ORIGINAL RESEARCH

Maternal and neonatal predictive variables for quality of cord blood as a source of stem cells

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ABSTRACT

Objective: This study aimed to identify the maternal and neonatal predictive variables for quality of cord blood as a source of stem cells.

Methods: A descriptive design was followed in this study. A purposive sample of 143 pairs; pregnant women assigned for elective cesarean section and their newborns, was enrolled in current study. The subjects were recruited from the Operating Theater of Mansoura University Hospital, Egypt. One hundred forty three umbilical cord blood units were collected in utero from cesarean deliveries. The collected units were assessed for its blood volume and total nucleated cells content. An assessment sheet of 12 items was used as a tool of data collection.

Results: The greater blood volume and higher nucleated cells obtained from the primigravida, between 37 to 40 gestation weeks, and those not exposed to cigarette smoke during pregnancy (163.1 ± 24.8 ml and $10.2 \pm 2.8 \times 10^6$ cells/ml, 169.3 ± 22.6 ml and $11.2 \pm 1.9 \times 10^6$ cells/ml, 169.8 ± 21.4 ml and $10.0 \pm 2.9 \times 10^6$ cells/ml respectively). The birth weight $\geq 3,600$ g, the first born baby, and the heavier placenta (≥ 550 g) produced significantly greater blood volume and cellular content (161.5 ± 20.6 ml and $9.8 \pm 2.4 \times 10^6$ cells/ml, 164.6 ± 19.4 ml and 9.6 ± 2.7 cells/ml, 164.8 ± 19.6 ml and $10.2 \pm 2.6 \times 10^6$ cells/ml respectively).

Conclusions: Primigravida, delivery between 37 to 40 gestation weeks, and no exposure to cigarette smoke during pregnancy were the maternal variables that were associated with larger blood volume and higher cellular content. Even though, first born baby, birth weight $\geq 3,600$ g, and placenta weight ≥ 550 g were the neonatal variables.

Key Words: Blood volume, Cellular content, Umbilical cord blood units, Predictive variables, In-utero collection, Stem-cell therapy

1. INTRODUCTION

The stem cell is a dominant cell that can form nearly any tissue in the human body. Peripheral blood, bone marrow, and umbilical cord blood (UCB), in that order of inclination are the main sources of stem cells.[1] The diversity of UCB-derived stem cells enables physicians to treat more than 70 life-threatening diseases.[2] UCB-derived stem cells provide hope to patients with chronic incurable diseases. Using UCB stem cells, clinical trials hold a promise for curative rather than palliative therapy for type I diabetes mellitus patients.[3]

There has been a rapid surge in UCB transplantation associated with increased number of cord blood banks throughout the world. Private or autologous cord blood banks are

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available to the owners and/or their family, while public or allogenic cord blood banks are open to all recipients whose tissue group matches.[4] It is important to state, that it was emphasized in a previous report of the European Commission "Ethical Aspects of Umbilical Cord Blood Banking", that it is right to support public cord blood banking for allogenic purposes.[4] However, it is imperative to reminder that the donations are made voluntarily.[5, 6]

Each individual has one chance in a lifetime to save one's own UCB. Accordingly, this requires nurses who are working at the delivery room to collect high-quality UCB units, consequently improving the chances of future lifesaving.[2] Acceptance or rejection of UCB units for banking are influenced by the number of stem cells per unit, which is mirrored by the total nucleated cell (TNC) content in each one.[7] Optimizing donor selection could be an abundant target for the nursing staff and obstetricians working in delivery room; they are the main responsible personnel for collecting UCB units.

