Original research article

Cord blood hematological profile of normal Indian neonates at an altitude of 3000 feet and above to the sea level

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 Abstract

BACKGROUND: Knowledge and cognizance of various hemopoietin cells and cord blood hematological profile of a new born has helped the mankind in not only early detection of various genetic, metabolic, hematological and malignant diseases but also to cure them. However, there is lot of variation in standard baseline reference values of hematological profile in newborns with regard to age, gender and demography. This study therefore aimed to analyze hematological values of cord blood of normal Indian neonates at an altitude of more than 3000 feet above sea level.

Objective: This study was conducted to record and analyze the complete hematological profile of cord blood of a normal newborn at an altitude of 3000 feet and above the sea level.

Methods: This was a tertiary care hospital based longitudinal observational study of hematological profile of cord blood of 200 normal term newborns. The various hematological parameters were analyzed and distributed accordingly to gender and the type of delivery. The continuous data was expressed as mean and standard deviation and the discrete data was expressed as percentage. The difference of variances of different baseline parameters were analyzed using student t- test as per gender and mode of delivery. The p-value less than 0.05 was considered as statistically significant.

Results: The mean hemoglobin, hematocrit, white blood cell count, red blood cell count, platelet count, reticulocyte count and nucleated RBC of the study population was 15.72 ± 1.67g/dl,$49.13\pm5.49\%$, 14.70 ± 3.96x10^9/L, 4.50 ± 0.59x10^9/L, 283.40 ± 74.08x10^9/L, $4.32\pm0.87\%$ and 6.87 ± 4.60/100 WBC respectively. There was no statistical difference in the hematological parameters of male and female newborns except in hemoglobin value of 16.02 ± 1.62g/dl and 15.44 ± 1.68g/dl respectively with $p<0.01$.The mode of delivery had no significant impact on the differences in the various hematological values.

Conclusion: This study is one of its kind conducted at an altitude of more than 3000 feet above sea level in northern part of India to evaluate various cord blood hematological parameters and is comparable to the other studies done at high altitude throughout the globe. Further studies are needed with large sample size from the different geographical areas of this region.

Keywords: Cord blood, hematological profile, newborns, altitude.

Introduction

The placenta once deemed to be a biological squander has regained importance not only for diagnostic but also for the therapeutic purposes [1]. The cord blood comprises of red blood cells, white blood cells, platelets and plasma and is as rich as the whole blood in the components. Cognizance and comprehension of various hemopoietin cells and cord blood and their use has helped in the cure of various genetic and malignant disorders [2]. The umbilical cord blood posing no harm to mother and developing foetus, is a good, reliable and safe source for the assessment of the hematological profile of the newborns [3].

The various disorders in a new born period and beyond rely on the complete blood count as an access to detect them. The hematological profile varies according to age, gender as well as demographic profile of an individual.[4]The umbilical cord blood hemoglobin and hematocrit values are important parameters for the assessment and follow up for neonatal anemia and neonatal hyperbilirubinaemia [5]. The role of white blood cells and platelet count is well accepted in neonatal sepsis as well as in general wellbeing of a

newborn [6]. So, recognition of the baseline standard values are needed for timely detection of various congenital, metabolic, genetic or malignant disorders.

The importance of altitude in setting standard baseline reference values and evaluating hematological profile of newborns are lacking in most of the Indian data with most of them considering an altitude of 1000 feet or less from the sea level. This study therefore aimed to study the hematological profile in a normal Indian newborns at a high altitude of 3000 feet and above to the sea level.

Methods

This prospective longitudinal study was conducted at Maharishi Markandeshwar Medical College and hospital, Kumarhatti, Solan, a tertiary care hospital in hilly regions of North India in 2021.

The hematological profile of the cord blood of normal term neonates (37-42 weeks) above 2500 grams was analyzed. The parents gave the written consent prior to the collection of the sample and the study was approved from the Institutional Ethical Committee.

All preterm neonates with congenital anomalies, complications such as respiratory distress, birth asphyxia and sepsis were excluded from the study.

The babies born to mothers with antenatal comorbities such as anemia, pre-eclampsia, eclampsia, hypertension, diabetes mellitus or any other systemic illness were also excluded.

As soon as the umbilical cord was clamped, 2ml of cord blood was collected by trained individual in pre-labelled EDTA vial and was transported to the laboratory within one hour of collection, thereafter processed and was examined by a trained pathologist.

The sample was analyzed on 3 Part differential Automated hematological analyzer. The peripheral smear along with the detailed hematological profile such as hemoglobin, hematocrit, RBC count, WBC count, total and differential count, nucleated RBC and reticulocyte count were also evaluated.

