

## Effect of Faeto-Maternal Factors on Haematological Parameters of Cord Blood

Dr. Ritushri Samantaray<sup>1</sup>, Dr. Bipin Bihari Pradhan<sup>2</sup>

<sup>1</sup>(Assistant Professor, Department of Physiology, M.K.C.G. Medical College, Berhampur, Odisha, India)

<sup>2</sup>(Professor and Head, Department of Physiology, M.K.C.G. Medical College, Berhampur, Odisha, India)

---

**Abstract:** The haematological parameters of newborn are amenable to certain changes under the influences of fetal, maternal & environmental factors. Here we analyse the effect of diverse fetal & maternal factors on haematological parameters of cord blood. A prospective study was undertaken for a period of 2 years. Different haematological parameters like Hb, TRBCs, TLC, PCV, TPC, MCV, MCHC, MCH, Reticulocyte count & nucleated red blood cell count were evaluated from 300 samples of cord blood. Cord bloods from babies delivered by NVD, at term & with birth weight of  $\geq 2.5$ kg were taken as control group. Then the effect of factors like sex, parity, birth weight, gestational age, mode of delivery & maternal haemoglobin on haematological parameters of cord blood were evaluated. Hb concentration, TRBC & PCV were having significant lower trend in case of female sex, multipara, ECS group & in preterm neonates. Higher MCH & MCHC values were observed in ECS group compared to NVD. High MCV values were observed in small for date, Preterm babies & early parity. Significant higher reticulocyte count & NRBC were observed in preterm & in ECS cases. Higher TLC was seen in preterm, SFD, NVD babies & early parity. Preterm showed significant lower TPC. This study showed that neonates are born with fairly constant haematological parameter with few variable parameters those affected by diverse fetal & maternal factors.

**Keywords:** Cord blood, Fetal, Haematological, Maternal, Parameters.

---

### I. Introduction

The study of the haematology of neonate has become the subject of cardinal concern, since the morphology of the blood of the newborn differs in many respects from that of the adult. In contrast to the adult, the foetal and neonatal haematopoiesis is a constantly changing process due to a number of physiological circumstances resulting in wide alteration in the haematological values. The haematological system of the newborn is amenable to certain changes under the influences of fetal, maternal and environmental factors. The latter constitute the geographic location of the place of study and race while the maternal factors include different socioeconomic status, nutritional status, parity, modes of delivery & complications during the pregnancy and labour. Fetal factors include sex of baby, gestational age and birth weight. Other factors which also appear to have a bearing are the time of clamping of the cord and the source and time of collection of blood sample itself. Despite the advances in perinatology over the past years, the exact influence of perinatal factors on haematological values in cord blood is still unclear. However inadequate data are available regarding the influence of perinatal factors on values in cord blood in normal pregnancy with uncomplicated labour<sup>[1]</sup>. In view of the conflicting reports on different haematological parameters of cord blood and its association with various factors the present work is undertaken to explore the influence of foetal & maternal factors on them.

### II. Materials And Methods

The prospective, non-interventional study, undertaken in the Department of Physiology with the help of Department of Obstretic & Gynaecology of MKCG Medical College & Hospital, Berhampur, Orissa for a period of 2 years. The cord blood samples were collected from the labor room and operation theater of the Department of Obstretic & Gynaecology, M.K.C.G. Medical College & Hospital, Berhampur. Informed consent was obtained from the parents. The study was approved by the Ethical Committee of the M.K.C.G. Medical College & Hospital, Berhampur. Statistical analysis was also carried out. The selection of cases and procedures adopted in this study are detailed below.

#### Selection of cases:

Cord blood samples from all new born babies born either by elective Cesarean section (ECS) or Normal vaginal delivery (NVD) having different ranges of birth weights and gestational ages were taken as cases for the purpose of study. The babies were categorized in to three categories according to their gestational age and birth weight as per the WHO criteria as mentioned below:

- i. Full term babies (Gestational age between 37wks – 41wks) with birth weight 2.5 kg or more of either sex.
- ii. Small for date newborns(SFD) (Normal gestational age of 37 to 41 weeks but birth weight of less than 2.5 kg)
- iii. Preterm newborns (Gestational age of less than 37 weeks and birth weight of less than 2.5 kg)

Total number of 300 cases were taken in this study. The study comprised of 182 full term babies with birth weight 2.5 kg or more, 68 preterm babies and 50 SFD infants, born by NVD and ECS. Cord blood samples of 106 babies delivered by NVD at term with birth weight of 2.5 kg or more forms the control group.