Earlier researches investigated the donor's criteria that are associated with larger blood volume and higher cellular content. It was reported that type of delivery, parity, birth weight, sex of newborn, weight of placenta, and method of collection are correlated with either one or both of the two UCB quality indicators: UCB volume and TNC content.[8, 9] However, previous findings that gave attention to the maternal and neonatal variables which might increase suitability of UCB units for banking are still open for discussion.[10]

1.1 Significance of the study

About 54.1% of the collected cord blood units are discarded before processing due to volume deficiency, laboratory issues or shipping obstacles.[7] Research studies seeked for the factors affecting the blood volume and number of TNC obtained from the umbilical cord are inadequate in Egyptian population. Identifying these variables can result in reducing the cost and time spent in collecting, processing, and storing of unsuitable cord blood units.[10] Thus, the present study was conducted to identify the maternal and neonatal predictive variables for quality of cord blood as a source of stem cells.

1.2 Operational definitions

1.2.1 *Umbilical cord blood unit*

Umbilical cord blood unit is a special bag containing the collected cord blood. Umbilical cord blood is the blood left over in the placenta and in the umbilical cord after childbirth. It contains red blood cells, white blood cells, plasma, platelets and is also rich in hematopoietic stem cells. The blood can be collected by piercing vein of the umbilical cord using a needle connected to the cord blood bag.

1.2.2 *Quality of the umbilical cord blood unit*

Quality of the umbilical cord blood unit can be judged by the blood content of the stem cells per unit. Number of stem cells per each umbilical cord blood unit is mirrored by its TNC content.[7]

1.3 Aim of the study

This study aimed to identify the maternal and neonatal predictive variables for quality of cord blood as a source of stem cells.

1.4 Study question

To accomplish the aim of this study, one question was voiced: "What are the maternal and neonatal variables that can predict the higher quality indicators of UCB units; cord blood volume and TNC content?"

2. SUBJECTS AND METHOD

2.1 Research design

A descriptive design was followed to achieve the aim of the prevailing study.

2.2 Study setting

This study was conducted at the Operating Theater of Mansoura University Hospital, Egypt. It was the site of collecting the UCB units in this study. The operating theatre of Mansoura University Hospital receives around 1,500 pregnant mothers referred for cesarean deliveries annually. The hematology laboratory at the Oncology Center of Mansoura University Hospital was a supportive setting; where the TNC content was identified for each UCB sample.

2.3 Sampling

A purposive sample of 143 women assigned for elective cesarean section and their neonates was enrolled in this study. The women were eligible to be enrolled in the current research if was 1) Free from any medical or obstetric problems, 2) Assigned for elective cesarean section without experiencing stressful events of the first stage of labor. Each newborn baby was eligible to be joined in this research if had: 1) Umbilical cord not adversely affected by any abnormality that interferes with the blood aspiration; such as thrombi, false or true knot, 2) Free from known congenital anomalies, and 3) Recorded a first minute APGAR score of 7-10 points.

2.4 Sample size calculation

The aim of the existing study was to identify the maternal and neonatal predictive variables for quality of cord blood as a source of stem cells. A previous study by Keersmaekers et al. (2014), had shown that the neonatal birth weight

that met the TNC requirement was 3,503 ± 463 grams compared to 3,215 ± 453 grams for those that did not met the TNC requirement.[7] To calculate the sample size with precision/absolute error meet of 5% and type 1 error of 5%, the following formula was used: Sample size = [2 × (SD obtained from a previous study)^2 × (Z$_{\alpha/2}$ + Z$_\beta$)^2] / mean difference obtained from previous study.[11] Therefore, n = [2 × (463)^2 × (1.96 + 0.84)^2] / [3,503 − 3,215] = 142.02. Accordingly, the sample size required in this study was 143 women with their neonates.

2.5 Tool of data collection

One tool was used to collect the required data.

Tool I: Assessment sheet: The researcher used an assessment sheet of three parts in data collection. It enclosed basic characteristics of the pregnant women: in terms of maternal age, gravidity, gestation weeks and exposure to cigarette smoke during pregnancy. This section was completed from the medical records before delivery. Information on the newborn was included in the second part of the assessment sheet; particularly neonatal gender, birth weight, and order of birth. The last part of the assessment sheet included description of the placentae and the collected UCB units. Placentae were described by diameter, weight, and length of the umbilical cord, while the UCB units were assessed for its blood volume in ml, and TNC count. This sheet was completed by a researcher after childbirth. Content validity of the assessment sheet was proven by a panel of five experts in maternity nursing and obstetrics medicine.

