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ARAŞTIRMA / RESEARCH

Comparison of the effect of supine and prone positions on physiological parameters of preterm infants under nasal continuous positive airway pressure (N-CPAP): a cross over clinical trial

Nazal ve sürekli hava yolu basıncı (N-CPAP) altında sırtüstü ve yüzükoyun pozisyonların preterm bebeklerin fizyolojik parametreleri üzerindeki etkisinin karşılaştırılması: bir çapraz klinik çalışma

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Abstract

Purpose: The aim of this study was to compare the effect of supine and prone positions on physiological parameters of preterm infants under nasal continuous positive airway pressure (N-CPAP).

Materials and Methods: This cross-over clinical trial was conducted on 62 hospitalized preterm infants under N-CPAP in the neonatal intensive care unit of Imam Reza Hospital Kermanshah, Iran. Neonates were placed in supine position at first for 180 minutes and then their position was changed into prone position for another 180 minutes. During this period, heart rate (HR), respiratory rate (RR) and arterial oxygen saturation (So2) were assessed once every 15 minutes in two positions.

Results: There was significant difference observed in the means of HR in two positions. The RR in the prone position was significantly lower than that in the supine position; however, the So2 in the prone position was significantly higher than the supine position.

Conclusion: The results of this study showed in preterm infants with respiratory distress syndrome under N-CPAP, there was lower RR and higher So2 in prone position when compared to the supine position. Therefore, preterm infants have better physiological stability in prone position.

Keywords: Preterm infant, prone position, supine position, oxygenation, respiratory distress syndrome

Öz

Amaç: Bu çalışmanın amacı, sırtüstü ve yüzüstü konumların nazal sürekli pozitif hava yolu basıncı (N-CPAP) altındaki preterm bebeklerin fizyolojik parametreleri üzerindeki etkilerini karşılaştırmaktır.

Gereç ve Yöntem: Bu çapraz klinik çalışma, İran' Kermanşah'taki İmam Reza Hastanesi Yenidoğan yoğun bakım ünitesinde N-CPAP altındaki 62 hastaneye yatmış erken doğmuş bebek üzerinde yapıldı. Yenidoğanlar ilk önce 180 dakika boyunca sırtüstü pozisyona getirildi ve daha sonra onların pozisyonu 180 dakika yüzüstü bir pozisyona getirildi. Bu süre zarfında kalp atım hızı (HR), solunum hızı (RR) ve arteriyel oksijen satürasyonu (So2) her 15 dakikada bir iki pozisyonda değerlendirildi.

Bulgular: İki pozisyonda İK araçlarında anlamlı fark gözlendi. Yüzüstü pozisyonda RR, sırtüstü pozisyondan anlamlı derecede düşüktü; ancak, yüzüstü pozisyonda So2 sırtüstü pozisyondan anlamlı derecede yüksekti.

Sonuç: Bu çalışmanın sonuçları, N-CPAP altında solunum sıkıntısı sendromu olan erken doğmuş bebeklerde, sırtüstü pozisyona kıyasla yüzüstü pozisyonda daha düşük RR ve daha yüksek So2 olduğunu göstermiştir. Bu nedenle, erken doğmuş bebekler yüzüstü pozisyonda daha iyi fizyolojik stabiliteye sahiptir.

Anahtar kelimeler: Erken doğmuş bebek, yüzüstü pozisyon, sırtüstü pozisyon, oksijenasyon, solunum sıkıntısı sendromu

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INTRODUCTION

The most common reason for admission of premature infants to the neonatal intensive care units is respiratory distress syndrome. One of the less invasive common methods in treating respiratory distress syndrome is the use of nasal continuous positive airway pressure (N-CPAP). CPAP can be useful in the treatment of RDS through fixing alveoli and maintaining Functional Residual Capacity. It is also useful in the treatment of obstructive apnea in premature infants[1,2].

