ORIGINAL ARTICLE

CORRELATION BETWEEN UMBILICAL CORD BLOOD VOLUME WITH GESTATIONAL AGE AND BIRTH WEIGHT: A BASELINE FOR CORD BLOOD BANKS IN PAKISTAN

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Received: November 13, 2018 Accepted: December 4, 2018

ABSTRACT
Placental vessels contain one-third of newborn blood volume termed as umbilical cord blood (UCB). It is an enriched product with many benefits but unfortunately, it is usually discarded as waste. Since the identification of its benefits, many countries have established Cord Blood Banks using UCB for transfusion and transplantation. Despite having a high fertility rate, no such facility is currently present in Pakistan. UCB is used as autologous blood and can also be used as a homologous source. In this study, 200 UCB units (250 ml blood bags; anticoagulant volume adjusted) were collected, volume obtained was calculated and correlated with gestational age and birth weight. Pearson's correlation coefficient has been applied on means that showed a strong positive relationship. In addition, different hematological and biochemical parameters (storage lesion parameters) were measured and mean values were calculated in order to provide baseline values. The study concluded that UCB can be collected in blood bags. More the gestational age and birth weight more will be the blood volume collected. It is recommended to conduct large-scale studies regarding the collection, storage and transfusion of UCB to provide a platform for the establishment of Cord Blood Banks in Pakistan.

Keywords: Cord blood banks, storage lesion parameters, umbilical cord blood.

1. INTRODUCTION
According to Collin's English dictionary, the umbilical cord is the long flexible tube-like structure connecting a fetus with the placenta provides a means of metabolic interchange with the mother[1]. While Dorland's medical dictionary defines it as an organ formed during embryogenesis by the fusion of mesoderm of the vitello-intestinal duct with mesoderm of the amniotic cavity. It consists of an external covering of amniotic ectoderm and a core of mesoderm in which lie the two umbilical arteries and a single umbilical vein[2].

Awareness of placental blood was initiated in mid-nineties but the discussion mainly was about the amount, timing and advantage/disadvantage of transfer of placental blood to the fetus and the factors affecting this transfer[3]. Placenta (or placental vessels) contains a quarter to a third of newborn blood volume, which in the current clinical practice is discarded as waste[4]. This waste is actually a gift of nature that humans failed to identify earlier. The animals appear to have inbuilt wisdom as some creatures like herbivore animals (e.g. cow) swallow the placenta after the birth of their infant[5,6]. Umbilical cord blood (UCB) is rich in fetal hemoglobin, growth factors, cytokines and is protected in the infection-free environment inside placenta. This rich content of cytokine and growth factors may play a role in immune response modification in chronic anemia[7]. UCB is also reported to have the antimalarial effect probably due to the high content of fetal hemoglobin[8]. The biggest benefit of UCB is the presence of hematopoietic stem cells (HSCs) which have greater proliferative and colony forming capacity, more responsive to some growth factors, immunologically immature and produce fewer complications if transplanted[9,10]. Since the first successful umbilical cord stem cell transplantation (UCSCT) in 1988 in Fanconi's anemia patient, great advances have

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occurred. Public and private UCB banks have been established worldwide that are providing services for storage[11-13]. The use of allogeneic HSCs is limited as they need to find a human leukocyte antigen (HLA)–compatible donor[12]. HSCs constitute only 0.01% of the nucleated cells of the cord blood while the remaining 99.99% is wasted[6].

For many years scientists are searching to determine the efficacy of transfusing UCB as an alternative to adult blood as autologous source[14,15]. A research group in India after a series of studies in different diseases has reported that UCB can safely be used as a homologous source[6,7]. UCB can be used as a source of autologous blood transfusion especially in neonates to eliminate or minimize the risks associated with homologous blood[16]. Successful use of UCB has been reported in major surgical procedures in neonates[17,18]. On the basis of these studies, it is suggested that UCB should be frequently used as an alternative source for adult blood particularly in developing countries where there is a shortage in supply of voluntarily donated blood[6]. It is quite feasible to establish UCB banks in Pakistan due to a high birth rate. The birth rate in Pakistan is 24.81/1000 per year whereas worldwide it is 19.15/1000[19] with a fertility rate of 4.1%. Such high birth rate in Pakistan point towards the wastage of these placentas and umbilical cords and urges the need for establishing UCB banks[20].

