Original Article

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Effect of Position Priority on Physiological Variables in Preterm Newborns Receiving Respiratory Support: Randomized Controlled Trial

Solunum Desteği Alan Preterm Yenidoğanlarda Pozisyon Önceliğinin Fizyolojik Değişkenlere Etkisi: Randomize Kontrollü Çalışma

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ABSTRACT

Objective: This study was designed to evaluate the effect of supine and prone position priority on oxygen saturation and heart rate in preterm newborns receiving respiratory support.

Methods: This was a randomized controlled study. Preterm newborns who were aged <7 days, clinically stable and received respiratory support were included. The sample group consisted of 38 preterm newborns were divided into two groups by randomization according to position priority; Group 1 [supine/prone (S/P)], Group 2 [prone/supine (P/S)].

Results: In both prone and supine positions, the mean oxygen saturation of preterm newborns in Group 2 (P/S) was found to be significantly higher than those in Group 1 (S/P). It was determined that the mean heart rate of preterm newborns in Group 1 (S/P) in the supine position was significantly lower than in Group 2 (P/S).

Conclusion: Giving the prone position first and then the supine position to preterm newborns receiving respiratory support increases oxygen saturation.

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

ÖZ

Amaç: Bu çalışma, solunum desteği alan erken doğmuş yenidoğanlarda sırtüstü ve yüzüstü pozisyon önceliğinin oksijen satürasyonu ve kalp hızı üzerindeki etkisini değerlendirmek için tasarlanmıştır.

Yöntemler: Bu çalışma randomize kontrollü bir çalışmadır. Doğum sonrası en fazla yedi günlük olan ve klinik olarak stabil olan, solunum desteği alan preterm yenidoğanlar dahil edildi. Örnek grubunu oluşturan 38 preterm yenidoğan öncelik sırasına göre iki gruba randomize edildi: Grup 1 [sırtüstü/yüzüstü (S/P)], Grup 2 [yüzüstü/sırtüstü (P/S)].

Bulgular: Grup 2'deki (S/P) erken doğmuş yenidoğanların ortalama oksijen satürasyonu, Grup 1'dekilere (S/P) göre anlamlı derecede yüksek bulundu. Grup 1'deki yenidoğanların ortalama kalp hızlarının sırtüstü pozisyonda Grup 2'dekilere göre anlamlı derecede düşük olduğu belirlendi.

Sonuç: Solunum desteği alan preterm yenidoğanlara ilk önce yüzüstü pozisyonu daha sonra sırtüstü pozisyonu verilmesi oksijen satürasyonunu artırır.

Anahtar Sözcükler: Kalp hızı, oksijen satürasyonu, sırtüstü pozisyon, yüzüstü pozisyon, erken doğmuş yenidoğan

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Introduction

Preterm newborns constitute the most important group of newborns hospitalized in the neonatal intensive care unit (NICU) (1). As the birth weight and gestational age of preterm newborns decrease, the lack of maturation in organs and systems and their susceptibility to premature complications increase (2). Since the respiratory center and lungs of preterm newborns are anatomically and functionally immature, respiratory distress is the most common problem they experience (3,4). Respiratory problems (74%) are in the first place in preterm newborns (5). In the NICU, preterm newborns have to get respiratory support due to respiratory distress (6). Respiratory support is used to provide oxygenation and excretion of accumulated carbon dioxide through alveolar ventilation, as well as to relieve and support breathing in newborns with insufficient respiratory function or without breathing (7,8). In the care of the newborn under respiratory support, application of moist and heated oxygen, routine physical examination and close monitoring of vital signs, especially respiratory distress symptoms and blood gases are required (9,10). During respiratory support, the body temperature of the newborn should be preserved, and liquid electrolyte and nutritional support should be provided. One of the important nursing care practices on newborns who receive respiratory support is to lay them in the appropriate position and change their position frequently (11,12).

Proper positioning of preterm newborns in the NICU is one of the important applications of individualized developmental care (13-15). Appropriate positioning is an application that supports newborns to get the least harm from environmental factors (16). Appropriate positioning is an intervention that enables preterm newborns to maintain their body posture and feel safe (17). It has been reported that proper positioning of newborns affects the respiratory system and heart rate of the newborn (18).

Supine, prone and side lying positions, called therapeutic positions, are recommended to prevent excessive tension of the joints of preterm newborns and to maintain the flexion position (19,20). With therapeutic position applications (supine, prone and lying on the side), normal growth and development are facilitated, staying in the same position for a long time is prevented, muscle deformity and asymmetry are prevented, unnecessary energy expenditure and stress are reduced and the newborn is allowed to rest. Within the scope of individualized supportive developmental care, the neonatal calming and physiological stability are increased by ensuring that the newborn feels safe (21,22).