The various baseline characteristics were analyzed and were distributed according to gender and the type of delivery. The continuous data was expressed as mean and standard deviation and the discrete data was expressed as number and percentage. The mean difference of the variances of the different hematological parameters were analyzed according to gender and the mode of delivery and the student's t-test was applied. A value of less than 0.05 was considered as significant.

Results

The total of 200 term newborns cord blood sample was taken and thereafter analyzed. There were 105 males and 95 females. A total of 148 neonates were born by normal vaginal delivery and 52 were born by LSCS. The mean hemoglobin, hematocrit, WBC, RBC, platelet count, reticulocyte count and nRBC of the study population were 15.72 ± 1.67g/dl,49.13 ± 5.49%, 14.70 ± 3.96x10^9/L, 4.50 ± 0.5x10^9/L, 283.40 ± 74.08x10^9/L, 4.32 ± 0.87% and 6.87 ± 4.60/100 WBC respectively. Table 1 shows the cord blood hematological profile of the newborns in the current study and its comparison to the various other studies.

Figure 1. Shows the distribution of the study population on the basis of the gender and figure 2 shows the distribution of study population on the basis of mode of delivery.

Table 2 outlines the hematological cord blood values in males and females and shows the distribution as mean and standard deviation. The mean hemoglobin, hematocrit, WBC, RBC, platelet count, reticulocyte count and nRBC was 16.02 ± 1.62g/dl,49.49 ± 5.19%, 14.78 ± 3.94x10^9/L, 4.56 ± 0.53x10^9/L, 279.24 ± 0.66x10^9/L, 4.29 ± 0.88% and 6.66 ± 4.34/100WBC respectively in males and 15.44 ± 1.68g/dl,48.80 ± 5.75%,14.62 ± 4.01x10^9/L, 4.48 ± 0.64x10^9/L,288.0 ± 0.82x10^9/L,4.36 ± 0.86% and 7.11 ± 5.01/100WBC in females respectively. There was no statistical difference in WBC, RBC count, total differential count, reticulocyte count, and nucleated RBC values in males and females. However, there was a significant difference in hemoglobin values in males and females with a p value of 0.01.

Table 3 shows the cord blood values in the newborn as per the mode of delivery and their distribution as mean and standard deviation. The mean hemoglobin, hematocrit WBC, RBC, platelet count, reticulocyte count and nRBC was 15.72 ± 1.74g/dl,49.22 ± 5.46%, 14.79 ± 4.16x10^9/L, 4.53 ± 0.60x10^9/L, 284.16 ± 0.73x10^9/L, 4.35 ± 0.85% and 6.79 ± 4.42/100WBC respectively in normal vaginally delivered newborns whereas the values in LSCS born neonates were 15.73 ± 1.50g/dl,48.84 ± 5.62%, 14.46 ± 3.34x10^9/L, 4.49 ± 0.58x10^9/L, 281.21 ± 0.76x10^9/L, 4.25 ± 0.93% and 7.09 ± 5.34/100WBC respectively. It was observed that there was no statistical significant difference in the hematological parameters in the newborns delivered by either normal vaginal delivery or LSCS.

Discussion

Keeping in view the fact that the limited available data on hematological parameters of umbilical cord blood of newborns in this part of the region, this study was conducted in hilly area of Himachal Pradesh, India at an altitude of more than 3000 above sea level. In the current study, hematological parameters were compared with the other studies done across the globe albeit different with regards to race, culture, dietary behavior and geographical distribution.

The cord blood hemoglobin in the current study was 15.72 ± 1.67g/dl. The value was higher in

comparison to the studies done in Greece, Iraq, Nigeria, Sudan and in coastal area of India, Mumbai [3, 7, 8, 9, 10]. Our value was higher than the most of the studies but corresponded to the studies done on higher altitudes of Nepal and Ethiopia [11, 12].

The good nutritional status and the higher altitude could be the main factors of higher cord blood hemoglobin values in the current study [11, 12].

The cord blood hematocrit value of 49.13±5.49% was higher in comparison to the most of the studies but in concurrence to the study done in Nepal [3, 11]. The altitude and good nutritional status, race and ethnicity may have attributed to this fact [3, 11].

The altitude could have accounted for the high RBC number of 4.50±4.49x10^9/L in comparison to studies from Mumbai, Karachi, Africa but paralleled to the study from high altitude of Ethiopia [3, 12, 13, 14].

The red cell indices such as MCV and MCH were 107.35±9.07fl and 35.99±7.96pg/dl respectively and in the range as per Synex KX-21(0-24 hour's newborns) [15]. The MCV was higher than the studies from Karachi, Nepal, Ethiopia and Africa but lower than study from Mumbai and Iraq. The difference could be attributed to the number of subjects, race, various maternal factors, ethnicity and geographical distribution [3, 8, 11, 12, 13, 14].

