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Correlation between Placental Morphometric Parameters and Birth Weight of Neonates

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ABSTRACT

Introduction: The placenta is a single organ and a vital regulator for fetal development and birth weight. The morphometry of the placenta helps to understand the antepartum and postnatal health of the neonates.

Objective: To assess the placental morphometry of low and normal birth weight neonates and their correlation with birth weight.

Materials and Methods: The present study was an institutional case-control study conducted at MES Medical College, Perinthalmanna, Kerala, India. New-borns with normal (≥2500 g) and low birth weight (< 2500 g.) born at 34 – 42 weeks were included in the study. The study included 350 subjects whose placentae were collected immediately after delivery for morphometric analysis. Neonatal birth weight and placental morphometry were analysed, and the fetoplacental ratio and placental coefficient were calculated.

Result: The present study indicates that all the placental morphometric parameters in low birth weight are significantly lower than those of the normal birth weight neonates. Moreover, there is a positive and significant correlation between the placental morphometric parameters and the birth weight of neonates.

Conclusion: Placental morphometric parameters are directly related to birth weight. It may be useful in predicting the postnatal health status of the baby and early adulthood diseases.

Key Words: LBW, NBW, Neonates, Placental morphometry, Fetoplacental ratio, Placental coefficient

INTRODUCTION

The placenta, a transient extracorporeal organ, unites the developing fetus to the wall of the uterus. It is a single dynamic organ derived from two separate individuals, the mother and the fetus. The placenta is the prime regulator for the organs, including the lungs, liver, gut, kidneys and endocrine glands of the fetus necessary to fetal development.[1] According to Kinare et al., fetal growth and birth weight are related to placental development.[2]Low birth weight (LBW) is defined as the birth weight of live-born infants below 2500 g irrespective of gestational age.[3] Yearly more than 20 million low birth weight neonates are born worldwide, which accounts for 15 to 20% of all births.[4] The prevalence of LBW ranges from 7.2% in developed nations to 17.3% in undeveloped countries. In Asia itself, the prevalence is 5.6% in central Asia and 27.2 % in southern Asia.[5] In India, the prevalence of LBW has significantly declined from 20.4% to 16.4% in the last decade.[6] In 2012, the World Health Assembly (WHA) endorsed a Comprehensive Implementation Plan on Maternal, Infant and Young Child Nutrition, which specified six global nutrition targets, including an ambitious 30% reduction in LBW prevalence between 2012 and 2025 hoping to reduce 20 million to about 14 million.[7]

Normal growth of the fetus is mainly reliant on normal placental function, normal morphometry, and normal structure of the placenta.[8]Morphometric parameters of the placenta were significantly affected by low birth weight deliveries.[9]LBW babies have a higher probability of dying within the first month of life or are connected with adverse health outcomes like stunted growth.[10]

The morphological parameters such as placental weight, volume, thickness, surface area, number of cotyledons, fetoplacental ratio, and placental coefficient give an idea about intrauterine and intrapartum events of gestation and help to

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understand the postnatal health of the neonates.[11]Placental morphometry has been considered as an indicator of its growth and function. The placental weight which reflects the development and function of the placenta, correlate with birth weight, maternal age, and history of pregnancy complications, parity, gender, and fetal distress.[12]Placental volume varies according to fetal weight; the observed values were compared with the expected values (50th percentile) for the appropriate fetal weight.[13]Goldy et al. reported a significant positive correlation between placental thickness and estimated fetal weight.[14]The placental surface area at term was positively correlated with the weight of a baby at the time of birth.[15]

Fetoplacental ratio (F/P ratio) was introduced as a predictor of perinatal outcome.[16,17] A relationship has been reported between a low F/ P ratio and the risk of adult cardiovascular diseases.[18] The altered growth of the placenta will give valuable information about the state of the fetal well-being, and examination of the placental morphology could be a predictor of adult-onset diseases. There are meagre studies on placental morphometry in the northern part of Kerala, which differs in ethnicity, socioeconomic status, maternal education, and cultural practices. Hence, this study on placental morphometric parameters and their correlation with the birth weight of neonates was undertaken.

MATERIALS AND METHODS

A case-control study was conducted in the Department of Anatomy, MES Medical College, Perinthalmanna. The subjects for the study were recruited from the Obstetrics & Gynaecology department of the same medical college. Placentae were collected from 350 births (Low Birth Weight N=175 and Normal Birth Weight, N=175) that occurred from December 2014 to November 2017. Permission for the study was taken from the Institutional Ethics Committee (IEC/ MES/75/ 2014). Written consent was obtained from mothers. The data regarding the demographic and clinical parameters of the mothers and their offspring were recorded.