The best lying position for preterm newborns is the prone position. The American Academy of Pediatrics recommends placing preterm newborns in the prone position during their stay in intensive care units, partly due to well-documented physiological effects in sick newborns, particularly those with lung disease (23). In the literature, it is reported that prone position increases oxygenation (24-27) and lung function (28). When the prone position is applied to preterm newborns first and then the supine position, the oxygen saturation and heart rate of the newborn may remain stable. However, no studies were found showing the changes in position priority in oxygen saturation and heart rate.

Methods

Purpose

The aim of this randomized controlled study is to evaluate the effect of priority of supine/prone (S/P) positions on oxygen saturation and heart rate in preterm newborns receiving respiratory support.

Research Hypotheses

(1) Hypotheses 1: The first prone position, then the supine position will provide better regulation of the oxygen saturation of preterm newborns with statistically significant differences compared to the first supine then prone position

(2) Hypotheses 2: The first prone position, then the supine position will provide better regulation of the heart rate of preterm newborns with statistically significant differences compared to the first supine then prone position

Study Design

This was a two-period crossover, experimental, randomized controlled trial. Preterm newborns in the study were divided into two groups by randomization according to position priority; Group 1 (S/P) and Group 2 [prone/supine (P/S)]. In this study, each newborn was both a study and a control group (crossover design).The study protocol prepared on the basis of the literature (24,26,29) was reviewed and approved by Clinical Trials.gov (NCT03895242).

The study was conducted in the NICU of an education and research hospital in Turkey, between February 2015 and June 2016. Study sample was deemed adequate based on sample size calculation performed with 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. Thus, the sample of the study consisted of 38 preterm newborns who met the inclusion criteria.

Inclusion criteria of the study were; (a) having 25 to 36 weeks of gestation age, (b) receiving respiratory support [mechanical ventilation (intubated) or nasal CPAP at least 12 hours], (c) postnatal age ≤7 days, and (c) being clinically stable.

We excluded newborns who had cardiopulmonary instability, underwent high-frequency oscillating ventilation, had congenital impairment preventing positioning, and received continuous sedative and anticonvulsant drugs.

The closed envelope method was used as a randomization method in the study. Preterm newborns in the research were divided into two groups according to the priority of position; Group 1 (S/P) and Group 2 (P/S). Papers on which "Group 1 (S/P)" or "Group 2 (P/S)" was written were placed one by one into the opaque sealed envelopes. When deciding a preterm newborn's position, a random envelope was selected among the envelopes by the clinical nurse who was not included in the study. Then the envelope was opened by the positioning researcher and the position of the preterm newborn was determined based on which group was written on the paper. The group of the newborn was determined just before positioning. Due to the nature of the interventions, it was not possible to blind the researcher's intervention to any of those involved. However, assessment of outcome measures was blind.

Procedure

After determining the group of the preterm newborns randomly, routine nursing care was given to the preterm newborns. After supine or prone position was given with positioning materials, the newborns were treated and fed.

The preterm newborns in Group 1 (S/P) were first placed in supine position and were waited for 60 minutes to stabilize after the positioning (no data was collected during this time). From the 61st minute, SpO_2 and HR were recorded with the pulse oximetry for 120 minutes every 15 minutes. Two hours later, the preterm newborns in Group 1 (S/P) was gently turned into the prone position by the investigator and they were waited for 60 minutes to stabilize after the positioning (no data was collected during this time). From the 61st minute, SpO_2 and HR were recorded with the pulse oximetry for 120 minutes every 15 minutes. Figure 1 shows the sample flow and protocol of the study.

In this study, all positioning and data collection procedures were performed by the researcher. The preterm newborns stayed in each position for 3 hours (1 hour for their stabilization and 2 hours for monitoring SpO_2 and HR values). Physiological parameters (oxygen saturation and heart rate) of the newborns were evaluated every 15 minutes for 120 minutes in accordance with the literature (24,26,30). Both groups were positioned in the midline and the head of the bed was raised 15-30 degrees