2.6 Ethical considerations

The board of Obstetrics and Gynecology department of Mansoura University Hospital and Ethical Committee of Nursing Faculty approved the existing study conduction. Each participant woman was signed an informed written consent before childbirth. After assessment of the study outcome, the UCB units were endorsed to the Mansoura Research Center for Cord Stem Cells (MARC-CSC) staff members. The UCB units were used for research purposes only without any intend to donate it to any person before taking owner's permission.

2.7 Pilot study

A pilot study was done on 10% of the required sample (n = 14 UCB units). Its aim was to investigate clarity of the developed tool and to identify the barriers that may impede the researchers in collecting the blood units. Result of the pilot indicated that the tool's statements were clear and no corrections were done. Pilot sample was excluded from the analyzed study sample.

2.8 Field work

2.8.1 Preparation for the work

Before collecting the UCB units, the researcher who was responsible about the UCB units collection received a training; under patronage of staff members of MARC-CSC, on how to collect the UCB units from the cesarean section field without interfering the operating staff practices. As well as, got approvals for carrying out the research from the concerned authorities. This phase started on January 2016 and consumed around eight weeks.

2.8.2 Collection of UCB units

Initially, each eligible woman was signed an informed written consent after clarifying the study nature. To collect the UCB units, the trained researcher attended the operating theatre two days weekly. Researcher's attendance was based on the operating theater schedule of elective Cesarean deliveries. All UCB units were collected in utero; before placental separation. In utero collection was done according to the following steps: 1) The researcher scrubbed before the operation start; with the operating theatre team. 2) At the moment of childbirth, the surgeon was requested to clamp the umbilical cord as near from the baby's side as possible. This action aims to preserve the longest available part of the cord toward placental site. Thus, get larger blood volume. 3) The umbilical cord was transected within 10 seconds from childbirth; according to the protocol of care in the operating theatre, Mansoura University Hospital. 4) Before placenta expulsion and within few seconds from taking the newborn baby out of the surgical field to the radiant warmer, the distal part of the umbilical cord from the placental site was cleaned by 70% alcohol and Povidone-iodine swab. 5) The umbilical cord vein was punctured by needle of a cord blood collection set and the UCB was allowed to drain until the vein was shrunken. The UCB collection set is a specific set for UCB collection. It contains 30 ml anticoagulant (CPDA-1 U.S.P.). Total number of UCB units was collected in about six months; started from March to August 2016.

2.8.3 Assessment of the UCB units

Each UCB unit was taken after collection to be assessed for its volume and content of nucleated cells.

The UCB volume was determined in grams by using a weighing scale. Net volume of the harvested cord blood was calculated by deducting weight of the empty unit (42 g) and the anticoagulant volume (30 ml) from the gotten weight. Supposing that 1 gm equals 0.95 ml. The nucleated cell count was identified; by using an automatic cell counter (CELL-DYN 3700, Abbott Laboratories, and Abbott Park, IL) at the hematology laboratory, per 1 cm blood taken from the collected UCB unit. The TNC count per UCB unit was cal-

culated by multiplying the gotten number with the net blood volume. Thereafter, the collected data coded, analyzed, and correlated. This step took about two months; from September to October 2016.

2.9 Strengths and weaknesses of the study

Investigating of a new factor; the exposure to cigarette smoke during pregnancy, may strengthen the results of this study. On the other hand, collecting the UCB units from Cesarean births only and recruiting the healthy women and newborns may limit generalizing the present study findings. As, maternal and fetal compromise may influence the quantity and quality of cord blood stem cell.

2.10 Data analysis

All statistical analyses were performed using SPSS for windows version 20.0 (SPSS, Chicago, IL). Data were tested for normality of distribution prior to any calculations. Continuous data were normally distribute and were expressed in mean ± standard deviation (SD). Categorical data were expressed in number and percentage. The comparisons were determined using Student's t test or ANOVA test for variables with continuous data while chi-square test was used for comparison of variables with categorical data. Statistical significance was set at $p < .05$.

