IJN
Iranian Journal of Neonatology
http://ijn.mums.ac.ir

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Original Article

Effect of Blood Sampling Site on the Changes in the Physiological Indices of Preterm Infants: A Crossover Clinical Trial

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ABSTRACT

Background: Venipuncture is one of the most painful and common interventions in Neonatal ward. A preterm infant can not cope long-lasting physiologic stresses; therefore, the pain caused by blood sampling may change the infant's physiologic responses to the stress. This present study aim is to investigated and compare physiologic changes (pulse rate and oxygen saturation) in two sites of blood sampling in preterm infants.

Methods: This crossover clinical trial was performed on 105 preterm infants of 28-32 weeks' gestational age in Tabriz Alzahra teaching hospital. Infants were selected through convenient sampling method and were allocated to two groups using doubleblock. In group 1(53 infants): the blood was first drawn from head veins and after a 24-hour interval, it was repeated at the back of the hand. In group 2 (52 infants): this procedure was implemented conversely.Infants' demographic variables and physiologic values(pulse rate and oxygen saturation) were measured in both sampling methods. The data were analyzed using SPSS.13, Paired t-test and Friedman test. P< 0.05 was considered as significant.

***Results*:** There was a significant difference between two groups considering infants' age and various assessing timeswhen pulse rate changeswere investigated (Pv≤0.001);however, no significant difference was found regarding toblood sampling sites(head & back of the hand)).In addition, no significant difference was found in oxygen saturation changes in terms of age and blood sampling sites(head& back of the hand); however, these changes were significantly different in terms of different blood sampling times (PvTIME≤ 0.001).

Conclusion: Pulse rate and oxygen saturation changingwas not significantly different in two methods of blood sampling from head veins and back of the hand veins in preterm infants; therefore, both sites can be used for drawing blood. During blood sampling in preterm infants of lower gestational age, the rate of pulse increased;however, the level of oxygen saturation decreased. As a result, since infants of lower gestational age are more vulnerable, drawing blood is required to be performed at the first attempt and no more attempts should be made.

Keywords: Blood, Hand, Head, Infant, Physiologic, Venipuncture

Introduction

Infants hospitalized in the neonatal intensive care unit (NICU) are often exposed to painful interventions repeatedly (1). Blood sampling is a frequent, painful intervention in the NICU (2), which is part of disease diagnosis and medical procedures (3). Based on priority, the selected veins to be pricked for drawing blood are the antecubital vein, veins in the back of the hand, dorsal foot vein, great saphenous vein in the ankle, jugular vein, hand/foot central vein, and scalp veins (4).

Venipuncture comprises 8-13% of invasive therapeutic interventions (3). The importance of venipuncture in infants is emphasized in the cases requiring more blood, non-hemolyzed samples,

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Please cite this paper as:
Pourashoori Z, Mirnia K, Ghorbani F, Safaiyan A, Nematzadeh MA, Arshadi Bostanabad M. Effect of Blood Sampling Site on the Changes in the Physiological Indices of Preterm Infants: A Crossover Clinical Trial. Iranian Journal of Neonatology. 2018 Sep: 9(3). DOI: 10.22038/ijn.2018.27487.1366

inability of capillary sampling due to poor perfusion, blood culture, and precise diagnosis of polycythemia (4). Venipuncture is one of the most painful and common interventions in NICUs. The pain caused by venipuncture leads to justifiable physiological changes in the body in response to stress (5) as a result of increased catecholamines, pulse rate, blood pressure, and intracranial pressure.

In preterm infants, classic stress signs (e.g., pulse rate, high blood pressure, anxiety) are not reliable indices for painful stimuli (6). It has been proven that preterm infants respond to pain more than term infants (7). Preterm infants cannot bear long-lasting physiological stress (8). Some of the measurable behavioral and physiological reactions to painful stimuli in preterm neonates are facial changes, crying, increased pulse rate, and decreased arterial blood oxygen saturation (9).

Minimizing physiological changes in premature infants is of paramount importance to healthcare providers. Therefore, extensive research has been focused on the effects of drawing blood on the pain intensity and physiological indices of newborns across the world. In these studies, the physiological and behavioral responses of neonates to the pain caused by blood sampling have been investigated. According to the findings, the pulse rate increases, and the oxygen saturation decreases after blood sampling (10-13). However, no studies have compared the changes in the pulse rate and oxygen saturation between blood sampling from the head and dorsal hand veins.

