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Comparison of the Effects of Prone and Supine Positions on Abdominal Distention in the Premature Infants Receiving Nasal Continuous Positive Airway Pressure (NCPAP)

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ABSTRACT

Background: Premature infants with respiratory distress syndrome (RDS) are in dire need of respiratory support with a ventilator. However, the high tidal volume of mechanical ventilation may cause lung injury, and researchers have been concerned with the use of nasal continuous positive airway pressure (NCPAP). NCPAP has concomitant side effects, such as abdominal distention, which might disrupt the proper nutrition of neonates. The present study aimed to compare the effects of supine and prone positions on the abdominal distension of the newborns with NCPAP.

Methods: This clinical trial was conducted on 37 neonates during six months with a randomized block crossover design selected for the supine and prone positions on the back and abdomen, respectively. Samples were breastfed infants receiving noninvasive ventilation, who were kept in the mentioned positions for two hours. Data analysis was performed in Application SRS version 19 using descriptive and inferential statistics.

Results: In the analysis of variance, comparison of the changes in the abdominal circumference at 15, 30, 60, 90, and 120 minutes in the supine position (P=0.004) and prone position (P=0.001) with repeated sizes indicated a significant difference in at least one of the mentioned timings.

Conclusion: According to the results, prone position while feeding could effectively reduce abdominal distension in the neonates receiving NCPAP.

Keywords: Abdominal distension, Positive airway pressure, Posture, Premature infant

Introduction

Provision of intensive care to high-risk infants is one of most significant challenges in nursing, and nurses endeavor to increasingly improve the quality of care by incorporating evidence-based approaches into the science and art of nursing. Immaturity is the most common cause of neonatal mortality. According to statistics, 1.1 million preterm infants die due to the complications of prematurity, and more than 80% of premature infants are born at 32-37 weeks of gestation. In addition, 75% of these newborns die within the first week of life due to these complications (1).

According to the latest report of the World Health Organization (WHO), the rate preterm is 23% in Iran (2). Numerous pulmonary issues threaten the life of preterm infants, and respiratory distress syndrome (RDS) is considered to be the most common cause of admission to neonatal intensive care units (NICUs) and neonatal mortality and morbidity. However, the etiology and pathology of the syndrome remain controversial.

Use of masks and nasal prongs is among the

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minimally invasive methods to reduce lung injuries, whereby the infant is not fixed to a tracheal tube to facilitate the entry of large air volumes into the stomach, which in turn leads to abdominal distention. Nasal continuous positive airway pressure (NCPAP) is an available supportive treatment for the neonates with RDS to improve their condition (3).

Despite the advancement in neonatal care, ventilator-induced lung injuries are still an unresolved issue in terms of neonatal mortality. As a result, researchers have proposed less invasive ventilation methods, such as the use of NCPAP for preterm infants (4, 5). NCPAP has proved beneficial in keeping the alveoli open and stabilizing the functional residual capacity (FRC) in the treatment of RDS within short periods. It has been recommended that continuous positive airway pressure (CPAP) be applied within the first few minutes after birth in order to prevent RDS or during treatment and after the removal of the tracheal tube to reduce the need for reintubation (3).

Abdominal distension is an important complication that disrupts the feeding of infants. The aim of care provision for premature neonates is to ensure adequate growth and development similar to the pattern of intrauterine growth (6). Malnutrition in the neonatal period is associated with the reduced cell growth in the body systems, including the cardiovascular system, which causes chronic diseases in the system. Therefore, nutrition plays a pivotal role in the proper growth and development of newborns. On the other hand, the risk of growth failure increases with low gestational age and birth weight, and premature infants require additional nutritional support (7).

Infants born before 34 weeks of gestation are at a high risk of aspiration due to the lack of coordination between sucking, swallowing, and breathing. As such, gavage feeding of these newborns is essential, and failure to accomplish these goals (e.g., repeated episodes of hypoxemia while feeding) adversely affects the pulmonary and cardiac function, disrupting the development of oral feeding skills (8, 7).