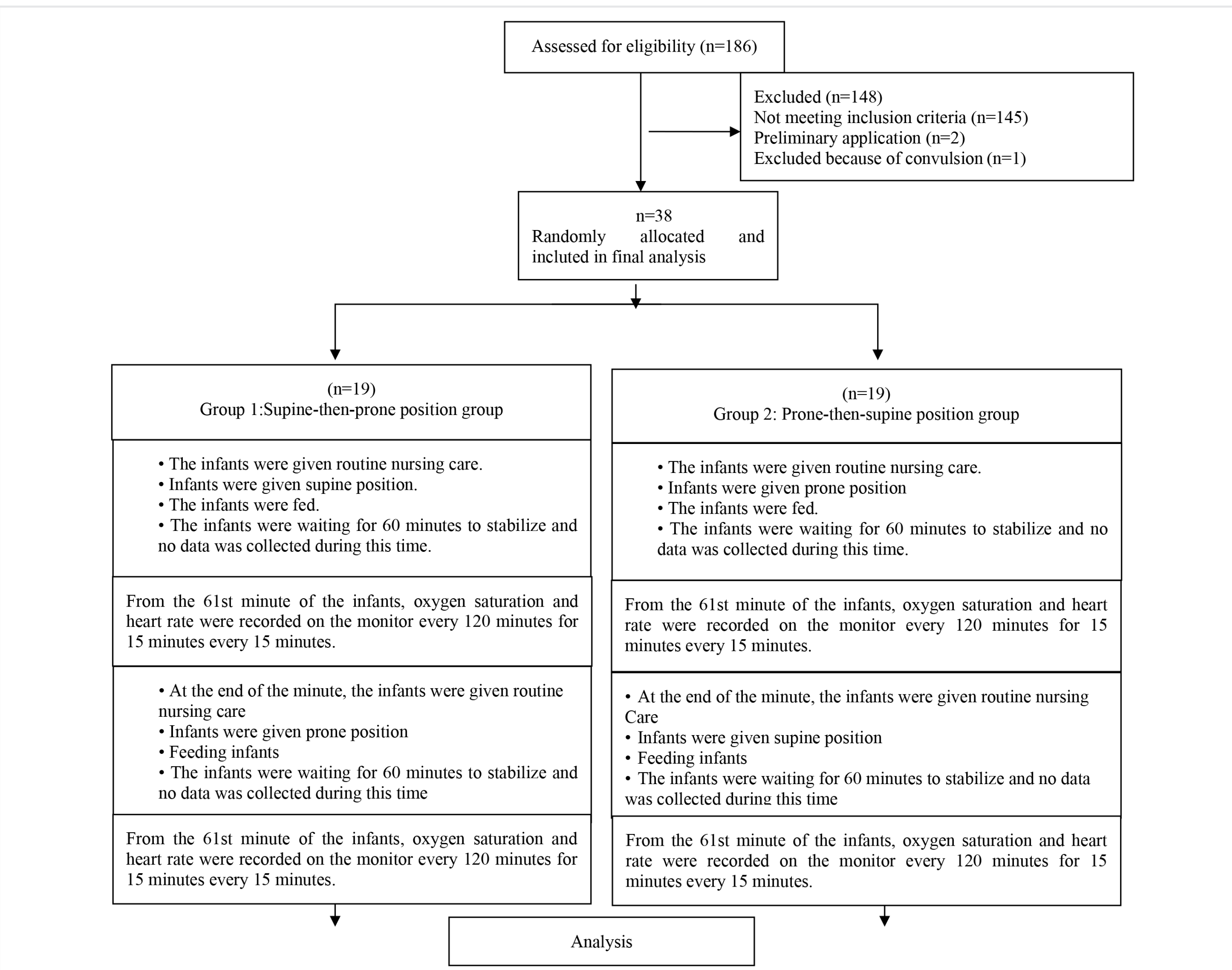

Figure 1. Flowchart based on the CONSORT diagram

(30,31). In all positioning procedures, it was ensured that the extremities were in symmetrical physiological flexion, the neck was slightly flexed (<30 degrees), and the head and body were aligned.

Positioning materials were used to increase the positive effects of positions and to prevent positional deformities (32). Towel rolls were used as materials 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. 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. The newborns involved in the study were cared for in a incubator and wore diapers only.

Measures

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 (24,30,33). Descriptive characteristics were gender, age, gestational age and birth weight. Clinical variables were respiratory support, treatment with surfactant and caffein. Physiological variables were heart rate (HR) (minimum) and oxygen saturation (% SpO_2). A pulse oximetry (Philips Model) was used to determine HR and SpO_2. The normal vital sign ranges assumed for the study subjects were as follows; 121 to 179 beats per minute for HR and oxygen saturation ≥92% (34). 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.

In order to conduct the study, written permissions were obtained from the hospital. The study was approved by the Institutional Review Board of the University (IRB no: 2015-41) and was conducted in compliance with the Helsinki Declaration. Before starting the study, the parents were informed about the objective, plan, and period of the study, and their written and verbal consents were received.

