INTRODUCTION

The umbilical cord blood haemoglobin is an important haematological parameter in newborns at birth. Haemoglobin (Hb) and haematocrit (Hct) values have been used frequently in the diagnosis and follow-up of the neonatal anemia.2 Other haematological parameters, e.g., white blood cell count and platelet count are also helpful in the assessment of neonatal sepsis and haemostatic status of infant.2 The haematological values of newborns depend on several factors, including ethnic group, maternal health, nutritional status and antenatal complications such as anemia, growth retardation and fetal infections.3 In addition, intra-partum factors including asphyxia play an important role.4 Delayed cord clamping results in an increase in haemoglobin (Hb) without causing unacceptable side effects in term newborn babies.5

The sole source of nutrients for the growing fetus is the maternal blood.3 Furthermore, iron deficiency anemia is the most frequent nutritional deficiency in pregnancy, with an impact on maternal and fetal morbidity and mortality.1 Anemia is regarded as the most important preventable cause of perinatal complications, such as premature delivery, intrauterine growth retardation and neonatal and perinatal death.1 Many studies have supported the belief that iron transport from the mother to their fetus occurs independently of maternal iron levels,1,3 which might even induce deficiency in the mother as a result of fetal “parasitism”. However, later studies have questioned this belief and no consensus regarding this subject has been reached so far.1 A few studies have correlated haematological indices of pregnant mothers with those of their newborns, using haemoglobin level and iron status, either in anemic patients or in those who had iron supplementation.3 A statistically significant correlation was found between
parents and cord blood with regard to red blood count, mean corpuscular volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration and packed cell volume. However, correlation of cell count showed a significant positive correlation between mother and cord blood whereas white blood haemoglobin concentration showed negative correlation [6]. The contrary, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration showed negative correlation between mother and cord blood whereas white blood cell count showed a significant positive correlation between both groups. However, correlation of haematological parameters between healthy mothers and their newborns is not frequently reported in the literature. Furthermore, may be some haematological parameters of newborns (including red blood count, mean corpuscular volume, mean corpuscular haemoglobin concentration, and packed cell volume) are genetically determined.

The objective of this study was to determine any significant correlation that may exist between haematological parameters (including haemoglobin, RBCs count, HCT, MCV, MCH, MCHC, white blood cell count, differential leukocyte count and platelet count) of maternal blood and the umbilical cord blood of their respective newborns.

**METHODOLOGY**

It was a cross-sectional study based on blood samples of mothers and the cord blood of their respective newborns from four public and private hospitals in Karachi, Pakistan, from July 2006 to April 2008. Four hundred and four (404) maternal and newborns cord blood sample were collected, who fulfilled both the inclusion and exclusion criteria for the study.

Inclusion criteria for mothers included booked pregnant woman, uneventful pregnancy and a haemoglobin ≥ 10 g/dL. Inclusion criteria for neonates included full term gestation (37 – 42 weeks), with normal birth weight (2.5 – 4.0 Kg). Detailed history was taken from mothers regarding their age, parity, gravida, socio-economic status etc. and physical examination was done.

Exclusion criteria for mothers were multiple pregnancies, diseases complicating pregnancy (anaemia, antepartum haemorrhage, pregnancy induced hypertension, eclampsia, diabetes (gestational or insulin dependent), significant heart, kidney or lung disease, malaria, disseminated intravascular coagulation) / thalassaemia and/or sickle cell disease, drug or alcohol abuse, excessive perinatal blood or postpartum and emergency caesarean section. Exclusion criteria for the neonates were abnormal partogram, perinatal blood loss, hydrops fetalis, birth asphyxia, low Apgar score (< 8 at 5 minutes), obvious congenital/suspected chromosomal abnormality and any pathologic jaundice (within 24 hours of birth).

Procedure for cord blood sampling was explained to the pregnant mother. Written informed consent was also taken from mothers. Three ml venous blood was collected in EDTA containing tube for complete blood count of mother when she came in labour or for elective caesarean section. Five milliliters cord blood was collected into an EDTA containing tube from the umbilical cord of the babies immediately after delivery by clamping and cutting the babies’ end of the cord. The sample was then sent as early as possible (maximum 3 – 6 hours) to Ziauddin Hospital Laboratory for analysis. For haematological parameters, a standard coultergram was done on the Beckman Coulter Counter Max M.8-11 The differential leukocyte count was done manually by light microscopy on Leishman's stained smears.

