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ORIGINAL ARTICLE

ASSOCIATION OF PLACENTAL MORPHOMETRY WITH NEWBORN ANTHROPOMETRY

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ABSTRACT: BACKGROUND: The fetal growth is the outcome of the maternal nutrient stores and efficient transport across the placenta. Hence, any variation in the placenta leads to disproportionate fetal growth leading to long term risk of chronic diseases in the newborn. This study was designed to explore influence of placental morphometry on newborn anthropometry. **MATERIALS AND METHODS:** The study was conducted on 391 placentae of singleton newborn from a teaching hospital of North Karnataka, India. Data was collected from August 2012 to January 2013 by using standard operating procedures in a pre-designed and pre-tested proforma. The distributions of placental morphology and newborn anthropometry are mentioned with their percentiles and Box plots. Analysis of variance is used to study the differences in means of placental morphometry in different groups of newborn anthropometry. **RESULTS:** The Means and standard deviations of placental morphometry; weight, volume, surface area and thickness were 440±100gm, 386±101 ml, 230±50 cm sq, and 2.1±0.4cm respectively. Mean and standard deviations of birth weight and newborn length were 2700±500 gm. 46.6±2.5cm. Placental morphometry and newborn anthropometry increased significantly with gestation. **CONCLUSIONS:** This study infers that suboptimal growth of placenta leads to adverse pregnancy outcome.

KEYWORDS: Placental weight, Placental surface area, Gestation, Birth weight, Newborn length.

INTRODUCTION: Placental evolution was established from fossil evidence of Ichthyosaurus, more than 170 million years ago. Disc shaped haemochorial placenta of many primates, including humans, existed throughout the Eutherian lineage. The evolutionary pressures shaped mammal placenta to be an organ that must meet nutritional demands of gestational. Therefore the effect of selection, inserts pressures on the efficiency of placenta.[1]

Placenta is an organ of dual origin: chorionic plate derived from the developing embryo and decidual plate derived from modification of the uterine lining of the mother. Hence, human placenta develops from both uterus and developing embryo.[2,3,4,5]

Early in the second trimester, the placenta approximates the fetus in size and continues to grow until term. As pregnancy advances, it become relatively smaller and by term the ratio of its weight to that of the fetus is about 1:6 to 1:7.[2,3]

Placental weight is one of several standard placental measurements by which fetal growth can be characterized[6]. The chorionic plate area specifies the placental surface area covering the uterus and defines, how many maternal spiral arteries and veins are potential suppliers to surface area[7]. Placental thickness, by contrast, marks the extent of arborisation of the villous capillary bed, the actual locus of maternal foetal exchange.

The placental development and efficiency are the sole fetal source of nutrients and oxygen supply. Placental growth is almost completed by early 3rd trimester, while thickness of placenta increases in late 3rd trimester.[8,9,10,11] Abnormal chorionic plate shape usually reflects pathologic

DOI: 10.14260/jemds/2015/1362

villous atrophy from the end of first trimester or placental infarct. Thus these parameters of placental growth may be essential markers of placental weight at delivery.[12] Placental volume improves the ability to predict the birth size. It helps in early identification of the fetus at risk and facilitates the preparations for the management at least in neonatal and childhood period. Placental volume was directly proportional to the birth weight of the baby.[13]

MATERIALS AND METHODS: The present study was conducted in the Department of Anatomy, Jawaharlal Nehru Medical College, Belgaum. Placentae were collected from Obstetrics and Gynecology Unit of Dr. Prabhakar Kore Charitable Hospital, Belgaum. Data was collected from August 2012 to January 2013. The study was conducted on 391 mothers and their singleton offspring. The study was approved by the KLE University Ethical Clearance Committee. Detailed information about the intended research work was given to the mothers and written consent was obtained from them. A pilot study was carried out before commencing the actual study. This was done to assess the feasibility and practicability of the whole research design. The subjects without antenatal check-up during first trimester and with history of pre-pregnancy systemic and chronic diseases were excluded. Placental morphometry and newborn parameters were recorded on predesigned and pretested proforma.