Only 108 cases of ECS group were included (excluding the cesarean section with labor) in the study to avoid the effects prolonged labor, that will have influence on the parameters of the cord blood.

Control group of 106 cases were also taken as the study group for comparison of influence of various factors like (i) sex of baby, (ii) parity, (iii) maternal haemoglobin status. Cord blood samples from ECS deliveries or from cases of preterm or small for gestational age were excluded from the study for the above factors. Similarly 192 samples of cord blood from babies delivered by NVD were included to detect the influence of gestational age and birth weight and samples from term babies with normal birth weight born by NVD(106 cases) or ECS(76 cases) were included to study the effect of mode of delivery.

**Exclusion criteria:**

Newborns with any gross congenital anomaly, Rh incompatibility, respiratory distress, septicemia, metabolic disturbances, herido-familial haematological disorders of newborn, mothers with any endocrinological and haematological disorders, maternal history of drug abuse, evidence of any maternal systemic illness or maternal infection, maternal hypertension, prolonged rupture of membrane, meconium stained amniotic fluid or meconium aspiration, evidence of foetal distress, need for resuscitation at birth or clinically suspected sepsis at birth were excluded from study. Also excluded were those whose mothers were in labor before cesarean section. The clinical informations collected from each case included maternal age, maternal Hb status, parity, past obstetric history, gestational age, mode of delivery, sex of the baby and birth weight. The weighing machine of the labor room was checked with known weights. The count, nucleated red blood cell count and peripheral smear study were done in Post Graduate Research Lab. of the Department of Physiology.

**III. Observation**

**Table 1: Haematological Parameters of Cord Blood In Control Group According To Sex**

Parameters	Hb in Gm%	TRBC X 10 <sup>6</sup> /cmm	PCV in%	MCV in fl	MCH in pg	MCHC in %	RETI in%	NRBC / 100 WBCs	TPC X 10 <sup>5</sup> / cmm	TLC X 10 <sup>7</sup> / cmm	
<b>M-49</b>	MEAN	15.7	5.04	53.1	105	31.49	30	6.47	3.88	3.51	22.1
	SD	±1.65	±0.67	±7.2	±6.1	±2.84	±2.82	±1.66	±1.18	±5	±3.59
<b>F-57</b>	MEAN	15.1	4.9	52.1	106	31.05	29.3	6.37	4	3.34	22.2
	SD	±1.64	±0.54	±6.37	±4.6	±2.49	±2.85	±1.72	±1.25	±5.3	±2.84
	<b>z VALUE</b>	1.87	1.17	0.75	0.94	0.84	1.27	0.3	0.51	0.17	0.16
	<b>p VALUE</b>	<0.05*	<0.05*	<0.05*	<0.05*	<0.05*	>0.1	>0.1	>0.05	>0.1	

\* Significant

**Table 2: Variations In The Haematological Parameters According To Parity Of The Control Cases**

Parameters	Hb in Gm%	TRBC X 10 <sup>6</sup> /cmm	PCV in%	MCV in fl	MCH in pg	MCHC in %	RETI in%	NRBC / 100 WBCs	TPC X 10 <sup>5</sup> / cmm	TLC X 10 <sup>7</sup> / cmm	
<b>P1(40)</b>	MEAN	15.88	5.23	55.2	107	31	29.1	6.38	4.38	3.45	24.1
	SD	±1.7	±0.57	±6.42	±3.71	±2.33	±2.59	±1.53	±1.29	±5.63	±2.43
<b>P2(31)</b>	MEAN	15.67	5.01	53.2	106	30.6	28.8	6.39	3.71	3.48	22.3
	SD	±1.7	±0.55	±5.33	±4.95	±6.21	±6.04	±1.76	±1.07	±5.52	±2.71
<b>P3(25)</b>	MEAN	14.74	4.82	50.6	105	31	29.6	6.56	3.68	3.31	20.4
	SD	±1.3	±0.47	±5.09	±3.44	±3.4	±3.43	±1.78	±1.14	±4.7	±2.74
<b>P4(10)</b>	MEAN	13.68	4.11	42.2	103	31.6	30.8	6.3	3.6	3.31	18.5
	SD	±0.9	±0.21	±2.69	±3.33	±2.33	±2.15	±2	±1.17	±3.23	±2.78

