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Association of placental morphology and fetal birth weight: A morphometric study

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Abstract---Background: The placenta plays a crucial role in sustaining pregnancy and supporting healthy foetal growth and function. Placental morphology predicts illness patterns in adults and foetal development. Birth weight is a significant predictor of a child's survival, healthy development, and growth. The connection between birth weight and perinatal outcome has long been understood in obstetrics. As is generally known, low birth weight is a known risk factor for the child's long-term health. The aim of the study was to find any association between birth weight, gender and placental morphology. Methods: An analytical cross sectional study was conducted in the anatomy department of Anatomy, Bhaarith Medical college and Hospital, Chennai. Placentae of 200 were collected. Morphological analysis including placental weight, number of cotyledons, site of umbilical cord insertion and fetal and maternal surface area, were measured in normal and low birth weight babies. Results: Birth weight showed a positive connection with gestational

age. Birth weight and greater values in men were positively and significantly correlated with placental parameters ($p < 0.001$). Regression models employing the newborn's sex and placental morphometry were used to estimate the birth weight; weight ($R^2=0.461$), surface area ($R^2=0.411$), and volume ($R^2=0.456$) were calculated. Increase in placental size is an independent predictor of birth weight and gender has a substantial relationship with maternal weight. Conclusion: The birth weight was accurately determined by placental morphometry, which also took into account the baby's weight, surface area, volume, and sex. This allowed for the planning of better maternal care and the calming of mothers and their relatives. Therefore, it is possible to predict the result of birth using all the parameters in a clinical setting.

Keywords---placenta, birth weight, low birth weight, cotyledons.

Introduction

The placenta is an organ, that connects the emerging or developing fetus to the uterine wall. Numerous factors influence the health of the foetus, but the placenta is the single most crucial component in the development of a healthy child. The placental morphology and its ability to efficiently transfer nutrients, gases, waste products, heat, hormones, and other regulatory molecules determine the outcome of pregnancy. It also stops the foetal allograft from being rejected. The growth trajectory of the foetus is primarily controlled by placental shape, blood flow, and nutrient transport processes.(1)

The first stage of placental evacuation is a physiological detachment from the uterine wall. The third stage of labour is defined as the time immediately following childbirth through placenta expulsion. After birth, the placenta typically passes within 15 to 30 minutes. The cord is typically cut right away after birth, however there is no medical need for doing so; on the contrary, it is believed that leaving the cord intact aids the newborn in adjusting to life outside the womb, particularly in premature infants. The association between birth weight and perinatal outcome has long been understood in obstetrics, but one sometimes overlooked factor is the placenta's shape, an organ that is crucial to fetal growth. Either placental hypertrophy or placental growth limitation is linked to worse pregnancy outcomes. It shows that the placenta has its own regulation path-physiologic system that serves as a compensating reaction to unfavourable mother obstetric situations.(2). As a result, the placental morphological variables all have differing effects on the patterns of foetal growth in male and female infants. Numerous research have been conducted on the fetoplacental ratio and placental weight in relation to neonatal birth weight. Regarding the impact of placental morphology (weight, volume, surface area, and thickness) in different birth weight groups, there is a dearth of field-specific information. A serious health issue in developing nations like India is low birth weight. According to the 2005 National Family Health Survey, India has a prevalence of LBW newborns of 22.2%. According to the WHO, approximately 28% of all live births in India and roughly 25 million low birth weight babies are born each year globally. Big British

cohort studies have shown evidence that a large placenta combined with a low birth weight is a significant independent risk factor for cardiovascular disease in adults. (3)

If a person's history contains a placenta that was excessively large compared to their birth weight, or if their placental weight to birth weight ratio was high, then they are far more likely to have hypertension (3). The weight of a newborn is reported to equal 1:6 of the placenta's weight. With regard to the placental proportions in various nations, this measurement varies greatly and is unique in each one (4). Poor perinatal outcomes, a low APGAR score, and perinatal death were associated with placental weight that was high, while medical issues for the mother were associated with placental weight that was low (5). Over a century has been spent researching the association between placenta weight and birthweight of the newborn (6). Numerous research on placental weight in connection to neonatal birth weight and feto-placental ratio have been conducted.(7) In order to assess the association between placental morphology such as weight, surface area, number of cotyledons, and umbilical insertion in normal and low birth weight groups, the current cross-sectional study was conducted.