Methods of Specimen Collection, Preparation, and Assessment of Placental Morphometry[14]:

- Placentae were collected soon after separating the baby from the umbilical cord. The collected placentae were examined thoroughly and washed under running tap water, thereafter, membranes were trimmed.
- The specimens were tagged with numbers for identification, and were transported to the skill lab by placing in a 10% formalin container.
- The weight of each placenta were determined by the digital baby weighing scale CS-8316(CE certified) and recorded with accuracy of 1 gm.
- The maternal surface area of the placenta was calculated using the formula.[15]
    - Surface area= π x dl x ds/4, (where dl: largest diameter, ds: smallest diameter).
    - The Surface area was recorded with accuracy of 1 sq cm.
- The volume was recorded using water displacement method, with accuracy of 1 ml.[16]
- The thickness was measured by inserting a calibrated Knitting needle at the center of placenta and measured in centimeter, with accuracy of 0.1 cm.

Parameters of Newborn Baby Assessed were:

- Gestational age, weight of the baby, length of the new born.
- The gestational age was recorded from last menstrual period (LMP) and further confirmed by Ultrasonography (USG); grouped as 28-34, 35-36, 37+ weeks (wk).
- Birth weight was measured by using Digital baby weighing scale CS-8316(CE certified) with accuracy of 10 gm.

Statistical analysis was carried out using SPSS-16. The differences in means were tested using Analysis of Variances and comparisons of means were studied by t-test. Differences were considered statistically significant at p value less than 0.05, 0.01 and 0.001. The Box plots were prepared to study the relative distributions placental morphometry and newborn anthropometry.

DOI: 10.14260/jemds/2015/1362

RESULTS:

Variables	Percent	Cumulative Percent	
		Observed	Expected
a. Gestation in wks, Mean=38.3, SD=2.2			
28-32	4.1	4.10	0.87
33-36	10.7	14.80	28.00
37-40	78.5	93.40	88.70
41+	6.6	100.00	100.00
Total	100		
b. Birth weight in gm, Mean=2700, SD=500			
1000-1499	3.6	3.6	0.8
1500-1999	3.6	7.2	8.1
2000-2499	21	28.2	34.5
2500-2999	44.5	72.6	72.6
3000-3499	22.8	95.4	94.5
3500+	4.6	100	100
Total	**100**		

Table 1: Distribution of gestation and birth weight

Gestational age distributions in Table 1a reveals that a maximum of 78.5 percent newborn were born at gestational age 37-40wks and 14.8 percent were preterm babies. Birth weight distribution in Table 1b reveals that a maximum of 44.5 percent newborns were of birth weight 2500-2999gm and 28.1 percent were less than 2,500gm (LBW).

Newborn Birth Weight Groups (Mean=2700, SD=500)	Percent (n=391)	Percentiles						
		5	10	25	50	75	90	95
a. Placental weight in gm								
<(Mean-1SD)	11.51	201.5	227.6	272.5	342.0	426.0	500.0	559.7
(Mean±1SD)	75.70	304.9	340.5	386.0	440.0	495.8	562.9	586.0
>(Mean+1SD)	12.79	373.1	402.1	469.8	517.5	580.0	649.8	802.6
b. Placental volume in ml								
<(Mean-1SD)	11.51	106.0	176.0	225.0	290.0	380.0	414.0	486.0
(Mean±1SD)	75.70	250.0	280.0	320.0	390.0	430.0	500.0	520.0
>(Mean+1SD)	12.79	300.0	371.0	420.0	470.0	520.0	609.0	746.0
c. Placental surface area in cm sq								
<(Mean-1SD)	11.51	106.5	127.0	154.0	187.0	213.7	243.3	262.4
(Mean±1SD)	75.70	164.8	176.8	200.4	226.3	253.8	282.9	314.3
>(Mean+1SD)	12.79	193.8	206.8	227.1	265.6	297.4	314.2	368.2
d. Placental thickness in cm								
<(Mean-1SD)	11.51	1.3	1.5	1.5	2.0	2.5	2.5	3.0
(Mean±1SD)	75.70	1.5	1.5	2.0	2.0	2.5	2.6	3.0
>(Mean+1SD)	12.79	1.5	1.6	2.0	2.1	2.5	3.0	3.0

Table 2: Percentiles of placental morphometry by birth weight groups

DOI: 10.14260/jemds/2015/1362

Percentiles of placental weight by birth weight groups in Table 2-a reveal that in the three groups of birth weight the 5th percentile of the placental weight increased consistently from 202 gm to 373 gm. The similar consistent increasing trends were observed in all higher percentiles.

Table 2-b reveals that in three groups of birth weight, the 5th percentile of placental volume increased consistently from 106 to 300 ml. The similar consistent increasing trends were observed in all higher percentiles.

Table 2-c reveals that in three groups of birth weight, 5th percentile of the placental surface area increased consistently from 107 to 194 cm sq. The similar consistent increasing trends were observed in all higher percentiles.

