MPT and 98 % for MPD and PPV was 16 % AND 13 % respectively.

Early predictors of placental dysfunction is lacking in obstetric care. Administration of low dose aspirin in early pregnancy leads to significant reduction in foetal growth restriction.

Placental biometry measurement by two-dimensional ultrasonography has innumerable advantages ranging from simple inexpensive technique, easily available equipment, less expertise, quick evaluation and inter-operator reproducibility. Further, the placental measurements can be integrated with anatomical ultrasound scan in the second trimester, thus decreasing the number of antenatal visits of the patient and increasing the compliance.

Role of Placental Biometry in Detection of Fetal Growth Restriction

Various studies in literature have found that foetal growth restriction was associated with altered placental morphometry such as decreased surface areas, decreased placental diameter, and decreased placental volume and placental weight. (Egbor et al 2006; Mayhew et al 2007; Almasry and Elfayomy, 2012) [15,16,17]. Few other studies have found a difference between placental thickness in pregnancies with normal growth and pregnancies with growth restriction like study by Mathai et al 49 in the year 2013.

In my study, there was a statistically significant difference between the placental thickness and placental diameter in pregnancies with normal growth and birth weight and pregnancies with SGA and cut off values of placental thickness and diameter were formulated to detect growth restriction. However, as our sample size was small and only one-time measurement of placenta was done, further large-scale prospective studies have to be

undertaken to create a standard cut off value for placental thickness and placental diameter which will be useful to ensure early detection of growth restricted pregnancies and further management.

Conclusion

Early detection, timely intervention and good antenatal care of high risk patients may prevent the adverse fetal outcome and thus reduce the incidence of foetal growth restriction. A statistically significant difference was found in the placental biometry (placental thickness and placental diameter) between pregnancies with normal growth and pregnancies with intrauterine growth restriction. Thus, placental measurements can be used as a parameter to detect pregnancies likely to develop foetal growth restriction

As a subnormal placental thickness and diameter may be the earliest indicator of foetal growth restriction, such cases showing reduced placental measurements in mid gestation should be dealt with caution and watched for further abnormalities in foetal growth. Based on the present study it can be concluded that placental measurements taken in mid-gestation are a valuable predictor of SGA.

Measurement of placental diameter and thickness is quick and simple. This approach should be explored in future to develop a predictive model for growth restricted foetuses.

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