Since both hypoxia and hyperoxia damage infants, especially premature ones, optimal oxygenation plays an important role in neonatal period. Therefore, it is important to maintain proper oxygen saturation level based on the gestational age. There are various respiratory care methods for improving and maintaining the optimal oxygenation and heart rate in the optimal range. The selection of proper positioning for the infants with respiratory distress is an important factor in this study.

Several studies have shown that the body position is an important factor in ventilation and tissue oxygenation in infants who receive respiratory support; therefore, frequent changes in infants' position are required every 2-3 hours[3,4]. However, due to the easier supervision and neonatal care, premature infants are often placed in supine position[5]. Prone position, first introduced by Bryan, is considered to be a therapeutic maneuver to improve arterial oxygen saturation in neonates[6]. Several studies have been performed in this regard and most of them have suggested using prone position to improve arterial oxygenation[7,8,9,10]. Prone position also has other benefits including improving neurodevelopment in neonates, reducing heart rate changes, improving respiratory and apnea control, reducing energy consumption and reducing gastroesophageal reflux in preterm infants which is of particular importance[11,12].

Several studies have been conducted to investigate the effect of the position on respiratory function in newborns, including Yao et al. study, in which there was a higher oxygen saturation in the prone position when compared to the supine position in newborns during the first 6 hours of weaning from ventilator[13]. Abdeyazdan et al. also found that, the percentage of arterial oxygen saturation in the prone position was significantly higher than that in the supine position[14].

The results of the study carried out by Gouna et al. also showed that arterial O2 saturation levels were higher in the left lateral and prone positions when compared to the supine position[15]. However, the study conducted by Elder et al. showed that there is no difference in terms of oxygen saturation in premature infants with chronic pulmonary disease between the supine and prone positions at the time of discharge[16]. The study by Torabi et al. showed that oxygen saturation of in premature newborns is better in the supine position when compared to the prone position[17].

However, the studies investigating the effects of prone position on the physiological parameters such as heart rate, respiration rate and oxygen saturation have shown conflicting results. Therefore, the aim of this study was to comparison of the effect of supine and prone position on physiological parameters of premature infants with respiratory distress syndrome under nasal continuous positive airway pressure (N-CPAP).

MATERIALS AND METHODS

In this cross-over clinical trial, 62 preterm infants with respiratory distress syndrome who were under nasal continuous positive airway pressure and were admitted to neonatal intensive care unit in Imam Reza Hospital of Kermanshah were evaluated. These infants after reviewing similar studies were selected based on their volume calculated and were selected by available method, and the newborns who had inclusion criteria were included in the study. The study lasted 3 months. The study was registered at the Iranian Registry of Clinical Trials (IRCT= 20101018004961N11).

The inclusion criteria were: infants with gestational age of 24 to 37 weeks and birth weight of over 1000 grams who were diagnosed with respiratory distress syndrome and were under nasal continuous positive airway pressure (N-CPAP). Neonates with lung emphysema, pneumothorax, sepsis with positive culture, congenital heart disease, intraventricular hemorrhage, diaphragmatic hernia, instability of vital signs, and frequent apnea were excluded from the study.

Firstly, the objectives of the study were explained to the parents of the neonate and if agreed, written informed consent was obtained. The data gathering tool was a data recorder form and a pulse-oximeter

and monitor. Demographic characteristics of the neonates (gestational age, birth weight, and sex) were extracted from the patient file.

To determine the reliability of the tool for data collection, monitor model OXYPLENTH (NOVAMETRIX) and pulse oximetry model Datascope Passport2 which was special for the neonates, was used to measure SPO2 and one of the researchers recorded data displayed by the monitor. In addition, devices were calibrated before starting sampling. The use of pulse oximetry to evaluate the oxygenation of newborns was due to the fact that this method is a simple and non invasive and it can predict the occurrence of hypoxia attacks.