Materials & Methods

The current study was conducted for one year at the department of Anatomy, Bharath Medical college and Hospital in Chennai. 200 placentas were collected. The placentae were studied was in the Department of Anatomy . The placentae were received to the department of anatomy , after normal deliveries and caesarean procedures between 32 and 40 weeks of gestation. The pre-tested proforma contained all the information on the mother and placenta. Placentae were collected immediately after delivery, examined thoroughly and washed under running tap water thereafter; membranes were trimmed and stored in 10% formalin container. The weight of placenta was determined by using Digital baby weighing scale. No of cotyledons and site of umbilical cord insertion (either central or peripheral) were recorded. Placental maternal surface area was calculated using the formula,

$$\text{Surface area} = \pi \times dl \times ds / 4$$

In which, dl=largest diameter, ds= smallest diameter, $\pi = 22/7$

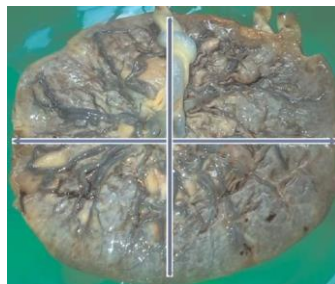


Fig-1: Measurement of diameter of placenta

Before the investigation began, the specimens were identified by number discs that were attached to them. Multiple pregnancies, intrauterine growth retardation (IUGR), mothers with a history of pre-gestational hypertension, diabetes mellitus, infants with congenital abnormalities, coronary artery disorders, anaemia, other vascular diseases, etc. were all excluded from this study.(Fig-1)

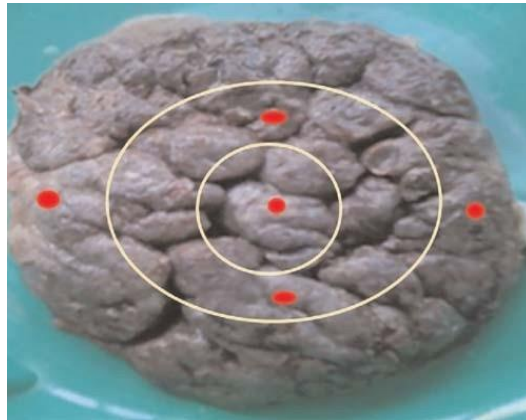


Fig-2:Measurement of thickness of placenta

A long needle was used to measure the placental thickness at five different sites. By making two circles on the maternal surface of the placenta, the organ was separated into three equal pieces. These circles divide the placenta's radius into three equal pieces. Three thicknesses—one from the middle zone, two from the peripheral zone, and one from the central zone—were measured. On a line parallel to the previous imaginary line in the central zone, the peripheral points were taken within the outer zone (Figure 2). The thickness of the placenta was finally determined by taking the mean of the five measurements.

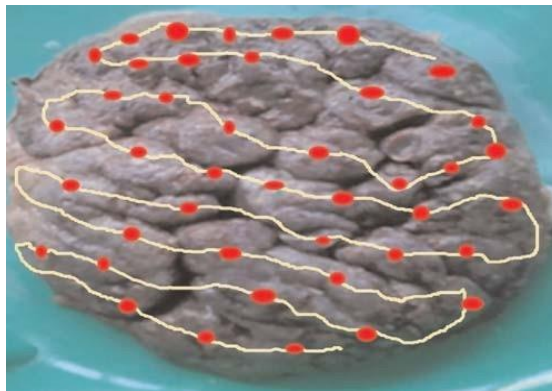


Fig-3: Measurement of cotyledon

To make the placenta groove visible so that the cotyledons could be counted, the placenta was immersed in a 10% formalin solution for 24 hours. The core of the foetal surface of the placenta was then gently pressed. The outcome was a conspicuous cotyledon on the maternal surface. On a foetal surface with the maternal surface facing up, the placenta was positioned. Beginning on the left

side of the placenta's one end, the cotyledons were counted before moving to the right, then returning to the left in a loop.(Fig-3)

Statistical Analysis: The data was processed and analysed after being tabulated in an MS.excel file. The statistical significance of the unpaired test and correlation coefficient were summarised using mean and standard deviation. Placental weight, the number of cotyledons on the mother's and fetus' surfaces, and the location of umbilical insertion were all expressed in mean standard deviation and percent, respectively. To compare the continuous difference between infants with low birth weight and normal birth weight as well as with the placental weight, all statistical factors were looked at.

