Arch Health Sci Res. 2022;9(1):43-50
DOI: 10.5152/ArcHealthSciRes.2021.21046

Original Article

The Effect of Prone and Supine Positions on Heart Rate and Oxygen Saturation in Preterm Newborns Receiving Respiratory Support: A Randomized Controlled Study

Sultan BEŞİKTAŞ[1], Emine EFE[2]

[1]Mengücek Gazi Training and Research Hospital, Erzincan, Turkey
[2]Department of Child Health Nursing, Akdeniz University, Faculty of Nursing, Antalya, Turkey

Cite this article as: Beşiktaş S, Efe E. The effect of prone and supine positions on heart rate and oxygen saturation in preterm newborns receiving respiratory support: A randomized controlled study. *Arch Health Sci Res.* 2022; 9(1): 43-50.

ABSTRACT

Objective: Therapeutic positions are widely used in preterm newborns in the neonatal intensive care unit (NICU). The aim of this study was to determine the effect of prone and supine positions on the oxygen saturation and heart rate of preterm newborns receiving respiratory support.

Material and Methods: This was an experimental, randomized controlled trial. Preterm infants were divided into 2 groups by randomization. Nineteen newborns in group 1 (Supine/Prone (S/P)) were first started in the supine position, and then placed in the prone position. Nineteen newborns in group 2 (Prone/Supine (P/S)) were first started in the prone position and were then placed in the supine position. The physiological parameters (oxygen saturation and heart rate) of preterm newborns was evaluated every 15 minutes in 2 hours after positioning for both groups.

Results: The 2 groups were determined to be similar in terms of descriptive and clinical variables. The difference between the mean oxygen saturation values of preterm newborns at the 105th minute, according to the positions, was found to be significantly higher in the prone position ($P = .001$). There was no statistically significant difference between the mean values of heart rate according to the positions ($P > .05$). It was determined that the mean oxygen saturation levels of premature newborns with nasal continuous positive airway pressure (CPAP) at the 60th minute ($P = .005$) and the 105th minute ($P = .018$) were significantly higher in the prone position.

Conclusion: The prone position provides high and stable oxygen saturation for preterm newborns who receive respiratory support.

Keywords: Heart rate, oxygen saturation, supine position, prone position, preterm newborns

Introduction

There are 13 million preterm births every year worldwide.[1] Preterm newborns face some major problems because of under developed organs and body systems. It is known that the majority of preterm newborns receive mechanical ventilation (MV) support in neonatal intensive care unit (NICU) due to respiratory distress.[2] It is recommended that individualized developmental care methods should be used in the NICU, as the preterm birth will affect the developmental process. Positioning, which is one of the individualized developmental care methods, is an important process in supportive care applied to provide the least harm from the environmental factors encountered in the extrauterine life of preterm newborns, who leave the intrauterine environment prematurely.[3] The positional support for the protection of the preterm newborns to protect them from environmental factors helps to maintain healthy body posture and also to helps the infant to feel safe.[3,4] This position, in the early extrauterine life, can affect physical and physiological values and the developmental process. It is also known that the position affects the respiratory system, heart rate, and pain sensation.[5]

Positioning in the preterm newborn receiving respiratory support is significant in terms of neurological and physiological development.[6] Positioning has been shown to have a positive effect on respiratory mechanics that affect the newborn's breathing patterns, cardio-respiratory activities, oxygenation, and lung ventilation.[7-9] Some studies have focused on the effects of specific positions on respiratory function and the

Corresponding author: Emine EFE, e-mail: eefe@akdeniz.edu.tr

Received: April 11, 2021
Accepted: July 2, 2021
Available Online Date: August 23, 2021

lung ventilation distribution of premature infants.[10,11] The studies have shown that the prone position is beneficial for gastric residual,[12] oxygenation,[13,14] and pulmonary function,[15] and also in order to increase tidal volume, improve diaphragm function, and reduce respiratory distress during periods of apnea and active sleep.[16] The prone position also has its disadvantages. These include extubation during care, an increased risk of sudden infant death syndrome, developmental retardation, position-related facial and subcutaneous edema, corneal lesions, and loss of vascular access.[10] In a systematic review study, it was reported that the prone position led to slightly improved oxygenation, including and fewer desaturation episodes.[17]

In preterm newborns receiving respiratory support in the NICU, it is important to determine the proper position, and the frequency and time of position change, to reduce oxygen need. Positioning in preterm newborns is the basis of neonatal nursing care.[18,19] There are studies in the literature which compare the effectiveness of supine and prone positions in preterm newborns. However, there are a limited number of studies, with a limited number of samples, in which the effects of the supine and prone positions on oxygen saturation and heart rate have been evaluated in newborns in MV and nasal continuous positive airway pressure (CPAP) of respiratory support. Such a study is needed to contribute to the literature. The aim of this study was to determine the effect of supine and prone positions on oxygen saturation and heart rate in respiratory-supported preterm newborns.

Materials and Methods

Study Design

This was a two-period crossover, experimental, randomized controlled trial. Preterm newborns in the study were divided into 2 groups by randomization according to position priority; group 1 (S/P) and group 2 (P/S). In this study, each newborn was a part of both the study and the control group (crossover design). The study protocol was prepared on the basis of the literature.[10,13,14] The study protocol was reviewed and approved by Clinical Trials.gov (NCT03895242).

The study was conducted in the NICU of an education research hospital in Turkey, between February 2015 and June 2016. The study sample was deemed adequate based on a sample size calculation conducted in PS Power and Sample Size Calculations (Version 3.0). According to the formula of the calculated sample size, for a crossover design with $a = 0.05$, the sample size required to achieve a 90% power was 36 newborns. Thus, the sample of the study consisted of 38 preterm newborns who met the inclusion criteria.