Table 2-d reveals that in the three groups of birth weight, placental thickness did not exhibit any consistent relation.

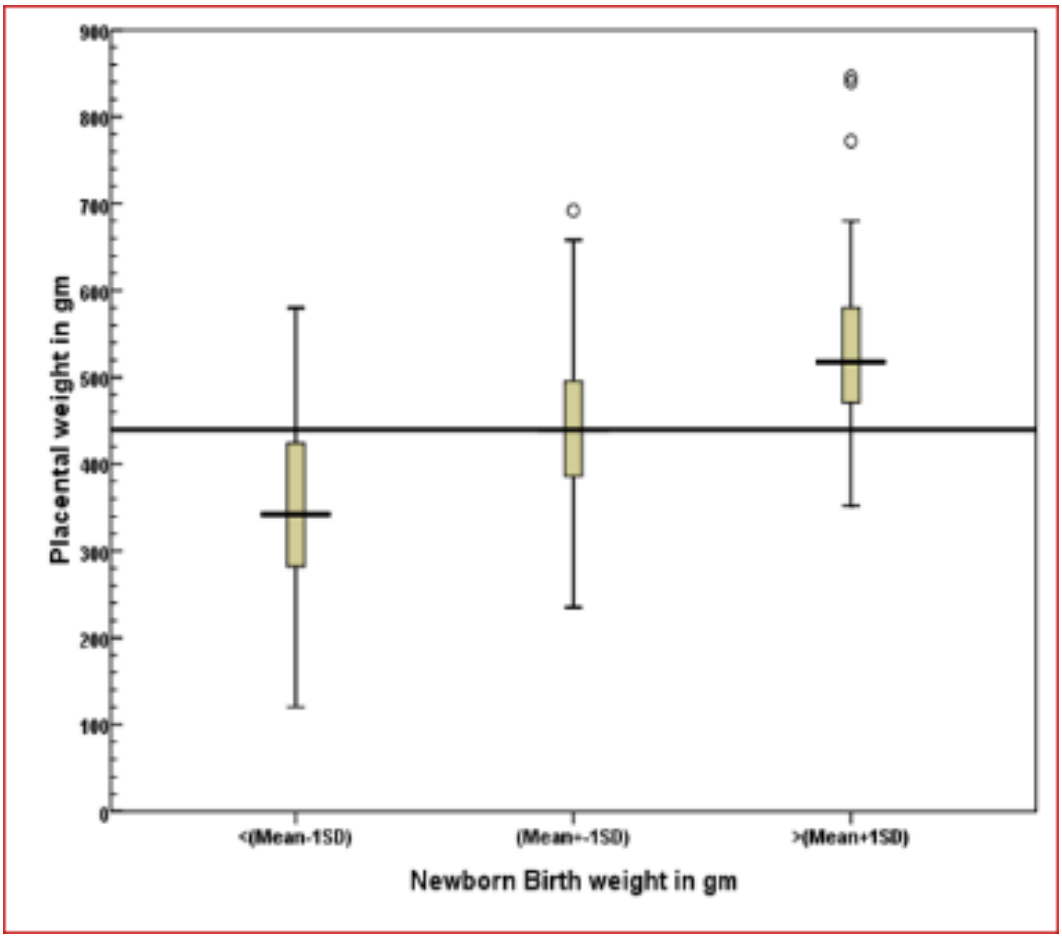

Fig. 1a: Box plots of placental weight by birth weight

Box plots of placental weight in three groups birth weight in Fig. 1-a reveal that the overall median reference line of placental weight was at 440 gm. Placental weight exhibited consistent and linear relation with three groups of birth weight. The median of first group <(Mean-1SD) was at 342gm, lesser than overall median. The median of second group (Mean±1SD) was at 440gm coinciding with overall median. However, this group exhibited normal distribution with median near the mean. The median of third group >(Mean+1SD) was at 518gm, higher than overall median.

