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Placental morphometry in normal and anaemia complicating pregnancy in South Indian Population

Manoj Navamani[1], **Hannahsugirthabai Rajilarajendran**[2]✉, **Siva Govindan**[3], **Maghesh Ramesh**[4], **Indumathi Sundaramurthi**[5], **Jonathan Seshiah**[6]

[1]CRRI, Chettinad Hospital & Research Institute, Chettinad Academy of Research & Education, Chennai-603 103. Orcid id 0000-0003-4968-491X

[2]Professor, Department of Anatomy, Chettinad Hospital & Research Institute, Chettinad Academy of Research & Education, Chennai-603 103

[3]CRRI, Chettinad Hospital & Research Institute, Chettinad Academy of Research & Education, Chennai-603 103

[4]CRRI, Chettinad Hospital & Research Institute, Chettinad Academy of Research & Education, Chennai-603 103

[5]Professor & Head, Department of Anatomy, Chettinad Hospital & Research Institute, Chettinad Academy of Research & Education, Chennai-603 103

[6]CRRI, Chettinad Hospital & Research Institute, Chettinad Academy of Research & Education, Chennai-603 103

✉**Corresponding author**

Professor, Department of Anatomy, Chettinad Hospital & Research Institute, Chettinad Academy of Research & Education, Chennai, India

Email: drrajilarajendran@chettinadhealthcity.com / ashrajsanada@gmail.com

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General Note

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ABSTRACT

Anaemia is one of the most common nutritional deficiencies among Indian woman in reproductive age group. Maternal anaemia not only affects the mother but also the growing fetus. The aim of this study is to compare the anatomical variations in the placenta of the normal pregnant mothers with that of the anaemic mothers. Only a very few literatures are available in this topic. A prospective cohort study was done in 68 placentas collected over a period of 4 weeks, to determine whether the anaemia during pregnancy has any gross morphological effect on the placenta. Of the various parameters studied, the shortest placental diameter was found among the anaemic.

Keywords: Placenta, morphometry, anaemia, pregnancy, cotyledons, APGAR score

1. INTRODUCTION

Anaemia is emerging as a major health burden among Indian women and adolescent girls. According to the National Family Health Survey -4 (NFHS) 2015-16, 50.3%of pregnant women in India are anaemic. Iron deficiency anaemia (IDA) is the commonest among all the causes. The IDA is associated with increased maternal and perinatal morbidity and mortality and also long term adverse effects on the new born (Goonewardene M, 2012). IDA was found to be associated with higher risk of low birth weight and preterm birth (Haider BA, 2013). The fetal growth depends on the maternal nutritional stores, ability of placenta to transport the same to the foetus. The placenta is the most accurate record of the infant's prenatal experience (Benirschke K, 1981). Preeclampsia causes several microscopic and ultra structural placental changes as demonstrated by several studies. Though there are studies correlating the anaemic status of the mother and overall outcome of pregnancy, there are very few articles in literature about the placental changes associated with this condition. The study of placental morphology gives insight about the fetal programming, the process through which fetal malnutrition and consequent small body size at birth leads to lifelong changes in the body's organs and systems in ways that may lead to disease in later life (Harding J, 2001). Toddler psychiatric problems may be associated with variability in the villous membrane thickness of peripheral villi in term placentas (Marius Lahti-Pulkkinen et al., 2018). Reduced placental weight and surface area is associated with the risk of development of hypertension in the foetus at later stages of life (David JP Barker et al., 2010). This study is undertaken to record the hitherto unpublished data on morphological changes in the placenta of anaemic mothers in comparison with the mothers who are not anaemic.

2. MATERIALS AND METHODS

A prospective cohort study of placentae was done at our institution, Chettinad Hospital and Research Institute. It includes placentae obtained from normal vaginal deliveries, elective and emergency Caesarean sections. 68 placentae in total were collected from the department of obstetrics and gynecology, CARE. The severity of anaemia among expectant mothers is judged by the criteria suggested by WHO 1989. According to this a level of haemoglobin below 11gm per dl during pregnancy is an indication of anaemia which has 55.9% prevalence at global level. The placentae were categorised into two groups, namely, a control group-maternal Hb>11g/dl and a study group-maternal Hb<11g/dl. In both cases, the general particulars of the mother was be recorded, with the detailed history taken from the hospital records.The placentae were compared in various aspects such as morphological aspects including their diameter, shape, volume, surface area, number of cotyledons, presence of infarction or haemorrhage on fetal and maternal sides of the placentas, thickness of centre, attachment of umbilical cord on the placenta, the diameter of the umbilical cord, variation in umbilical vessels if any(apart from the usual two umbilical arteries and a single umbilical vein), the weight of the placenta , fetal birth weight, fetoplacental ratio, total period of gestation and in case if the mother is anaemic the gestational period with anaemia, the completion of the placenta, lobe structure, presence of nodules on the fetal side, velamentous vessels if present (whether it is till the end or not), mother's haemoglobin count and the APGAR score taken at 1 min and 5 min after birth.