Inclusion Criteria

The inclusion criteria of preterm newborns in the study were: (a) 25 to 36 weeks of gestation age, (b) receiving respiratory support (MV (intubated) and at least 12 hours in nasal CPAP), (c) postnatal age $\leq$ 7 days, and (d) clinically stable.

Exclusion Criteria

Newborns who had cardiopulmonary instability or a congenital impairment that prevented positioning, who were on ventilation using high-frequency oscillating ventilation, or who were receiving continuous sedative and anticonvulsant drugs, were excluded from the study.

Randomization

A simple randomization method was used. The preterm newborns in the research were divided into 2 groups according to the priority of position; group 1 (S/P) and group 2 (P/S). Group 1 (S/P) and/ or group 2 (P/S) were written on slips of paper to allocate the newborns to the groups. then the papers were placed one by one into opaque sealed envelopes. The name of 1 group was contained in each envelope (group 1 (S/P) or group 2 (P/S)). When the preterm newborn's position was being planned, a random envelope was selected from the envelopes by the clinical nurse (who was not part of the research). Then the envelope was opened by the positioning researcher and the positioning was decided based on the group (group 1(S/P) or group 2(P/S)) the newborn would be in. The group allocation of the newborn was determined just before positioning.

Data Collection Procedure

After the random determination of the group that the preterm newborns were placed in, routine nursing care such as diapering, body cleaning, weighing, and suctioning was given to the preterm newborn. After the newborns were placed in the supine or prone position, using positioning materials, they were treated and fed.

The preterm newborns in group 1 (S/P) were first placed in the supine position and were allowed to rest for 60 minutes to stabilize after the positioning (no data were collected during this time). From the 61st minute, the SpO_2 and heart rate (HR) were recorded by pulse oximetry every 15 minutes, for 120 minutes. Two hours later, the preterm newborns in group 1 (S/P) were gently turned to the prone position by the investigator, and were allowed to rest for 60 minutes to stabilize after the position change (no data were collected during this time). From the 61st minute, the SpO_2 and HR were recorded with pulse oximetry, every 15 minutes, for 120 minutes (Figure 1).

The preterm newborns in group 2 (P/S) were first placed in the prone position and were allowed to rest for 60 minutes to stabilize after the positioning (no data were collected during this time). From the 61st minute, the SpO_2 and HR were recorded with pulse oximetry every 15 minutes, for 120 minutes. Two hours later, the preterm newborns in group 2 (P/S) were gently turned to the supine position by the investigator and were allowed to rest for 60 minutes to stabilize after the position change (no data were collected during this time). From the 61st minute, the SpO_2 and HR were recorded with pulse oximetry every 15 minutes, for 120 minutes (Figure 1).

In this study, all positioning and data collection procedures were carried out by the researcher. The preterm newborns stayed in each position for 3 hours (1 hour for their stabilization and 2 hours for monitoring the SpO_2 and HR values). The physiological parameters (oxygen saturation and heart rate) of the newborns were evaluated every 15 minutes (at 0, 15, 30, 45, 60, 75, 90, 105, and 120 minutes) for 120 minutes, in accordance with the literature. [13,14,20] Both groups were positioned in the midline, and the head of the bed was raised by 15-30°.[19,20] In all positioning procedures, it was ensured that the extremities were in symmetrical physiological flexion, the neck was slightly flexed (<30°), and the head and body were aligned. Positioning materials were used to increase the positive effects of the positions and to prevent positional deformities.[21] Towel rolls were used as the material for positioning the newborns. In the supine position, the head was turned to the midline or to the right or left side. The upper extremities were placed near the chest wall. The lower extremities were given a flexion position by placing a rolled towel under the knees. In the prone position, the head was turned to the right or left side. A towel roll was placed under the head to provide a slight extension. The hands were placed on both sides of the head. The flexion position was given to the lower extremities by placing a towel cover on the abdominal area. During the application, the newborns were provided with standardization of lying position and staying in this position for 2 hours under the control of the researcher. The researcher positioned all the newborns, followed them for 2 hours, and kept them in the given position. The newborns involved in the study were cared for in an incubator and wore diapers only. In the unit where the study was conducted, routine nursing care is provided between 09:00 AM