The total WBC count of 14.70±3.96 x10^9/L was higher than most of the studies except from Nepal, which reported 14.93±4.44x10^9/L and the study done by Al Mudallal *et al* [17] (15.1±3.17x10^9/L). The higher value could be related to the higher number of vaginal deliveries [6, 13]. The difference in the sample size, altitude, methods of sample collection and variation in race could be the other contributing factors [9, 13, 19].

The nRBC was 6.87±4.60/100 WBC and was in the range as per Synex KX-21 and corresponded to studies done in Pakistan and Africa [13, 14].

The platelet count value varied within the different studies though in normal range as per Sysmex-KX 21 reference. The difference could be attributed to the method of the collection and further processing of the sample [13].

The various umbilical cord blood hematological parameters were compared according to gender and the mode of delivery. The hemoglobin value of 16.02±1.6g/dl was higher in males than 15.44±1.68g/dl of females. The difference was statistically significant with p-value of 0.01.

The studies done by Dacie and Lewis from Nigeria, Chang *et al* and Dima *et al* have reported high mean values of hemoglobin in males than in females [21, 22, 23]. The difference in other hematological parameters was statistically insignificant.

The difference in the hematological parameters was statistically insignificant as per the mode of deliveries, either NVD or LSCS. Only few studies have shown that there may be significant difference in umbilical cord blood hematological values affected by the type of delivery however further studies are needed to establish a strong relationship [24].
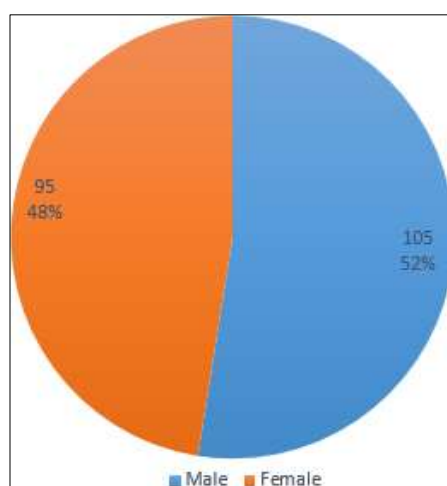

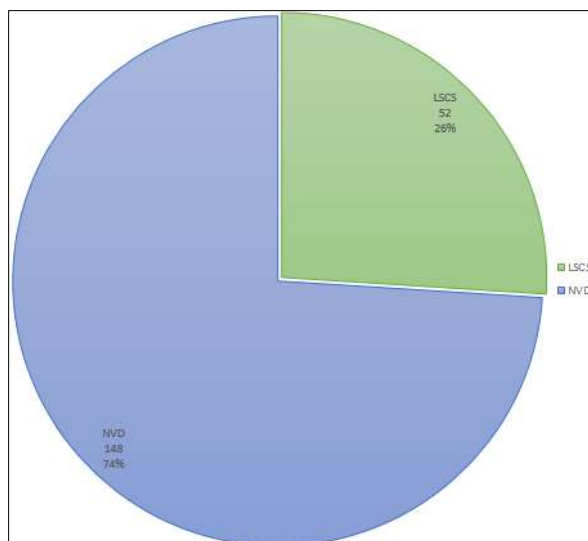**Fig 1:** Distribution of study population by gender

Fig 2: Distribution of the study population by mode of delivery

Table 1:

Comparison of the cord blood hematological profile of newborns in the current study with the other studies

Hematological Parameters	sysmexkx-21 (0-24 newborn)	Our Study (n=200)	Mumbai (India) (n=127)	Karachi (Pakistan) (n=404)	IRAQ (BL) marzokijm (n=220)	Ethiopia Angelo A n=139	Nigera Adewumi (n=130)	Nepal Basnets (n=210)	Afra Abidjn (n=12)
Hb(g/dl)	15.0-24.0	15.72±1.67	14.76±3.33	14.99±1.47	13.76±1.46	15.8±1.64	13.9±1.50	15.24±1.96	15±1.7
Hematocrit (%)	44-70	49.13±5.49	48±9.0	45.65±4.83	44.42±4.74	46.1±4.62	44.8±5.78	-	43.6±5.5
RBC(x10^{12}/L)	4.1-6.7	4.50±0.59	4.36±0.95	4.29±0.44	4.0±0.47	4.51±4.49	4.05±0.55	4.30±0.63	4.37±0.5
WBC(x10^9/L)	9.0-30.0	14.70±3.96	11.87±4.66	13.61±4.23	10.12±2.80	12.4±3.38	13.1±5.20	14.93±4.44	13.7±5.4
MCV(fl)	102-115	107.35±9.07	109.07±25	105.81±6.24	111.56±6.09	101.2±5.97	110.4±11.88	101.22±6.01	100±6.2
MCH(pg)	33.0-33.9	35.99±7.96	34.16±1.81	34.96±2.11	34.41±2.36	35.1±1.97	32.6±4.13	33.91±2.27	34.5±2.4
MCHC(g/dl)	32.0-36.0	-	31.31±0.72	32.47±2.12	30.93±1.90	34.5±1.17	29.8±1.64	33.27±1.58	34.2±1.0
Platelet count(x10^9/L)	40-385	283.40±74.08	248.21±115.6	256.25±76.54	267.63±60.62	245.5±69.78	225.1±72.21	226.88±61.28	161±45
Reticulocyte count (%)	-	4.32±0.87	-	-	-		-	-	-
nRBC/100WBC	-	6.87±4.60	-	-	-		-	-	6±3.6