DOI: 10.14260/jemds/2015/1362

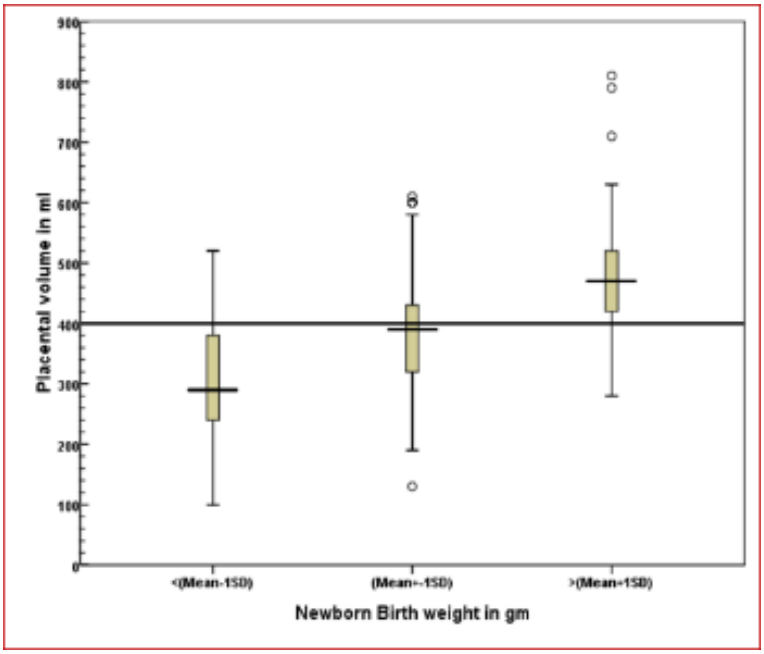

Fig. 1b: Box plots of placental volume by birth weight

Box plots of placental volume in three groups of birth weight in Fig 1-b reveal that the overall median reference line of placental volume was at 400 ml. Placental volume exhibited consistent and linear relation with three increasing groups of birth weight. The median of first group <(mean-1SD) was at 290 ml lesser than overall median. The median of second group (mean±1SD) was at 390 ml lesser than overall median whereas, third group>(mean+1SD) median was at 470 ml, higher than overall median.

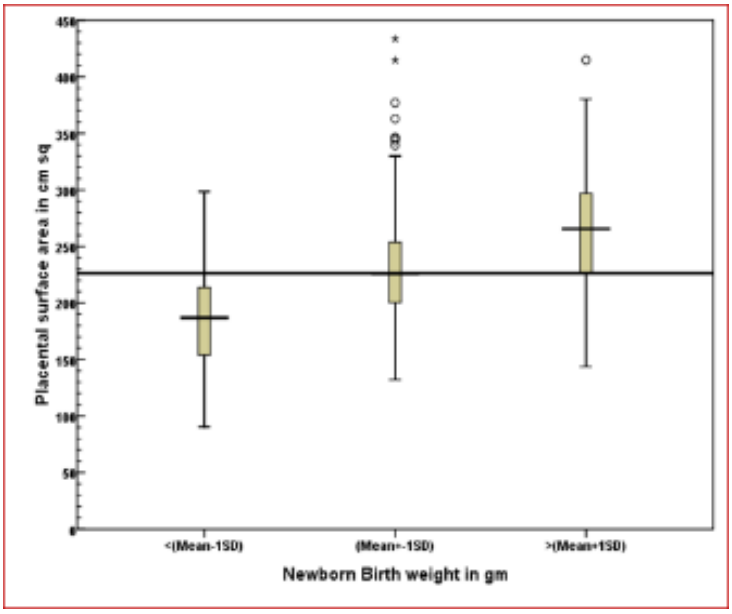

Fig. 1c: Box plots of placental surface area by birth

DOI: 10.14260/jemds/2015/1362

Box plots of placental surface area by birth weight in Fig.1-c reveal that the overall median reference line of placental surface area was at 226 cm sq. Placental surface area exhibited consistent and linear relation with three groups of birth weight. The median of first group <(Mean-1SD) was at 187 cm sq, lesser than overall median. The median of second group (Mean±1SD) was at 226 cm sq coinciding with overall median, however, this group exhibited wide spread distribution of outliers. The median of third group >(Mean+1SD) was at 266 cm sq higher than overall median.