Gastric lavage is frequently needed in premature neonates, while its increased application might give rise to feeding intolerance and necrotizing colitis. Furthermore, *Escherichia coli* have been shown to be a major cause of mortality in premature and low-birth-weight infants at birth (9). As increased abdominal girth or dilated bowel loops, abdominal distention is associated with nausea and emesis. Enteral nutrition is delayed in the preterm infants with feeding intolerance, leading to reduced calorie and nutritional improvement. Therefore, avoidance of the damages stemming from the stable buildup of residual volume has become a major challenge in the care of premature infants (3).

Nurses can contribute to the improvement of feeding tolerance in preterm infants through specific interventions, such as the provision of proper conditions during and after feeding (8). Premature infants with increased nutritional disorders require mechanical ventilation via nasal prongs or masks.

The present study aimed to compare the effects of prone and supine positions on abdominal distention in premature infants.

Methods

This clinical trial was conducted with a crossover design on 37 newborns. Inclusion criteria of the study were as follows: 1) gestational age of 32-36 weeks at birth; 2) birth weight of 1,000-2,000 grams; 3) one- and five-minute Apgar scores of >7; 4) infants with RDS requiring respiratory aid measures; 5) lack of congenital disorders (e.g., gastroschisis, omphalocele, cardiac disorders) and known infections; 6) receiving CPAP or noninvasive ventilation (Duo PAP) via nasal prongs or masks and 7) breastfeeding through oral gavage or mouth. Exclusion criteria were need for surgery and mechanical ventilation through an endotracheal tube, detachment from the CPAP device, and need for re-feeding in less than 120 minutes.

The study protocol was approved by Ethics Committee of the university (code: IR.IUMS. REC.1394.9213387202), and the study was registered under the code IRCT509211788N11. Afterwards, sampling was performed based on the inclusion criteria with the test power of 0.8 and 95% confidence interval in accordance with the previous studies in this regard (S=15, maximum α=0.5, d=10). In a pilot study, the sample size was calculated at 35 infants per each group using the mean comparison formula for two populations. Considering 10% attrition, the sample size increased to 40 infants.

$$N = \frac{\left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}\right)^2 * 2S_2}{d^2}$$

After selecting the samples, written consent was obtained from the parents of the infants, and the demographic data of the newborns were recorded. For each pair of infants, randomization was carried out in blocks of four, so that a box was picked and divided into four sections, each containing four cards describing the conditions of the neonates. By the random drawing of the cards, the newborns were identified in their relevant conditions for further evaluation. In addition, each neonate was assigned a code so as to ensure the confidentiality of their information. Accordingly, half of the neonates were initially placed in the prone position inside their nest, followed by the supine position. The remaining samples were initially placed in the supine position, followed by the prone position inside the nest.

The infants were placed in the required positions twice at appropriate intervals, and the results were compared. To increase the accuracy of the findings and need for fewer samples for the crossover design of the study, the neonates were compared to their own conditions in terms of the two treatment methods. The pressure on the airways and amount of breast milk during the day were recorded in order to assess abdominal distention in the premature infants with RDS receiving CPAP or noninvasive ventilation via nasal prongs or masks.

Measurement of the abdominal circumference was performed immediately after gavage or oral feeding after a 15-minute lapse. Prior to recording the conditions, the girth was measured using a paper measuring tape at one centimeter above the navel. The measurements were performed at 15, 30, 60, 90, and 120 minutes after each event recording, and the abdominal distension scores were compared in the prone and supine positions (9).

Data were collected using a questionnaire consisting of two sections, including the maternal and neonatal data. Neonatal data were gender, gestational age (weeks), one- and five-minute Apgar scores, birth weight, and abdominal circumference. Maternal data included the mode of delivery and complications at labor. Afterwards, the abdominal circumference of the newborns was measured using a paper measuring tape before and after the supine and prone positions.

Results

In total, 43 infants that were admitted in the NICU were enrolled in the study, while six infants were excluded from further evaluation due to intubation, digestive disorders (choanal atresia), meningomyelocele, and cardiac disorders (coarctation of the aorta). Final sample size consisted of 37 infants.

