

FOETAL OXYGENATION IN NORMAL AND ABNORMAL OBSTETRIC CASES

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Foetal oxygenation in 330 normal and abnormal obstetric cases was studied. It was observed that duration of labour appeared to have no significant influence on the mechanism of foetal oxygenation. The amount of foetal haemoglobin was related to the maternal age. The maximum amount of haemoglobin has been recorded in those foetuses belonging to mothers aged 20 to 24 yrs. High values of oxygen content and percentage saturation of oxygen were found in the age groups which correspond to lowest perinatal mortality. Anaemia forms a major group of abnormal deliveries in Hyderabad. In these cases there was a significant compensatory response to the existing hypoxia. This response seems to be directly related to the degree of anaemia. In cases of toxæmia of pregnancy, the oxygen carrying capacity, haemoglobin and red blood corpuscle count were increased, together with a fall in oxygen content and percentage saturation of oxygen. This compensatory response to foetal ischaemia was directly related to the severity of disease.

The present work was taken up on the basis that hypoxia was an important cause of perinatal mortality, therefore, during this work the authors have directed their attention on (i) the measurement of oxygen and carbon dioxide in umbilical vessels, (ii) the assessment of the effects of various maternal factors on the foetus, e.g., age of the mother, parity, duration of pregnancy, anaemia, toxæmia of pregnancy and duration of labour, (iii) correlation of the clinical signs of foetal distress (such as meconium-stained liquor and irregularity of foetal heart) with the biochemical and haematological data of foetal cord blood.

Wattes (1951) observed that oxygen in the arterial blood of new born infants was within normal limits in uncomplicated cases, but was lower in infants delivered after major obstetrical manoeuvres and was associated with high incidence of clinical asphyxia. Walker (1953) studied the oxygen levels in human cord blood and showed that foetus at term was adequately oxygenated and normal labour did not embarrass foetal oxygenation, as there was adequate reserve (i.e., 5-6 vol. per cent) but in abnormal conditions, e.g., pre-eclamptic toxæmia etc., the already low oxygen supply was not adequately compensated by the rise in oxygen capacity and thus foetal distress

occured even during normal labour. He observed that the normal haemoglobin was 14.8 g/100 ml and erythrocyte count was about 4 million/cmm. Clemetson (1953) analysed the oxygen saturation of umbilical vessels in normal pregnancy and in toxæmia of pregnancy. The average normal oxygen saturation was 63.2 per cent in umbilical vein and 31.5 per cent in artery, whereas in pre-eclamptic toxæmia it was 62.3 per cent in vein and 16.1 per cent in artery. Walker (1954) studied the foetal anoxia and showed that oxygen supply fell gradually upto 40th week, but rapidly thereafter, thus explaining rising foetal mortality, especially in primigravidae.

Mackay (1957) observed the oxygenation of foetus in normal pregnancy and toxæmia of pregnancy and showed the arterio-venous difference in oxygen percentage saturation about 30-35 per cent. Though more or less same results were obtained in toxæmia of pregnancy, there was reduction in oxygen reserve with a rise in haemoglobin level. Low (1959) studied the mechanism of foetal oxygenation in the normal obstetric patients. The mean levels obtained were oxygen capacity 20.77 vol per cent, the oxygen content in umbilical vein 12.82 vol per cent, oxygen saturation 62.18 per cent. The umbilical arterial oxygen content was 5.32 vol per cent and oxygen saturation 25.78 vol per cent. The tissue oxygen uptake was estimated to be 7.34 vol per cent and coefficient of oxygen utilisation, 57.74 per cent. He also observed the relationship between the duration of labour and delivery and mechanism of foetal oxygenation in new born infants and showed evidence that the duration of labour, proper use of analgesia, anaesthesia, method of delivery and infant's weight did not significantly affect the foetal oxygenation. No association was evident between the appearance of meconium during labour and foetal hypoxia at delivery. There was no relationship between the foetal oxygenation at delivery and the time required for the spontaneous onset of respiration.

METHOD

The loop technique was adopted, i. e., isolation of about 20-30 cm loop of umbilical cord by clamping at two points after rapid delivery of foetus and before the commencement of foetal respiration or cry. But it was found difficult to obtain the required amount of blood; therefore, later on, only the foetal side of the umbilical cord was clamped and adequate quantity of blood was collected from vein and artery by separate syringes under liquid paraffin in oxalated test tube. No difference in the readings was noted between the two methods of collecting the blood. The estimation of haemoglobin was done by using the Leitz's electric photometer and the erythrocytes count, by the haemocytometer. The oxygen content, capacity and percentage

saturation were analysed by Van Slyke and Neill volumetric technique (Van Slyke and Neill 1924).

Three hundred and thirty cases were studied, of which in 180 cases all the data were obtained but in the other 150 haematological data only were recorded. Nearly 100 cases were of normal spontaneous vertex delivery, 16 were of toxæmia of pregnancy, 12 cases belonged to miscellaneous group and the remaining 203 were of anaemias which were further sub-divided into three groups viz., (i) severe anaemia (42 cases, haemoglobin 50 per cent or less), (ii) moderate anaemia (145 cases, haemoglobin 50-70 per cent), and (iii) mild anaemia (16 cases, haemoglobin 70 per cent or above).

The effect of different factors such as maternal age, parity, duration of labour, anaemia and toxæmia etc., on foetal oxygenation was studied.

RESULTS

The normal average haematological and biochemical values of the foetal cord blood is given in Table I.

