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Effect of Different Positions on Arterial Oxygen Saturation during Enteral Feeding of Preterm Infants Admitted to Neonatal Intensive Care Units

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ABSTRACT

Background: This study aimed to determine the effects of various positions on the arterial oxygen saturation during enteral feeding of preterm infants admitted to Neonatal Intensive Care Units (NICUs). It is assumed that different body positions influence arterial oxygen saturation during enteral feeding.

Methods: This crossover clinical trial included 88 infants. The inclusion criteria were gestation age of fewer than 32 weeks, a weight of 1001-1500 gr, age of fewer than one month, 5-minute Apgar score of at least 5, exclusive breast-feeding, absence of any underlying illness, no oxygen therapy, and a minimum feed volume of 10cc for two h. The subjects were selected from the infants admitted to NICUs at Alzahra, Shahid Beheshti, and Amin hospitals, Isfahan, Iran, using a convenience sampling method. Subsequently, they were randomly assigned to four groups of 22 cases per group. The four groups were A, B, C, and D who were initially positioned on the left side, supine, prone, and right side, respectively. The arterial oxygen saturation was recorded on a minute-by-minute basis 5 min before, during, and 5 min after enteral feeding. Data were analyzed in STATA software (version 14) using a one-way analysis of variance, (ANOVA), linear mixed model, and the Chi-square test.

Results: According to the results of the one-way ANOVA and Chi-square test, no significant difference was observed among the four groups regarding the demographic characteristics. Moreover, the linear mixed model revealed no significant difference among the four groups of intervention, the four periods of the study, and carryover effect in terms of the mean oxygen saturation before, during, and after enteral feeding.

Conclusion: The results revealed that variations in infant positions during feeding had no effects on the arterial oxygen saturation. Therefore, neonatal nurses are advised to carry out enteral feeding without unnecessary changing of the infant position, which leads to lower manipulation, and improved sleep and awakening cycle of the infants.

Keywords: Enteral feeding, Infant, Oximetry, Positions, Preterm

Introduction

With the advancement of science and technology in the past decades, the survival and birth of preterm infants have increased significantly resulting in a growth of premature infants requiring special care (1). Moreover, preterm infants who are at more risk and immaturity are recognized as the most important cause of death in the first month of life (2). However, the overall survival rates of preterm infants are on the rise due to the extensive use of neonatal intensive care since the early 1970s (3). As reported by the World Health Organization, the number of infants with very low birth weight in Iran is 7% with preterm birth accounting for 31% of infant mortality (4).

According to the World Health Organization, the term "preterm" describes infants who are born before 37 weeks of gestation (5). Therefore, preterm infants are at the risk of various illnesses due to the lack of balance and coordination

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between different systems of the body. This highlights the importance of access to a team of specialists, nurses, and caregivers (6). These infants require long-term care to compensate for growth deficiency and prevent neurological disorders. In this context, one of the major problems is feeding these newborns (7).

The interventions carried out to improve nutrition and accelerate personal and long-term health, as well as the well-being of the newborns, have significant influences on reducing the infant mortality rate in the community. Considering the increasing number of neonates in need of special care, attempts have been made to minimize the length of hospitalization in Neonatal Intensive Care Units (NICUs) so that more newborns can benefit from these special cares (6). Therefore, with regard to the importance of weighing and curtailing the length of preterm infants' stay in the NICU, interventions that can shorten the length of admission for preterm infants can mitigate the complications associated with neonatal admission in the NICU to a large extent.

The goal of primary care offered to preterm infants is to accelerate weight gain and prevent complications that may have a deleterious effect on the growth of healthy infants. Accordingly, enteral feeding is the first strategy recommended for preterm infants, which offers benefits, such as lower septic complications and mortality rate, as well as faster weight gain, and shorter length of stay (8). On the other hand, the preterm infants have poor suck-swallow coordination, and therefore, cannot be breastfed or bottle-fed. As a result, until they learn how to suck properly, the gastric-tube feeding will be an approved method for proper enteral feeding (9).

The positioning of infants, which is one of the main duties of neonatal nurses (8), plays a key role in lung and gastrointestinal function of preterm infants (10). Therefore, proper positioning during and after feeding by nurses can enhance feeding tolerance in preterm infants (11). In addition, it has been shown that various body positions may influence the amount of arterial oxygen saturation in infants with respiratory impairment admitted to the NICUs. Sam conducted a study to investigate the effect of prone and supine positions on the amount of arterial oxygen saturation in newborns with respiratory impairment admitted to NICUs, according to the results, the prone position had a significantly higher effect, compared to the supine position upon the first, second, and third days of admission. Furthermore, he reported that the sequence of position had no significant effect on the amount of arterial oxygen saturation (12). Studies have demonstrated the effect of body position on arterial oxygen saturation, gastroesophageal reflux, lung function, breathing pattern improvement, stress relief, and improved gastric discharge. Moreover, the supine position is usually used in NICUs during gavage feeding.