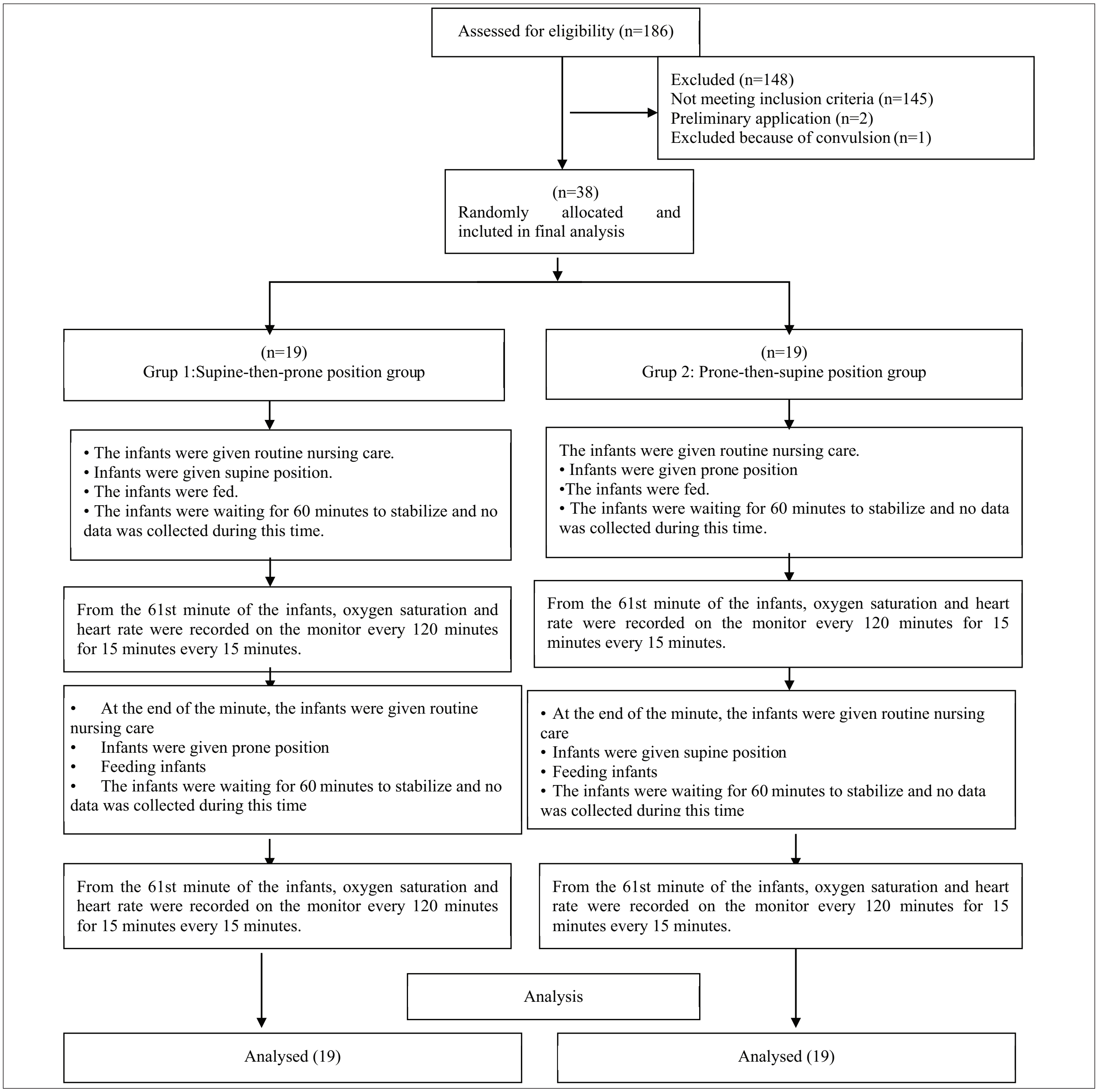

Figure 1. Flowchart based on the CONSORT diagram.

and 10:00 AM. The incubators are covered with sheets to prevent the newborns from being affected by the light, and the lights in the halls are turned off after the nursing care is over. In order to prevent noise, people are advised not to talk on the phone and loudly in the halls, to ensure that the alarm sounds of the devices are not too loud, and care is taken to combine the routine care and nursing care at the same hours.

Data Collection Tools

The data collection tools—The Newborn Descriptive Characteristics Form, The Newborn Clinical Variable Form, and The Physiological Variable Monitoring Form—were specially designed for this study, based on the literature.[14,20,22] The descriptive characteristics are gender, age, gestational age, and birth weight. The clinical variables are respiratory support, and treatment with surfactant or caffeine. The physiological variables are heart rate (HR, beats/min) and oxygen saturation (SpO_2%). A pulse oximetry (Philips Model) was used to determine the HR and SpO_2. The normal vital sign ranges assumed for the study subjects were as follows: HR range of 121 to 179 beats per minute, SpO_2 range ≥92%.[23] The pulse oximetry was calibrated as recommended by the manufacturer prior to use at the beginning of each shift within the study period. The pulse oximetry probe was attached to the foot.

Statistical Analysis

Data analysis was carried out using the Statistical Package for the Social Sciences version 22.0 (IBM SPSS Corp., Armonk, NY, USA) statistical program. Frequencies, percentages, mean values, standard deviation, and range were used as descriptive statistics. The Kolmogorov–Smirnov test was used to determine the suitability of variables for normal distribution. All the variables were normally distributed. Accordingly, parametric tests such as variance analysis and *t*-test were used to determine the differences between the variables of the 2 groups. Variance analysis was used for repeated measurements of heart rates and oxygen saturation levels of preterm newborns at 15-minute intervals. A value of $P < .05$ was considered statistically significant.

Results

Study Participants

Of the 186 preterm newborns screened for participation in this study, 148 were not included in the study, because they did not meet the inclusion criteria, and 2 were pre-applied. Thirty-nine newborns who met the criteria were included in the study. One newborn was excluded because of convulsions. Thus, the research sample consisted of 38 preterm newborns who completed the study protocol (Figure 1).

Comparison of Descriptive and Clinical Variables of the Study Participants

The study included 38 preterm infants, 18 (47.4%) were male, and 20 (52.6%) were female. The mean age of the infants was 2.73 ± 1.40 days. The mean gestational age was 31.40 ± 3.05 weeks. Their mean birth weight was 1713.16 ± 634.11 g. Among the preterm newborns who received respiratory support, 47.4% were on MV and 52.6% were on nasal CPAP. There was no statistically significant difference between group 1(S/P) and group 2 (P/S) in terms of gender, age, gestational age, birth weight, or respiratory support, or the descriptive and clinical variables ($P > .05$) (Table 1). These results show that the groups in the study were similar in terms of variables.

Comparison of Physiological Parameters of Preterm Newborns

As shown in Table 2 and Figure 2, the mean oxygen saturation of preterm newborns according to supine and prone positions at the 105th minute, was 98.47 ± 1.52 in the prone position and 97.66 ± 1.96 in the supine position. According to the statistical analysis, it was determined that the difference between the mean oxygen saturation of the preterm newborns was statistically higher in the prone position, at the 105th minute ($P = .001$).