TABLE I

Normal average haematological values of the foetal cord blood

Cases	M. Hb. percent	F. Hb g%	F. Wt lbs	F.RBC millions /cmm	O ₂ Content vol%		CO ₂ Content vol%		Ox ygen Capacity vol%	Percentage of O ₂ Saturation	
					UmV	UmA	UmV	UmA		UmV	UmA
100	65-80	16.1	5-8	4.2	14.4	11.4	39.4	47.9	21.9	62.8	53.3

From Table II it will be found that there is no significant difference in the reading between the two groups, specially as far as the carrying capacity of O₂ was concerned. It showed that duration of labour *per se* did not interfere with the foetal oxygenation.

TABLE II

Effects of duration of labour on foetal oxygenation

Group	Duration hours	Foetal Hb g%	F RBC millions /cmm	O ₂ Content vol%		CO ₂ Content vol%		Oxygen Capacity vol%	Percentage of O ₂ Saturation	
				UmV	UmA	UmV	UmA		UmV	UmA
I	0-12	16.15	4.35	15.1	12.4	40.8	51.3	22.1	61.7	56.8
II	12-24	16.5	4.5	16.1	12.4	41.5	47.9	22.1	73.5	58.7

Table III showed increasing carrying capacity of oxygen with advancing maternal age, with a corresponding fall in oxygen content & oxygen saturation. Highest value of oxygen content and percentage saturation of oxygen appeared to be

in the second group (i e. between the age of 20-24) showing that the foetal oxygenation was best in that group which coincided with the lowest rate of perinatal mortality. There was gradual increase of the foetal haemoglobin with the severity of the anaemia.

TABLE III

Relation of the maternal age with biochemical and haematological values of foetal cord blood

Group	Age mother	F. Hb. g%	F. RBC millions /cmm	O ₂ Content vol%		CO ₂ Content vol%		Oxygen Capacity vol%	Percentage of O ₂ Saturation	
				UmV	UmA	UmV	UmA		UmV	UmA
I	16-19	15.9	4.4	10.2	7.9	38.6	39.6	21.7	56.2	35.9
II	20-24	17.09	4.6	15.0	9.7	41.5	47.4	22.8	67.2	61.8
III	25-29	17.3	4.8	14.5	9.2	36.5	52.8	23.1	58.4	43.4
IV	30-34	18.02	4.9	12.2	8.1	40.2	50.1	24.1	59.6	33.5
V	35-39	19.25	4.9	12.2	8.1	40.2	50.1	25.7	47.4	31.5

There was a gradual rise in the carrying capacity of oxygen with increasing severity anaemia, associated with marked reduction in the oxygen content and percentage saturation of oxygen as shown in the Table IV. The foetal erythrocytes were increased with severity of anaemia.

TABLE IV

The relation of different graded groups of anaemia of Pregnancy

Type	M. Hb. per cent	F. Hb. g%	F. RBC. millions mmc/	O ₂ Content vol%		CO ₂ Content vol%		O ₂ Capacity vol%	Percentage of O ₂ Saturation	
				UmV	UmA	UmV	UmA		Um V	Um A
Mild	70 & above	16.2	4.1	18.7	12.09	46.8	51.1	21.9	79.2	51.1
Moderate	70-50	16.48	4.34	15.2	12.2	45.6	52.7	22.3	67.3	54.8
Severe	50 and below	17.3	4.9	12.1	8.1	40.8	46.3	23.5	46.2	35.0

The relation between pre-eclamptic toxæmia and eclamptic toxæmia of pregnancy is given in Table V. The compensatory response to existing hypoxia was more in the cases of severe pre-eclamptic toxæmia when compared to mild and eclamptic type of toxæmia. The high CO₂ content showed the co-existing asphyxia which was increasing became more and more with severity of disease.

TABLE V

Relation between pre-eclamptic toxæmia and eclamptic toxæmia of pregnancy

Type	F. H. g%	F. RBC million /cmm.	O ₂ content vol%		CO ₂ content vol %		Oxygen capacity vol %	Percentage of O ₂ saturation	
			UmV	UmA	UmV	UmA		UmV	UmA
Mild pre-eclamptic toxæmia	17.5	4.7	11.2	4.9	36.04	41.8	23.4	47.4	31.9
Severe pre-eclamptic toxæmia	18.7	4.9	12.8	9.6	41.1	46.2	24.1	52.1	38.4
Eclamptic toxæmia	15.6	..	2.4	2.1	48.8	...	20.9	11.4	6.7

The compensatory response to existing hypoxia was more in case of severe preeclamptic toxæmia when compared to mild and eclamptic type of toxæmia. The high CO₂ content showed the co-existing asphyxia, which was increasing gradually with the severity of disease.

DISCUSSION

The above observations would suggest that although the mechanism of foetal oxygenation is unstable, it is not affected by the events of labour and delivery. It appears that so long as the oxygen content is maintained there is no rise in haemoglobin content. Once oxygen level falls below this level there is an attempt to maintain the oxygen level by raising the foetal haemoglobin and thus increasing the oxygen capacity. In spite of this, the oxygen content and percentage saturation of oxygen fall. Therefore, in anoxic conditions of anaemia and toxæmia during pregnancy and labour, the foetus attempts to overcome the reduced oxygen by producing more foetal haemoglobin. This is one of the adaptation mechanisms in the foetus to ensure homeostasis of oxygen content of blood. It is interesting to note that foetal haemoglobin and oxygen levels are related to the maternal age.

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