Minimum and maximum weight of the neonates was 1,000 and 2000 grams, respectively. In 19 infants, the one-minute Apgar score was seven, while it was nine in three newborns. In 18 infants, the five-minute Apgar score was nine, while it was seven in four cases. Minimum and maximum gestational age was 32 and 36 weeks, respectively. Feeding intolerance was 3.1 ml in 29 neonates, while it was up to 10 ml in two cases. Mean abdominal circumference of the infants in the prone and supine positions is presented in Table 1.

According to the information in Table 1, the mean changes in the abdominal circumference of the neonates was measured at 15, 30, 60, 90, and 120 minutes in the supine and prone positions, indicating a statistically significant difference between the supine and prone positions according to the analysis of variance with repeated measurements in at least one of the timings. Moreover, the results of Bonferroni post-hoc in the follow-up showed a significant decrease in the abdominal circumference of the infants between 30, 60, and 120 minutes (P=0.048 and 0.01, respectively). A significant reduction was also observed in this regard in the supine position between 30 minutes and 90 minutes (P=0.026).

According to the results, the abdominal circumference of the neonates increased in the supine position within 15 minutes to 30 minutes, while it decreased within 30 minutes and 60 minutes, followed by a significant reduction

Table 1. Mean Changes in Abdominal Circumference of Infants in Supine and Prone Positions

Condition	Time (minute)					
	15	30	60	90	120	Analysis of Variance with Repeated Measures
Abdominal Circumference in Supine Position	26.59±2.78	26.86±2.76	26.84±2.65	26.46±2.57	26.36±2.59	0.004
Abdominal Circumference in Prone Position	26.64±2.30	26.83±2.36	26.60±2.58	26.41±2.57	26.44±2.51	0.001

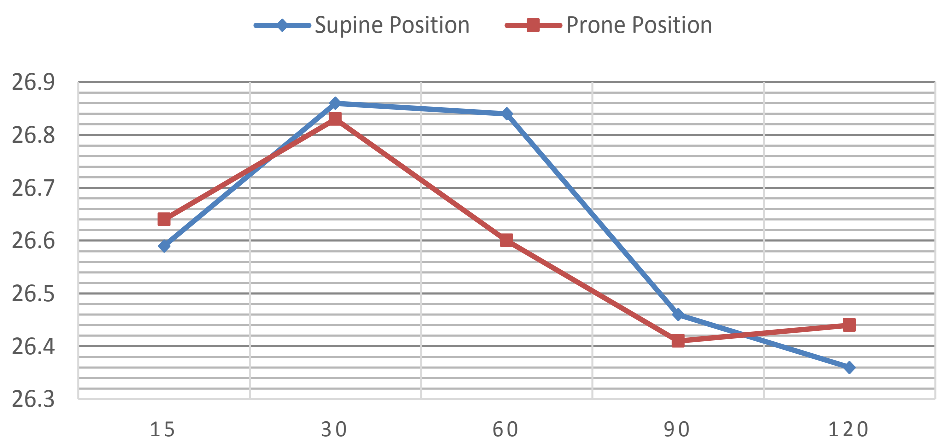

Figure 1. Comparison of Mean Abdominal Circumference in Supine and Prone Positions of Infants

within 60 minutes and 90 minutes, which continued from 90 minutes to 120 minutes.

Figure 1 depicts the trend of the changes in the abdominal circumference of the newborns in the supine and prone positions. According to the results of paired t-test, the mean abdominal circumference in the supine and prone positions had a significant difference over the mentioned intervals. In the prone position, abdominal circumference increased at 15-30 minutes, while it decreased more significantly compared to the supine position, continuing to 90 minutes, followed by a slight increase at 90-120 minutes.

According to the information in Figure 1, the reduction of the abdominal circumference was more significant in the prone position compared to the supine position, indicating the increased abdominal circumference in the supine position and its reduction in the prone position.

Discussion

According to the results of the present study, preterm infants with RDS who received assisted ventilation with NCPAP via nasal prongs or masks had lower abdominal distention in the supine position and leaning in the prone position while feeding.