3. RESULTS

3.1 Descriptive data of the participant women, newborns, and placentae

The descriptive data of the participant women are demonstrated in Table 1. Mothers' age ranged from 20 to 40 years with an average of 26.8 ± 5.4 years. Among these mothers, 42 (29.4%) were primigravida while 101 (70.6%) were multigravida. The average gestational age of the current pregnancy was 38.5 ± 1.0 weeks with 18 (12.6%) of the women were between 37 weeks and 38 weeks, 108 (75.5%) were more than 38 weeks to 40 weeks and 17 (11.9%) were beyond 40 weeks. Table 1 also shows that 86% of the mothers were exposed to cigarette smoke.

The descriptive data of the participant newborns are shown in Table 2. Female gender represented 65 (45.5%) of the newborns, while 78 (54.5%) were males. The newborn average weight was 3,310.1 ± 547.7 grams. Of these newborns, 51 (35.7%) were the first born baby, while 92 (64.3%) were the second or more.

Table 3 clarifies the descriptive data of the placentae. The placental weight ranged from 300 g to 600 g with an average of 462.2 ± 75.8 g. The placental diameter ranged from 20-24 cm with an average of 21.8 ± 1.5 cm, while the umbilical cord length ranged from 54-59 cm with an average of 56.6

± 1.6 cm.

Table 1. Descriptive data of the participant women (n = 143)

Characteristics	Mean ± SD or n	%
Mother's age (years)		
Mean ± SD	26.8 ± 5.4	
Range	20-40	
Gravidity (n, %)		
Primigravida	42	29.4
Multigravida	101	70.6
Gestation age (weeks)		
37-38	18	12.6
> 38-40	108	75.5
> 40	17	11.9
Mean ± SD	38.5 ± 1.0	
Exposure to cigarette smoke		
Yes	123	86
No	20	14

Table 2. Descriptive data of the participant newborns (n = 143)

Characteristics	Mean ± SD or n	%
Newborn gender		
Female	65	45.5
Male	78	54.5
Newborn weight (gm)		
2,400-<3,000	53	37.1
3,000-<3,600	38	26.6
3,600-4,200	52	36.4
Mean ± SD	3,310.1 ± 547.7	
Range	2,400-4,200	
Order of birth		
First baby	51	35.7
Second or more baby	92	64.3

Table 3. Descriptive data of the placentae (n = 143)

Characteristic	Mean ± SD or n	%
Placental weight (gm)		
< 500	80	55.9
500 - <550	31	21.7
≥ 550	32	22.4
Mean ± SD	462.2 ± 75.8	
Range	300-600	
Placental diameter (cm)		
Mean ± SD	21.8 ± 1.5	
Range	20-24 cm	
Umbilical cord length (cm)		
Mean ± SD	56.6 ± 1.6	
Range	54-59 cm	

3.2 The UCB volume and TNC content according to the maternal characteristics

Table 4 shows that the UCB volume obtained from newborns of primigravidae was significantly greater than that obtained from those of multigravidae by a mean difference of 10.9 ml ($t = 2.85$, $p = .005$). Similarly, the TNC obtained from those of primigravidae was significantly greater than that obtained from those of multigravidae by 1.9×10^6 cells/ml ($t = 4.20$, $p < .001$). Newborns of women exposed to cigarette smoke during pregnancy, provided significantly lower UCB volume and cellular content compared to those not exposed to cigarette smoke by mean differences of 16.7 ml and 1.3×10^6 cells/ml; $p < .001$ and .036 respectively. The same table does not show significant difference between the mothers < 30 years and those $\geq$ 30 years of age regarding the obtained UCB volume nor the TNC content ($p = .259$ and .497 respectively). Figure 1 shows that the both UCB quality indicators; UCB volume and TNC content, were inversely correlated with the gestation age ($r = 0.173$, $p = .039$ & $r = 0.186$, $p = .026$ respectively). Equally, the UCB volume and TNC content were reduced by advanced gestation weeks beyond 40 weeks.

