The impacts of prone position on the blood oxygen saturations and heart rates of preterm infants under the mechanical ventilation

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Original Article

Tahereh Babuyeh (MD) [1, 2]
Roya Farhadi (MD) [3]
Yadollah Zahed Pasha (MD) [1, 4]
Mohsen Haghshenas Mojaveri (MD) * [1, 5]

1.Non-Communicable Pediatric Diseases Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, Iran.
2.Student Committee Research, Babol University of Medical Sciences, Babol, Iran ORCID ID orcid.org/0000-0003-2150-6708.
3.Assistant Professor of Neonatal Specialty, Mazandaran University of Medical Sciences, Sari, Iran.
4.The Clinical Research Development Unit of Amirkola Children's Hospital, Babol University of Medical Sciences, Babol, Iran.
5.The Clinical Research Development Unit of Rouhani Hospital, Babol University of Medical Sciences, Babol, Iran ORCID ID orcid.org/0000-0002-1698-6906.

* Correspondence:

Mohsen Haghshenas Mojaveri (MD), Non-Communicable Pediatric Diseases Research Center, No 19, Amirkola Children's Hospital, Amirkola, Babol, Mazandaran Province, 47317-41151, IR Iran.

E-mail: matia.mojaveri@yahoo.com
Tel: +98 1132346963
Fax: +98 1132346963

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Abstract

Background: The methods of baby's position are an important critical factor in ventilation and oxygenation of tissues. Although the prone position as one of the recommended position has beneficial effect on the development of premature infants, little research has been done.

Methods: In a clinical trial among mechanically ventilated infants, hospitalized in the neonatal intensive care units (NICUs), 35 preterm infants were selected in 2014-2015. Each infant was positioned in a supine (control group) and prone (case group) positions for 2 hours, respectively. The values of blood oxygen saturations (SpO_2) and heart rates were assessed and recorded every 10 minutes by a cardio-respiratory monitoring device. Data analysis was performed using SPSS v.22.

Results: The mean heart rates were 136.909±2.861 and 136.600±2.560 beats per minute in the supine and prone positions, respectively. Heart rates were within the normal ranges in both positions, but the range of fluctuation was slightly lower and statistically non-significant in the prone position (p-value=0.805). The average of SpO_2 was 92.364% and 95.046% in the supine and prone positions, both of them were within the normal range.

Conclusions: This study showed that the prone position compared to the supine position has a more favorable effect of SpO_2 and heart rate fluctuations in preterm infants.

Keywords: Blood Oxygen Saturations, Heart Rate, Position, Premature Infant, Ventilator.

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Introduction

Positioning of preterm infants not only has a direct impact on their neurological developments, but also can reduce the long-term complications of prematurity [1]. Positioning is an important factor associated with ventilation [2, 3]. Although the best method of positioning for newborn babies is unknown, there is a tendency to keep the babies under mechanical ventilation in the supine position, which mainly results in an easy view, more convenient examination of the baby and a need for periodic monitoring and intervention. [4, 5]. In comparison with the prone position, the respiratory muscle strength is better in the supine position with or without a slight head raise of up to 45° [6]. In some studies, it has been stated that a prone position is effective on improved oxygenation in infants with very low birth weights [7-10] while in other studies, the supine position has been shown as a proper positioning for low-birth infants since the prone position increases the pressure of the abdominal contents