Newborn length groups (Mean=46.6, SD=2.5 cm)	Percent (n=391)	Percentiles						
		5	10	25	50	75	90	95
a. Birth weight in gm								
<(Mean-1SD)	10.49	1100	1200	1372	1800	2000	2940	3100
(Mean±1SD)	79.28	2200	2300	2500	2700	2900	3000	3200
>(Mean+1SD)	10.23	3000	3000	3100	3325	3500	3698	3924
b. Placental weight in gm								
<(Mean-1SD)	10.49	196.5	225.2	261.5	334.0	430.0	511.4	560.9
(Mean±1SD)	79.28	307.2	344.4	388.0	440.0	496.0	560.0	583.5
>(Mean+1SD)	10.23	352.2	386.0	469.3	560.5	585.5	652.1	832.0
c. Placental volume in ml								
<(Mean-1SD)	10.49	102.0	172.0	210.0	290.0	370.0	426.0	479.0
(Mean±1SD)	79.28	260.0	280.0	320.0	400.0	430.0	500.0	520.0
>(Mean+1SD)	10.23	300.5	341.0	420.0	500.0	527.5	607.0	782.0
d. Placental surface area in cmsq								
<(Mean-1SD)	10.49	103.6	121.9	153.6	187.0	207.4	251.1	287.0
(Mean±1SD)	79.28	165.0	176.8	200.4	226.3	253.8	282.9	314.3
>(Mean+1SD)	10.23	177.3	212.3	235.7	267.1	298.5	314.2	329.5
e. Placental thickness in cm								
<(Mean-1SD)	10.49	1.2	1.4	1.5	2.0	2.5	2.5	2.6
(Mean±1SD)	79.28	1.5	1.5	2.0	2.0	2.5	2.6	3.0
>(Mean+1SD)	10.23	1.5	1.5	2.0	2.0	2.5	3.0	3.0

Table 3: Percentiles of birth weight and placental morphometry by newborn length group

Percentiles of birth weight by newborn length in Table 3.a reveal that in the three groups of newborn length, the 5th percentile of the birth weight increased consistently from 1100 to 3000 gm. The similar consistent increasing trends were observed in all percentiles.

Table 3.b reveals that in the three increasing groups of newborn length, 5th percentile of the placental weight increased consistently from 197 to 352 gm. The similar consistent increasing trends were observed in all higher percentiles.

Table 3.c reveals that in the three groups of newborn length 5th percentile of the placental volume increased consistently from 102 to 301 ml, similar consistent increasing trends were observed in all higher percentiles.

Table 3.d reveals that in the three groups of newborn length 5th percentile of the placental surface area increased consistently from 104 to177 cm sq, the similar consistent increasing trends were observed in all higher percentiles.

DOI: 10.14260/jemds/2015/1362

Table 3.e reveals that in the three groups of newborn length placental thickness did not exhibit any consistent relation.

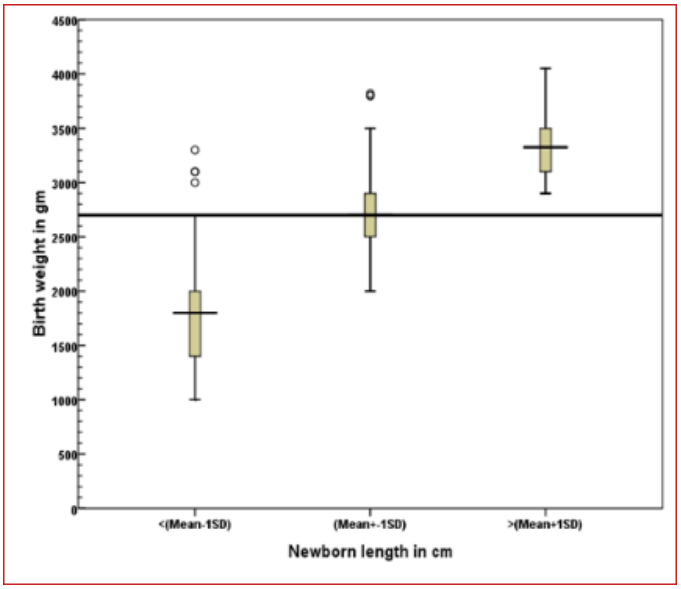

Fig. 2a: Box plots of birth weight by newborn length

Box plots of birth weight by newborn length in Fig 2-a reveal that the overall median reference line of birth weight was at 2700gm. Birth weight increased consistently and linearly with newborn length. The median of first group <(Mean-1SD) was at 1800gm, lesser than overall median. The median of second group (Mean±1SD) was at 2700gm coinciding with overall median, however, this group exhibited normal distribution with median near the mean. The median of third group >(Mean+1SD) was at 3325gm.