Blood tests are necessary for diagnostic and therapeutic purposes in newborns, particularly preterm infants. On the other hand, the stability of vital signs is of paramount importance in the neonatal developmental care programs for premature infants. Therefore, it is crucial to select the most appropriate sampling site that is easy to access and causes the least physiological changes in infants in order prevent the short-term and long-term damages caused by repeated sampling, especially in preterm infants.

The present study aimed to compare the effects of sampling site on the changes in the physiological indices between blood sampling from the head veins and dorsal hand veins.

Methods

Study Design

This single-blind, crossover clinical trial was conducted on 105 preterm infants requiring venous blood sampling during days 4-8 of birth. The study setting was the NICU of Alzahra Hospital in Tabriz, Iran. The infants were allocated to two groups with the gestational age of 28-30 weeks and six days and 30-32 weeks and six days. Inclusion criteria were receiving no sedatives within 12 hours before the procedure and undergoing no invasive interventions within six hours before blood sampling. Exclusion criteria were as follows: 1) maternal smoking habits/substance abuse; 2) congenital disorders; 3) skin disorders on the infant's hand or head; 4) failure to draw blood on the first attempt; 5) instable vital signs in the infant before blood sampling and 6) five-minute Apgar score of <6.

Inclusion and Randomization

This study was registered in the website of the Iranian Registry of Clinical Trials (No. IRCT2016042513691N6; ethical code: IR.TBZMED.REC.1395.136). The qualified infants were selected via convenience sampling and allocated to two groups using the RAND listing software through double-block.

Objectives of the research were explained to the parents of the neonates; they were assured of the safety of blood sampling, and written informed consent was obtained. Maternal and neonatal demographic data were recorded, including gestational age, gender, weight, risk factors for preterm delivery, and maternal drug use during pregnancy. In addition, physiological changes in the infants were collected using questionnaires.

Intervention

Physiological indices of the infants included changes in the pulse rate, respiratory rate, blood pressure, temperature, and oxygen saturation (14). In the present study, changes in the pulse rate and oxygen saturation were recorded after drawing blood from the infants with stable cardio-respiratory status. Normal measures for these indices in stable status were considered to be over 88% for oxygen saturation, pulse rate of 120-160, respiratory rate of 40-60 per minute, and axillary temperature of 36.5-37.3◦C (15, 16).

Venipuncture was performed twice on each infant (once from the head veins at the frontal orparital area and once from the veins in the back of the hand). In the first group, blood was initially drawn from the dorsal hand veins. After a 24-hour interval, the procedure was repeated for the head veins. In the second group, the procedure was performed conversely (blood drawing from the head veins followed by the veins in the back of

the hand). A maximum of 2 cc of blood was drawn without syringe using the droplet method into test tubes. Sampling was performed during 8:00 AM-2:00 PM in the NICU at the temperature of 23-26◦C at the interval between two feeding times. Samples were provided while the infants were awake and in the supine position while receiving the least developmental care, including nesting.

The supine position was carried out since two minutes before starting the sampling procedure until six minutes after the procedure. To draw blood from the head veins, a soft elastic band (model: Coban/3M healthcare, D-41453 Neuss, Germany) with the width of 1.5 centimeters was used as the tourniquet around the head on top of the eyebrows in order to avoid touching the eyes of the infants. Sampling was implemented without shaving the head. To draw blood from the back of the hand, a nurse circled her hand around the infant's wrist (C-shape grip with the thumb on the infant's fingers and other four fingers at the bottom as a pit).

Blood sampling was performed using Angiokit BIO.FLON (India) No. 24. In the sampling of the head veins, Angiokit was inserted an angle of 15-20 degrees and In the sampling of the hand veins, an angle of 25-45 degrees (4). Sampling procedures were carried out with a single attempt; if not successful, no other attempt was made, and the infant was excluded from the study.

To measure the physiological indices during sampling, we used a Massimo monitor (model: Saadat/S1600). Following that, a pulse oximetry sensor was attached to the infant's foot to monitor the pulse rate and oxygen saturation since two minutes before the procedure until six minutes after sampling. Additionally, a camera (model: Samsung Galaxy S5/16 MEGA) was placed on the monitor in order to record the physiological indices of the neonates. At the end of the sampling procedure, data were extracted from the recorded videos.

Data Collection

Two researchers provided the data collection forms, which consisted of demographic and physiological information. Face and content validity of these forms were evaluated by 10 nursing professors and neonatologist. Moreover, data validity was identified using Cohen's Kappa coefficient and estimated at 87% in the first 10 cases.

