Received: 8 Oct. 2010 **Accepted: 18 Dec. 2010**

Original Article

The effects of supine and prone positions on oxygenation in premature infants undergoing mechanical ventilation

Zahra Abdeyazdan, Monirosadat Nematollahi**, Zohreh Ghazavi***, Majid Mohhamadizadeh*****

Abstract

BACKGROUND: Since the use of high concentrations of oxygen in infants may lead to chronic lung problems, using proper methods of care in infants under mechanical ventilation is one of the most important measures in NICU.
This study aimed to investigate the effects of prone and supine positions on oxygenation (SPO_2) in premature infants under mechanical ventilation and comparing infants' oxygenation in the two positions.

METHODS: In across over non randomized clinical trial study, 32 preterm infants under mechanical ventilation who had inclusion criteria were enrolled in simple convenient method. Firstly, they were placed in supine position for 120 minutes and further in prone position for 120 minutes .Their SPO_2 were monitored by pulse oximeter continuously and was recorded every minute. Data analysis was done using Software $SPSS_{15}$ by ANOVA test and post hoc test.

RESULTS: The data showed that during 120 minutes of exposure of infants in each position there were no significant changes in SPO_2. In addition, the SPO_2 levels in the prone position were significantly higher than the SPO_2 levels in the supine position from 15^{th} minute to 120^{th} minute (to the end).

CONCLUSIONS: Neonatal positioning in prone position is a simple, non-invasive, and free of charge method that could lead to improve oxygenation in infants undergoing mechanical ventilation.

KEY WORDS: Neonate, respiratory distress, mechanical ventilation, oxygenated hemoglobin, supine position, prone position.

IJNMR 2010; 15(4):229-233

Today, prematurity is the most important cause of admission in NICUs.[1] Prematurity of lung tissue and respiratory distress syndrome are common problems in premature infants that illustrate the need for special attentions for the respiratory cares.[2] Oxygen administration and mechanical ventilation are done based on infant's needs[1] and applying high oxygen concentration may lead to pulmonary damage and subsequently chronic lung problems.[2, 3] Therefore, considering to the use of appropriate care measures in infants undergoing mechanical ventilation with aim of reducing the need of these infants to oxygen are the important measures in intensive care units.[3]

There have been many studies on the effects of body position on tissue oxygenation. The study of Chang showed that positioning infants on the prone position decreased their activities and led to better oxygenation and decreased the number of SPO_2 attacks drops compared to supine position.[4] In addition, prone position increases the duration of active sleep and decreases crying in infants.[5] The study of Keene et al showed that the number of attacks of apnea and bradycardia had no difference in the supine

* MD, Associated Professor, Nursing and Midwifery Care Research Center, Faculty of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran.
** MSc Student, School of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran.
*** MSc, Pediatric Instructor, Faculty of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran.
**** MD, Assistant Professor, Department of Neonatology, School of Medicine, Isfahan University of Medical Sciences, Isfahan ,Iran.
Correspondence to: Monirosadat Nematollahi, MSc.
Email: monirnematollahi@yahoo.com
This article was derived from MSc thesis in the Isfahan University of Medical Sciences, No: 387041

and prone positions in preterm infants.[6] In Iran, the study of Salman Yazdi et al showed that prone position improves oxygenation in infants with respiratory distress, who were receiving oxygen through a hood.[7]

Since there are rare studies about comparing the effect of supine and prone positions on tissue oxygenation rate in infants and the results are controversial [4, 6, 8, 9-12], the present study aimed to assess and compare tissue oxygenation in preterm infants undergoing mechanical ventilation in the first week after the birth in prone and supine positions.

Methods

This was a one-group non-randomized clinical trial study which has been done on 32 preterm infants undergoing mechanical ventilation to evaluate the effects of prone and supine positioning (independent variables) on hemoglobin oxygen saturation rate(dependent variable).

The study environment included NICUs of Al-Zahra and Shahid Beheshti hospitals affiliated to Isfahan University of Medical Sciences. The study population included all the preterm infants admitted in these centers. The number of the samples calculated based on the mean difference of 0.9 in the Chang's study [4] and 0.95 test power. Sampling was done using simple convenient method among the infants who had inclusion criteria from 20 April to 19 August 2008. In this study, each infant was considered as his/her own control (cross over design).

Gestational age less than 37 weeks, chronologic age of less than 7 days, undergoing at least 4 hours of mechanical ventilation, using SIMV mode for ventilation, having a relatively stable physiological condition (no need for frequent change of ventilator settings), no respiratory disorder due to congenital heart disease, pulmonary emphysema, active bleeding, neuromuscular disease and pulmonary arterial hypertension were the inclusion criteria. In cases in which infant needed exchange transfusion or its products, it was required to change ventilator settings or was suffering from hypothermia, the infant would be excluded from the study.

Moreover, those infants who experienced SPO_2 level ≤ 80%, during the study and had no appropriate response to interventional measures (increasing FIO_2) were excluded from the study. . Furthermore, provided that any infant needed intensive emergency care during the study, the necessary process had been done for them and after ensuring about stability status, the study started over from the beginning.

Prior to conduct the intervention, the infants' parents were informed about the study and a written consent form was received from them. Data collection tool was a data recording form and pulse oximeter and finger probe. The infants' demographic data (infant's post natal age, gestational age and gender) were extracted from their files. For reliability of the data collection tool, in the both hospitals the SPO_2 was measured by pulse oximeter (Sood-Afarinesh® Model) and finger probe was measured by Dolphin Model special for infants and all the data were displayed by the monitor and were recorded only by one partner.