**Table 3: p Values For Different Parity Groups**

	P1 – P2		P1 – P3		P1 – P4		P2 – P3		P2 – P4		P3 – P4	
	z VALUE	p VALUE	t VALUE	p VALUE								
Hb	0.51	>0.1	2.92	<0.01*	4	<0.001*	2.28	<0.05*	3.57	<0.001*	2.43	<0.05*
TRBC	1.65	<0.1	2.98	<0.01*	8.42	<0.001*	1.35	>0.1	5.07	<0.001*	1.02	>0.1
PCV	1.43	>0.1	3.53	<0.001*	9.12	<0.001*	1.88	>0.05	6.32	<0.001*	1.14	>0.1
MCV	0.94	>0.1	2.23	<0.05*	4.6	<0.001*	1.29	>0.1	2.25	<0.05*	0.15	>0.1
MCH	0.34	>0.1	0.08	>0.1	1.11	>0.1	0.82	>0.1	0.06	>0.1	0.13	>0.1
MCHC	0.26	>0.1	0.6	>0.1	2.6	<0.02*	0.31	>0.1	1	>0.1	0.3	>0.1
RETI	0.03	>0.1	0.4	>0.1	0.18	>0.1	0.4	>0.1	0.13	>0.1	0.23	>0.1
NRBC	2.39	<0.02*	2.2	<0.05*	2.39	<0.05*	0.1	>0.1	0.28	>0.1	0.12	>0.1
TPC	0.02	>0.1	1.04	>0.1	1.05	>0.1	1.21	>0.1	0.93	>0.1	0.003	>0.1
TLC	2.9	<0.01*	5.72	<0.001*	8.86	<0.001*	2.67	<0.01*	3.96	<0.001*	0.63	>0.1

\* Significant

**Table 4: Haematological Parameters Of Cord Blood Of Term Babies In Relation To Mode Of Delivery**

	Parameters	Hb in Gm%	TRBC X 10 <sup>6</sup> /cmm	PCV in %	MCV in fl	MCH in pg	MCHC in %	RETI in %	NRBC / 100 WBCs	TPC X 10 <sup>5</sup> / cmm	TLC X 10 <sup>3</sup> / cmm
		NVD	MEAN	15.34	4.97	52.6	106	30.9	29.3	6.42	3.94
	SD	±1.67	±0.65	±6.75	±4.18	±4.03	±4.04	±1.68	±1.22	±5.2	±3.19
ECS	MEAN	14.2	4.24	44.6	105	33.9	32.4	9.03	5.32	2.46	17.5
	SD	±0.71	±0.47	±5.27	±3.36	±4.34	±4.38	±1.91	±2.16	±4.75	±3.03
	z VALUE	6.33	8.9	8.97	1.78	4.74	7.62	4.66	5.5	1.29	10.09
	p VALUE	< 0.01*	< 0.01*	> 0.01	> 0.05	< 0.001*	< 0.001*	< 0.001*	< 0.001*	> 0.05	< 0.001*

\*Significant

**Table 5: Interrelationship Between Maternal Haemoglobin Status With That Of Cord Blood**

	Maternal Hb in gm%
Cord Hb < 14 gm%	9.18 ± 1.02
Cord Hb > 14 gm%	12 ± 1.17

**Table 6: Haematological Parameters Of Cord Blood In Relation To Gestational Age**

Parameters		Hb in Gm%	TRBC X 10 <sup>6</sup> /cmm	PCV in %	MCV in fl	MCH in pg	MCHC in %	RETI in %	NRBC / 100 WBCs	TPC X 10 <sup>5</sup> / cmm	TLC X 10 <sup>3</sup> / cmm
		TERM	MEAN	15.34	4.97	52.6	106	30.9	29.3	6.42	3.94
	SD	±1.67	±0.65	±6.75	±4.18	±4.03	±4.04	±1.68	±1.22	±5.2	±3.19
PRETERM	MEAN	13.8	4.27	47.1	110	32.4	29.5	9.03	6.11	2.22	23.7
	SD	±1.6	±0.65	±6.98	±2.09	±7.57	±6.93	±1.92	±1.8	±1.71	±3.91
	z VALUE	5.03	5.73	4.2	7.5	1.16	0.17	7.4	6.8	2.08	2.1
	p VALUE	<0.001*	<0.001*	<0.001*	<0.001*	>0.5	>0.5	<0.001*	<0.001*	<0.05*	<0.05*