The various methods by which these parameters were calculated are,

- Volume of the placenta - calculated by Archimedes principle i.e. based on the amount of water it displaces. The best way to measure volume is by displacement studies (Shanklin, 1958).
- Surface area of the placenta - calculated by using the following formula,

$$\text{Surface area} = \varpi \times dl \times ds/4, \text{ (dl: largest diameter, ds: smallest diameter).}$$

- Number of cotyledons - counted on as it is seen on the fetal surface
- Infarction, haemorrhage, attachment of umbilical cord , variation of umbilical vessels , the completeness of lobe structure, nodules are just looked upon
- The umbilical cord diameter and the thickness of the centre of the placenta were scaled in centimetres. Thickness was measured by inserting a fine needle through the centre of the placenta and measured with an accuracy of 0.1 cm.
- Placental diameter: measured by taking as average of the diameter in the three various planes with measuring tape.
- Weight of the placenta: measured up to nearest grams using a weighing machine.
- Fetal birth weight, APGAR score: as measured in the department of obstetrics soon after the birth of the baby.
- Fetoplacental ratio: ratio of fetal birth weight to that of the placenta

INCLUSION CRITERIA

1. Singleton Uncomplicated term pregnancy.
2. Blood pressure <140/90 mm of Hg throughout pregnancy.

EXCLUSION CRITERIA

1. Associated obstetric complications of pregnancy.
2. Associated medical disorders of pregnancy.

Relevant statistical tests of significance were done. Ethical clearance has been obtained.

3. RESULTS AND DISCUSSION

Of the various parameters assessed, the diameter of the placenta is significantly dependent on the mothers anemic status i.e. small placentas are associated with anemic mothers (p=0.047). There is no significant difference in the placental weight, fetal weight (table 1-3 & fig. 1).

Table 1 overall table of all values

	Group				Independent Samples t-test	
	Anaemic (n = 19)		Non – Anaemic (n = 49)			
	Mean	SD	Mean	SD	t-Value	P – Value
Largest Diameter (cm)	16.05	1.22	16.35	1.74	-.673	.503
Shortest Diameter (cm)	12.37	2.45	13.50	1.91	-2.021	.047
Volume (ml)	557.89	121.64	584.69	191.81	-.565	.574
Surface Area (square cm)	155.79	34.15	174.39	38.70	-1.835	.071
Thickness of Centre (cm)	3.03	.84	2.89	1.13	.464	.644
Placenta Weight (gm)	501.95	91.15	518.78	129.59	-.517	.607
Foetal birth weight (kg)	2.89	.55	3.00	.44	-.847	.400
Feto Placental Ratio	5.84	1.13	6.13	1.60	-.725	.471
Total period of Gestation	266.21	17.02	267.43	11.04	-.348	.729
Gestational period with Anaemia (months)	3.37	1.16	.	.		
Umbilical cord diameter (cm)	.99	.19	.98	.20	.286	.776
Haemoglobin count (g/dl)	10.04	.68	12.26	.81	-10.590	.000

APGAR Score(1st min)	8.21	.42	8.06	.43	1.297	.199
APGAR Score (5th min)	8.95	.40	8.94	.38	.083	.934

