The effect of position on oxygen saturation and heart rate in very low birth weight neonates

Original Article

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Abstract:

Background: Optimal oxygenation in preterm neonates is very important, therefore different measures are recommended to improve their oxygenation. One of these measures is the position of these infants. The studies on the effects of prone and left lateral positions showed conflicting results. So, the aim of this study was to determine the effect of position on arterial oxygen saturation (SaO_2) and heart rate (HR) in very low birth weight (VLBW) neonates.

Methods: This non-randomized simple convenient interventional study was conducted on 40 VLBW 7-28-day infants with 29-35-weeks gestational age using in 2014-2015. The infants were hospitalized in the neonatal intensive care unit of Rouhani Hospital in Babol. Based on the inclusion criteria, each of them was initially kept in supine position for 120 minutes and then in prone and finally left lateral position for 120-min after 10-min rest. During this period, SaO2 and HR parameters were recorded every 15-min and data were analyzed.

Results: The mean of SaO2 was 97.41±1.91%, 96.74±2.09% and 96.14±2.36% in prone, supine and left lateral positions, respectively and this difference was statistically significant (P=0.032). The mean of HR was 146.09±9.65, 148.15±11.46 and 146.02±10.54 (beat/min) in prone, supine and left lateral positions, respectively. HR was normal in all three positions but the HR variability in prone position was slightly less than other positions (P=0.596).

Conclusions: The results of the current study indicated that in preterm newborns, the prone position made more desirable oxygenation and HR variability compared to the supine and left lateral positions

Keywords: Arterial Oxygen Saturation, Preterm Neonate, Heart Rate, Position Change

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Introduction:

The number of very low birth weight (VLBW) and premature neonates has increased due to the enhance of artificial insemination methods and multiple births [1].Thus, the optimal oxygenation is very important in preterm infants so that both hypoxia and hyperoxia cause damage to infants, especially premature ones. Therefore, it is important to maintain proper oxygen range according to the gestational age and age of the infants in neonatal medicine. There are various methods including pharmacotherapy and respiratory cares for improving and maintaining the optimal oxygenation and heart rate within desirable ranges. The selection of proper positioning of the infants on a hospital bed is one of the methods, which is important for researchers [2]. Two studies mentioned that the prone position was successfully used for lung disease by Bryan for the first time [2, 3].

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Similarly, Douglas published an article about the impact of increased oxygenation in the prone position on patients with respiratory failures [4]. These neonates may often be hospitalized a long time in neonatal intensive care unit (NICU). Physiological flexibility in the areas of trunk, waist and hip in preterm infants and inadequate muscular tonicity caused by prematurity in neuromuscular system cause these neonates to have abnormal changes of this system when they encounter the prolonged immobility [3]. In addition, the immobilization is associated with the risk of skin damage so it is necessary to change the positions of these infants every 2-3 hours [4].

There are few researches about the positive effects of prone position on the oxygenation in neonates and comparing it with the supine position [2, 5]. Improved oxygenation in the prone position cannot be justified with the increased respiratory muscle strength in preterm infants because it seems that the respiratory muscle strength does not increase in prone position [6].

Therefore, higher levels of arterial oxygen saturation in premature infants with prone position can be due to the improved mechanical activity of lungs, increased lung volume, decreased mismatch between ventilation and pulmonary circulation [7]. However, one study suggested that the prone position led to decreased lung volume and the oxygenation was getting worse in this position due to the increased pressure of intra-abdominal content on the diaphragm and they believed that the supine position was a suitable position in VLBW infants [7].

On the other hand, one research indicated that unlike the supine position, the prone position could increase the risk of sudden infant death syndrome (SIDS) [8]. Another one showed the effects of right and left lateral positions and it was concluded that these positions had no effect on arterial oxygen while the prone and left lateral positions could decrease the gastro esophageal reflux [9]. One study indicated that the speed of motor skills and muscle tonicity increased among infants nursed in a lateral position; therefore, this position can be paid more attention for neonates admitted in NICU except those who have no stable respiratory condition.

The other one illustrated that the arterial oxygen saturation and required oxygen concentration enhanced and reduced at the time of switching from supine to prone position [1]. Considering the hypothesis that rotating the neonates to prone position improves perfusion to ventilation, thus it is concluded that the patients may suffer from supine position because of impairment of blood circulation to the lungs [10]. However, there are many conflicting results so that no difference was found between prone, supine and left lateral positions in terms of oxygenation and hypoxia [11] while in another study, it was observed that the arterial CO2 pressure was greater in prone position than supine position [12]. On the other hand, there are many reports of reducing the gastro esophageal reflux in left lateral position [4, 9, 13]. There are few studies about the effect of position change on the heart rate. In a study, it was observed that the heart rate increased 8.5% half an hour after changing position than that time before this change [10].

Mostly, the supine position is used for neonates in NICU. Although the lateral positions are important for premature infants to improve their developmental skills [14], health care staff are reluctant to place the neonates in this position .

Hence, the aim of this study was to evaluate the effect of prone, supine and lateral positions on oxygen saturation and heart rate in VLBW infants, considering the conflicting results about the effects of position change on oxygen saturation and heart rate.

Methods:

This non-randomized simple convenient interventional study was conducted on very low birth weight (VLBW) infants in 2014-2015. These newborns were non-randomly selected and entered into the study on the seventh day of birth after the stability of vital signs. Sample size was 40 preterm VLBW infants whose gestational age and birth weight was less than 37 weeks and 1500 g, respectively.

These neonates were fed by their mothers and using gastric gavage and did not have any respiratory disease. The exclusion criteria were congenital anomaly, apparent and significant cardiovascular disease, pulmonary disease, digestive problems, seizure and neurological problems and neonates who need respiratory support, umbilical catheter and chest tube, as well as infants with new clinical problem.