\*Significant

**Table 7: Haematological Parameters Of Cord Blood In Relation To Birth Weight**

		Hb in Gm%	TRBC X 10 <sup>6</sup> /cmm	PCV in %	MCV in fl	MCH in pg	MCHC in %	RETI in %	NRBC / 100 WBCs	TPC X 10 <sup>5</sup> / cmm	TLC X 10 <sup>3</sup> / cmm
		TERM	MEAN	15.34	4.97	52.6	106	30.9	29.3	6.42	3.94
	SD	±1.67	±0.65	±6.75	±4.18	±4.03	±4.04	±1.68	±1.22	±5.2	±3.19
SFD	MEAN	16.4	5.2	55.8	108	31.3	29.2	7.06	4.9	2.45	23.6
	SD	±1.4	±0.61	±6.6	±3.84	±2.45	±2.43	±2.44	±2.13	±4.9	±3.87
	z VALUE	4.09	2.12	2.77	2.91	0.76	0.19	1.65	2.91	1.12	2.19
	p VALUE	<0.001*	<0.05*	<0.01*	<0.01*	>0.1	>0.1	<0.1	<0.01*	>0.1	<0.05*

\* Significant

#### **IV. Discussion**

A total numbers of 300 cases of newborns were taken in this study. The total numbers of newborns delivered by NVD were 192 (64%) and the numbers of newborns delivered by ECS were 108 (36%). Out of a total number of 192 cases born by NVD, term babies were 106 in number (55.2%), preterm babies were 38 in number (19.8%) and small for date newborns were 48 in number (25%). Similarly of the 108 cases of ECS, 76 were of term babies (70.37%), 12 were of preterm (11.1%) and 20 were of small for date (18.5%). Thus the control group in this study was the cord bloods of those 106 cases of term newborns, who were delivered by NVD and having birth weight within normal range.

In the control group there is slight female sex preponderance in the present study with 53.8% (57 cases) of female babies & 46.2% (49 cases) of male babies. Primi paras are maximum in number in the control group accounting to 37.7% (40 cases). The number of cases decreases as the parity increases. The 2<sup>nd</sup> parity constitute 29.3% (31 cases), the 3<sup>rd</sup> parity was 23.6% (25 cases) and the 4<sup>th</sup> para cases accounting for only 9.4% (10 cases) of the control group. Though there are some variations in the haematological parameters evaluated according to the sex of the baby; the influence of the sex of the baby on these parameters is very insignificant except the Hb, TRBC, PCV & other RBC indices. Babies born by ECS or preterm & SFD babies were not included in this analysis as the mode of delivery, gestational age & birth weight would have additional influences on the parameters (Table 1). In this study the RBC indices of cord blood; Hb, TRBC, PCV & MCV show inverse relationship to the parity. The parity has effects on all the cord blood parameters except MCH, MCHC, Reticulocyte count & TPC (Table 2). The values of all parameters decrease as the parity increases. This effect is significant when the difference in the parity status is more (P1 – P4) & a statistically insignificant effect is noticed in successive parities i.e. between P1 - P2 or P2 - P3 (Table 3). This is in concordance with the studies of Vora S et al, Borna H et al and Gadhia MA et al<sup>[2,3,4]</sup>.

RBC indices like Hb, TRBC, PCV & MCV; TPC & TLC values are significantly higher in NVD cases than ECS. However the reticulocyte count & normoblast levels in cord blood are significantly higher in cases born by ECS (Table 4). This influence of mode of delivery on the Hb value of cord blood was also observed in the studies of Das MK et al, Aneja et al, Marwaha N et al, Redzko S et al. and Borna H et al<sup>[5,6,7,8,3]</sup>.

In this study the mean cord blood Hb value has a direct relationship with the maternal mean Hb level. It has been observed that in cases of cord blood Hb less than 14 gms% the mean maternal Hb level was 9.8 gms% & in cases with cord blood Hb more than or equal to 14 gms% the mean maternal Hb level was 12 gms% (Table 5). The 106 cases of term babies with normal birth weight delivered by NVD constituted the study group. This observation of low mean cord blood Hb level in the low mean maternal Hb group was similar to the findings of studies conducted by Marwaha N et al and Siddiqui MAR et al<sup>[7,9]</sup>.