In order to have effective cord blood collection and transfusion services, baseline normal values of hematological and biochemical parameters of UCB are necessary. These parameters not only help to assess the deficiencies of mature and premature infants but also help in determining storage-related changes of cord blood during its storage. Since there is no such published data available regarding these values in Pakistani population, a total of 200 UCB units were collected from full-term babies, tests for hematological and biochemical parameters have been carried out and volume obtained was correlated with gestational age and birth weight to establish the feasibility of collection and determine baseline values.

2. METHODS

2.1. Study Design

A cross-sectional analytical study has been carried out at the Pathology Department, Gynecology / Obstetrics Department and Fatima Laboratory of Baqai Medical University from January 2013 to January 2014. The study included 200 non-probability convenient UCB samples of babies. All those babies that were born through normal vaginal delivery to mothers having uncomplicated pregnancy were selected whereas cesarean babies or babies born with complicated pregnancy were not selected in the study.

2.2. Sample Collection

Soon after delivery, the expelled placenta was received in a sterile bowl with the umbilical end of cord clamped. After stringent cleaning, the umbilical cord was wiped with 70% alcohol and iodine swab at the intended site of insertion of the needle. Blood was obtained in 250 ml blood bags in which anticoagulant volume (CPDA-1) was adjusted to 14 ml (deduced from the pilot study) to maintain a ratio of 1:7. The volume obtained was calculated with the help of digital weighing scale. Gestational age was recorded from ultrasound report taken just before the delivery while birth weight was recorded using digital pediatric weighing scale just after the delivery.

2.3. Hematological and Biochemical Tests

Each UCB sample was tested for hematological and biochemical parameters that are considered as storage lesion parameters. Hematological parameters included hemoglobin (Hb), hematocrit (HcT), red blood cells (RBCs), white blood cells (WBCs) and platelet (PLT) counts while biochemical parameters included plasma K^+ and red cell ATP. Hematological parameters were analyzed on an automatic hematology analyzer (Sysmex KX-21, Block Scientific, USA), plasma potassium was measured by a flame photometer (410C Sherwood Scientific, England) while ATP level was determined spectrophotometrically by a plate reader (Digitex, China) using commercial ATP colorimetric assay kit (Biovision, USA). None of the blood bags was used for any kind of transfusion.

2.4. Data Analysis

For hematological and biochemical parameters, mean values were calculated. The mean of gestational age, birth weight and UCB volume obtained was calculated and correlated with each other using Pearson's correlation test to get statistical significance through SPSS (version 16, IBM, USA).

3. RESULTS AND DISCUSSION

Neonates usually do not need a blood transfusion unless there is a clinical requirement. Blood transfusion in neonates is generally required in conditions such as premature births, iatrogenic blood loss cases (accounts for 90% of all RBC transfusion in neonates), thrombocytopenia or granulocyte insufficiency. It is also required in those who are in need of urgent surgical intervention and are prone to suffer from mild to moderate anemia which needs correction[17,21].

The mean values of hematological and biochemical parameters of UCB are shown in Table 1 while the mean gestational age, birth weight, and UCB volume are given in Table 2. The results show normal values of different hematological and biochemical parameters of UCB in the local population (Table 1). The correlation of cord blood volume (75.02±15.1 ml) with gestational age (37.16±1.22 weeks) and birth weight (2742±215.8 g) is found to be strong and shows a correlation (r) of 0.835 and 0.825, respectively with a *p*-value of 0.001 in either case (Figs. 1 and 2).