Infants who met the inclusion criteria were placed in supine position at first for 2 hours after the approval of ethics committee and consent of parents then their position was changed into prone position. The first ten minutes were considered as the resting phase and position change. After that time, the prone position was followed for 2 hours and finally they were placed in the left lateral position and after 10 minutes of rest, they were fallowed in this position for 2 hours.

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During this period except the rest phase, parameters of arterial blood oxygen and heart rate were recorded in a questionnaire with demographic characteristics of infants every 15 minutes and its mean was determined. Then the mean of above cases were compared with each other in terms of the effect on parameters of blood oxygen saturation and heart rate in three positions. The information was recorded by a neonatal nurse. None of the neonates required therapeutic intervention during the intervention and recording the changes in oxygen saturation and heart rate.

The collected data were statistically analyzed using SPSS 21 and descriptive statistics (mean variance criterion relative frequency distribution). Paired sample test and repeated measurement test were used to determine the significance of oxygen saturation and heart rate mean at different times in any position. P<0.05 was statistically considered significant.

Results:

In this study, 40 neonates 7-28-day (30.17±79.50) were studied. They were 12 (45%) males and 18 (55%) females. The minimum and maximum gestational ages were 27 and 35 weeks, respectively (30.10±2.158). The minimum and maximum weights of the newborns were 754 g and 1490 g respectively (1180.38±205.318).

The mean of oxygen saturation and heart rate in supine, prone and left lateral positions is illustrated in table 1. Arterial oxygen saturation was significantly different in the supine, prone and left lateral positions during 120 minutes (P=0.023). Moreover, the study of arterial oxygen saturation between two positions of left lateral and prone showed that there was no significant difference between these two positions (P= 0.392).

The maximum and minimum of heart rate were 123.44 and 175.33, 124 and 165.78, and 164.56 and 124.11 (beat/min) in the supine, prone and left lateral position, respectively. Heart rate variability was slightly lower in the prone position than the other two positions but this difference was not significant (P=0.596). The results also showed that the mean of heart rate was not significant between the supine and left lateral positions (P=0.233) (table 1).

Table 1: Comparison the mean of arterial oxygen saturation and heart rate in three studied positions of supine, prone and left lateral

Position / variables	Supine	Prone	Lateral	P -value
Oxygen saturation (percent) (mean±SD)	96.74±2.09	97.41±1.91	96.14±2.36	**0.032**
Heart rate (beat/min) (mean±SD)	148.15±11.46	146.09±9.65	146.02±10.54	**0.596**

Discussion:

This study represented that the mean of oxygen saturation was higher in prone than lateral position. There was no significant difference among these three positions in terms of the mean of heart rate during two hours.

Riani et al. reported the effect of prone position on oxygenation in 40 preterm infants weaned from mechanical ventilation and they concluded that the mean of arterial oxygen saturation was higher in prone than supine position, which is similar to the current study [15]. Balaguer et al. demonstrated the percentage of oxygen saturation was higher in the prone than supine position [5].

Saadati et al. conducted a study on 40 low birth weight infants with respiratory distress and each infant was placed in the prone and supine positions for 2 hours then the ABG was individually measured in each position. The mean of arterial oxygen saturation in the supine and prone positions was 87.65% and 96.04%, respectively (p<0.05). On the other hand, the mean of arterial pressure of CO2 suggested significant difference between the supine and prone positions. Although the invasive ABG was used in mentioned study, its result was the same as our study [12].

Yao et al. performed a study on 30 weaned infants from the ventilator, it was indicated that the infants had better oxygenation in the prone than supine position during the first 9 hours of weaning from mechanical ventilator [16]. Despite the different conditions of

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infants in their study, the results are consistent with the findings of the present study.

A study was done on 32 ventilated premature infants by Abdeyazdan et al. in 2013 and they concluded that the SPO2 difference was not significant between the lateral position and other positions during 120 minutes of neonates' positioning. In fact, the preterm infants receiving mechanical ventilation could well tolerate the lateral position [17].

Other study was conducted on 52 infants to compare their oxygenation in different positions and it was found that there was no difference between prone, supine and left lateral positions in terms of oxygenation and hypoxia attacks [18].

Guana et al. in 2012 carried out a study on 19 newborns with mean gestational age of 27 weeks and mean age of 17 day. They investigated the effect of different positions on premature infants with mild respiratory failure receiving NCPAP and their breathing pattern was evaluated by plethysmography. It was seen that the arterial oxygen was higher in both prone and left lateral positions than supine position. Because left lateral position had no effect on the arterial oxygen saturation in this study, which may be due to the difference in respiratory disease among infants in these two studies [19].

In one study, 88 healthy preterm infants who were fed by mouth and ready for discharge were placed in the prone position for 30 minutes and then in the supine position for 30 minutes. Unlike the current study, they suggested that the arterial oxygenation was the same in the prone and supine positions and this difference may be owing to the short duration of the intervention (30 min) [20].

In the study of Elder et al., the arterial oxygen saturation of 7 infants with chronic lung disease (CLD) and mean gestational age of 27 weeks and of 8 infants without CLD was evaluated and no significant difference was found [21]. The difference between the results of Elder and those of us can be due to the need of oxygen because the infants participating in Elder's study were different in terms of oxygen need, while in the present study, all infants had the same conditions and did not have any need for oxygen.

The result of the current study showed that the arterial oxygen saturation in VLBW infants was increased in the prone position than the supine and left lateral positions while the heart rate was not significantly different in all these three positions.

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Conflict of interest: The authors declare that they have no conflict of interests.

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