Procedure

The technique of intervention was that the infants were randomly placed in one of two positions in the prone and supine position. Infants were placed in supine position for 180 minutes then their position was changed into prone position for another 180 minutes. After each body position change, in order to avoid the effect of the previous body position, the neonate was left free for 15 minutes (i.e., washout period) and then, the neonates was monitored for another 180 minutes (once every 15 minutes).

In order for the infant to be placed in the supine position, while the infant was put back, the head was placed in the midline position and was slightly turned toward the tubes of Nasal CPAP. The prone position was performed with head in midline, upper limbs adducted to the side of the chest wall, lower limbs slightly flexed (30–40º) in hips and knees and the head turned slightly toward the tubes of Nasal CPAP.

When the change position and during intervention, nurse responsible for the infant was duty for supporting catheters and the change of position and recording of observations by a constant person was done. Due to the possibility of instability of the physiological conditions, in the first 15 minutes of placing the infant in any of the two positions, no data was recorded; then, while the infant was in constant conditions, every 15 minutes HR, SPO2 and respiratory rate were recorded.

Respiratory rate was measured by observing the number of breaths the infants took in a minute. Oxygen saturation and heart rate continually monitored by transcutaneous pulse oximetry for 180 minutes in each position and mean oxygen saturation, heart rate and respiratory rate were also calculated at the end of each 180 minute period.

Then, the mean values of heart rate, oxygen saturation and respiratory rate of newborns in 15 minutes were measured and recorded. During the intervention, to ensure that the infant's body temperature is not reduced, the body temperature was monitored every hour by a thermometer and the least painful diagnostic or therapeutic procedure was performed. During the study, If the oxygen saturation in any position was less than 85%, or the infant's heart rate reached above 200 or less than 100, or the respiratory rate increased in the infant (more than 60 breaths per minute), the newborn would return to the previous position and he was immediately notified to the physician. If a desaturation happened in neonates, it was increased value of FIO2, if necessary and with the order of the physician.

Statistical analysis

The data was analyzed using SPSS 18 software. To describe the results, descriptive indices including average, standard deviation, mean, and frequency (percent) were used and Independent sample t-test was employed to compare the effect of the intervention. In this study, $p < 0.05$ was considered significant.

RESULTS

In this study, 62 preterm neonates with respiratory distress syndrome who were under N-CPAP were evaluated from 2015 to 2016. Of these infants 30 (48.5%) were male and 32(51.5%) were female. the patients had a mean gestational age of 32.66 weeks (minimum and maximum gestational ages were 28 and 36 weeks, respectively). Of these infants, 15 (24.2%) had a mean gestational age of less than 30 weeks, 41 (66.1%) had between 30 and 35 weeks of gestational age, and 6 (9.7%) had more than 35 weeks of gestational age. The mean birth weight of the infants was 1509.5 ±381. The minimum and maximum birth weights of the newborns were 1000 gram and 2650 gram respectively.

The maximum and minimum of Arterial oxygen saturation levels in the supine position were 93% and 82% and in the prone position were 94% and 85%, respectively. The mean of respiratory rate was 57.77 bpm in the supine position and 55.61 bpm in the

prone position. Also, the maximum and minimum heart rate 182 and 115, and 170 and 110 (beat/min) in the supine and prone positions, respectively.

The results of the Independent sample t-test used to compare the variables (HR, RR, SO2) in the prone and supine positions are shown in Table 1.

There was significant difference in the HR between the newborns placed in the prone and supine positions (P<0.001). Also, the oxygen saturation in the prone position was more than that in the supine position (P<0.001) and finally, RR in the prone position was less than that in the supine position (P<0.001).