Statistical Analysis

Data analysis was performed in SPSS version 13. Nested repeated measures analysis was used to compare the crossovers formed in five periods at two-minute intervals (-2, 0, 2, 4, 6), which were nested in two sites (hand and head) and two age groups (28-30 weeks and six days, 30-32 weeks and six days). The results were expressed as Mean±SE at 95% confidence interval (CI) and P-value of less than 0.05.

Result

In total, 105 preterm infants were investigated in two groups. Gestational age of the neonates in the first and second group was 28-30 weeks and six days (mean weight: 1096.73±8.83 grams) and 30-32 weeks and six days (mean weight: 1710.94±13.17 grams), respectively. Five-minute Apgar score of the neonates was 7-10.

In both groups, the infants were homogenous in terms of birth weight, gestational age at birth, and illness severity upon admission to the NICU. Moreover, no significant differences were observed between the groups in terms of demographic variables, such as gender, mode of delivery, and congenital factors of preterm delivery (e.g., multiple birth, preeclampsia). Demographic characteristics of the neonates are presented in Table 1.

Table 1. Demographic Characteristics of Preterm Infants in Two Groups

Variable		Gestational Age		Total	P-value
		30-32	28-30		
		N (%)	N (%)	N (%)	
Gender	Male	30 (56.6)	26 (5)	56 (53.33)	0.338
	Female	23 (43.4)	26 (5)	49 (46.67)	
Mode of Delivery	Natural Vaginal	9 (16.98)	14 (26.92)	23 (21.9)	0.082
	C-section	44 (83.02)	38 (73.08)	82 (78.1)	
Preeclampsia	No	34 (64.15)	31 (59.62)	65 (61.9)	0.499
	Yes	19 (35.85)	21 (40.38)	40 (38.1)	
Maternal Diabetes	No	47 (88.68)	48 (92.31)	95 (90.48)	0.371
	Yes	6 (11.32)	4 (07.69)	10 (09.52)	
Maternal Thyroid Disorders	No	47 (88.68)	45 (86.54)	92 (87.62)	0.638
	Yes	6 (11.32)	7 (13.46)	13 (12.38)	
Multiple Birth	No	33 (62.26)	38 (73.08)	71 (67.62)	0.094
	Yes	20 (37.74)	14 (26.92)	34 (32.38)	

Chi-square test

Table 2. Comparison of Oxygen Saturation (SO2) Changes in Preterm Infants during Blood Sampling from Scalp and Dorsum of Hand at Different Periods and Sampling Sites

Age Groups		28-30 Weeks (n=52)		30-32 Weeks (n=53)	
Method		Scalp	Hand	Scalp	Hand
Variable	Time	Mean±SE	Mean±SE	Mean±SE	Mean±SE
SO2	-2	95.54±0.33	95.38±0.38	95.83±0.35	95.87±0.31
	0	94.46±0.42	94.25±0.55	94.47±0.4	95.43±0.35
	2	94.19±0.52	94.35±0.5	95.06±0.4	95.58±0.43
	4	94.88±0.48	94.63±0.48	95.79±0.32	95.79±0.4
	6	95.75±0.29	95.33±0.38	96.15±0.3	96.15±0.34
	Total	94.97±0.19	94.79±0.21	95.46±0.16	95.77±0.16
P-value	Model	Matching=0.707; Time=0.000; Type=0.791; Age Group=.582			

Nested repeated measure with controlled confounding variables

Table 3. Comparison of Pulse rate Changes in Preterm Infants during Blood Sampling from Scalp and Dorsum of Hand at Different Periods and Sampling Sites

Age Groups		28-30 Weeks (n=52)		30-32 Weeks (n=53)	
Method		Scalp	Hand	Scalp	Hand
Variable	Time	Mean±SE	Mean±SE	Mean±SE	Mean±SE
Pulse Rate	-2	150.23±2.34	150.23±2.66	149.65±2.46	149.31±2.53
	0	169.73±2.69	164.4±2.95	167.21±2.62	167.81±2.56
	2	164.38±2.99	159.29±2.78	159.96±2.79	159.7±3.09
	4	160.88±2.7	154.23±2.6	151.62±2.87	154.85±2.95
	6	156.33±2.62	155.29±2.58	147.45±2.95	149.32±2.37
	Total	160.31±1.26	156.69±1.24	155.2±1.3	156.22±1.28
P-value	Model	Matching=0.748; Time=0.000; Type=0.553; Age Group=0.000			