Table 4. The UCB volume and TNC content according to the maternal characteristics (n = 143)

Maternal characteristics	Blood volume (ml)	TNC count (×10⁶/ml)
	Mean ± SD	Mean ± SD
Maternal age (years)		
< 30 years	154.3 ± 21.3	8.8 ± 2.5
≥ 30 years	159.2 ± 22.0	9.1 ± 2.9
Mean difference	4.9	0.3
t	1.13	0.68
p	.259	.497
Gravidity number		
Primigravida	163.1 ± 24.8	10.2 ± 2.8
Multigravida	152.2 ± 19.2	8.3 ± 2.3
Mean difference	10.9	1.9
t	2.85	4.20
p	.005*	< .001**
Exposure to cigarette smoke		
Yes	153.1 ± 20.7	8.7 ± 2.5
No	169.8 ± 21.4	10.0 ± 2.9
Mean difference	16.7	1.3
t	3.33	2.12
p	< .001**	.036*

*$p < .05$; **$p < .01$

3.3 The UCB volume and TNC content according to the newborns and placental characteristics

Table 5 clarifies that there was no significant difference between the male and female genders in the produced amount of UCB nor TNC content ($p = .647$ and .193 respectively). The harvested blood volume and TNC count were significantly affected by the order of birth; in favor to the first order of birth. As, amount of the collected UCB and TNC content given by the first baby were higher than that obtained from the second or more babies by mean differences of 14.3 ml and 1.1×10^6 cells/ml respectively; $p < .001$ and .013 respectively.

It is obvious from Figure 2 that the blood volume obtained from the umbilical cord was positively correlated with the newborn weight ($r = 0.280$, $p < .001$, Figure 2a). Similarly, the TNC content obtained from the umbilical cord was positively correlated with the newborn weight ($r = .256$, $p < .001$, Figure 2b). As, the higher birth weight; $\geq$ 3,600 g, yielded significantly greater blood volume and higher cellular count. As shown in Figure 3 the heavier placentae ($\geq$ 550 g) gave significantly greater UCB volume and higher cellular count (164.8 ± 19.6 ml and $10.2 \pm 2.6 \times 10^6$ cells/ml; $p = .013$ and .003 respectively) compared to those < 550 g.

4. DISCUSSION

The present study aimed to identify the maternal and neonatal predictive variables for quality of cord blood as a source of stem cells. This aim was attained through the present study findings. The findings revealed the maternal variables that might predict the production of the UCB volume and the TNC count, as primigravida, childbirth between 37 to 40 weeks gestation, and the non-exposure to cigarette smoke during pregnancy. Even though, neonatal variables were the first born; whatever male or female, the larger birth weight $\geq$ 3,600 g, and those had heavier placenta $\geq$ 550 g. Thus, the study question "What are the maternal and neonatal variables that can predict the higher quality indicators of UCB units; cord blood volume and TNC content?" was answered.