Results

Comparison of age of the mother and birth weight

Birth weight	N=206	Age of mother	Fetal surface Area in sq cm	No of cotyledons	Maternal surface area sq cm	Weight of Placenta in grams	Thickness in cm
Low birth weight (>2000grms)	Mean	26.15	156.03	11.32	152.50	415.19	1.83
	± SD	2.88	11.01	2.3	13.16	19.37	0.48
Normal birth weight <2000gram	Mean	28.35	249.18	15.13	253.60	515.43	2.10
	± SD	3.56	17.31	3.16	20.74	26.09	0.44
	p-value	0.003	0.001	<0.001	<0.001	<0.001	<0.048

Comparison of gender and birth weight with placental morphology

Gender with weight	Male	Female	p-value
Low birth Weight			<0.005
Weight of the placenta			
Mean± SD	426.55±10.12	401.11±10.23	
Fetal Surface area in sq cm			<0.005
Mean± SD	153.03±10.09	158.08±17.04	
Thickness			<0.005
Mean± SD	2.10±0.08	2.12±0.65	
Maternal surface area sq cm			<0.005
Mean± SD	234.21±53.85	201.65±15	
Normal weight			
Weight of the placenta			<0.005
Mean± SD	512.01±12.03	518.54±10.01	
Fetal Surface area in sq cm			<0.005
Mean± SD	223.09±07.12	251.11±10.01	
Thickness			<0.005
Mean± SD	2.11±0.35	2.17±0.44	

Maternal surface area sq cm			<0.005
Mean± SD	156.04±11.09	264.23±23.11	

Strength of association

correlation	Weight of placenta	Placental surface area	Maternal surface area	No.of cotyledons
r =	0.765	0.876	0.815	0.578
p =	< .001	< .001	< .001	< .001

In this study, placentae from mothers with ages ranging from 21 to 38 years were measured for morphological characteristics. 206 placentas were examined, of which 130 belonged to newborns with normal birth weights (<2000gms of birth weight) and the remaining 104 to babies with low birth weights (>2000grms). Placentae were also categorized on the basis of duration of pregnancy into term placentae (195 cases) and post term (4 cases). Shape of the placentae is also noted at the time of delivery (around 183 were circular in shape, 23 were oval in shape). Central umbilical cord insertion was observed in 178 cases (86%) and peripheral insertion in remaining cases 28 (14%).

All the morphological measurements of placentae were tabulated and statistically compared between low birth weight and normal birth weight babies and gender. All the parameters were statistically significant (pvalue<0.05) while comparing placental morphology with age of the mother and gender of the baby. The significant differences were observed between two groups (P<0.001). At the same time these value are less in low birth weight babies. Statistical significance were seen between all these parameters (p<0.001).

Discussion

The placenta's development, formation, maturation, and formation are crucial for the foetus' growth and survival. The most straightforward criterion that acts as the most accurate predictor of the neonate's growth, development, and nourishment is birth weight. A serious health issue in developing nations like India is low birth weight (8). 12 The association between birth weight and perinatal outcome has long been understood in obstetrics, but one sometimes overlooked factor is the placenta's shape, an organ that is crucial for foetal growth (9). To improve the current understanding, more thorough placental phenotyping is required: characterisation of the maternal and foetal circulations, measurement of structural characteristics such as surface area and internal distance, consecutive PMs during pregnancy by ultrasound; In present study mean weight of placenta is 415.19±19.37grams in low birth weight and 515.43± 26.09 grams in normal birth weight, showed that there was a significant difference This is comparable with Ifra et.al(10). Gunapriya et.al (2011) study showed the average weight of normal weight was 528.55 gm.(11) In our study the placental surface area was 156.04±11.09sq cm in male and 264.23±23.11 sq.cm in female which is slightly higher than the previous workers.in contrast, Londhe et.al (2012) showed that the mean placental surface area was 184.0±61.6 sq.cm in SFA group (small for gestational age) which was lower than control group 219.7±41.6 sq.cm. (12)

Balihallimath et.al (2013) studied 164 placentae and mean placental surface area 225.7 sq.cm.(14) Girish et al showed the fetal surface area was less in low birth weight and high in normal birth weight babies.(12) Our study also observed the similar findings. In present study, the mean no of cotyledons were high in normal birth weight and low in low birth weight babies. Similarly, Londhe et al, study found that the no of cotyledons were 14.37 ± 2.56 in hypertensive group and 16.09 ± 1.90 in normal group of pregnancies.(13) Kallpana et al study showed that in normal birth weight, in 84.2% cases the mode of umbilical cord insertion was central, 72.7% cases it was marginal and 90% cases its eccentric. (8) All the placental parameters that is birth weight, maternal weight, cotyledon, fetal surface, and placental weight was statistically significant with gender and placental morphology. Therefore, it is possible to predict the result of birth using all the factors in a clinical setting.

Conclusion

Since the placenta serves as the primary source of knowledge regarding the foetus, research on it is crucial. From this study, it can be inferred that all placental characteristics, such as weight, surface area, and the number of cotyledons, are significantly lower in low birth weight babies than they are in normal babies. In order to detect low birth weight before delivery, this theorem can be used in conjunction with cutting-edge diagnostic techniques like ultrasound and colour doppler imaging. Additionally, steps can be taken to lower the number of low birth weight deliveries and the difficulties they bring, which will lower the infant mortality rate.

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