In a study conducted by Shiau-shr-chen et al. (2013) in Taiwan, 35 preterm infants were assessed in order to determine the effect of positioning on the reduction of the stomach residual volume and decrease the gastric residual effect. According to the findings, the gastric residual volume was not statistically significant in the supine position at 30, 60, 90, 120, and 150 minutes after feeding, which is consistent with the current research in terms of methodology. Changing the position of neonates plays a key role in their feeding, especially during the first half-hour after feeding (9). In terms of statistical analysis, the reduced gastric residual volume in the supine position is not significantly different and is consistent with the results regarding the supine position in the present study.

Our findings are in congruence with the study by Valizadeh et al. (2013), which aimed to compare the effects of the breastfeeding of infants in the arms of the mother and supine positioning on the gavage residual volume in preterm infants. According to the results regarding the supine position, the gavage residual volume increased as a result of measuring the abdominal circumference at different stages, which is consistent with the present study (10).

In another research, Balali et al. (2012) compared the effects of positioning on the arterial blood oxygen saturation, vital signs, and abdominal distention in the preterm and low-birth-weight infants receiving NCPAP in Alzahra Hospital in Tabriz (Iran). Findings of the mentioned study are in line with the results of the present study (11).

Prone positioning not only improves the oxygenation and mechanical activity of the lungs, but it also could reduce the energy intake and need for artificial respiration in infants, while preventing ventilator-associated pneumonia (12, 13). Furthermore, prone positioning in preterm infants is associated with a more significant improvement in oxygen saturation compared to supine positioning. Among the other benefits of the prone position are better sleep patterns, less changes in the heart rate, central apnea, lower risk of bradycardia (14), higher efficiency of the diaphragm during contraction, increased vigor, improved ventilation, and optimized gas exchange through increasing the tidal volume and functional residual capacity, which in turn result in the stability of the chest and abdominal movements.

Our findings are consistent with a research conducted by Ghorbani et al. (2013), which aimed to compare the effects of the supine and prone positions on the heart rate and respiration rate of the preterm infants receiving noninvasive ventilation. The mentioned crossover study was performed on 44 neonates in Alzahra Hospital in Tabriz (Iran), and the results indicated that the preterm infants receiving positive airway pressure ventilation in the prone and supine positions did not develop apnea and bradycardia, while they also had better breathing patterns in the supine position compared to the prone position. These findings are in line with the results of the present study (15).

Another study in this regard was performed by Gabrielle (2012) on preterm infants in order to evaluate the effects of lateral (right side) and prone positions on the gavage residual volume, and the results showed no statistically significant difference between these position. This is inconsistent with the current research as we noted a significant difference in the abdominal distention of the neonates in the prone position (16).

As is depicted in Figure 1, reduction of the abdominal circumference in the prone positioning compared to the supine positioning was indicative of a significant difference in this regard, denoting that the abdominal circumference increased in the supine position and decreased in the prone position. Numerous studies have confirmed that the positioning of preterm infants could dramatically decrease their exposure to the possible complications of premature birth, which is in line with the results of the present study.

The results of the current research demonstrated that the preterm infants who are in the prone position while feeding experienced lower abdominal distension compared to those in the supine position. Our findings could be beneficial in developing the nursing knowledge, selecting the optimal position in the Newborn Individualized Developmental Care and Assessment Program (NIDCAP), formulating standard clinical positioning guidelines for the infants undergoing NCPAP and CPAP, and training of nurses in order to enhance the quality of care in neonates.

Conclusion

According to the results, prone positioning could effectively reduce abdominal distension in the preterm infants receiving positive airway pressure. Considering the advancement in the field of survival, the feeding of premature infants has gained great importance. Some of the basic problems in this regard include the lack of nutritional skills and possible cardiopulmonary effects on the breathing pattern of these neonates. Due to the lack of standard clinical guidelines for preterm newborns, it is recommended that similar studies be conducted in this regard.

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Conflicts of interests

None declared.

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