On comparing amount of the obtained cord blood and total nucleated cell count according to the mothers' age, the present study findings revealed that there were no significant differences between the UCB volume and TNC content produced by the pregnant mothers < 30 years and those at or elder than 30 years of age. This finding is consistent with that of a Chinese study involved 10 in utero collected cord blood samples from elective Caesarean section.[6] Yet, the same finding is inconsistent with that of Wen;[12] found significant association between the mother's age and UCB volume and cellular content in an analysis of 1,549 UCB units of Taiwanian women. The difference between the present study finding and that of Wen, can be related to the difference of mean age of the subjects of the two studies.
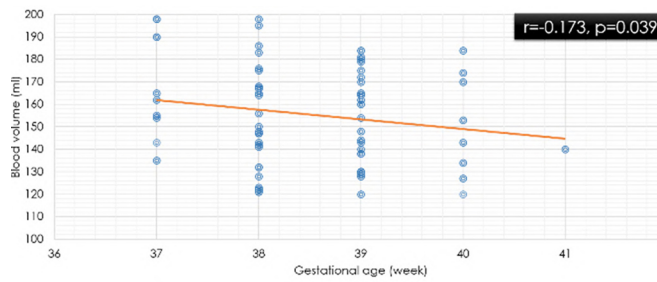
(Fig. 1a)
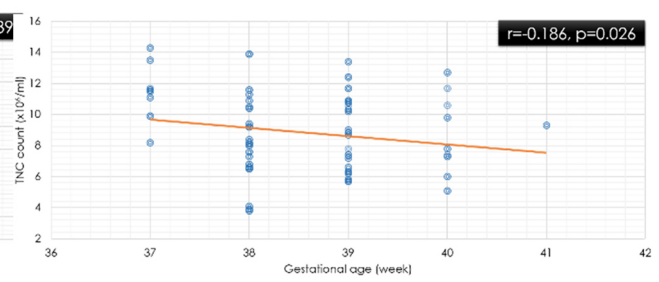
(Fig. 1b)

Figure 1. Correlation between the gestational age and (a) blood volume and (b) TNC

**Table 5.** The UCB volume and TNC content according to the newborn characteristics (n = 143)

| Neonatal characteristics	Blood volume (ml)	TNC count (×10⁶/ml)
	Mean ± SD	Mean ± SD
Newborn gender		
Female	154.5 ± 23.3	9.2 ± 2.6
Male	156.2 ± 20.0	8.6 ± 2.7
Mean difference	1.7	0.6
t	0.46	1.31
p	.647	.193
Order of birth		
First baby	164.6 ± 19.4	9.6 ± 2.7
Second or more baby	150.3 ± 21.0	8.5 ± 2.5
Mean difference	14.3	1.1
t	3.99	2.52
p	< .001**	.013*

$*p < .05$; $**p < .01$

The present study finding revealed a significant difference in the UCB volume and the TNC content produced by the primigravida and the multigravida; in favor to the primigravida women. Conversely, Keersmaekers et al.,[7] found no significant power of the gravidity number on the obtained UCB volume and its cellular content in a study included 7,839 in utero collected UCB units at Michigan. This disagreement

between the present study finding and that of Keersmaekers and colleagues could be related to the discrepancy between the subjects criteria. Keersmaekers' study included both low and high risk pregnancy and both vaginal and Cesarean deliveries, while the present study excluded high risk pregnancy and was limited to Cesarean birth only.