With this background in mind, this study was conducted to explore whether various body positions during gavage feeding had a bearing on arterial oxygen saturation or not. Moreover, it aimed to understand which of these positions exerted a greater impact in this regard. To this end, this study examined the impact of various body positions on the amount of arterial oxygenation during enteral feeding in preterm infants admitted to the NICUs of the selected hospitals affiliated to Isfahan University of Medical Sciences, Isfahan, Iran. Accordingly, it is hypothesized that the mean arterial oxygen saturation is different during gastric tube feeding of preterm infants at different body positions.

Methods

This crossover clinical trial included four groups from whom the data were collected in three stages. The data were collected for 11 months from the infants who were admitted to NICUs at Medical and Educational Centers of University (Alzahra, Shahid Beheshti and Amin hospitals) in Isfahan, Iran. The sampling was carried out using a convenience method so that available subjects were selected until the desired sample size was obtained. After referring to the selected hospitals and gaining permission from the authorities and the head of the NICUs, the researcher listed the names of all preterm infants who met the inclusion criteria.

Each subject was randomly assigned to one of the four groups under study, including groups A, B, C, and, D who were initially positioned on the left side, supine, prone, and right side, respectively. The subjects were assigned to each group using random draws until the sample size was complete. Initially, a sample size of 20 cases per group was estimated based on the comparison of a variable (mean of arterial oxygen saturation) considering a 95% confidence level, 80% power test, with at least 0.9 S, and a 10% dropout rate in each group. Finally 22 subjects were selected for each group (a total of 88 subjects). It is worth mentioning that no dropout was reported during the study.

The inclusion criteria were: 1) gestation age of fewer than 32 weeks, 2) a weight of 1001-1500 g,

3) chronological age of fewer than a month, 4) 5-minute Apgar score of at least 5, 5) exclusive breastfeeding, 6) lack of underlying conditions, such as congenital cardiovascular diseases, sepsis, and metabolic diseases, 7) a stable hemodynamic condition, 8) no oxygen therapy in infants, and 9) the feed volume of at least 10 cc every 2 h.

On the other hand, the infants whose parents were unwilling to continue the study, and those who experienced health deterioration during the intervention or had feeding intolerance and oxygen saturation of less than 85% during feeding along with the cases who were subjected to other feeding methods by the physician were excluded from the study. It should be noted that infants with health deterioration were referred to a specialist.

The data were collected through intervention, testing, observation, questioning, and studying the medical records of subjects for using demographic characteristics form covering such information as birth weight, weight and age at the time of entering the study, gender, 5-min Apgar score, body temperature, and gestational age. Moreover, a monitor manufactured by Pooyandegan Rahe Salamat Co.,(CE1254 model, Iran), a pulse oximeter (Soureafarinesh Co. Iran), a finger probe (Dolphin model) for neonates, a digital thermometer, were utilized to measure the amount of arterial oxygen saturation, heart rate, and body temperature through the armpit. The above data were recorded in questionnaires and the checklists.

After obtaining the necessary permissions and explaining the research objectives and procedure, the researcher selected the subjects. Furthermore, the researcher informed the parents of infants about the research goals and procedure followed by obtaining written informed consent from them. The demographic characteristics of the infants (i.e., age, gender, and birth weight) were obtained from the neonate's medical file, and the researcher ensured that pulse oximetry or special care monitor were operating properly. The sampling was conducted based on a convenience method in which the infants who were fed via the gastric tube were randomly assigned to four groups.

To do this, a number of cards labeled A to D were poured into a box and a random card was drawn for each infant. Accordingly, the infants in group A were first positioned on the left side and then changed into the right-side followed by prone and supine positions every two h. In the second group (Group B), the infants were initially placed in the supine position and then changed into the left-side followed by the right-side and prone positions every two hours. In the third group (Group C), the newborns were initially placed in the prone position and then placed in the supine position followed by left-side and right-side positions every two h. Finally, the infants in the fourth group (Group D) were initially placed in the right-side position and then prone position followed by supine and left-side positions every two h.

The newborns were placed in one of the positions (interventions) for 30 min at a 30-degree angle. At this time, the neonates in all groups were fed with a gastric tube, and the arterial oxygen saturation was measured and recorded on a minute-by-minute basis 5min before,20 min during, and 5 min after gastric tube feeding using a special neonate monitor device by the researcher. Moreover, according to the order of the physician, the neonates were fed every 2 h; therefore, the washout period was determined 1.5h. The research method and all the necessary instructions were provided in the briefing sessions held for the research assistants.