Inclusion criteria

Cases: – Low Birth Weight (LBW).

Neonates with birth weight <2500 g. (34 weeks to 42 weeks of gestation)

Controls: - Normal Birth Weight (NBW).

Neonates with birth weight ≥ 2500 g. (34 weeks to 42 weeks of gestation)

Mothers aged between 18-35 years, singleton neonates delivered either by vaginal route or caesarean section.

Exclusion criteria: Subjects with gestational diabetes mellitus (GDM), hypertensive disorders, congenital anomalies, and intrauterine death were excluded.

Study parameters

Newborn birth weight was taken within the first hour of birth using a digital weighing scale recorded to the nearest 10 g. The collected placenta was immediately squeezed to evacuate the blood and washed under running tap water. The placental membrane was trimmed off and wiped to drain excess fluid and maternal blood. The placenta was weighed after cutting the umbilical cord at 5cm from its site of insertion. The weight of the placenta was measured by using a sensitive digital baby weighing scale. The volume of the placenta was determined by using the water displacement method[19]. The surface area was calculated by taking the mean value of the shortest and longest diameter of the placenta. Surface area = π x dl x ds / 4 (π = 3.14, dl is the - long diameter of the placenta, ds – short diameter of placenta). Placental thickness was measured by inserting a needle 2cm away from the margin and 1cm from the centre, respectively. The total number of placental cotyledons were counted and recorded. Counting of cotyledons was started from the left side of one end of the placenta and then going to the right side and again turning back to the left in a loop. The fetoplacental ratio was calculated using the formula:

$$\text{Fetoplacental Ratio} = \frac{\text{Birth weight of neonate (g)}}{\text{Placental weight (g)}}$$

The placental coefficient was calculated by using the formula.

$$\text{Placental coefficient} = \frac{\text{Placental weight (g)}}{\text{Birth weight of neonate (g)}}$$

The parameters among the groups were compared using the student`s t' test. Pearson correlation was used to correlate placental morphometry with birth weight. Linear regression analysis was carried out to estimate birth weight using placental morphometry. Analysis of data was carried out using SPSS v.21.

RESULTS

The results expressed in Table 1 showed that placental morphometric parameters were significantly lower in LBW neonates when compared to NBW neonates. Placental weight was 347.01± 58.11g. in LBW and 456.00 ± 67.83g in NBW (P<0.001). Placental volume was 246.59 ±55.51 ml. in LBW and392.98 ± 78.25 ml. in NBW (P<0.001). Placental thickness was 2.04 ± 0.31ml. in LBW and (2.57 ± 0.44) in NBW

neonates (P<0.001). The placental surface area of LBW was 170.95 ±35.63cm^2 and of NBW was 225.44 ± 43.91cm^2 (P<0.001). The number of placental cotyledons in LBW was 19.11 ± 2.65 and in NBW was 22.77 ± 3.86 (P<0.001). The fetoplacental ratio in LBW was 6.54±1.04 and in NBW was 6.87 ±0.86 (P=0.002). The Placental coefficient in LBW was 0.1563 ± 0.0225 and in NBW was 0.1479±0.0184 (P<0.001).

The result expressed in Table 2 showed positive correlation with all parameters such as placental weight (r=0.779), volume (r=0.766), thickness (r=0.652), surface area (r=0.615), and number of cotyledons (r=0.598). This result showed that the placental weight, volume, thickness, surface area and number of cotyledons increases with birth weight of neonates.

The results expressed in table 3 shows the linear regression analysis of placental morphometric parameters (placental weight, volume, thickness, and surface area) with an R^2 value of 0.69 can predict the birth weight of neonates.