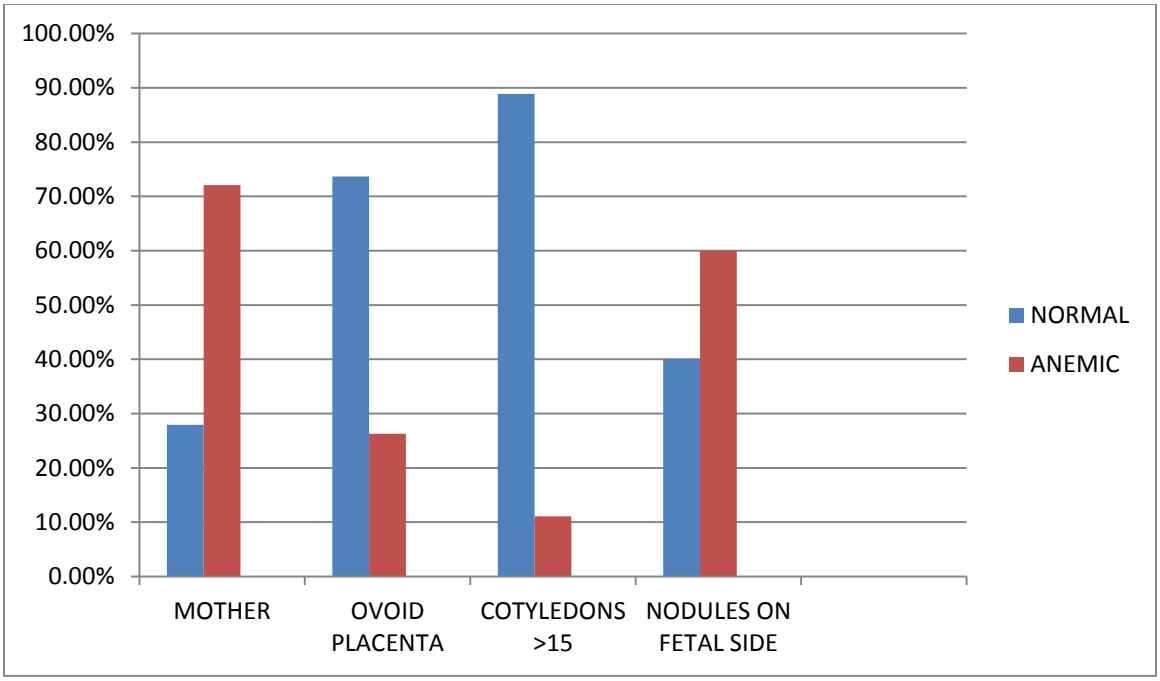

Figure 1 A few comparable data

Table 2 correlation table

		N	Col %
Group	Anaemic	19	27.94
	Non – Anaemic	49	72.06
Shape	Ovoid	57	83.82
	Circular	11	16.18
Number of Cotyledons	Diffuse	40	58.82
	15 or less	19	27.94
	> 15	9	13.24
Infarction/Haemorrhage	Absent	53	77.94
	Hemorrhagic	9	13.24
	Infarct present	2	2.94
	Infarct at centre	1	1.47
	Infarct-margins, haemorrhage -base of stump	1	1.47
	Marginal Infarct	1	1.47
	Multiple small infarcts	1	1.47
Attachment of Umbilical cord	Middle	44	64.71
	Marginal	18	26.47
	Central	5	7.35
	Central and marginal	1	1.47
Completeness	Complete	68	100.00
Lobe Structure	Flat	39	57.35
	Bent on itself	27	39.71

	Bipartite	2	2.94
Nodules on Foetal side	Present	5	7.35
	Absent	63	92.65
Velamentous Vessels (till end or not)	Not till end	32	47.06
	Present till end	3	4.41
	Absent	33	48.53
Variation of Umbilical vessels	1UA & 1UV	1	100.00

The number of cotyledons on an average in anaemic women is thus usually less than 15. Is this parameter actually is because of the anaemia in mother, is yet to be established.

Table 3 significance of each morphological structure

		Group						Mann-Whitney U test	
		Anaemics			Non – Anaemics				
		n	Col %	Row %	N	Col %	Row %	U Value	P – Value
Shape	Ovoid	15	78.95	26.32	42	85.71	73.68	434	.500
	Circular	4	21.05	36.36	7	14.29	63.64		
Number of Cotyledons	Diffuse	10	52.63	25.00	30	61.22	75.00	452	.834
	15 or less	8	42.11	42.11	11	22.45	57.89		
	> 15	1	5.26	11.11	8	16.33	88.89		
Infarction/Haemorrhage	Absent	16	84.21	30.19	37	75.51	69.81	422	.406
	Hemorrhagic	2	10.53	22.22	7	14.29	77.78		
	Infarct present	1	5.26	50.00	1	2.04	50.00		
	Infarct at centre	0	.00	.00	1	2.04	100.00		
	Infarct-margins haemorrhage-base of stump	0	.00	.00	1	2.04	100.00		
	Marginal Infarct	0	.00	.00	1	2.04	100.00		
	Multiple small infarcts	0	.00	.00	1	2.04	100.00		
Attachment of Umbilical cord	Middle	9	47.37	20.45	35	71.43	79.55	349	.059
	Marginal	7	36.84	38.89	11	22.45	61.11		
	Central	3	15.79	60.00	2	4.08	40.00		
	Central and marginal	0	.00	.00	1	2.04	100.00		
Completeness	Complete	19	100.00	27.94	49	100.00	72.06	466	1.000
Lobe Structure	Flat	9	47.37	23.08	30	61.22	76.92	411	.389
	Bent on itself	10	52.63	37.04	17	34.69	62.96		
	Bipartite	0	.00	.00	2	4.08	100.00		
Nodules on Foetal side	Present	3	15.79	60.00	2	4.08	40.00	411	.099
	Absent	16	84.21	25.40	47	95.92	74.60		
Velamentous Vessels (till end or not)	Not till end	10	52.63	31.25	22	44.90	68.75	407	.366
	Present till end	2	10.53	66.67	1	2.04	33.33		
	Absent	7	36.84	21.21	26	53.06	78.79		
Variation of Umbilical vessels	1UA & 1UV	0	.00	.00	1	100.00	100.00	--	--