The data were analyzed using STATA software (version 14) through the Chi-square test, one-way analysis of variance (ANOVA) to assess demographic characteristics, and a linear mixed model to investigate the effect of the intervention, period, and carryover. A p-value less than 0.05 was considered statistically significant.

Results

According to the results of one-way ANOVA, there was no significant difference among the four groups in terms of demographic characteristics, such as the mean of gestational age, infant age, birth weight, infant weight when entering the study, current weight, 5-min Apgar score, and infant body temperature ($P>0.05$). It means that the four groups were homogenous regarding demographic characteristics. Moreover, the majority of the subjects were female in groups B and C (59.1%); however, males were more in group D than females (54.5%). On the other hand, group A contained an equal number of infants regarding gender (50%). The results of the Chi-square test revealed no significant difference among the infants in terms of gender distribution in all groups ($P>0.05$), which indicated the homogeneity of the groups in this regard (Table 1).

Furthermore, the results were expressed as mean ± standard deviation of arterial oxygen saturation in four periods of intervention in all

Table 1. Comparison of the four groups (A, B, C, and D) regarding demographic characteristics (gestational age, neonates' age, birth weight, current weight, 5-minute Apgar scores, body temperature, and gender)

Groups		A: (At first, left side position)		B: (At first, supine position)		C: (At first, prone position)		D: (At first, right side position)		Statistical results	
Statistical index / Demographic characteristics		mean	SD	mean	SD	mean	SD	mean	SD	F	P
Gestational age (week)		30.5	1.2	30.6	1.1	30.3	1.7	29.6	1.6	2	1.12
Infant age (day)		10.6	2.9	12.4	4.9	11.1	3.9	11	3.3	0.88	0.46
Birth weight (g)		1318.9	154.02	1309.5	156.01	1279.3	188.1	1260.5	164.4	0.58	0.63
Current weight(g)		1248	167.9	1296.7	132.4	1244.7	173.01	1233.9	158.8	0.68	0.57
5-min Apgar score		8.6	1	8.5	1.1	8.5	1.2	8.7	0.09	0.20	0.89
Body temperature		36.58	0.14	36.60	0.17	36.62	0.18	36.59	1.18	0.98	0.40
	Statistical index	N	%	N	%	N	%	N	%	χ^2	P
Gender	Female	11	50	13	59.1	13	59.1	10	45.5	1.23	0.74
	Male	11	50	9	40.9	9	40.9	12	54.5		

Table 2. Mean arterial oxygen saturation in enteral feeding times of preterm infants at four interventional periods in four groups (A, B, C, and D)

Groups	Enteral feeding time	Periods							
		First		Second		Third		Fourth	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
A: (At first, left side position)	Before	94.94	2.18	94.92	2.25	95.09	2.11	95.42	1.97
	During	95.04	1.93	95.24	1.56	94.50	2.29	95.22	1.63
	After	95.10	2.06	96.05	2.07	95.38	1.71	94.61	1.93
B: (At first, supine position)	before	94.81	2.23	94.92	2.43	95.61	1.86	93.88	2.74
	during	94.73	2.01	94.44	246	94.53	2.01	94.15	2.42
	after	94.22	2.41	94.39	2.89	94.37	2.09	94.45	2.11
C: (At first, prone position)	before	95.24	3.31	94.25	2.44	94.94	2.07	94.91	1.62
	during	94.73	3.21	94.19	2.31	95.04	1.76	94.15	1.57
	after	94.32	4.23	94.11	2.94	95.37	2.59	93.68	1.71
D: (At first, right side position)	before	95.28	1.47	94.98	2.01	95.09	1.66	94.79	1.59
	during	94.63	1.46	94.89	1.91	95.03	1.71	94.78	1.49
	after	94.52	1.91	95.37	1.61	94.88	1.76	95.13	1.81

Table 3. Effect of intervention, period, and carryover on arterial oxygen saturation before, during, and after enteral feeding times in preterm infants of the four groups (A, B, C, and D)

Enteral feeding time	Statistical results					
	Intervention		Period		Carryover	
	F	P-value	F	P-value	F	P-value
Before	0.282	0.839	2.047	0.131	1.501	0.215
During	0.633	0.596	0.494	0.611	1.115	0.344
After	1.828	0.150	2.628	0.074	2.328	0.075

groups, irrespective of the fact that they were initially placed in the left-side (A), supine (B), prone (C) or right-side (D) positions before, during, and after enteral feeding (Table 2). In addition, the results of the linear mixed model showed no significant difference among the four groups of intervention, the four periods of study, and carryover effect in terms of the mean of oxygen saturation before, during, and after enteral feeding (P>0.05) (Table 3).