Nested repeated measure with controlled confounding variables

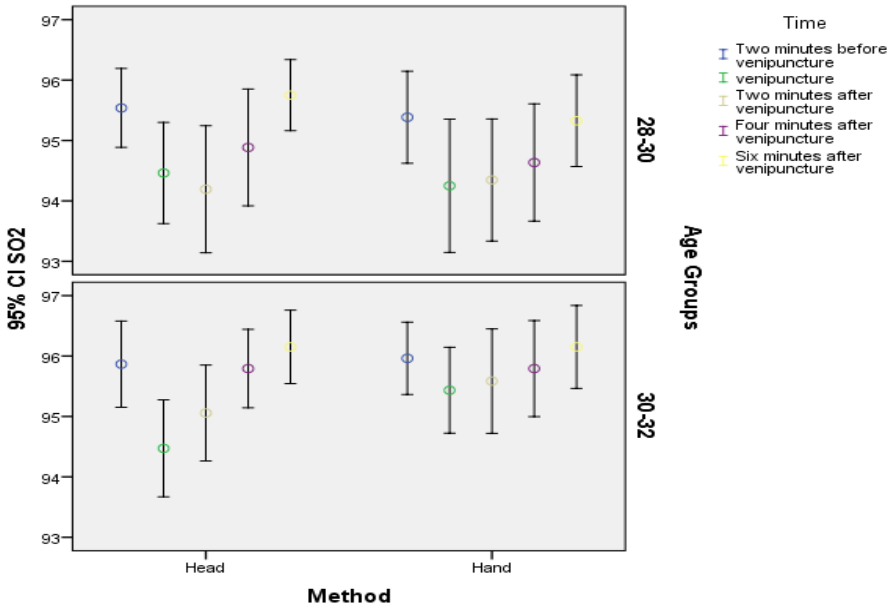

Figure 1. Comparison of Changes in Oxygen Saturation (SO2) between Head and Hand Blood Sampling Sites

In the present study, changes in physiological indices (pulse rate and oxygen saturation) were recorded and compared since two minutes before sampling until six minutes after the procedure at five intervals. Changes in the physiological indices of the infants in terms of sampling sites (head and hand) are shown in tables 2 and 3. According to the information in these Table 2 and Figure 1, changes in oxygen saturation (SO2) were not significantly different between the two groups in terms of the gestational age (P≤0.582) or sampling sites (P≤0.791). However, a significant difference was observed in the times of drawing blood between the study groups (P≤0.001).

According to the information in Table 3 and Figure 2, there was a significant difference between the two groups in terms of age range

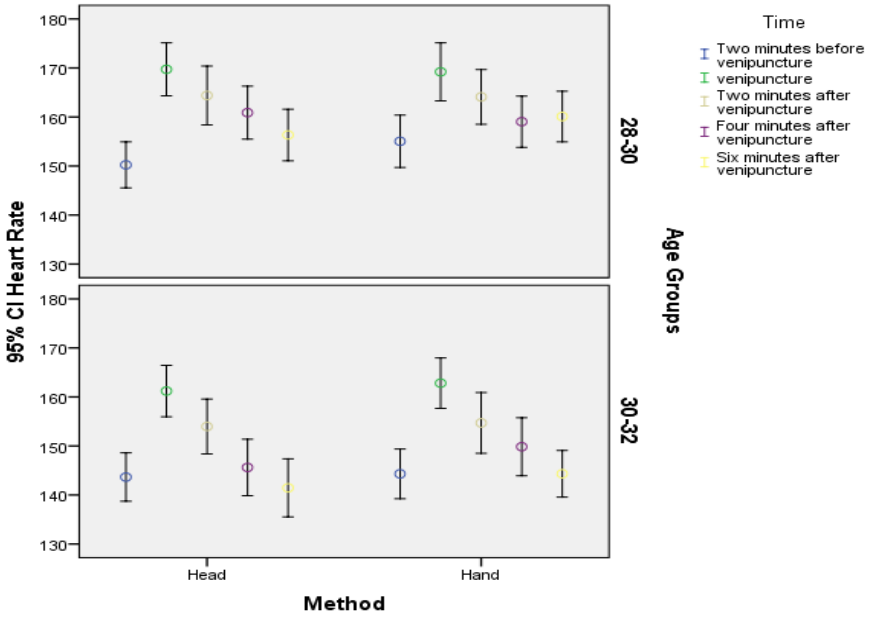

Figure 2. Comparison of Changes in Pulse Rate between Head and Hand Blood Sampling Sites

(P≤0.001) and sampling times (P≤0.001). However, the difference was not statistically significant compared to the sampling sites of head and hand (P≤0.553).