Variations in structure

The placentae are all complete (no cotyledons are missing). Of those only one of the placenta has shown variation with a single umbilical artery and an umbilical vein, the mother was not anaemic in that case, but the finding has been supported by 1 minute APGAR score of 7/10. Absence of one artery is associated with congenital anomalies of the fetus (Bernischke K et al., 1995), but in this case no congenital anomaly was seen grossly. Lobe structures of the placentae are single lobed 97.06% whereas 2.94% of them were bipartite.

Shape of the placenta

Among anaemic group, 78.15% are ovoid and among non anaemic group, 85.71% are ovoid, remaining discoid in shape. This data is normal as according to previous authors.

Insertion of the cord on the placenta

The cord can get inserted in the centre or at the margins. Of the placentae examined, 73.16% among anaemic and 75.51% among non anaemic have their umbilical cords centrally whereas the remaining percentage have their cord marginally inserted.

Weight, Volume, Surface Area, Thickness of the Placenta

The weight range of all placentae is from 320 to 710 grams in anemic mothers and from 280 to 780 grams in non anemic mothers, which does not convey any significance. The mean volume, surface area and thickness at the centre of the placentae of anemic mothers are comparatively lesser than those of non anemic mothers, suggesting that the mothers, if anemic can end up in producing placentae that are less dense. The smallest and the largest volume are 200 ml and 1000ml respectively both of them being among the non anemic group. The mean surface area of the placenta is minimum among the anemic group (155.79cm^2) and maximum among the non anemic group (174.39cm^2). The thickness of centre of the placentae varied from 1.5 to 4 cm, no variation or significant difference in this aspect between the anemic and non anemic group.

Weight of the fetus

Anaemia is the most frequently encountered complication of pregnancy which is responsible for high incidence of low birth weight babies (Walter M Wolfe et al., 1969). As is the case here, the mean weight of the fetus of anemic mothers is 2.89 kg and that of normal mothers is 3.0 kg. Obviously birth weight or rather the growth of the fetus depends upon the state of oxygen supply it received during its stay within the mother's womb.

Fetoplacental ratio

Among anemic group, mean fetoplacental ratio is 1:5.84 and among non anemic group, mean fetoplacental ratio is 1:6.13. According to Molteni R A (1979) the incidence of perinatal problems increased in those infants whose placental and fetal weight ratio was greater than 1:11

Number of cotyledons

The placentae may have diffuse maternal surface or the cotyledons may be counted (most common). In this study, the cotyledons on the maternal side range from 7-19 among anemic group and 6-22 among non anemic group. Normally the number of maternal cotyledons is 15–30 (Susan Standring, 2005)

Nodules on fetal side

Among anemic group, 15.79% of the placentae show nodules on the fetal side and among non anemic group, only 3.08% have shown nodules on fetal side. No significance has been cited by previous authors on the significance of occurrence of nodules.

Presence of infarcts

Only 1 infarct among anemic group and 2 among non anemic have been come across in this study and their significance has not be studied by previous authors.

4. CONCLUSION

Factors undertaken to accomplish the study were morphological parameters of the placenta between those of normal mothers from anemic mothers. The mean weight of placenta in anemic people was 501g and that of non anemic people was 504g.Among all placenta collected 83.8% were ovoid and the remaining 16.2% were circular. The diameter of the placenta has shown that when the diameter of the placenta was measured and mean was taken the mean shortest diameter was the anemic placenta (12.37cm). The mean of the short diameter of non anemic mother was found to be 13.5 cm. The data differed from the previous authors in the form of lowered incidence of central insertion and increased incidence of marginal insertion. Overall study has revealed that morphologically significant changes in placenta, between anemia complicating pregnancy and normal pregnancy is its diameter and hence its surface area. This is important because larger the surface area of the placenta more are the number of villi and hence maximum diffusion of nutrients can take place. Early stage of fetal development determines the overall run of that individual as a healthy individual. The incidence of Fetal Onset Adult Diseases (FOAD) can be reduced. Thus we conclude that Prevention of anemia in pregnancy determines the health status of a country. This study has been the first of its kind to record the morphometric parameters of placenta in anemia complicating pregnancy.

Conflicts of interest statement

The authors declare none of conflict of interest.

Financial statement

This study did not receive financial support from any resources.

Ethical committee approval code

I IHEC/03/12 May 2015/Desp.no.082/15.6.2015

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