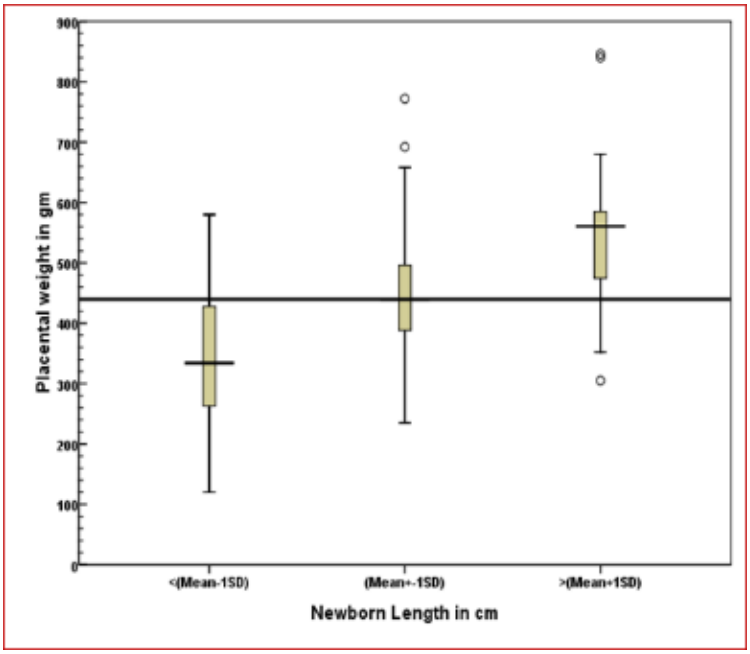

Fig. 2b: Box plots of placental weight by newborn

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Box plots of placental weight by newborn length in Fig. 2-b reveal that overall median reference line of placental weight was at 440gm. Placental weight exhibited consistent and linear relation with three groups of newborn length. The median of first group <(Mean-1SD) was at 334gm, lesser than overall median. The median of second group (Mean±1SD) was at 440gm coinciding with overall median. However, this group exhibited normal distribution with median near the mean. The median of third group >(Mean+1SD) was at 561gm higher than overall median.

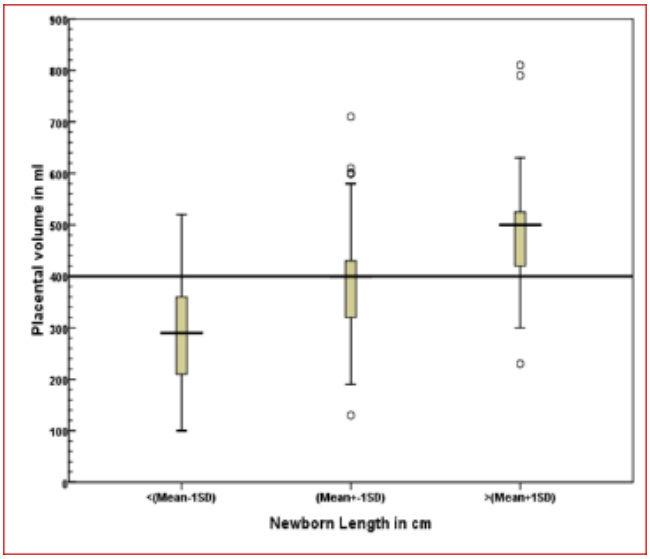

Fig. 2c: Box plots of placental volume by newborn length length

Box plots of placental volume in three groups of newborn length in Fig 2-c, reveal that the overall median reference line of placental volume was at 400ml. Placental volume exhibited consistent and linear relation with three increasing groups of newborn length. The median of first group <(Mean-1SD) was at 290ml, lesser than overall median. The median of second group (mean±1SD) was at 400ml coinciding with overall median. The third group >(Mean+1SD) median was at 500 ml, greater than overall median.

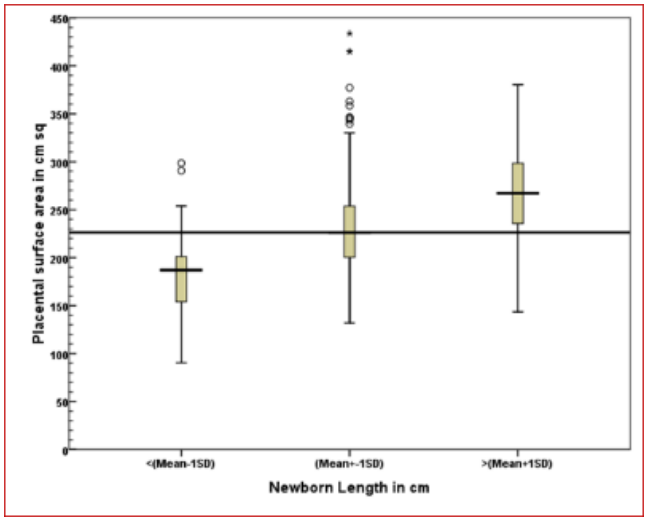

Fig. 2d: Box plots of placental surface area by newborn length

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Box plots of placental surface area by newborn length in Fig. 2-d reveal that the overall median reference line of placental surface area was at 226 cm sq. Placental surface area exhibited consistent and linear relation with three groups of newborn length. The median of first group <(mean-1SD) was at 187 cm sq, lower than the overall median. The median of second group (mean±1SD) was at 226 cm sq coinciding with overall median. However, this group exhibited normal distribution with median near the mean and wide spread distributions of outliers. Third group >(mean+1SD) median was at 267 cm sq higher than the overall median.

