Research Paper

The Association between Maternal Hemoglobin Concentration and Neonatal Birth Weight: A Prospective Observational Study

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INTRODUCTION

Anemia is one of the frequently seen complications reported in pregnancy. According to WHO reports, 15 to 20% of women from developed countries are anemic while 35 to 75% (of pregnant women in resource limited nations[1].

During pregnancy, maternal iron requirement increases by 1 g due to increased fetal demand for iron[2]. Normal physiological changes affect the hemoglobin (Hb) in pregnancy, and there is an absolute or relative reduction in Hb concentration.

During normal pregnancy, red blood cell count rises due to erythroid hyperplasia of the marrow. But, compared to red cell mass, there is a significant rise in intravascular volume leading to dilutional or physiologicanemia of pregnancy. This is mostly seen at 30 to 34 weeks period of gestation. So, anemia is defined as hemoglobin (Hb) < 10 g/dL during pregnancy[3].

The leading causes of anemia in pregnancy are iron and folic acid deficiency. Severe anemia is known to have adverse effects on the mother and the fetus. There are several complications that increase with severe anemia like spontaneous abortions, prematurity, low birth weight, and fetal deaths[4,5].

There are many studies that have reported a significant association between anemia in prenatal period and low birth weight babies. On the other side, very high hemoglobin concentration (>13gm/dl) causes increased viscosity of blood, which results in inadequate delivery of oxygen to tissues. Many studies have also reported an association between increased maternal hemoglobin concentration and an increased incidence of adverse pregnancy outcome[6].

Concentration of 9.5–11.5 g/dL with a normal mean corpuscular volume (MCV) should be considered optimum for growth of fetus. As anemia is regarded as one of the common medical conditions during pregnancy, this association is of significant importance. The objective of present study was to assess the relationship of maternal hemoglobin level in pregnancy with neonatal birth weight.

MATERIALS AND METHODS

This cross-sectional study was conducted at department of Obstetrics and Gynaecology, Pacific Medical College and Hospital, Udaipur, Rajasthan. The study period was 6 months from June 2019 to March 2020.The institute ethic committee approved the study protocol. We included all women giving birth to live neonate and having complete case files. We excluded patients with history of diabetes, multiple pregnancies, hematological disorders in mother, and the obstetric causes of the preterm labour (PTL), including abruption placenta or preterm rupture of membranes as well as pre-eclampsia and infants with gross congenital abnormalities. Informed written consent was taken from all participants before starting the study.

Baseline characteristics were recorded for all enrolled participants

including data related to their age, educational status, and place of residence, previous history of blood transfusion, family history of anemia, the number of previous pregnancies, number of antenatal visits, infant gender, and neonatal outcomes. Birth weight data was collected from case files of the newborns and gestational age (GA) were collected from the case files based on ultrasounds. The required data was obtained from medical records of the subjects and proforma was filled. The Hb measurement was done by Technicon H-1 blood counter. Based on WHO criteria, the Hb was classified into low (<10.5g/dl), normal (10.5-13g/dl), and high (>13 g/dl).

STATISTICAL ANALYSIS

Data were analyzed according to the assigned group (intention to treat analysis-ITT). Normality of data was checked with Kolmogorov-Smirnov Z test. Data were summarized as means with standard deviations (±SD) or medians with interquartile ranges (IQR), or proportions. Continuous data were compared by Student's t-test if normally distributed or Mann-Whitney U test if non-normally distributed. The binary outcome was analyzed with use of the chi-square test (Fisher's exact test if cell frequencies were small). A two-sided p-value of 0.05 was considered as statistically significant. IBM PASW statistics (SPSS)-version 20.0 software (SPSS Inc. Chicago, Illinois) and Epi Info ™ 7 (7.0.9.7, CDC) was used for data analysis.

RESULTS

We recruited a total of 405 pregnant women in this study. The mean age of the women was 26 years. Table 1 describes the demographic variables of the women. The mean birth weight of the newborns in our study was 2980 g (birth weight range: 2100-4700g). 21 (5.5%) of the neonates had low birth weight, while 353 (92.2%) newborns had the birth weight between 2500-4000 g; 9 (2.3%) cases had the birth weight of more than 4000 g.

The Hemoglobin categories of the subjects are shown in Table 2. The frequency of anemia in pregnant women increased from first to third trimester. The Mean Hb of the subjects was also lowest in the third trimester.