Discussion

The present study aimed to investigate and compare the changes in the pulse rate and oxygen saturation of preterm infants in two sampling sites. In the group with the gestational age of 28-30 weeks, pulse rate increased and returned to the relaxation state at a lower speed compared to the group aged 30-32 weeks at the time of drawing blood. Changes in the oxygen saturation were similar in the study groups in terms of age range and sampling site (head and hand), and no significant differences were observed in this regard.

According to the current research, the physiological indices in both groups were similar in terms of the sampling sites. However, oxygen saturation decreased significantly while drawing blood, which could be the sign of metabolism increase in response to the pain caused by the procedure, as well as the increased need of the body for oxygen (9). In preterm infants, physiological responses to painful procedures differ from those of children and adults. The muscular power of the heart is lower in preterm infants compared to those with a higher gestational age; therefore, the pulse rate increases in preterm infants compared to term infants in order to compensate for oxygen saturation.

Some researchers have denoted that preterm infants are not able to present appropriate behavioral and physiological reactions to painful procedures (17, 18). However, other researchers have stated that premature infants have a lower pain threshold compared to term infants and express more physiological reactions following obvious painful procedures (3, 19, 20). In the study by Liisa Holsti et al. (2006), which aimed to compare the behavioral and physiological responses in preterm infants with the gestational age of 25-32 weeks, the pain response, pulse rate, and sleep-wake time were investigated in 43 infants during various stages of drawing blood in relaxation and cluster nursing care. In the mentioned study, higher pulse rate was reported in the infants with lower gestational age (21), which is consistent with the results of the present study.

In a study by Kurdahibadar et al. (2010), which aimed to investigate the behavioral and physiological responses to heel puncturing in 72 infants with the gestational age of 27-40 weeks, the premature infant pain profile scale showed higher scores in the infants with lower gestational age compared to others. Furthermore, the findings of the mentioned research indicated that although behavioral and physiological signs were not apparent in the preterm infants during a painful procedure, the expressed responses were nonetheless severe (22).

In similar studies, physiological responses during blood sampling from different sites have

been compared. For instance, in the study by Manuprakash (2012), the response to pain and physiological changes caused by blood sampling from the hand and heel were investigated in term infants. Moreover, the pulse rate, respiratory rate, and oxygen saturation were evaluated. In response to painful stimuli in both groups, the pulse rate increased, while the respiratory rate and oxygen saturation decreased (23). These findings are consistent with the present study, showing that infants have similar physiological changes in response to the pain caused by blood sampling.

According to the study by Mirzarahimi et al. (2013), arterial oxygen saturation was significantly lower after drawing blood from the heel compared to before sampling. However, the pulse rate was higher after drawing blood compared to before the procedure. This is in congruence with the results of the present study (24). Similarly, Manish Shrestha et al. (2012) investigated the effect of two sampling sites. In addition, the pulse rate and oxygen saturation of the term infants requiring blood sampling were investigated. After a certain period, notable changes were observed in the two groups, such as increased pulse rate and decreased oxygen saturation. However, these changes were significantly higher in the heel-punctured infants compared to those undergoing venipuncture (25). Consistent with the current research, the study by Manish indicated that the process of similar physiological changes was apparent, while the reported changes in physiological indices were inconsistent with our findings in terms of the sampling site.

Although few studies have investigated the pain caused by drawing blood from the head in preterm infants, using head veins have been reported to be more appropriate for sampling. For instance, the results obtained by Schlueter et al. (26) and Peihua et al. (27) denoted that head veins could be used in several blood sampling procedures with fewer complications in infants, particularly those requiring respiratory support. This could be due to the fact that the subcutaneous tissue is particularly thinner in preterm infants compared to term infants (26). The results of the aforementioned studies prove the issue that blood could be drawn from the head veins of preterm infants with fewer complications. In general, sampling from different parts of the body could lead to variable physiological responses.

Conclusion

According to the results, there was no significant difference between blood sampling from the head and hand veins in terms of oxygen saturation and pulse rate in premature neonates. Therefore, it could be concluded both the head and hand veins could be used for drawing blood from preterm infants in NICUs.

Acknowledgments

This study was extracted from a master's thesis on NICU nursing. Hereby, we extend our gratitude to the NICU manager and staff of Alzahra Teaching Hospital in Tabriz, Iran. We would also like to thank the assistant director of research at Tabriz University of Medical Sciences for sponsoring this reesrach project.

Conflicts of interests

None declared.

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