Discussion

According to the results of this study, there was no significant difference among the four groups of intervention, the four periods, and carryover effect regarding the mean of arterial oxygen saturation before, during, and after gastric feeding tube in different positions. Moreover, no difference was observed in the mean of oxygen saturation before, during, and after enteral feeding in any position in the groups.

Overall, it can be seen from Table 2 that the mean values of arterial oxygen saturation are in the acceptable range (91%-95%) at various positions in four groups of intervention and four periods before, during, and after enteral feeding, which indicate no threat to the infant life. The rise of the values may be possible by performing correct gastric feeding tube procedure using an infusion syringe pump that causes to reduce stress related to routine (manually) feeding method.

In this regard, Brunherotti et al. conducted a prospective randomized crossover clinical trial investigating the effect of body position on cardio-

respiratory indicators of preterm infants receiving continuous positive airway pressure (CPAP). The result of this study revealed no preferred position for the newborns receiving CPAP (13). According to a clinical trial conducted by Guana et al. (2013) in France, the effects of prone, left-side, and supine positions were investigated on lung function and breathing patterns in oxygen-dependent preterm infants. The results of the aforementioned study revealed that arterial oxygen saturation was higher in the left-side (Oxygen saturation [spo2]: 95%±2%) and prone (spo2: 96%±1%) positions, compared to the supine position (spo2: 91±3% 91) (P<0.05) (10).

In the same line, Sam performed a crossover study in 2013 to evaluate the effects of supine and prone sleeping positions on arterial oxygen saturation in infants with respiratory disorders admitted to the NICU, the results demonstrated that arterial oxygen saturation in the prone position was significantly higher than that in the supine position on the first to third days upon admission. Moreover, the sequence of newborn positions in groups had no effects on the amount of arterial oxygen saturation (12).

Similarly, Torabi, Ghaheri, and Falakaflaki assessed the effect of positions on arterial oxygen saturation in healthy preterm infants in Zanjan, Iran, during 2011. They reported that the mean oxygen saturation of the infants, when placed in the supine position for half an hour, was significantly higher than that of the prone position (P<.0.001) (14). Abdeyazdanet al. studied the impact of the prone and supine positions on the amount of arterial oxygen saturation in preterm infants under mechanical ventilation. The results of their study showed that placing infants in any of the mentioned positions for 120 min had no significant effects on the amount of arterial oxygen saturation (15).

In a study conducted by Montgomery et al. (2014), the effect of prone position at a 22-degree angle was evaluated on breathing rate in preterm infants. The results suggested no difference between supine position and other positions regarding the arterial oxygen amount (16). Despite some overlapping, the findings of previous studies are not consistent with those of the present study. This variation can be attributed to the stabilization of respiratory conditions in some studies, the inclusion of infants with respiratory disorders or newborns in need of respiratory support, as well as different chronological ages of infants in various researches.

In addition, in the study performed by Brunherottiet al., the prone and supine positions significantly increased the mean percentage of arterial oxygen saturation, compared to the left and right-side positions, which was at odds with the results of this study (17). In the same vein, in a study conducted by Montgomery, the result of prone position was significant, compared to the supine position, which was not in line with the findings of the present study (16). Furthermore, Gounaet al. showed the significant effects of the prone and left-side positions, which was not in line with the results of this study (10). Sam investigated the effects of supine and prone positions, and the results showed that the prone position was more effective; however, it was not in line with the findings of the present study (12). Furthermore, the results of the studies conducted by Torabi (14), Abdeyazdan (15), and Eghbalian (17) indicated the preference of the prone position, which were at odds with our findings. In general, the results of the aforementioned studies were in conflict with those of the current study, and therefore, they were not supported by the present study.

Conclusion

According to the results of this study, the infant position had no effect on the amount of arterial oxygen saturation during feeding. Therefore, it is of utmost importance to save energy and refrain from any unnecessary manipulation of preterm infants in order to maintain the sleep and awakening cycle, which is crucial for neonatal brain development. Accordingly, it is recommended that sufficient syringe pumps are supplied for the proper execution of the gastric tube feeding so that there will be no need to change the position of preterm infants. The infants can be fed at any position with the gastric tube feeding using the syringe pumps. The present study paves the way for future investigations. In this study, syringe pumps were utilized for feeding preterm infants, whereas this is often performed manually under clinical settings. As a result, it is suggested that researchers conduct the same study using routine feeding methods in the future.

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Conflicts of interest

The authors of the current study declare no conflict of interest for this study.

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