Table 1. Comparison of physiological indices based on the type of position in the neonates

Variable	Type of position	Number	Min	Max	Mean	S.D	P- Value
Percentage of Arterial Oxygen Saturation	Supine Position	62	82	93	88.47	2.47	<0.001
	Prone Position	62	85	94	89.71	2/51	
Respiratory Rate	Supine Position	62	42	74	57.77	7.16	<0.001
	Prone Position	62	45	72	55.61	6.4	
Heart Rate	Supine Position	62	115	182	142.11	13.45	<0.001
	Prone Position	62	110	170	140.55	13.3	

DISCUSSION

This study showed that, compared to the supine position, the mean of arterial oxygen saturation was higher in the prone position in the premature newborns with respiratory distress syndrome under N-CPAP. The better oxygen saturation in prone position might suggest a higher efficacy of the diaphragm during its contraction, generating more strength, improving ventilation and, thus, optimizing gas exchange. These results indicate that prone position can reduce the need for high inspiratory oxygen concentrations in premature infants who have respiratory problems and have been treated with N-CPAP. It is also helpful in preventing complications caused by high inspiratory oxygen concentrations. These findings are consistent with the results of the study by Baird et al. in Chicago, USA conducted on 70 children with respiratory disease; in which it was shown that, when compared to the supine position, the oxygenation rate of the children was significantly better in the prone position[18]. Similar results are observed in the study by Wells et al.[7]. In 2012 Guana et al. carried out a study on 19 preterm newborns to investigate the effect of different positions on infants with mild respiratory distress receiving NCPAP. In the study breathing pattern was evaluated by plethysmography and it was observed that the arterial oxygen was higher in both of the prone and left lateral positions than it was in the supine position[15]. Also, the results of the study by Vafaienejad et al. showed that oxygen saturation in the prone position was higher than that in the supine position[19]. However, in the study by Balali et al. it was showed that there is no significant difference between mean arterial oxygen saturation in the supine and prone positions[20]. In a study by Shah Farhat et al. conducted on 31 preterm infants weighing less than 1500 grams, no significant difference was observed in the level of arterial oxygen saturation in the prone position in comparison with the supine position[21] which is not consistent with the results of the present study. The inconsistency seen between the results of these two studies and the present study is probably due to the differences in sample size and weight of the studied neonates.

The results showed that respiratory rates are similar to the arterial oxygen saturation, indicating the influence of the prone position on RR. Respiratory rate in the prone position was significantly lower when compared to the supine position. This decrease in respiratory rate in prone position might be due to the alteration in the length-tension relationship of the diaphragm, which occurs with postural change. Previous studies have shown that prone position increases the tidal volume and the functional residual capacity, resulting in stabilization of the chest wall with more synchrony between thorax and abdomen.

The results of this study showed that HR (heart rate) was significantly different between the prone and supine positions. In a study by Vafaienejad et al. conducted in 2015 to compare the effects of supine and prone positions on respiratory state of premature infants suffering from acute respiratory distress syndrome who have been treated with the INSURE protocol, the results showed that heart rate and respiration in the prone position were lower than those in the supine position[19]. Also, in a study by the

Ghorbani et al, the results showed that heart rate and respiration were lower in the prone position[22]. Another study by Tricia et al. showed a lower respiratory rate and better coordination of respiratory rhythm in the prone position[23]; these results are consistent with the results of the present study. In the study by Heimler et al. carried out to investigate the effect of position on the respiratory pattern of premature infants, the increase of central apnea in premature infants with supine position was compared to that of the prone position; however, there was no significant difference observed in heart rate between the two positions[24]. In another study, by Ma et al., the results showed that, in the short run, placing the newborn in the prone position reduces cardiac output and increases heart rate[25]. The results of these studies are not consistent with those of the present study. The reason for this difference may be due to differences in the study method and the size of the sample and the duration of the placement of neonates in any position.

In this study sometimes the presence of IV Line (IV) and other special care of infant prevent placing the infants in the correct position. Also, sometimes the infant's shaking and crying during the intervention caused changes in the physiological parameters on the monitor. Using simple methods such as prone position is recommended, to stabilize physiological parameters in preterm infants and improve oxygenation and reduce the duration of oxygen therapy in preterm newborns.

Based on the results of present study, positioning preterm infants under the NCPAP in the neonatal intensive care unit can be considered as an effective way of modifying the physiological parameters and improving oxygenation in the infants.

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