International Journal of Anatomy and Applied Physiology (IJAAP)
ISSN: 2572-7451

Placental Morphometry in Preterm and Term Neonates and its Association with their Birth Weights

Research Article

Martin K John[1], Ursula Sampson[2], Ranjith Sreedharan[3*]

[1] Ph.D. Scholar, Meenakshi Academy of Higher Education and Research (MAHER) and Department of Anatomy, MES Medical College Perinthalmanna. Kerala, India.
[2] Department of Biochemistry, Meenakshi Medical College Hospital & Research Institute, Kanchipuram, Tamil Nadu, India.
[3] Department of Anatomy, Jubilee Mission Medical College & Research Institute, Thrissur, Kerala, India.

Abstract

Background: - Placenta, a feto-maternal organ that provides oxygen, nutrients and removes waste products from the fetus. The morphometry of the placenta was broadly recognized as having high significance for the outcome of gestation and promoting life long well being of neonates.
Objective: To assess the placental morphometry in preterm and term neonates and its association with their birthweights.
Materials and Methods: The study was an institution based cross-sectional study conducted at MES Medical College, Perinthalmanna, Kerala, India.350 Placenta with gestational age 34 - 42 weeks were collected after the termination of pregnancy, washed thoroughly, cleaned, and trimmed for morphometric analysis.
Result: It was observed that all the placental morphometric parameters were lower in preterms when compared to term neonates. Moreover, placental weight was less in both preterm and term low birth weight neonates than that of corresponding normal weight neonates.
Conclusion: Placental morphometric parameters in preterm and term neonates had a significant association with their birthweights. However, in low birth weight neonates, the placental weight showed no significance with gestational age, wherein normal birth weight neonates placental weight significantly increased with gestational age. This shows that as the gestational age advances, the nutritional requirements of the fetus also increases, resulting in a concomitant increase in the morphometric parameters of the placenta and birth weight.

Keywords: Placental Morphometry; Term; Preterm; LBW- Low Birth Weight; NBW: Normal Birth Weight.

Introduction

The placenta is an embryonic organ of communication between the mother and the fetus during pregnancy. It enables the transport of nutrients, waste removal, and gaseous exchange between the mother's blood and the fetus. Hence, a healthy placenta is essential for fetal growth and development [1]. In Southern Asia, there is a higher fraction of newborn mortality (57•0%), with preterm birth complications being the leading cause [2]. Preterm birth rates in India are increasing and are now responsible for 27.5% of the neonatal deaths [3]. The condition is the second leading cause of death among children under five, after pneumonia worldwide [2]. The American College of Obstetricians and Gynaecologists (2016) [4] defined preterm labor or premature labor as regular contractions of the uterus, causing changes in the cervix that start before 37 weeks of pregnancy.

Preterm neonates are almost 18 times more at risk of being low birth weight (LBW) and viceversa [5]. Preterm birth and LBW were associated with lower cognitive ability in childhood as well as poor health in later life [6]. Studies on postnatal placental morphometry and birth weight showed that low birth weight was associated with lower placental weight, volume and a smaller placental area [7, 8]. Researchers are gaining interest in revealing and displaying the factors associated with LBW. By contrast, fewer studies consider the association of placental morphometry with

***Corresponding Author**:
Dr. Ranjith Sreedharan,
Department of Anatomy, Jubilee Mission Medical College and Research Institute, Thrissur, Kerala, 680005, India.
Tel: +91-938-834-4448
E-mail: drranjithanatomy@gmail.com

Received: October 23, 2020
Accepted: November 09, 2020
Published: November 13, 2020

Citation: Martin K John, Ursula Sampson, Ranjith Sreedharan. Placental Morphometry in Preterm and Term Neonates and its Association with their Birth Weights. *Int J Anat Appl Physiol.* 2020;6(4):152-155. **doi:** http://dx.doi.org/10.19070/2572-7451-2000028

birth weight in preterm and term neonates. Hence there are requirements to put more investigative efforts to elucidate the link between placental morphometry in preterm and term neonates and its association with birth weight.