The mean heart rate of preterm newborns according to supine and prone positions is given in Table 2 and Figure 2. When the mean heart rate of preterm newborns measured every 15 minutes was compared between the supine and prone positions, there was no statistically significant difference between the mean heart rate in the 2 positions ($P > .05$).

Table 3 shows the comparison of the mean oxygen saturation of preterm newborns receiving respiratory support. Oxygen saturation of the preterm newborns on MV, according to their supine and prone positions, was found to be 97.28 ± 2.05 in the supine position and 98.00 ± 1.64 in the prone position, at the 105th minute. It was determined that the difference between the mean oxygen saturation of the preterm newborns who were on MV in the 105th minute, according to the supine and prone positions, was significantly higher in the prone position ($P = .015$). It was determined that the mean oxygen saturation levels of premature newborns on nasal CPAP at the 60th minute ($P = .005$) and the 105th minute ($P = .018$) were statistically significantly higher in the prone position (Table 3, Figure 3).

Table 4 and Figure 3 show the comparison of the mean heart rate of preterm newborns with respiratory support. It was found that there

Table 1. Comparison of the Descriptive and Clinical Variables of Preterm Newborns (n = 38)

	S/P (*n* = 19)		P/S (*n* = 19)		Total (*n* = 38)			S/P	P/S	Total	
	n	%	n	%	n	%	χ^{2a} (*P*)	± SD	± SD	± SD	*t** (*P*)
Descriptive Variables											
Gender											
Female	9	47.4	11	57.9	20	52.6	.422				
Male	10	52.6	8	42.1	18	47.4	.516				
Age (days)								2.42 ± 1.30	3.05 ± 1.47	2.73 ± 1.40	1.400 (.170)
Gestational Age (weeks)								31.53 ± 2.99	31.26 ± 3.18	31.40 ± 3.05	0.263 (.794)
Birth Weight (g)								1750.53 ± 637.29	1675.79 ± 646.09	1713.16 ± 634.11	0.359 (.722)
Clinical Variables											
Respiratory Support											
MV	11	57.9	7	36.8	18	47.4	1.689 (.194)				
NCPAP	8	42.1	12	63.2	20	52.6					
Treatment with Surfactant											
Yes	10	52.6	13	68.4	23	60.5	.991 (.319)				
No	9	47.4	6	31.6	15	39.5					
Treatment with Caffeine											
Yes	9	47.4	12	63.2	21	55.3	.958 (.328)				
No	10	52.6	7	36.8	17	44.7					
Nutritional Status											
Parenteral+Enteral	9	47.4	9	47.4	18	47.4	<.001 (1.000)				
Parenteral	10	52.6	10	52.6	20	52.6					
Diagnosis											
RDS	10	52.6	9	47.4	19	50	.105 (.746)				
TTN	9	47.4	10	52.6	19	50					

Abbreviations: S/P, supine/prone; P/S, prone/supine; MV, mechanical ventilation; NCPAP, nasal continuous positive airway pressure; RDS, respiratory distress syndrome; TTN, transient tachypnea of newborn.

[a]*P* values are provided within parentheses.

Table 2. Comparison of Oxygen Saturation and Mean Heart Rate According to Measurement Time and Position

	Oxygen Saturation			
Measurement Time (Minutes)	Supine, Mean ± SD	Prone, Mean ± SD	*t*	*P*
0	98.13 ± 1.86	98.05 ± 2.16	0.19	.8472
15	98.50 ± 1.52	98.53 ± 1.54	−0.10	.9231
30	98.08 ± 1.76	98.42 ± 1.50	−1.06	.2962
45	98.32 ± 1.68	98.45 ± 1.70	−0.41	.6857
60	98.08 ± 1.53	98.53 ± 1.70	−1.62	.114
75	98.29 ± 1.68	98.29 ± 1.63	0	1
90	98.21 ± 1.74	98.24 ± 1.85	−0.07	.9432
105	97.66 ± 1.96	98.47 ± 1.52	−3.72	.0007
120	97.92 ± 1.88	98.00 ± 2.06	−0.21	.8323
	Heart Rate			
Measurement Time (Minutes)	Supine, Mean ± SD	Prone, Mean ± SD	*t*	*p*
0	139.58 ± 17.52	139.08 ± 15.13	0.19	.8477
15	141.95 ± 16.66	138.68 ± 14.41	1.35	.1853
30	141.03 ± 16.22	138.97 ± 13.93	0.84	.4076
45	142.00 ± 19.15	141.55 ± 14.21	0.19	.8504
60	141.58 ± 19.78	140.74 ± 14.56	0.33	.7444
75	140.55 ± 17.06	143.34 ± 15.17	−1.21	.2338
90	140.55 ± 15.26	143.87 ± 16.54	−1.45	.1561
105	141.92 ± 16.66	144.92 ± 16.37	−1.26	.2171
120	143.05 ± 17.73	145.11 ± 15.66	−0.92	.3636

Abbreviations: SD, standart deviation.

was no significant difference in terms of heart rate in both prone and supine positions, in preterm newborns receiving MV and nasal CPAP ($P > .05$).

Discussion

The bone structure of the newborn is mainly comprised of cartilage, the articular ligament is relatively loose, the muscle is relatively weak, and the bone is easy to bend and deform. Thus, maintaining the same position for a long time may result in malformations.[24] It is important to give different positions to preterm newborns receiving MV or nasal CPAP support, to prevent body malformations. It is also important in evaluating the effect of different positions on the physiological variables of the newborn. The results of this study, investigating the effects of prone and supine positions given to preterm newborns receiving respiratory support in the first postnatal week on physiological variables (oxygen saturation and heart rate) of preterm newborns are discussed using the literature.