A positive correlation between gestation age, birth weight, and UCB volume indicated that more the gestational age and birth weight, higher will be the volume of UCB obtained. The findings of this study are comparable to some other studies[22,23] that have shown similar results. It has been reported that UCB volume is dependent on the mode of delivery and time interval of clamping the umbilical cord[14]. Various studies have suggested that using UCB as a source of autologous blood transfusion in neonates is safe[17,24] even in preterm infants[15]. Moreover, UCB can be efficiently collected, stored and transfused[16,24]

Table 1. Means of normal hematological and biochemical parameters of UCB (n = 200)

Hematological and Biochemical Parameters	Normal Values (Mean±SD)
Plasma Hb (g/dl)	13.7±2.50
HcT (%)	34.2±4.20
RBC × 10^{12}/L	4.7±0.85
Hemolysis (%)	0.09±0.02
WBC × 10^{9}/L	6.14±1.60
PLT × 10^{9}/L	210.94±18.76
Plasma K^{+} level (mEq/L)	5.82±1.05
ATP level (µmol/g Hb)	5.11±0.73

Table 2. Mean values of gestational age, birth weight, and volume of UCB (n = 200)

Gestational Age (weeks)	Birth Weight (g)	UCB Volume (ml)
37.16±1.22	2742±215.8	75.02±15.1

as compared to homologous adult blood, which is beset with many infectious and non-infectious hazards[25]. Good history, intense serological testing before transfusion and screening programs have decreased the rate of hazards in homologous blood transfusions but in developing countries (including Pakistan) it is still a major concern[26].

4. CONCLUSION

On the basis of the findings of this study, it is concluded that UCB may prove to be a very useful source of blood transfusion as compared to the current source of homologous adult blood. The data presented in the study can serve as a baseline for large-scale studies and will pave the way to establish cord blood banks in Pakistan, which is an utmost need of the time due to high birth rates.

ACKNOWLEDGMENT

The authors are very grateful for the help and support of Gynecology/Obstetrics Department of the Baqai Medical University. The contribution of the technical and clerical staff was also praiseworthy.

FUNDING

None mentioned.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICAL APPROVAL

The study was conducted after the approval from the Ethics Committee of Baqai Medical University, Karachi.

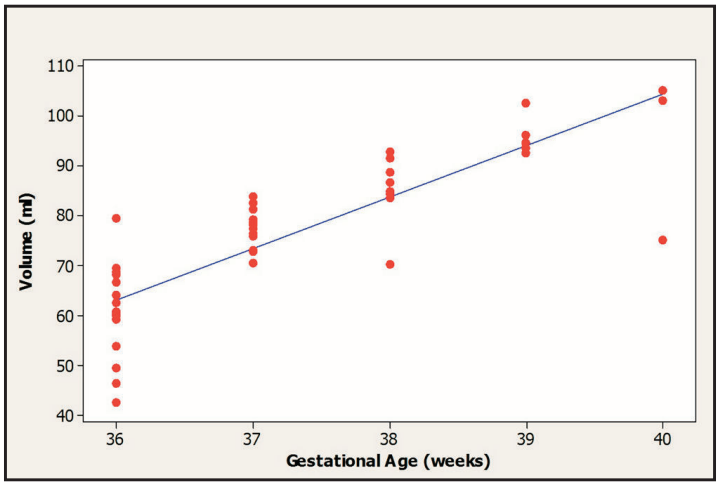

Fig. 1. Correlation between UCB volume (ml) and gestational age (weeks).

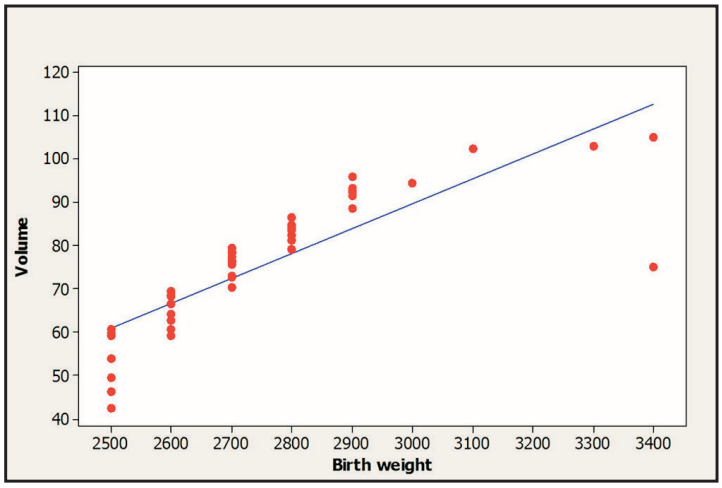

Fig. 2. Correlation between UCB volume (ml) and birth weight.

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