DISCUSSION

Birth weight is a result of multiple factors like maternal nutrition, endocrine factors, maternal metabolism, placental insufficiency, genetic expression, ethnic and geographical variations. As the placenta and fetus share the same intrauterine environment, maternal diseases and nutritional deficiency limit the growth of both. In the present study, all the placental morphometric parameters in low birth weight are significantly lower than those of the normal birth weight neonates. Moreover, placental weight[20], volume[21], thickness[22], surface area, and the number of cotyledons[23] showed a positive correlation with the birth weight of neonates. Studies showed that low birth weight was associated with lower placental weight and volume. A reduction in the placental thickness affects the functional efficiency that results in smaller neonates.[24,25] Placental thickness may reflect the vascularization and branching of the chorionic villi and is the main dimension of placental growth during the third trimester.[26, 27] Freedman et al. stated that the surface area had more influence on the birth weight of the neonates.[25] Sirpurkar et al. showed that the placental surface area and the number of cotyledons are associated with birth weight.[28] The surface area of the placenta increases with a placental weight according to the growth of the fetal villi.[1] The surface area of the chorionic plate is mostly established before the third trimester and may reflect the number of spiral arteries supplying the placenta.[26,27,29] The placental co-efficient falls as the placental weight increases and a high placental co-efficient is seen if the placental weight decreases. Placental co-efficient outside the normal range (0.10 to 0.18) is shown to be associated with perinatal effects.[30] We conducted a secondary analysis using linear regression to evaluate the placental variables associated with birth weight. Linear regression analysis showed that placental morphometric parameters (placental weight, volume, thickness, and surface area) can predict the birth weight of neonates. The present study concludes that the development of the placenta and that of the fetus are causally related. Moreover, the observation of reduced values of placental morphometric parameters in low birth weight is a direct indication of the influence of the placenta on antenatal growth in utero.

CONCLUSION

The present postnatal morphometric studies of the placenta allow helping in finding neonates who suffer undetected growth restriction and should be monitored more closely during postnatal care. Placental morphometric parameters and their range differ from place to place due to the influence of factors like the environment, maternal nutrition, genetic expression, ethnicity, and geographical variations. However, the present information may assist in assessing progress towards the achievement of the global nutrition targets by 2025.

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Table 1: Placental morphometric parameters in low birth weight and normal birth weight neonates (values are expressed as mean ±SD)

PARAMETERS	LBW (n=175) Mean ± SD	NBW (n=175) Mean ± SD	Mean Difference	t value	P-value
Placental Weight (g)	347.01±58.11	456.00 ± 67.83	108.99	16.14	<0.001***
Placental Volume (ml)	246.59 ± 55.51	392.98 ± 78.25	146.38	20.19	<0.001***
Placental Thickness (cm)	2.04 ± 0.31	2.57 ± 0.44	0.53	13.09	<0.001***
Placental Surface area (cm^2)	170.95 ±35.63	225.44 ± 43.91	54.50	12.75	<0.001***
Placental cotyledons (no.)	19.11 ± 2.65	22.77 ± 3.86	3.66	10.33	<0.001***
Fetoplacental Ratio	6.54±1.04	6.87 ±0.86	0.33	3.17	0.002**
Placental Co – efficient	0.1563 ±0.0225	0.1479±0.0184	0.0085	3.84	<0.001***

n = number of subjects. The values obtained for low birth weight neonates are compared with those obtained for normal birth weight neonates. Level of significance. ** $P < 0.01$, *** $P < 0.001$.

Table 2: Pearson correlation between placental morphometric parameters and birth weight of all the neonates under study (n= 350, NBW + LBW)

Parameters – Overall	Birth Weight		
	N	Pearson Correlation	p-value
Placental Weight (g)	350	0.779	<0.001***
Placental Volume (ml)	350	0.766	<0.001***
Placental Thickness (cm)	350	0.652	<0.001***
Placental Surface area(cm^2)	350	0.615	<0.001***
Placental cotyledons (no.)	350	0.598	<0.001***

The Values obtained for placental parameters are correlated with the birth weight of neonates. Level of significance. ***P < 0.001.

Table 3: Linear regression models for predicting birth weight using placental morphometry.

Parameters	Point Estimate	95.0% Confidence Interval		R Square	P-Value
		Lower Bound	Upper Bound		
Constant	529.86	320.21	739.50	0.69	<0.001***
Placental Weight (g.)	2.52	1.81	3.22		<0.001***
Placental Volume (ml)	1.26	0.63	1.89		<0.001***
Placental Thickness (cm)	256.32	164.36	348.27		<0.001***
Placental Surface area(cm^2)	1.27	0.36	2.18		0.007**
Placental cotyledons (no)	-6.12	-18.56	6.31		0.333

The placental measurements (Placental weight, volume, thickness and surface area) were considered together as a predictor of birth weight with confidence interval 95%; significance at < 0.001 level.

Regression Equation: -

Birth Weight = 529.86 + [2.52xPlacental Weight (g)] + [1.26xPlacental Volume (ml)] + [256.32xPlacental Thickness (cm)] + [1.27xPlacental Surface area (cm^2)]– [6.12 x Placental cotyledons (number)].