To know the effect of gestational age on the haematological parameters of cord blood, 192 cases born by NVD were taken in study group. Babies born by ECS were excluded from the study group to avoid the effect of mode of delivery. Cord blood Hb, TRBC, PCV & TPC values of the preterm babies are significantly lower than the term control babies but the MCV, Reticulocyte count, NRBC & TLC values were significantly higher (Table 6). Observations of authors like Aneja S et al, Noguera NI et al, Ali MA et al, Blanchhette V et al and Pradeep A et al is similar to the present study<sup>[6,10,11,12,13]</sup>.

The effect of birth weight on the haematological parameters of cord blood was seen in 192 cases born by NVD. Babies born by ECS were excluded from the study group to avoid the effect of mode of delivery. Comparing the parameters in SFD & Term control group, the mean values of cord blood Hb, TRBC, PCV, MCV, NRBC & TLC were significantly higher in cases of SFD. Other haematological parameters does not show any significant relationship with the birth weight (Table 7). This finding is similar to the observations of Aneja S et al, Meberg A et al, Ozyurek E et al and Ali MA et al<sup>[6,14,15,11]</sup>.

The peripheral blood smear examination showed anisocytosis, macrocytosis and polychromasia and the cytoplasm of RBC stained more diffusely.

#### **V. Conclusion**

1. Birth weight of newborn affects all parameters except MCH, MCHC, reticulocyte and TPC.
2. Gestational age of the newborn influences all cord blood parameters except MCH and MCHC.
3. The maternal Hb concentration affects the cord blood Hb concentration.
4. Influences of the sex of the baby were observed in most of the erythroid parameters, but not on the reticulocyte, NRBC, TLC and TPC.
5. Influences of the parity of mothers were observed in most of the erythroid parameters and TLC but not on the reticulocyte, NRBC and TPC.
6. Mode of delivery has an influence on all erythroid parameters except PCV and MCV. It affects also TLC but not the TPC.

Thus, the study showed that the neonate is born with fairly constant haematological parameters in spite of such diverse foetal and maternal factors.

### References

- [1]. Slawomir R, Jerzy P, Janusz Z et al. Influence of perinatal factors on haematological variables in umbilical cord blood. *J Perinatal Medicine* 2005;33:42-45.
- [2]. Vora S, Ramnath S, Bhagat MP et al. Haematological values at birth in Indian newborns. *Indian Journal of Medical Sciences* 1975(Jul);29(6,7):153-158.
- [3]. Borna H, Borna S, Rafati SH et al. Umbilical cord haematologic variables in different modes of delivery. *Tehran University of Medical Journal* 2006;64(8):49-56.
- [4]. Gadhia MA, Jani RD, Anand AK. Haematological values at birth in Gujarati newborns. *J Indian Medical Association* 1982;79(5,6):68-70.
- [5]. Das MK, Banerjee PK. Studies on blood of newborns during the first week of life. *Indian Pediatrics* 1976;13(6):423-426.
- [6]. Aneja S, Manchanda R, Patwari A et al. Normal haematological values in newborns. *Indian Pediatrics* 1979;16(9):781-785.
- [7]. Marwaha N, Marwaha RK, Narang A et al. Routine haematological values in term newborns. *Indian Pediatrics* 1992;29:1095-1099.
- [8]. Redzko S, Przepiesc, Zak J et al. Influence of perinatal factors on haematological variables in umbilical cord blood. *J Perinat Med* 2005;33:42-45.
- [9]. Siddiqui MAR, Saxena H, Srivastava JR. A study of haematological values in newborn. *Indian Pediatr* 1972;9:90.
- [10]. Noguera NI, Detarsio G, Perez SM et al. Haematologic study of newborn umbilical cord blood. *Medicina* 1999;59:446-448.
- [11]. Ali MA, Shahidullah M, Hossain MA et al. Comparison of haematological values among different groups of low birth weight babies and normal birth weight babies. *Mymensingh Med J* 2008(Jul);17(2):152-156.
- [12]. Blanchhette V, Zipursky A. Assessment of anaemia in newborns. *Clin Perinatal* 1985;11:489-492.
- [13]. Pradeep A, Satish D, Dennis MS et al. Impact of race and gestational age on red blood indices in very low birth weight infants. *J Pediatr* 2000;106:307-310.
- [14]. Meberg A. Haemoglobin concentrations and erythropoietin levels in appropriate and small for gestational age infants. *Scand J Haematol* 1980;24:162.
- [15]. Ozyurek E, Cetintas S, Ceylan T et al. Complete blood count parameters for healthy, small for gestational age full term new borns. *Clinical & laboratory Haematology* 2006;28(2):97-104.