In our study, it was determined that the mean oxygen saturation in preterm newborns was higher and stable in the prone position compared to the supine, in the period from 0 minutes to 120 minutes (Figure 2). In the literature, it was reported that the oxygen saturation in the preterm newborns who received respiratory support was higher in the prone position compared to the other positions (supine, right-lateral and left-lateral).[11,13,15,16,24] In the systematic reviews, it is reported that the oxygen saturation of the newborns in the prone position is high.[18,21,22,25] The results of this study were found to be similar to the results of other studies.

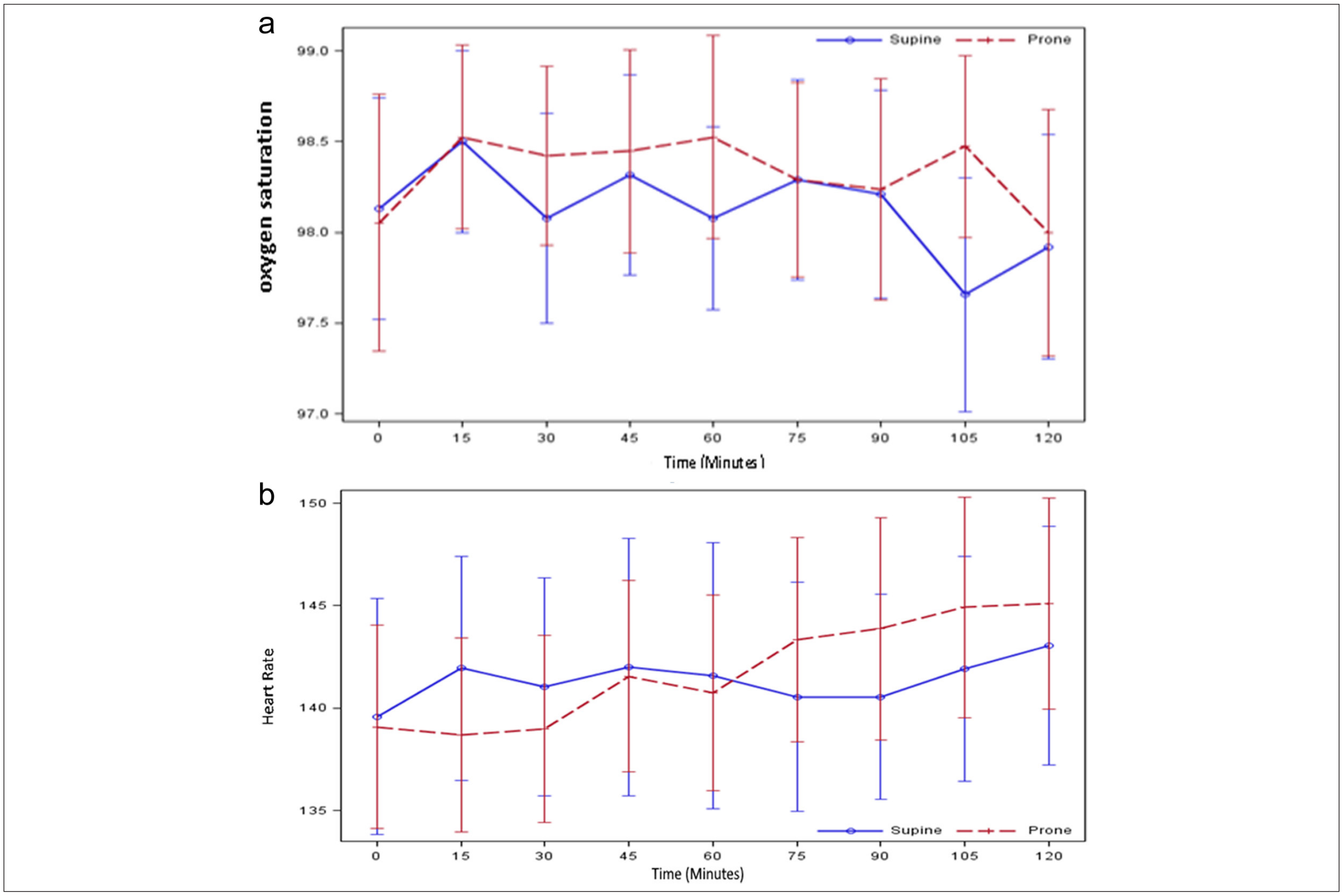

Figure 2. Comparison of preterm newborns' physiological parameters in the supine and prone positions.

Table 3. Comparison of Mean Oxygen Saturation of Preterm Newborns with Respiratory Support

Respiratory support	Measurement Time (Minutes)	Oxygen Saturation Supine, Mean ± SD	Oxygen Saturation Prone, Mean ± SD	*t*	*P*
Nasal CPAP (n=20)	0	98.15 ± 2.11	98.40 ± 2.19	−0.38	.7109
	15	98.60 ± 1.76	99.00 ± 1.12	−1.12	.2783
	30	98.55 ± 1.70	98.95 ± 1.15	−1.00	.3299
	45	98.50 ± 1.70	98.60 ± 1.64	−0.24	.8127
	60	98.15 ± 1.66	99.15 ± 1.09	−3.16	.0051
	75	98.70 ± 1.75	98.70 ± 1.38	0	1
	90	98.45 ± 1.73	98.45 ± 1.85	0	1
	105	98.00 ± 1.86	98.90 ± 1.29	−2.59	.0179
	120	98.35 ± 1.57	98.10 ± 2.07	0.46	.65
Mechanical ventilation (n=18)	0	98.11 ± 1.60	97.67 ± 2.11	1	.3313
	15	98.39 ± 1.24	98.00 ± 1.79	0.98	.3413
	30	97.56 ± 1.72	97.83 ± 1.65	−0.53	.6063
	45	98.11 ± 1.68	98.28 ± 1.81	−0.32	.7492
	60	98.00 ± 1.41	97.83 ± 2.01	0.39	.7029
	75	97.83 ± 1.50	97.83 ± 1.79	0	1
	90	97.94 ± 1.76	98.00 ± 1.88	−0.14	.8889
	105	97.28 ± 2.05	98.00 ± 1.64	−2.72	.0146
	120	97.44 ± 2.12	97.89 ± 2.11	−0.89	.3863

Abbreviations: CPAP, continuous positive airway pressure; SD, standart deviation.