The data entry and analysis was done on computer package Statistical Packages of Social Sciences (SPSS) version 16.0. The mean values for the blood parameters were compared between the maternal and infant values using the paired t-test for matching mothers with their newborns. Pearson's correlation was determined between maternal and umbilical cord blood haematological parameter. According to the value of correlation coefficient (r), following categories were used for the interpretation of correlation: 0.0 – 0.19 = very weak to negligible correlation, 0.2 – 0.39 = weak, low correlation, 0.4 – 0.69 = moderate correlation, 0.7 – 0.89 = strong, high correlation and 0.9 – 1.0 = very strong correlation.

Ninety five percent (95%) confidence interval of correlation coefficient (r) was also calculated by using statistical computation software.

**RESULTS**

A total of 404 maternal and umbilical cord blood were analyzed. Two hundred and seventy one were delivered by spontaneous vaginal delivery and 133 by elective caesarean section. Maternal age ranged from 15 to 45 years. The mean birth weight of the infant was found to be 3.03 ± 0.38 kg.

Table I shows the mean values, standard deviation and correlation between the maternal and baby’s cord blood on the basis of RBCs indices. The haemoglobin value was available for all the 404 maternal and infant blood samples, but the remaining blood parameters were available for 314 maternal samples - so the paired t-test and correlation values for these variables are based on the matched 314 maternal and infant blood samples. Haemoglobin, RBCs count, HCT, MCV and MCH were found to be high in cord blood as compared to the maternal blood with a p-value of < 0.001. There was a very weak to negligible correlation between haemoglobin, RBCs count and MCH, when correlating between the maternal and infant blood values. MCV (r = 0.30) and HCT (r = 0.23) showed a weak, low correlation which was not very significant. Figure 1 shows the correlation...
between the MCV values of mother and infant, while mean Corpuscular Haemoglobin Concentration (MCHC), showed a moderate correlation with an r-value of 0.49 (Figure 2).

The white cell count was more in maternal blood (p = 0.77), whereas platelet count was found to be higher in the cord blood (p = 0.02). There was a weak correlation (r = 0.32) between the maternal and infant WBC values but there was no correlation for the platelet count in between mothers and babies (Table I).

**DISCUSSION**

The present study was carried out to determine the correlation in routine haematological parameters of mother and their newborns from Karachi. Very few studies have shown positive correlation in haematological parameters between mother and cord blood whereas many studies have shown no correlation between these two groups.

A study was done by Babay *et al.* on normal healthy, non-anaemic females which showed that a statistically significant positive correlation exists for Hb, RBC, MCV, MCH, MCHC and PCV between the mothers blood and cord blood. On the other hand, in a study by Devi *et al.*, no statistically significant correlation could be demonstrated between cord blood and maternal haemoglobin level. Another study has suggested that maternal haematological and iron indices are not predictive of the haemoglobin or iron status of the newborn and the fetus continues to take up iron from the mother until delivery. Furthermore, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration have been shown to have a negative correlation between maternal and umbilical cord blood.

This study was carried out in non-anemic mothers (haemoglobin ≥ 10 g/dl) and the results of the study shows that all of the haematological parameters were higher in cord blood than maternal blood. Understandably the relatively lower values of haemoglobin and PCV (haematocrit) observed in the maternal blood may be due to plasma volume expansion leading to haemodilution during pregnancy. PCV (haematocrit) is high in newborns because of increased number and size of red blood cells in cord blood. Furthermore, a key physiological change during pregnancy, which modifies the chemical constitution of blood, amplifies transfer of some haemopoietic micronutrients, and increases the utilization of some of these micronutrients as defense mechanisms against pregnancy induced oxidative stress may lead to maternal depletion and low haematological values.

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**Table I:** Correlation between maternal haematological parameters and cord blood of their newborns (Red Blood Cells indices, white cell count and platelet count).