Materials and Methods

The present 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 MES Medical College, Perinthalmanna.350 Placenta, with gestational age 34 - 42 weeks were collected immediately after termination of pregnancy, washed thoroughly, cleaned, and trimmed for morphometric analysis.The data regarding demographic and clinical parameters of subjects were recorded. Permission for the study was obtained from the Institutional Ethics Committee (IEC/MES/75/2014). Written consent was obtained from the mothers.

Inclusion criteria

• Pregnant women aged 18-35years who gave birth to live neonates (singleton) by vaginal route or cesarean section.
• Gestational age: 34 - 42 weeks of gestation

Exclusion criteria

Maternal diseases are affecting the placenta like hypertension, diabetes mellitus, vascular diseases, maternal anemia, and other medical problems.

Grouping of study subjects

The collected placentae were classified according to gestational age as preterm (<37 weeks) and term (≥37 weeks). The gestational age of newborns was calculated from the first day of the last menstrual period till the day of birth and was expressed in completed weeks. These preterm and term placentae were further classified according to low (<2500g) and normal birth weight (≥2500g). Based on gestational age and birthweight, the following groups were made.

• Group I: Preterm LBW (34 – < 37 weeks of gestation and birth weight < 2500g.)
• Group II: Term LBW (37 – 42 weeks of gestation and birth weight< 2500g.)
• Group III: Preterm NBW (34 – < 37 weeks of gestation and birth weight ≥ 2500g.)
• Group IV: Term NBW (37 – 42 weeks of gestation and birth weight ≥ 2500g.)

Study parameters

The placenta was weighed after cutting the umbilical cord at 5cm from its site of insertion by using a sensitive digital baby weighing scale. Newborn birthweight was taken within the first hour of birth using a digital weighing scale recorded to the nearest 10g. The volume of the placenta was determined by using the water displacement method [9]. The surface area was calculated by taking the mean value of the shortest and longest diameter of the placenta [10]. Surface area = π x dl x ds / 4 (π = 3.14, dl and ds are the long and the short diameters of the placenta). Placental thickness was measured by piercing a toothpick at nine different points, selected along two planes that bisect at the right angle, along the point of umbilical cord insertion. The average values were computed to determine the placental thickness [11]. Feto–placental ratio was calculated using the formula [12].

Feto-placental Ratio = Feto-placental Ratio/Placental weight (g)

The placental coefficient was calculated by using the formula [13]

Placental coefficient = Placental weight (g)/Birth weight of neonate (g)

The parameters among the groups were compared using the student`s t-test. Analysis of data was carried out using SPSS v.21.

Results

Among 350 placentas, 187 were preterm, and 163 were term. On their further classification based on birthweight, the number of placentae in each group (group I to IV) was 141, 34, 46, and 124, respectively. Birthweight (mean ± SD) of group I to IV was 2.220 ± 0.181g, 2.241 ± 0.122 g, 2.980 ± 0.302 g. and 3.131 ± 0.370, respectively.

Table 1 shows the comparison of placental morphometric parameters in preterm and term subjects. The mean placental weight of preterm and term placentae was 362.53 ± 67.30g and 446.21 ± 77.59 g respectively whereas the mean value of the placental volume was found to be 255.96 ± 62.16 ml in the preterm placenta and 393.01 ± 83.22ml in term placenta. The mean thickness in the preterm placenta was observed to be 2.03 ± 0.29 cm, while the same in full-term placenta increased to 2.62 ± 0.42 cm. The placental surface area of 173.80± 42.23 sq. cm. was observed in the preterm placenta, whereas 226.18 ± 38.94 sq cm was observed in the full-term placenta. The mean number of cotyledons in the placentae of preterm and term groups were 19.01 ± 2.72 and 23.16 ± 3.61, respectively. All the aforementioned morphometric parameters were found to be statistically significant. On the other hand, the Feto-Placental Ratio and Placental Coefficient were statistically insignificant.