Abdeyazdan et al.[13] (2010) reported that oxygen saturation was significantly higher in the prone position in preterm newborns from 15 minutes to 120 minutes.[13] The prone position simulates the aspects of the intra uterine environment, such as the natural fetal position that facilitates flexion, hand-to-mouth contact, and containment of extremities. Thus, newborns in the prone position may be less affected by environmental stimuli. The decreased crying and increased duration of a quiet sleep state during the prone position might be temporally associated with the better oxygenation.[14] Gillies et al.[25] reported that the prone position was significantly superior to the supine position in terms of oxygenation. Eghbalian[26] showed that oxygen saturation in the prone position was significantly higher in premature babies with RDS than in the supine position. Similar to the results of our study, in some studies in the literature, it was reported that the supine and prone positions did not affect heart rate in preterm newborns with respiratory support.[15,17,16]

In our study, the physiological parameters of preterm newborns were evaluated according to respiratory support methods (MV or nasal CPAP) and positions, and it was found that oxygen saturation of preterm newborns receiving MV and nasal CPAP support was higher in the prone position. In the study by Abdeyazdan et al.,[13] it was reported that SpO_2 in the prone position (98.4 ± 2.2) was higher than in the supine position (95 ± 0.6), and that the prone position was an advantageous method to meet the oxygen requirement of newborns using the mechanical ventilator. Chang et al.[14] reported that in newborns receiving mechanical ventilation, the prone position improved oxygen

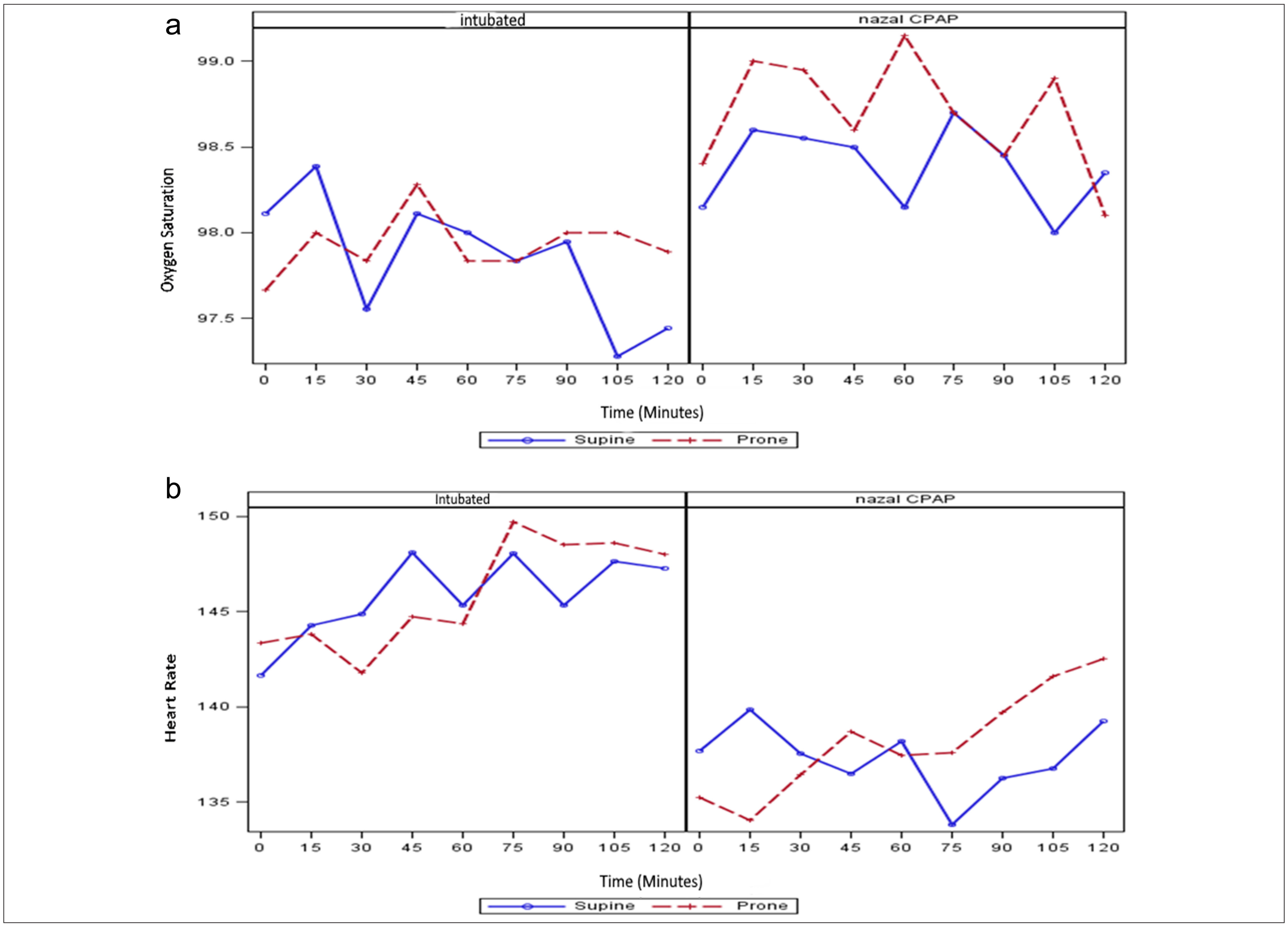

Figure 3. Comparison of physiological parameters of preterm newborns receiving respiratory support, according to supine and prone positions.