<table>
<thead>
<tr>
<th>Blood parameters</th>
<th>Mother (n = 314)</th>
<th>Infants (n = 314)</th>
<th>Significance between means of mother and infant (p)</th>
<th>95% Confidence Interval for (r)</th>
<th>Pearson's correlation coefficient (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemoglobin (gms/dl)</td>
<td>11.5 ± 1.1</td>
<td>15 ± 1.5</td>
<td>&lt; 0.001</td>
<td>0.023 - 0.215</td>
<td>0.12**</td>
</tr>
<tr>
<td>RBCs count (10¹²/L)</td>
<td>4.2 ± 0.5</td>
<td>4.3 ± 0.4</td>
<td>&lt; 0.001</td>
<td>0.059 - 0.265</td>
<td>0.16*</td>
</tr>
<tr>
<td>HCT (%)</td>
<td>35.6 ± 4.1</td>
<td>48.1 ± 4.7</td>
<td>&lt; 0.001</td>
<td>0.082 - 0.294</td>
<td>0.23**</td>
</tr>
<tr>
<td>MCV (fl)</td>
<td>84.9 ± 8.4</td>
<td>106.1 ± 6.1</td>
<td>&lt; 0.001</td>
<td>0.196 - 0.397</td>
<td>0.30**</td>
</tr>
<tr>
<td>MCH (pg)</td>
<td>27.9 ± 3</td>
<td>35 ± 2.2</td>
<td>&lt; 0.001</td>
<td>0.061 - 0.275</td>
<td>0.17*</td>
</tr>
<tr>
<td>MCHC (gms/dl)</td>
<td>32.4 ± 1.6</td>
<td>32.3 ± 2.2</td>
<td>0.98</td>
<td>0.402 - 0.569</td>
<td>0.49***</td>
</tr>
<tr>
<td>White blood cells count (10⁹/L)</td>
<td>13.9 ± 4.5</td>
<td>13.8 ± 4.1</td>
<td>0.77</td>
<td>0.218 - 0.415</td>
<td>0.32**</td>
</tr>
<tr>
<td>Platelet count (10⁹/L)</td>
<td>244.6 ± 84.5</td>
<td>258.2 ± 77.2</td>
<td>0.02</td>
<td>0.061 - 0.275</td>
<td>0.17*</td>
</tr>
</tbody>
</table>

* For Haemoglobin = 404; *Very weak to negligible correlation (0.0 to 0.19); **Weak, low correlation (not very significant) (0.2 to 0.39); ***Moderate correlation (0.4-0.69)

HCT = Haematocrit; MCV = Mean corpuscular volume; MCH = Mean corpuscular haemoglobin; MCHC = Mean corpuscular haemoglobin concentration.
There was no significant correlation between mothers and cord blood haematological parameters except for MCHC, which showed moderate correlation in this study. The result of no correlation in red blood cell indices in our study is similar to other studies.1,2,17-19 The reason may be that the iron storage in the fetus and mother are not directly related and they are under control of an independent system. Sisson and Lund (as cited by Chang et al.), however, considered that measurement of the red blood cell volume and haemoglobin would be more helpful in the study of pregnant women and their newborn infants because of the volumetric changes in the cardiovascular system at these times.19 Using these parameters, they were able to show that maternal anemia does lead to lower circulating haemoglobin in the newborn infants. No correlation was also found in white blood cell count and platelet count in this study, which has been reported by others.1,2,16,17,19 Dapper and Didia showed a direct positive correlation between the white blood cell count of maternal and cord blood, but it was not statistically significant.16

In the present study, a moderate correlation was observed between MCHC of mother and cord blood. This finding is consistent with the result of Babay et al.,3 whereas another study has suggested that mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) have a negative correlation between maternal and umbilical cord blood.6

CONCLUSION

There was no correlation between all the routine haematological parameters (including haemoglobin, RBCs count, HCT, MCV, MCH, white blood cell count, differential leukocyte count and platelet count) except MCHC in between mother and their respective newborns. Routine haematological parameters of newborns are independent of maternal routine haematological parameters.

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REFERENCES