Birth weight groups	N	Percent	Mean	SD	SE	95% Confidence Interval	
						Lower	Upper
Placental weight in gm;*; $F_{2,388}$=49.94; p<0.001**							
<(Mean-1SD)	45	11.5	353.2	103.2	15.4	322.2	384.3
(Mean±1SD)	296	75.7	442.8	82.3	4.8	433.4	452.3
>(Mean+1SD)	50	12.8	533.4	103.8	14.7	503.9	562.9
Total	**391**	**100.0**	**440.0**	**100.0**	**5.0**	**434.3**	**453.9**
Placental volume in ml;*;$F_{2,388}$=53.81; p<0.001**							
<(Mean-1SD)	45	11.5	296.1	98.8	14.7	266.4	325.8
(Mean±1SD)	296	75.7	384.2	82.8	4.8	374.7	393.6
>(Mean+1SD)	50	12.8	482.6	105.5	14.9	452.6	512.6
Total	**391**	**100.0**	**384.6**	**101.0**	**5.0**	**376.8**	**396.5**
Placental surface area in cm sq ;*; $F_{2,388}$=38.13; p<0.001**							
<(Mean-1SD)	45	11.5	183.9	42.7	6.4	171.1	196.8
(Mean±1SD)	296	75.7	230.7	45.9	2.7	225.4	235.9
>(Mean+1SD)	50	12.8	266.1	48.8	6.9	252.2	279.9
Total	**391**	**100.0**	**229.8**	**50.1**	**2.5**	**224.9**	**234.8**
Placental thickness in cm;*;$F_{2,388}$=4.12; p<0.05							
<(Mean-1SD)	45	11.5	2.0	0.5	0.1	1.9	2.2
(Mean±1SD)	296	75.7	2.1	0.4	0.0	2.1	2.2
>(Mean+1SD)	50	12.8	2.3	0.8	0.1	2.1	2.5
Total	391	100.0	2.1	0.5	0.0	2.1	2.2

Table 4: Association of placental morphometry with birth weight

Table-4 reveals that placental morphometry: weight, volume and surface area increased consistently and significantly with birth weight (p<0.001), whereas, the increase in placental thickness was significant at p<0.05. The SD of placental weight and volume in lower and upper groups of birth weight were considerably higher as compared to the middle group, indicating association of some placental abnormality with birth weight.

DOI: 10.14260/jemds/2015/1362

Newborn length groups	N	Percent	Mean	SD	SE	95% Confidence Interval	
						Lower Bound	Upper Bound
Birth weight in gm;*;$F_{2,388}$=198.0; p<0.001**							
<(Mean-1SD)	41	10.5	1829	576	90	1647	2011
(Mean±1SD)	310	79.3	2685	312	18	2650	2719
>(Mean+1SD)	40	10.2	3341	270	43	3255	3427
Total	**391**	**100.0**	**2700**	**500**	**25**	**2613**	**2711**
Placental weight in gm;*;$F_{2,388}$=46.7; p<0.001**							
<(Mean-1SD)	41	10.5	348.9	107.8	16.8	314.9	382.9
(Mean±1SD)	310	79.3	444.5	82.0	4.7	435.3	453.7
>(Mean+1SD)	40	10.2	538.7	112.2	17.7	502.8	574.6
Total	**391**	**100.0**	**440.0**	**100.0**	**5.0**	**434.3**	**453.9**
Placental volume in ml;*; $F_{2,388}$=48.1; p<0.001**							
<(Mean-1SD)	41	10.5	291.2	101.3	15.8	259.3	323.2
(Mean±1SD)	310	79.3	386.6	83.7	4.8	377.2	395.9
>(Mean+1SD)	40	10.2	485.0	112.1	17.7	449.1	520.9
Total	**391**	**100.0**	**384.6**	**101.0**	**5.0**	**376.8**	**396.5**
Placental surface area in cm sq ;*; $F_{2,388}$=30.30; p<0.001**							
<(Mean-1SD)	41	10.5	184.5	45.9	7.2	170.0	199.0
(Mean±1SD)	310	79.3	231.4	47.0	2.7	226.1	236.6
>(Mean+1SD)	40	10.2	264.2	45.2	7.1	249.8	278.6
Total	**391**	**100.0**	**229.8**	**50.1**	**2.5**	**224.9**	**234.8**
Placental thickness in cm;*; $F_{2,388}$=3.91; p<0.05							
<(Mean-1SD)	41	10.5	2.0	0.4	0.1	1.8	2.1
(Mean±1SD)	310	79.3	2.1	0.5	0.0	2.1	2.2
>(Mean+1SD)	40	10.2	2.2	0.4	0.1	2.1	2.3
Total	391	100.0	2.1	0.5	0.0	2.1	2.2