Table 4. Comparison of Mean Heart Rate of Preterm Newborns with Respiratory Support

Respiratory Support	Measurement Time (Minutes)	Heart Rate Supine, Mean ± SD	Heart Rate Prone, Mean ± SD	*t*	*P*
Nasal CPAP (n=20)	0	137.70 ± 18.22	135.25 ± 15.54	0.66	.5178
	15	139.85 ± 15.59	134.05 ± 14.20	1.52	.1438
	30	137.55 ± 16.00	136.45 ± 16.76	0.26	.7949
	45	136.50 ± 17.40	138.70 ± 16.34	−0.62	.545
	60	138.20 ± 18.42	137.45 ± 15.94	0.2	.8463
	75	133.80 ± 13.43	137.60 ± 14.30	−1.12	.2764
	90	136.25 ± 11.62	139.70 ± 17.28	−0.99	.3323
	105	136.75 ± 14.92	141.60 ± 17.83	−1.32	.203
	120	139.25 ± 16.67	142.50 ± 18.07	−0.90	.3781
Mechanical ventilation (n=18)	0	141.67 ± 16.97	143.33 ± 13.87	−0.46	.6499
	15	144.28 ± 17.92	143.83 ± 13.17	0.16	.877
	30	144.89 ± 16.00	141.78 ± 9.62	1.29	.2155
	45	148.11 ± 19.61	144.72 ± 11.00	1.15	.2667
	60	145.33 ± 21.08	144.39 ± 12.26	0.27	.7894
	75	148.06 ± 17.86	149.72 ± 13.80	−0.53	.6046
	90	145.33 ± 17.61	148.50 ± 14.77	−1.05	.3104
	105	147.67 ± 17.02	148.61 ± 14.16	−0.32	.756
	120	147.28 ± 18.37	148.00 ± 12.32	−0.28	.7816

Abbreviations: CPAP, continuous positive airway pressure; SD, standart deviation.

saturation. In a study comparing the effects of prone and right-side or left-side positions on oxygen saturation in preterm newborns with nasal CPAP, it was found that the oxygen saturation of the prone newborns was higher.[16]

In this study, there was no statistically significant difference between the heart rates in the preterm newborns on MV and nasal CPAP, whether they were in the supine or the prone position Montgomery et al.[27] found that positions (semi-prone, prone, and supine) had no significant effect on heart rate which is similar to the results of this study. Ghorbani et al.[28] found low heart rate in the prone position in preterm newborns with nasal CPAP. Zhong et al.[29] reported that there was no difference between the prone and supine positions in terms of heart rate in preterm newborns undergoing MV. The results of their study differ from this study. Antunes et al.[17] reported that there was no statistically significant difference in HR between the supine (144/min) and prone (147/min) positions in preterm newborns receiving MV.

The limitation of the present study was that it was not possible to control the noise due tothe personnel and devices. The effect of the right-side or left-side position was not investigated in the study. In the study, it was planned to monitor preterm newborns by placing them in the position at the same hours for 2 consecutive days. However, since the preterm newborns were not attached in the respiratory support with the same method (MV or nasal CPAP) for 2 consecutive days, preterm newborns were evaluated by placing them in the position for only 1 day. The sample size was limited due to the fact that the study was conducted in a single center.

Conclusion

The prone position significantly increased oxygen saturation in preterm newborns receiving respiratory support. It has been determined that oxygen saturation is high in the prone position in different respiratory support methods (nasal CPAP and MV). Supine and prone positions did not affect the heart rates of preterm newborns with nasal CPAP and MV. Neonatal intensive care nurses can support the increase of oxygen saturation by placing preterm newborns receiving respiratory support, in the prone position.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Akdeniz University (Date: January 21, 2015, No: 91).

Informed Consent: Written informed consent was obtained from the parents of the patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – S.B., E.E.; Design – S.B., E.E.; Supervision – S.B., E.E.; Resources – S.B., E.E.; Data Collection and/or Processing – S.B., E.E.; Analysis and/or Interpretation – S.B., E.E.; Literature Search – S.B., E.E.; Writing Manuscript – S.B., E.E.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