to the diaphragm, and decreases lung volume thereby worsening oxygenation [8, 11, 12]. A prone position has some probable positive effects including decreased heart rate variability, improved breathing control, improved oxygenation and reduced gastroesophageal reflux [1]. In a study conducted by Rossetti et al.'s on patients with acute respiratory distress syndrome in the prone position for 3 hours, a significant clinical improvement in oxygenation (more than 15% in 78% of patients) was observed and the prone position was suggested with respect to its clinical benefits [7]. In another study performed by Ammari et al.'s to determine the effect of changing body position on curve temperature, cardio-respiratory activity and metabolic changes in infants with low birth weight, the surface temperatures of the foot, arm, sides and forehead were found to be higher during both quiet and active sleeps in a prone position. Besides, a faster heart rate, higher breathing frequency as well as less variability of heart rate and breathing were observed [13]. In a systematic study carried out by Sud et al.'s on the effect of mechanical ventilation on the clinical outcomes of patients with acute hypoxic respiratory failure in a prone position, no reductions in mortality and duration of mechanical ventilation were seen despite improving oxygenation and reducing pneumonic risk associated with ventilation and in some cases, increased risk of pressure ulcers was further discovered. Therefore, it should not be routinely used for the mentioned patients [14]. In a meta-analytic study conducted by Bredemeyer et al.'s on 14 infants, no differences were found between prone, supine and lateral positions based on oxygenation and hypoxic attacks [9]. The risk of sudden infant death syndrome (SIDS) in preterm infants is 3 times more than in term infants [15]. Of course, due to the increased risk of SIDS in the prone position, many benefits of this method have faded [1]. Because of the presence of differing views on the impact of prone and supine positions on oxygenation and heart rate; therefore, the aim of this study was to determine the impacts of prone position on the SpO_2 and heart rates of preterm infants under mechanical ventilation.

Methods

This clinical trial research was carried out at the Ayatollah Rouhani Hospital, Babol City and Imam Khomeini and Bu-Ali Sina hospitals, Sari City from May 2014 to May 2015. The inclusion criteria were the intubated preterm infants less than 34 weeks of pregnancy with a weight of less than 2000 g. The exclusion criteria included the intubated infants with major congenital anomalies under mechanical ventilation duration for less than 4 hours, receiving sedation drugs, with umbilical artery and vein catheters and chest tubes as well as the incubated infants who involved in complications such as pneumothorax during the first 4 hours of mechanical ventilation. According to the mentioned criteria, a total of 35 premature infants were studied based on 95% probability and 80% power with standard deviation and arterial oxygen saturation differences of 30 and 15, respectively. They were first placed in a supine and then prone position for 2 hours in each case since the former (supine) was more conventional than the latter (prone). During these 2 hours, the physiological parameters (SpO_2 and heart rates) were measured every 10 minutes using a cardio-respiratory monitoring device (Sa'ādat Monitoring Device, Iran) with a pulse oximeter (Masimo,America), placed on the right hand of each neonate as well as these measured parameters and demographic data (gestational age, birth weight, 5-minute Apgar score, duration of mechanical ventilation, age of the mother) were recorded in a questionnaire. Then, their averages in both positions were compared. All infants were connected to the ventilator on the SIMV mode. In this study, a non-invasive monitoring of vital signs was used to evaluate SpO_2. The data were statistically analyzed using SPSS. To compare the physiological parameters, t-test was used at 95% confidence interval, and p-value<0.05 was considered as a significant level in all cases.

Results

Of the 35 premature infants receiving mechanical ventilation, 65.7% and 34.3% of neonates were born via cesarean and vaginal deliveries, respectively. The number of preterm infants under mechanical ventilation based on gestational age and Apgar score is shown in table 1.

According to table 2, comparison of heart rate based on the number of beats per minute in the preterm infants under mechanical ventilation in both positions (supine and prone) demonstrates that the heart rates are within the normal range for both positions, but the ranges of fluctuations in heartbeat are slightly less in the prone position so that this difference is not statistically significant (p-value=0.805).

SpO_2 average is illustrated based on percentage. SPO_2 indicated that both of them were within the normal range. However, the range of SpO_2 fluctuation in the

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prone position was better and this difference was statistically significant (p-value=0.000). Moreover, the heart rate in both groups was normal and the difference was not statistically significant (p-value=0.805).