Table 1 Demographic Variables of Subjects

Variable		Frequency	Percentage
Place of residence	Urban	130	32%
	Rural	275	68%
Level of education	Illiterate	35	8.6%
	High school	265	65.4%
	Graduate	105	26%
Economic status	Good	112	27.6%
	Moderate	204	50.4%
	Poor	89	22%
Neonate gender	Male	230	56.8%
	Female	175	43.2%
Birth weight	<2.5 kg	21	5.5%
	2.5- 4 kg	353	92.2%
	>4 kg	9	2.3%

Table 2 Hb Categories in each Trimester

Hemoglobin	1st Trimester Frequency	2nd Trimester Frequency	3rd Trimester Frequency
<10	112 (28%)	167 (41%)	203 (50%)
10-13	241 (59%)	204 (50%)	173 (43%)
>13	52 (13%)	34 (9%)	29 (7%)

Table 3 Relationship between Hb Categories and Birth Weight Categories in each Trimester

		Birth Weight		
Hemoglobin		<2.5 kg	>4 kg	>4 kg
1st Trimester	<10.5	81 (20%)	316 (78%)	8 (2%)
	10.5-13	28 (7%)	364 (90%)	12 (3%)
	>13	16 (4%)	373 (92%)	16 (4%)
2nd Trimester	<10.5	73 (18%)	320 (79%)	12 (3%)
	10.5-13	20 (5%)	38 (94%)	4 (1%)
	>13	8 (2%)	397 (98%)	0 (0%)
3rd Trimester	<10.5	81 (20%)	324 (80%)	0 (0%)
	10.5-13	8 (2%)	385 (95%)	12 (3%)
	>13	4 (1%)	60 (15%)	0(%)

Table 4 Relationship between Period of Gestation at Birth Categories and Hb Categories

		Period of Gestation at Birth		
Time	Hb	<37 weeks	37-40 weeks	>40 weeks
1st Trimester	<10.5	97 (24%)	303 (75%)	4 (1%)
	10.5-13	53 (13%)	316 (78%)	36 (9%)
	>13	16 (4%)	324 (80%)	65 (16%)
2nd Trimester	<10.5	138 (34%)	211 (52%)	56 (14%)
	10.5-13	32 (8%)	316 (78%)	57 (14%)
	>13	32 (8%)	369 (91%)	4 (1%)
3rd Trimester	<10.5	133 (33%)	202 (50%)	69 (17%)
	10.5-13	20 (5%)	332 (82%)	53 (13%)
	>13	4 (1%)	401 (99%)	0 (0%)

The mean GA of the subjects was 37 weeks (minimum GA: 30 weeks, maximum GA: 42 weeks). The PTL was observed in 38 (9.9%) subjects while term, and post-term pregnancies were observed in 296 (77.3%), and 49 (12.8%) subjects, respectively.

There was a significant relation between birth weight with the HCT and Hb levels in each trimesters (P<0.001) as per Chi square test. The association between the gestational age at birth with the Hb levels in pregnancy was also significant (P<0.01).

DISCUSSION

Maternal anemia is associated with sub-optimum outcome in pregnancy due to lower birth weight and preterm delivery[7,8].

As anemia is considered to be one of the common medical conditions during pregnancy, this association is of significant importance. Birth weight is the one of the most reliable determinant of mortality in the first year of life, and has therefore a strong claim to being a good indicator of the efficiency with which a woman has supported her fetus[9].

Our study has shown the striking association of birth weight withhemoglobin concentration. Our study reported the prevalence of anemia in 17.8% subjects. Anemia (Hb, 10 g/dl) was significantly associated with increased frequency of low birth weight (<2500 g).

Low birth weight is seen both in increased maternal Hb (>13 gm%) and maternal anemia (<9 gm %). Optimum hemoglobin concentration seems to be from 9 to 11 g/dl. Steer and colleagues [10,11] studied a large population of around

1,50,000 pregnancies and reported that the lower hemoglobin concentration during pregnancy (8.5–10.5 g/dL) is associated with maximum mean birth weight and the lowest incidences of LBW and preterm delivery. Malhotra, et al., for example, observed that the mean birth weight was highest in babies with maternal haemoglobin concentration between 9.6 and 10.5 gm% [12, 13]. It has been suggested that high levels of hemoglobin or serum ferritin reflect a failure in adequate plasma volume expansion or increased blood viscosity as a result of macrocytosis which would impair uteroplacental blood flow. This, in turn, might adversely affect fetal growth. Like this Chang et al also reported an increased incidence of LBW and preterm birth in association with either a high maternal hemoglobin concentration or high hematocrit[14].

The statistical analysis of this study shows that both high and low Hb Concentration are associated with adverse effect on birth weight. Several studies have reported that LBW babies are at higher risk of sepsis, hypothermia, hypoglycemia, asphyxia, and feeding problems, etc. in these neonates.

CONCLUSION

Optimum maternal Hb Concentration should be considered between 10-13 gm% for fetal growth and well-being and also associated with the lower incidence of low birth weight.

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