Table 2: Total and gender distribution of cord blood hematological profile of the study population

Hematological profile	Male N=105 (52.50%)	Female N=95 (47.50%)	Total N=200	P-value
Hb (g/dl)	16.02±1.62	15.44±1.68	15.72±1.67	**0.01***
Hematocrit (%)	49.49±5.19	48.80±5.75	49.13±5.49	0.37
WBC (x10^9/L)	14.78±3.94	14.62±4.01	14.70±3.96	0.78
RBC (x10^9/L)	4.56±0.53	4.48±0.64	4.50±0.59	0.32
MCV(fl)	107.78±4.96	106.86±12.10	107.35±9.07	0.48
MCH(pg)	36.50±10.60	35.42±3.07	35.99±7.96	0.34
Platelet count(x10^9)	279.24±0.66	288.0±0.82	283.40±74.08	0.41
Reticulocyte count (%)	4.29±0.88	4.36±0.86	4.32±0.87	0.59
Polymorhs (%)	53.39±6.34	54.62±7.14	53.97±6.74	0.20
Lymphocytes (%)	35.95±6.52	36.02±7.06	35.98±6.76	0.94
Eosinophils (%)	3.72±1.92	3.25±2.01	3.50±1.97	0.09
Monocytes (%)	6.65±3.09	5.92±3.09	6.31±3.11	0.10
nRBC/100 WBC	6.66±4.34	7.11±5.01	6.87±4.60	0.49

Table 3: Mode of delivery distribution of the study population

Hematological profile	Normal vaginal delivery n=148(74%)	LSCS n=52(26%)	p-value
Hb (g/dl)	15.72±1.74	15.73±1.50	0.95
Hematocrit (%)	49.22±5.46	48.84±5.62	0.67
WBC (x10^9/L)	14.79±4.16	14.46±33.44	0.61
RBC (x10^9/L)	4.53±0.60	4.49±0.58	0.70
MCV (fl)	107.25±10.16	107.63±4.85	0.80
MCH (pg)	36.30±9.13	35.10±2.53	0.35
Platelet count (x10$^{9)}$)	284.16±0.73	281.21±0.76	0.81
Reticulocyte count (%)	4.35±0.85	4.25±0.93	0.47
Polymorhs (%)	53.78±7.00	54.52±5.96	0.50
Lymphocytes (%)	35.89±7.02	36.23±6.03	0.76
Eosinophils (%)	3.60±2.03	3.21±1.79	0.22
Monocytes (%)	6.25±3.13	6.46±3.07	0.68
nRBC/100 WBC	6.79±4.42	7.09±5.34	0.69

Conclusion

This study is one of its kind at an altitude of more than 3000 feet above sea level conducted in the northern part of India to evaluate various cord blood hematological parameters in newborns. The hematological parameters of this study are comparable to the other studies done at high altitude throughout the globe. The altitude is an important criterion that needs to be considered when setting the baseline hematological profile of the cord blood taken from the newborns. Therefore, further studies are needed with large sample size from the different geographical areas of this region.

Abbreviations

EDTA: Ethylenediaminetetraacetic Acid
RBC: Red Blood Cell
Hb: Hemoglobin
LSCS: Lower Segment Cesarean Section
WBC: White Blood Cell
NRBC: Nucleated Red Blood Cell
MCV: Mean Cell Volume
MCH: Mean Cell Hemoglobin
NVD: Normal Vaginal Delivery

Aknowledgements

Authors' Contribution

GH, DS and HR planned and designed the study.GH, HR, AS and GN compiled the data and analyzed it. GN and AS thoroughly reviewed the article and thereafter gave the approval.

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