Table 1: Number of preterm infants under mechanical ventilation based on gestational age and Apgar score

Variable		Female (%)	Male (%)	Total (%)
Gestational age	32<week<34	5.7	2.9	8.6
	28<week≤32	11.4	17.1	28.5
	≤28	28.6	34.3	62.9
sex		45.7	54.3	
Apgar score	7-10	40	40	80
	3-6	5.7	11.4	17.1
	0-2	0	2.9	2.9

Table 2: Minimum, maximum, and average indices in the preterm infants under mechanical ventilation

variable	average	maximum	minimum
heart rate in supine (beats per minute)	136.909	166	90.69
heart rate in prone (beats per minute)	136.60	164.15	96.61
SpO_2 in supine (%)	92.36	98.84	82.76
SpO_2 in prone (%)	95.04	100	84.69
5-minute Apgar score	7	10	1
duration of mechanical ventilation (hours)	125.68	672	4
Birth weight (g)	1147.82	1999	590
age of the mother (year)	25	44	17

Discussion:

This study was conducted to evaluate the effect of prone position on the SpO_2 and heart rates of preterm infants under mechanical ventilation revealed that preterm infants had more favorable conditions of SpO_2 and heart rate fluctuations in the prone position than supine position. In addition, Balaguer et al. conducted a randomized or quasi-randomized clinical trial to examine the effects of different body positions on preterm infants under mechanical ventilation. In the prone compared to supine positions, there was a slight increase in arterial oxygen pressure (po_2=2.75-9.72 mm Hg) and SpO_2 of hemoglobin was measured using pulse oximeter (Sao_2 from 1.18% to 4.38%) [5], which is consistent with the results of other studies. The average oxygen saturations were 87.65% and 96.04% in the supine and prone positions, whereas significant differences (p<0.001) in the mean oxygen saturations and mean arterial pressure of CO_2 were discovered in the prone compared to supine positions [10]. Although an invasive method of ABG has been applied in the mentioned study compared to a non-invasive procedure in our study, this finding is also congruent with our results.

Furthermore, a cross-over study was performed on 44 preterm infants of 29-34 weeks undergoing N-CPAP treatments hospitalized in NICU. The infants were randomly divided into two groups: the first group was placed first in the prone and then supine positions and the second group underwent a reverse procedure. SaO_2 percentages and the oxygen concentration levels consumed were recorded for 30 minutes in each position. Statistically, significant differences were observed between two groups of infants in both positions based on the mentioned indices (p<0.05). Ghorbani et al. indicated the SaO2 of premature infants undergoing enhanced N-CPAP and their needs for oxygen concentration consequently declined in the prone position, therefore; if there was no limitation for changing an infant's position, a prone position could improve the oxygenation when receiving N-CPAP. [16] Although our study on preterm infants under mechanical ventilation was performed for 2 hours and there were some differences between the mentioned investigation and this study in terms of methodologies and study patients, the results are the same.

Torabi et al.'s assessed the impact of position on mean SpO_2 in 88 healthy infants with the mean birth weight, gestational age and postnatal age of 2330.9

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grams, 34.3 weeks and 4.2 days, respectively. They concluded different findings, meaning after randomly placing in the prone and supine positions for half an hour, the SpO_2 mean was 91.8±5 and 94.5±3.3 percent ($p<0.001$), respectively; thus, the supine position was found to produce a greater impact in improving oxygenation in healthy preterm infants who had only been fed and after that they were prepared for discharge [17]. The effect of health care on the SpO_2 of low-birth-weight infants admitted to the NICU was evaluated and 31 infants who had no difficulty in breathing did not receive any medication and serum and who were only fed, were randomly selected. Finally, the impacts of prone and supine positions on their SpO_2 levels were assessed for 30 minutes [17]. After half an hour, their mean percentages of SpO_2 were 93.05% ± 7.5 and 94.85%±6.6 in the supine and prone positions, respectively, which were statistically insignificant at $p=0.9$. This study indicated that placing low-birth-weight babies in a sleep position had no effect in improving arterial blood oxygenation [12]. However, the current research aimed at applying the prone position as an effective position in improving SpO_2 and heart rate for preterm infants under mechanical ventilation in NICU.

In conclusion, the significant differences were found in the SpO2 mean, but not in the mean of heart rates in prone vs. supine positions. Of course, to confirm the latter, a larger study with more samples will be required.

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Conflict of Interest: There was no conflict of interest.

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