Table 2 shows the comparison of placental morphometric parameters in preterm LBW (group I) and term LBW (group II). It could be observed that placental volume, thickness, surface area, and the number of cotyledons were significantly low in group I compared to group II and found to be statistically significant. Feto placental ratio and placental coefficient were also found to be significant. The mean placental weight in preterm LBW was observed to be 345.04 ± 63.70g, while the same in term placenta increased to 355.21 ± 22.37g. This increase was statistically insignificant.

The values of the placental morphometric parameters obtained in preterm NBW (group III) and in term NBW (group IV) were compared (Table 3). It could be observed that all the morphometric parameters were significantly low in group III when compared to group IV and were also found to be statistically significant.

Table 1. Placental morphometric parameters in preterm and term neonates. (Values are expressed as mean ±SD).

PARAMETERS	Preterm (n=187)	Term (n=163)	Mean Difference	t Value	P-Value
	Mean ± SD	Mean ± SD			
Placental Weight (g)	362.53 ± 67.30	446.21 ± 77.59	83.68	10.81	<0.001***
Placental Volume (ml)	255.96 ± 62.16	393.01 ± 83.22	137.06	17.59	<0.001***
Placental Thickness (cm)	2.03 ± 0.29	2.62 ±0.42	0.59	15.54	<0.001***
Placental Surface area (cm^2)	173.80 ± 42.23	226.18 ± 38.94	52.37	12	<0.001***
Placental cotyledons (no.)	19.01 ± 2.72	23.16 ± 3.61	4.15	12.23	<0.001***
Feto-Placental Ratio	6.75 ± 1.08	6.66 ± 0.82	0.09	0.84	0.399NS
Placental Coefficient	0.1518 ± 0.023	0.1523± 0.0184	0.001	0.24	0.808NS

n = number of subjects. The values obtained for preterm neonates are compared with term neonates.
Level of significance. ***P ≤ 0.001, NS - Not significant

Table 2. Placental morphometric parameters in preterm LBW and term LBW neonates. (Values are expressed as mean ± SD).

PARAMETERS	Preterm LBW Group I (n=141)	Term LBW Group II (n=34)	Mean Difference	t Value	P-Value
	Mean ± SD	Mean ± SD			
Placental Weight (g)	345.04 ± 63.70	355.21 ± 22.37	10.17	0.92	0.361NS
Placental Volume (ml)	235.30 ± 51.33	293.44 ± 47.54	58.14	6.01	<0.001***
Placental Thickness (cm)	1.98 ± 0.28	2.25 ± 0.35	0.27	4.75	<0.001***
Placental Surface area(cm2)	166.68 ± 36.17	188.66 ± 27.20	21.98	3.32	<0.001**
Placental cotyledons (no.)	18.86 ± 2.38	20.18 ± 3.41	1.32	2.65	< 0.001**
Feto-placntal ratio	6.59 ± 1.12	6.74 ± 0.86	0.4	2.63	<0.01**
Placental coefficient	0.1591 ± 0.145	0.1506 ± 0.0189	0.009	2.43	<0.05*

n = number of subjects. The values obtained for preterm low birth weight neonates are compared with those obtained for term low birth weight neonates.
Level of significance. *P<05, **P < 0.01,***P <0.001,NS not significant

Table 3. Placental morphometric parameters in preterm NBW and term NBW neonates.

PARAMETERS	Preterm NBW Group III (n=46)	Term NBW Group IV (n=129)	Mean Difference	t Value	P-Value
	Mean ± SD	Mean ± SD			
Placental Weight (g)	416.17 ± 46.84	470.20± 46.84	54.03	4.94	<0.001***
Placental Volume (ml)	319.28 ± 48.31	419.26±69.68	99.98	8.98	<0.001***
Placental Thickness (cm)	2.15 ±0.27	2.72±0.39	0.57	9.13	<0.001***
Placental Surface area(cm2)	195.65 ± 51.50	236.07±35.44	40.42	5.85	<0.001***
Placental cotyledons (no.)	19.48 ± 3.56	23.95±3.24	4.47	7.82	<0.001***
Feto placental ratio	7.21 ± 0.78	6.74± 0.86	0.47	3.26	<0.001***
Placental coefficient	0.1402 ± 0.0147	0.1506±0.0189	0.010	3.39	<0.001***

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

Discussion

Placental growth is associated with pregnancy outcomes, as the placental morphology and its physiology determine the growth trajectory of the fetus [14]. The placental weight reflects the development and function of the placenta and is correlated with gestational age [15]. The present study showed that placental weight increased according to birth weight and gestational age, which concurs with previous observation [7].