The current study demonstrated that the gestational age was inversely correlated with the collected blood volume and its cellular content. In other words, with advanced gestation beyond 40 weeks there were lower nucleated cell count and lesser blood volume. Parallel, Wen and coauthors[12] found gestation age beyond 40 weeks inversely influenced the UCB volume. This finding may be explained by the fact that with advancing gestation there is a physiological placental senescence causing a reduction in fetal oxygen supply and producing vasoconstrictors. Such changes result in decreased blood volume at birth. Yet, other studies[13, 14] showed a positive correlation between the gestation age and cellular content and attributed such increase of cellular content to the fetal defense mechanisms against hypoxia episodes associated with advanced gestation age and placental aging. Meanwhile, Abdelrazek and colleagues found no correlations between the gestational age and the both studied UCB quality indicators in a study involved UCB units of 200 Egyptian women.[15] Abdelrazek and colleagues attributed the given finding to selection of a narrow range of gestation age; from 35 to 40 weeks.
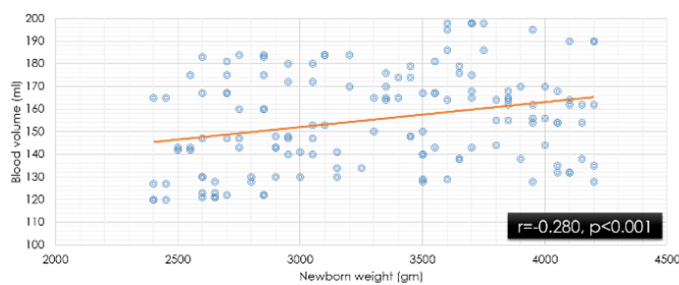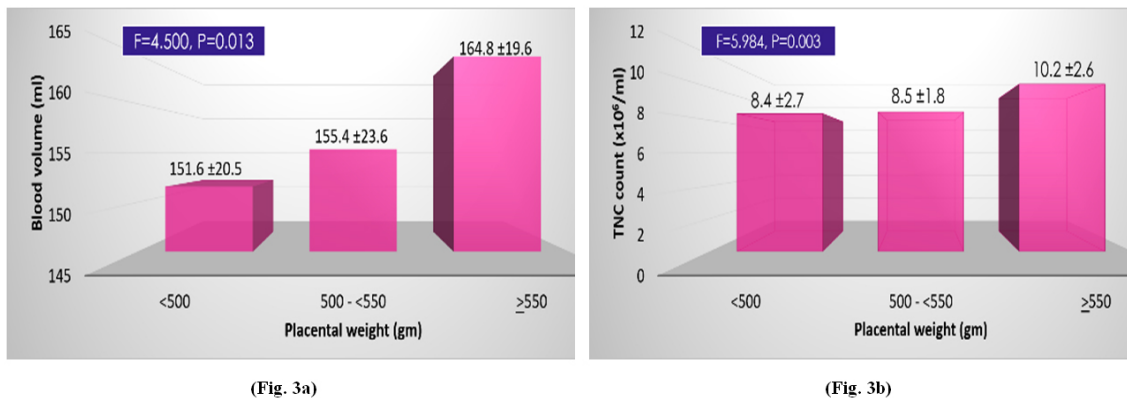

(Fig. 2a)
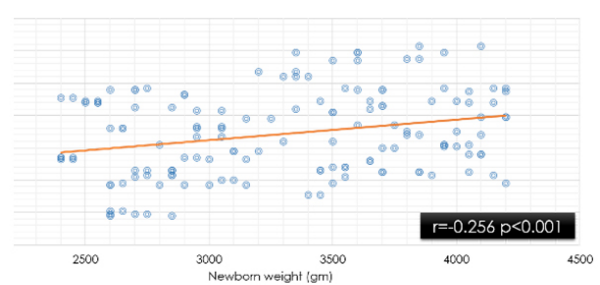
(Fig. 2b)

Figure 2. Correlation between the newborn weight and (a) blood volume and (b) TNC content

(Fig. 3a)   (Fig. 3b)

Figure 3. The association between the placental weight and UCB volume and TNC content

The present study subjects did not included active smokers. But a comparison between the cord blood volume and total nucleated cell content among the participants' exposed to cigarette smoke and those not exposed to cigarette smoke during pregnancy was done. It was evident in the current study that the passive smokers gave a lesser UCB volume and lower total nucleated cell count. Passive smokers are forced to breathe air contaminated by tobacco. This is resulting in increased risk of delivering smaller babies which in turn a predictor for lesser cord blood volume and lower cellular count.[16] Smoking factor was not considered in previous studies, making it difficult to compare the present finding with others.

The prevailing study found no significant difference between both neonatal genders for the given blood volume and nucleated cell count. Two previous reports enforced this finding.[8, 15] However, these findings are contradicted with other two studies.[7, 17] Female neonates were found to produce larger UCB volume and higher nucleated cell content in a study by Keersmaekers and colleagues,[7] while male neonates were reported to give larger UCB volume in an Egyptian study.[17] Cause of the present study finding is unclear. However, larger blood volume production with higher cell count among male gender can be explained by that the birth weight of males are heavier than that of females[18] and in the current study there was an evidence that with heavier birth weight there was larger blood volume and parallel higher cell count.