References

1. Als H, Butler S. Neurobehavioral development of the preterm infant. In: Martın RJ, Fanaroff AA, Walsh MC, eds. *Fanaroff & Martın's Neonatal-Perinatal Medicine Diseases of the Fetus and Infant*. St. Louis, Mosby; 2012:1057-1074.
2. Wheeler K, Klingenberg C, McCallion N, Morley CJ, Davis PG. Volume-targeted versus pressure-limited ventilation in the neonate. *Cochrane Database Syst Rev*. 2010;(11):CD003666. [CrossRef]
3. Turan T, Erdoğan Ç. Supporting the development of premature babies in neonatalintensive care unit. *J Acad Res Nurs*. 2018;4:127-132.
4. Association of Women's Health, Obstetric and Neonatal Nurses (AWHONN). New neonatal skin care: Evidence-based practice guideline. *Clin Pract*. 2013;17:545-546.
5. Graignic-Philippe R, Dayan J, Chokron S, Jacquet AY, Tordjman S. Effects of prenatal stress on fetal and child development: critical literature review. *Neurosci Biobehav Rev*. 2014;43:137-162. [CrossRef]
6. Hagedorn MIE, Gardner SL, Dıckey LA, Abman SH. Respiratory diseases. In: Merenstein GB, Gardner SL, eds. *Handbook of Neonatal Intensive Care*. MO, Mosby Elsevier; 2006:595-698.
7. Bhat RY, Hannam S, Pressler R, et al. Effect of prone and supine position on sleep, apneas, and arousal in preterm infants. *Pediatrics*. 2006;118(1):101-107. [CrossRef]
8. Sahni R, Schulze KF, Ohira-Kist K, et al. Interactions among peripheral perfusion, cardiac activity, oxygen saturation, thermal profile and body position in growing low birth weight infants. *Acta Paediatr*. 2010;99(1):135-139. [CrossRef]
9. Saiki T, Rao H, Landolfo F, et al. Sleeping position, oxygenation and lung function in prematurely born infants studied post term. *Arch Dis Child Fetal Neonatal Ed*. 2009;94(2):F133-F137. [CrossRef]
10. Rivas-Fernandez M, Roqué i Figuls M, Diez-Izquierdo A, Escribano J, Balaguer A. Infant Positionin Neonates Receiving Mechanical Ventilation. *Cochrane Database Syst Rev*. 2013;28:1-38.
11. Hough JL, Johnston L, Brauer SG, et al. Effect of body position on ventilation distribution in preterm infants on continuous positive airway pressure. *Pediatr Crit Care Med*. 2012;13(4):446-451. [CrossRef]
12. Chen SS, Tzeng YL, Gau BS, Kuo PC, Chen JY. Effects of prone and supine positioning on gastric residuals in preterm infants: a time series with cross-over study. *Int J Nurs Stud*. 2013;50(11):1459-1467. [CrossRef]
13. Abdeyazdan Z, Nematollahi M, Ghazavi Z, Mohhamadizadeh M. The effects of supine and prone positions on oxygenation in premature infants undergoing mechanical ventilation. *Iran J Nurs Midwifery Res*. 2010;15(4):229-233.
14. Chang YJ, Anderson GC, Dowling D, Lin CH. Decreased activity and oxygen desaturation in prone ventilated preterm infants during the first postnatal week. *Heart Lung*. 2002;31(1):34-42. [CrossRef]
15. Gouna G, Rakza T, Kuissi E, et al. Positioning effects on lung function and breathing pattern in premature newborns. *J Pediatr*. 2013;162(6):1133-7, 1137.e1. [CrossRef]
16. Brunherotti MA, Martinez EZ, Martinez FE. Effect of body position on preterm newborns receiving continuous positive airway pressure. *Acta Paediatr*. 2014;103(3):e101-e105. [CrossRef]

17. Antunes LCO, Rugolo LMSS, Crocci AJ. Effect of preterm infant position on weaning from mechanical ventilation. *J Pediatr (Rio J)*. 2003;79(3):239-244. [CrossRef]
18. Rivas-Fernandez M, Roqué i Figuls M, Diez-Izquierdo A, Escribano J, Balaguer A. Infant position in neonates receiving mechanical ventilation [review]. *Cochrane Database Syst Rev*. 2016;11:1-88.CD. 003668.pub4. [CrossRef]
19. *Best Practice: Evidence-Based Information Sheets for Health Professionals*. Adelaide:Royal Adelaide Hospital, 1997.
20. Malagoli RdC, Santos FFA, Oliveira EA, Bouzada MCF. Influência da posição prona na oxigenação, frequência respiratória e na força muscular nos recém-nascidos pré-termo em desmame da ventilação mecânica. *Rev Paul Pediatr*. 2012;30(2):251-256. [CrossRef]
21. McArthuR A. Positioning of preterm infants for optimal physiological development: a systematic review; Antidepressants versus placebo for depression in primary care; Blood donor skin preparation with alcohol vs. alcohol plus any antiseptic for preventing bacteraemia or contamination of blood for transfusion; Incentive spirometry for prevention of post-operative pulmonary complications in upper abdominal surgery. *J Adv Nurs*. 2010;66(2):255-259. [CrossRef]
22. Picheansathian W, Woragidpoonpol P, Baosoung C. Positioning of preterm infants for optimal physiological development: A systemic review. *Joanna Briggs Institute Library System Review*. 2009;7:224-259.
23. Colin AA, McEvoy C, Castile RG. Respiratory morbidity and lung function in preterm infants of 32 to 36 weeks' gestational age. *Pediatrics*. 2010;126(1):115-128. [CrossRef]
24. Wu J, Zhai J, Jiang H, et al. Effect of change of mechanical ventilation position on the treatment of neonatal respiratory failure. *Cell Biochem Biophys*. 2015;72(3):845-849. [CrossRef]
25. Gillies D, Wells D, Bhandari AP. Positioning for acute respiratory distress in hospitalised infants and children. *Cochrane Database Syst Rev*. 2012;7(7):CD003645. [CrossRef]
26. Eghbalian F. A comparison of supine and prone positioning on improves arterial oxygenation in premature neonates. *J Neonatal Perinatal Med*. 2014;7(4):273-277. [CrossRef]
27. Montgomery K, Choy NL, Steele M, Hough J. The effectiveness of quarter turn from prone in maintaining respiratory function in premature infants. *J Paediatr Child Health*. 2014;50(12):972-977. [CrossRef]
28. Ghorbani F, Asadollahi M, Valizadeh S. Comparison the effect of sleep positioning on cardiorespiratory rate in noninvasive ventilated premature infants. *Nurs Midwifery Stud*. 2013;2(2):182-187. [CrossRef]
29. Zhong QH, Duan J, Zhang CY, et al. Effect of prone positioning on respiratory function in very preterm infants undergoing mechanical ventilation. *Zhongguo Dang Dai Er Ke Za Zhi*. 2018;20(8):608-612.