Isakov et al., (2018) [16] stated that placental volume increases throughout gestation and follows a predictable parabolic curve. Placental volume was significantly lower in low birth weight neonates and had a significant correlation with the birth weight of the newborn. These observations were similar to the present observation that placental volume increases significantly with gestational age and birth weight.

Previous studies reported that placental thickness increases parallel to the gestational age [17, 18]. The present study was in conformity with the previous observation of an association between placental thickness and gestational age. Sharmila et al., (2015) [19] reported a correlation between placental surface area and intrauterine growth retardation. The placental surface area in the present study was 226.18 ± 38.94 in term neonates and 173.80 ± 42.23 in preterm neonates. Moreover, the mean surface area was found to increase significantly from preterm LBW to term NBW. The surface area is proportional to the number of uterine spiral arteries available for fetal nutrition [20]. The increased surface area observed in the term NBW neonates was also reflected in the number of cotyledons (19.01 ± 2.72 and 23.94 ± 3.61 in preterm and term, respectively). This is in accordance with the observation made by Baker et al. (2013) [21] that the number of cotyledons was positively related to the placental surface area.

In the present study, placental weight was less in both preterm and term LBW neonates but the difference statistically insignificant.In preterm and term NBW neonates, placental weight increased with gestational age. Jaya et al. (1995) [22] had observed that a lower placental weight was due to an increase in the cytotrophoblastic cellular proliferation and syncytial knot formation in the placental villi. To conclude, gestational age alters the placental morphometry, which inturn results in low birth weight of neonates.

Conclusion

Placental morphometric parameters in preterm and term neonates were found to be associated with their birthweights. However, in low birth weight neonates, the placental weight was not associated with gestational age, wherein normal birth weight neonates placental weight increased with gestational age. This shows that as the gestational age advances, the nutritional requirements of the fetus also increases, resulting in a concomitant increase in the morphometric parameters of the placenta and birth weight. Understanding the postnatal morphometry of the placenta will help to monitor the neonates with undetected intrauterine growth restriction during postnatal care. Good predictive morphometric values will help as diagnostic tools in the practice of evidence-based medicine (EBM) and to initiate early measures for fetal well-being.

References

[1]. Geddam JJB, Radhakrishna KV, Ramalaxmi BA, Balakrishna N, Qadri SSYH, Sesikiran B. Maternal nutrition in early pregnancy affects placental development. IJMEDPH. 2011; 1(2):22–9.

[2]. Liu L, Oza S, Hogan D, Chu Y, Perin J, Zhu J, et al. Global, regional, and national causes of under-5 mortality in 2000-15: an updated systematic analysis with implications for the Sustainable Development Goals. Lancet. 2016 Dec 17;388(10063):3027-3035.Pummed PMID: 27839855.

[3]. You D, Hug L, Ejdemyr S, Idele P, Hogan D, Mathers C, et al. Global, regional, and national levels and trends in under-5 mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN Inter-agency Group for Child Mortality Estimation. Lancet. 2015 Dec 5;386(10010):2275-86.

[4]. Al-Bayati MM, Muhammad EM, Salman AM. The Value of Free Thyroid Hormones and Aspartate Aminotransferase in Vaginal Washing Fluid for Detection of Preterm Pre-Labor Rupture of Membrane.IASJ. 2019;18(1):52-58.

[5]. Taha Z, Ali Hassan A, Wikkeling-Scott L, Papandreou D. Factors Associated with Preterm Birth and Low Birth Weight in Abu Dhabi, the United Arab Emirates. Int J Environ Res Public Health. 2020 Jan;17(4):1382.Pubmed PMID: 32098043.

[6]. Zmyj N, Witt S, Weitkämper A, Neumann H, Lücke T. Social Cognition in Children Born Preterm: A Perspective on Future Research Directions. Front Psychol. 2017 May 29;8:455.Pubmed PMID: 28611695.