Unsurprisingly, the present study results showed a positive relation between the neonatal birth weight and UCB volume and content of the total nucleated cell. Herein, with increased neonatal birth weight from 3,600 g to above, there were larger blood volume and higher total nucleated cell count. To find the factors that can influence the acceptability of UCB units for banking, Keersmaekers et al.,[7] reported that greater birth weight was associated with greater UCB volume and total

nucleated cell count and reinforced the present study finding.

Congruence with the current study findings and that of Keersmaekers, Brazilian study[19] conducted on 458 UCB units at a public UCB bank in Santa Catarina. The Brazilian study investigated the relation between certain obstetric variables including neonatal weight, and UCB quality indicators. The investigators of such study found that the greater UCB volume and total nucleated cell content were were associated with increasing neonatal weight than 3,500 g. Authors of the present study, attributed the larger blood volume among bigger neonates to the evidence that each 1.98 g increase in birth weight is related to an increase of 1 gm increase in placenta weight. This increase in placenta weight results in increased vascularity in the placental disc and giving a larger blood volume.[20]

In the current study, there were significant differences between the blood volume and nucleated cell content taken from the first baby and those taken from the after coming ones. There were larger blood volume and higher cellular count among the first born babies compared to the second or more babies. Approved with the present study finding, Ballen and colleagues[21] observed a significant association between the birth order and the UCB blood content of total nucleated cell in favor to the first baby. As the first baby had a cell count of 2.6×10^6 cells, second baby 2.4×10^6 cells, third baby 1.9×10^6, and subsequent babies 1.3×10^6 ($p < .001$). There was a decrease in the UCB volume with each subsequent live birth.

Authors of the present study attributed this finding to two reasons. First reasoning is a notional hypothesis; first babies have the most advantageous values with decreasing advantages in upcoming births. The second reasoning is that the first baby exposed to a longer duration of labor equated to the after coming ones. Longer exposure to uterine contractions was reported to be associated with higher number of

neonatal nucleated cell count.[22] Conversely, this finding is contradicted with that of a Brazilian study[23] involved 40 UCB units and with Abdelrazek and coauthors findings;[15] stated that order of birth was found to have no impact on the UCB cell count without stating a clear explanation for such findings.

It was observed in the current study that with increased placental weight; over 550 g, there was larger blood volumes and higher total nucleated cell count. Agreed with this finding, Italian study[24] examined the relation of placental weight with the collected UCB volume and its total nucleated cell content in 304 collected UCB units. The Italian study was revealed that with increasing placental weight over 600 g, there was a larger production of blood volume and higher nucleated cell content.[24] This finding may be explained by the notion that with increased placental weight, there is higher fetal blood supply giving greater blood volume and so cellular content. However, Abdelrazek et al.,[15] partially agreed with this finding and casts doubt the current study evidence; heavier placenta provides larger blood volume and higher cell count, by demonstrating that placental weight positively associated with the collected blood volume not total nucleated cell count.

Nursing implications

The need for UCB units is more likely to increase in the near future. It is essential that the staff working at the labour and delivery room share in making guiding principles regarding UCB stem cell collection. This is may be achieved by un-derstanding the factors that improve the amount and cellular content of cord blood. Hence that more units are available for utilization.

5. CONCLUSION AND RECOMMENDATIONS

Briefly, UCB units with larger blood volume and higher cellular content could be gained from the first born baby with higher birth weight and heavy placenta belonged to primigravida at earlier gestation; between 37 to 40 weeks, and did not exposed to cigarette smoke during pregnancy. Irrespective to the neonatal gender or the mother's age. These findings incite the following recommendations:

(1) Maternity staff are advised to consider, gravidity number, gestation weeks, exposure of mothers to cigarette smoke, placental weight, and neonatal order of birth and weight in collecting in utero UCB units from neonates born by Cesarean section.

(2) Future research studies exploring the hypothesis "maternal and fetal compromise may positively affect the sufficiency and efficiency of cord blood stem cell"; would be of interest.

CONFLICTS OF INTEREST DISCLOSURE

The authors declare that there is no conflict of interest.

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