Table 5: Association of placental morphometry with length of newborn

Table 5 reveals that birth weight and placental morphometry (weight, volume and surface area) increased consistently and significantly with newborn length (p<0.001) whereas, placental thickness increased significantly with newborn length at p<0.05.

DISCUSSION: The studies from Nigeria,[17] western Europe,[18] Ukraine[19] and Norway[20] reported the mean birth weight of 3275gm, 3382gm, 3425gm and 3588gm respectively. Mean birth weight in case of present study was 2,700gm, lesser than all above mentioned studies, but nearly similar to Mysore Parthenon study[21] as they were from same regional belt of India.

DOI: 10.14260/jemds/2015/1362

Valsamikis et al., (2006) specified the optimal range of birth weight in developed countries as 3000-4000gm to avoid maternal and fetal mortality and morbidity.[5] Sivarao et al., (2002) mentioned the mean and SD of birth weight of Malays, Chinese, and Indian neonates as 3126±300gm, 3245±300gm and 2935±400gm respectively[22]. Mean birth weight in the present study was nearer to that of Indian babies as mentioned in above study.

In the present study birth weight exhibited consistently positive and significant relationship with the following parameters: Placental morphometry: Weight ($p<0.001$), volume ($p<0.001$), surface area ($p<0.001$), thickness ($p<0.05$), newborn Length ($p<0.001$).

The endogenous and extrinsic factors influencing the birth weight were: Maternal factors (Ethnicity, race, stature and genetics), paternal factors (Height and genetic), environmental factors (high altitude and availability of proper nutrition), and physiological factors (Altered glucose metabolism, hemoglobin concentration, micro vascular integrity), pathologic factors (Uterine malformation), complications of pregnancy (Gestational diabetes mellitus, pre-eclampsia) and also the gestational age.[23] Besides these factors, the present study declares the placental weight, volume, and surface area are also significant determinants of birth weight.

The present study exhibited 28.2 percent low birth weight (LBW) babies. Low birth weight has been defined as less than 2500gm. Low birth weight was associated with increased risk of perinatal mortality and those babies who survive are prone to have impaired immune function, reduced muscle strength, and suffer cardiovascular diseases.[24] Hence, birth weight can be used as strong predictor of new born intact survival.

A study from Norway reported the mean newborn length of 50.8cm with SD 2.3.[20] Another Indian study reported the mean newborn length of 47.06 with SD 1.18.[25] Sivarao et al., (2002) observed the mean newborn length from Malays 48.8cm, Chinese 49.5cm and Indians 48.1cm, and concluded that Indian babies were shorter than Malays and Chinese neonates.[22] Lo et al., (2002) found the mean newborn length 48.7 cm, and reported significant positive correlation between the placental weight and newborn length.[26] In the present study, mean newborn length was lower than all above mentioned studies.

Newborn length in the current study showed significant and positive association with birth weight and placental weight, volume, surface area ($p<0.001$) and thickness ($p<0.05$). The positive association between the placental morphometry and newborn length infers that as the placenta grows there is increased rate of exchange of nutrients, providing more nutrition to fetus, thus increasing the newborn length. Fetal growth and development are also determined by genetic constitution of the parents and environmental factors. Length of an infant is also influenced by the genetic make-up of the parents[27]. Apart from these factors, the present study infers that placental weight, volume, and surface area are also significant determinants of newborn length.

CONCLUSION: Percentiles of placental morphometry exhibited consistent increase with increasing groups of newborn birth weight and length. Means of placental morphometry exhibited significant difference with increasing groups of birth weight and newborn length.

LIMITATIONS: Placental morphometry determines birth weight and newborn length. However, the results need further validation in other set ups with large number of subjects.

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