[7]. Balihallimath RL, Shirol VS, Gan AM, Tyagi NK, Bandankar MR. Placental morphometry determines the birth weight. J Clin Diagn Res. 2013 Nov;7(11):2428-31.Pubmed PMID: 24392363.

[8]. Kowsalya V, Vijayakumar R, Chidambaram R, Srikumar R, Reddy EP, Latha S, et al. A study on knowledge, attitude and practice regarding voluntary blood donation among medical students in Puducherry, India. Pak J Biol Sci. 2013 May 1;16(9):439-42.Pubmed PMID: 24498809.

[9]. Scherle W. A simple method for volumetry of organs in quantitative stereology. Mikroskopie. 1970 Jun;26(1):57-60.Pubmed PMID: 5530651.

[10]. Baptiste-Roberts K, Salafia CM, Nicholson WK, Duggan A, Wang NY, Brancati FL. Maternal risk factors for abnormal placental growth: the national collaborative perinatal project. BMC pregnancy and childbirth. 2008 Dec 1;8(1):44.

[11]. Abaidoo CS, Boateng KA, Warren MA. Morphological Variations of the "Baby\'s Supply Line". JST . 2008; 28 (2):1–9.

[12]. Salafia CM, Zhang J, Miller RK, Charles AK, Shrout P, Sun W. Placental growth patterns affect birth weight for given placental weight. Birth Defects Res A Clin Mol Teratol. 2007 Apr;79(4):281-8.Pubmed PMID: 17286292.

[13]. Keche HA, Keche AS. Morphometric differentiation between placenta in PIH and normal pregnancy. Int J Med Sci Public Health. 2015 Feb 1;4(2):62-7.

[14]. Ilekis JV, Tsilou E, Fisher S, Abrahams VM, Soares MJ, Cross JC, et al. Placental origins of adverse pregnancy outcomes: potential molecular targets: an Executive Workshop Summary of the Eunice Kennedy Shriver National Institute of Child Health and Human Development. Am J Obstet Gynecol. 2016 Jul;215(1 Suppl):S1-S46.Pubmed PMID: 26972897.

[15]. Asgharnia M, Esmailpour N, Poorghorban M, Atrkar-Roshan Z. Placental weight and its association with maternal and neonatal characteristics. Acta Med Iran. 2008:467-72.

[16]. Isakov KM, Emerson JW, Campbell KH, Galerneau F, Anders AM, Lee YK, et al. Estimated Placental Volume and Gestational Age. Am. J. Perinatol. 2018 Jul;35(08):748-57.

[17]. Mathai BM, Singla SC, Nittala PP, Chakravarti RJ, Toppo JN. Placental thickness: its correlation with ultrasonographic gestational age in normal and intrauterine growth-retarded pregnancies in the late second and third trimester. J Obstet Gynaecol India. 2013 Aug 1;63(4):230-3.Pubmed PMID: 24431647.

[18]. Nyberg DA, Finberg HJ. The placenta, placenta membranes and umbilical cord. In diagnostic ultrasound of fetal anomalies. Mosby year book, St Louis. 1990: 623-675.

[19]. N ThilagavathySharmila, G Meenakumari, S Ibrahim Shifa, L Muthuman. IUGR placenta and its implication in the therapeutic intervention. December 2015; 17(2): 131-135

[20]. Benirschke K, Burton GJ, Baergen RN. Placental Shape Aberrations. In: Pathology of the Human Placenta. 6th ed. Berlin: Springer-Verlag.2012; 377-93.

[21]. Barker D, Osmond C, Grant S, Thornburg KL, Cooper C, Ring S, Davey-Smith G. Maternal cotyledons at birth predict blood pressure in childhood. Placenta. 2013 Aug 1;34(8):672-5.Pubmed PMID: 23731799.

[22]. Jaya DS, Kumar NS, Bai LS. Anthropometric indices, cord length and placental weight in newborns. Indian Pediatr. 1995 Nov;32(11):1183-8.Pubmed PMID: 8772867.