Pulse oximeter was used to evaluate oxygenation of infants because it is a simple and non-invasive technique that could show the hypoxic attacks.

At the time of changing the infants' position and also during the intervention, the incharged nurse for the infant was responsible for protecting the catheters. Position changing and recording the observations were all done by one individual all the time.

When infants were placed in each position, no data was recorded for the first 10 minutes(washout period) due to the potential physiological respiratory instability and thereafter, when the infant was in a stable physiologic status, the SPO_2 displayed by the pulse oximeter was recorded every one minute (a total of 120 minutes for each position). To make sure about non-hypothermic status, the infants' temperature was monitored every one hour by a rectal mercury thermometer.

Intervention Technique

First, supine position and then prone position were tried for the infants. For the supine position, the infants were laid on back and their head was a little to the sides to adjust with the ventilator tubes. For the prone position, two small towels were rolled and placed under infants' knees and abdomen to prevent from pressure to knees and chest. In this position, elbows were bent and arms were placed at the two sides of the body, while hands were placed at the two sides of the head and the head was placed towards ventilator tubes.

Data Analysis

Data were analyzed using Software $SPSS_{15}$. The oxygen saturation rate in various positions from 0 to 120 minutes were shown as mean ± SD and the changes rate during the two hours in each position (supine or prone) were calculated by intra-group ANOVA. The comparison between oxygen saturation percentage in different times in the two positions was done by post-hoc test. P value less than 0.05 was considered as significant level.

Results

The mean of SpO_2 in prone and supine positions from minutes 0 to 120 are presented in table 1.

In supine position, the mean of SPO_2 in minute 0 was 95.6 ± 2.4 percent and in minute 120 it was 95 ± 5.5 percent. Intra-group ANOVA with repeated measures showed that during 120 minutes of supine position, changes in mean of SPO_2 were not significant (p = 0.93).

In the prone position, the mean of SPO_2 in minute 0 was 96.2 ± 3.3% and in minutes 120 it was 98.3 ± 6.1%. Intra-group ANOVA with repeated measures showed that during 120 minutes of prone position, mean of changes in SPO_2 in different times had a significant difference (p = 0.003).

To compare the means of SPO_2 in the two positions in various times, post hoc test was used. The results showed that from minutes 0 to 10, mean of SPO_2 in the two positions of supine and prone had no significant difference, but from minute 15 to 120, the mean of SPO_2 in the prone position significantly was higher than in supine position (Table 1).

Table 1. Comparison the mean of SPO_2 in supine and prone positions during the intervention

Time	Supine		Prone		P value
	mean	SD	mean	SD	
0	95.6	2.4	96.2	3.3	P = 0.54
5	95.8	2.2	96.3	3	P = 0.39
10	94.4	6.3	96	5.7	P = 0.46
15	94.6	5.2	97.4	3	P = 0.01*
30	95.4	1.8	97.1	3.2	P = 0.002*
45	95.8	1.7	97.7	2.2	P < 0.0001*
60	95.7	1.9	98.2	1.4	P < 0.0001*
75	94.8	5.7	98.5	1.6	P < 0.0001*
90	95.7	1.6	98.2	2	P < 0.0001*
105	95.8	1.9	98.4	1.7	P < 0.0001*
120	95	5.5	98.4	6.1	P = 0.01*

Discussion

The results showed that placing neonates in prone position for duration of 120 minutes increased the mean of SPO_2. Balaguer et al in a systematic review study about the effect of positioning on amount of SPO_2, showed that in several studies SPO_2 in the prone position increased between 1.18 to 4.36% during the intervention (prone position).[13] In the present study also, the difference between SPO_2 in minutes 0 and 120 was 1.2% in prone position, which was in accordance with the above studies.

Ravindra et al showed that premature infants, who were oxygen dependent and prepare for discharge from neonatal unit, had higher SPO_2 and FRC in prone position than in supine position.[9]

Yao et al showed that preterm infants 1 and 6 hours after weaning from mechanical ventilation had a higher PaO_2 in prone position compared with supine position.[10] In the present study the results showed that in prone position the mean of SPO_2 was significantly higher than in supine position. However, in this study, unlike Yao's study, assessing the tissue oxygenation was conducted using pulse oxymeter and the infants underwent mechanical ventilation at the time of intervention and at their first week of post natal. The present study was in accordance with study of Chang et al [4] regarding to the study population and method of infants' evaluation and also results. In the present study we did not investigate for exploring the cause of increasing SPO_2 in prone position, but the reason for better oxygenation in this position can be due to this fact that in prone position, the connection of hand-mouth and semi-embryonic flexion occur better than other position and this can lead to better sleep as well as less consumption of oxygen compared to other position. [4, 9]

In this study, no complication occurred during the short term duration that the infant was positioned in prone position. The longer the infants remained in this position, the more complications likely could be observed. According to our knowledge, no study has ever been conducted in Iran on the complications of prone positioning for a long time, but in a study by Curley, some of the infants, who were in prone position for a long time, suffered from bed sores.[14]

In general, the present study showed that infant positioning in prone position was a simple, non-invasive and inexpensive method that would lead to better oxygenation of infants undergoing mechanical ventilation.

The authors declare no conflict of interest in this study.

Acknowledgements

This study financially was sponsored by Research Deputy of Isfahan University of Medical Sciences (Research Project No. 387041). Thanks go to the authorities of hospitals and NICUs of Al-Zahra and Shahid Beheshti hospitals. Furthermore, we would appreciate nursing staff and parents of the infants participated in the study.

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