Statistical Analysis

Data analysis was carried out using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA) statistical program. Frequencies, percentages, mean values, standard deviation and range were used as descriptive statistics. 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 two groups. Variance analysis was used in repeated measurements of HR and oxygen saturation of preterm newborns at 15-minute intervals. A value of $p<0.05$ was considered statistically significant.

Results

As presented in Table 1, 18 (47.4%) preterm newborns were male, 20 (52.6%) were female. The mean age of the newborns

Table 1. Comparison of descriptive and clinical variables of preterm newborns (n=38)

Characteristic or clinical variables		Group 1 (S/P) (n=19) n (%) or M (SD)		Group 2 (P/S) (n=19) n (%) or M (SD)		Total (n=38) n (%) or M (SD)		p
Gender Female		9 (47.4)		11 (57.9)		20 (52.6)		0.516
Male		10 (52.6)		8 (42.1)		18 (47.4)		
Age(days)		2.42 (1.30)		3.05 (1.47)		2.73 (1.40)		0.170
Gestational age (weeks)		31.53 (2.99)		31.26 (3.18)		31.40 (3.05)		0.794
Birth weight (g)		1750.53 (637.29)		1675.79 (646.09)		1713.16 (634.11)		0.722
Respiratory support	MV	11 (57.9)		7 (36.8)		18 (47.4)		0.194
	NCPAP	8 (42.1)		12 (63.2)		20 (52.6)		
Treatment with surfactant	Yes	10 (52.6)		13 (68.4		23 (60.5)		0.319
	No	9 (47.4)		6 (31.6)		15 (39.5)		
Treatment with caffeine	Yes	9 (47.4)		12 (63.2)		21 (55.3)		0.328
	No	10 (52.6)		7 (36.8)		17 (44.7)		
Nutritional status	Parenteral + enteral	9	47.4	9	47.4	18	47.4	1.000
	Parenteral	10	52.6	10	52.6	20	52.6	
Diagnosis	RDS	10	52.6	9	47.4	19	50	0.746
	TTN	9	47.4	10	52.6	19	50	

S/P: Supine/prone, P/S: Prone/supine, MV: Mechanical ventilation, NCPAP: Nasal continuous positive airway pressure, RDS: Respiratory distress syndrome, TTN= Transient tachpynea of newborn, SD: Standart deviation

Table 2. Comparison of heart rate and oxygen saturation according to positions and measurement time of preterm newborns (n=38)

Group	Measurement time (min)	Heart rate		Oxygen saturation	
		Supine M (SD)	Prone M (SD)	Supine M (SD)	Prone M (SD)
Group 1 (supine/prone n=19)	0	136.48 (19.75)	141.84 (14.93)	98.16 (1.42)	97.37 (2.39)
	15	138.58 (16.62)	139.48 (16.20)	98.68 (1.11)	98.05 (1.75)
	30	137.21 (17.81)	139.58 (15.34)	97.63 (1.67)	98.05 (1.87)
	45	138.52 (20.14)	141.37 (13.03)	97.79 (1.78)	98.11 (1.91)
	60	138.21 (21.72)	140.37 (14.42)	97.74 (1.37)	98.16 (2.01)
	75	137.05 (18.19)	142.58 (13.68)	97.79 (1.90)	98.00 (1.70)
	90	138.42 (15.89)	143.63 (14.92)	97.84 (1.74)	97.58 (2.12)
	105	141.42 (17.54)	143.69 (15.47)	96.95 (2.04)	98.11 (1.37)
	120	139.74 (17.52)	142.84 (15.45)	97.42 (1.81)	97.79 (2.25)
	Total	138.40 (18.05)	141.71 (14.58)	97.78 (1.70)	97.91 (1.92)
Group 2 (prone/supine n=19)	0	142.68 (14.84)	136.31 (15.22)	98.11 (2.26)	98.74 (1.69)
	15	145.32 (16.44)	137.90 (12.78)	98.32 (1.86)	99.00 (1.15)
	30	144.84 (13.88)	138.37 (12.76)	98.53 (1.78)	98.79 (0.92)
	45	145.48 (17.97)	141.74 (15.66)	98.84 (1.42)	98.79 (1.44)
	60	144.95 (17.56)	141.11 (15.08)	98.42 (1.64)	98.90 (1.29)
	75	144.05 (15.54)	144.11 (16.88)	98.79 (1.27)	98.58 (1.54)
	90	142.68 (14.73)	144.11 (18.42)	98.58 (1.71)	98.90 (1.29)
	105	142.42 (16.20)	146.16 (17.56)	98.37 (1.64)	98.841 (1.61)
	120	146.37 (17.77)	147.37 (15.95)	98.42 (1.87)	98.21 (1.90)
	Total	144.31 (15.84)	141.91 (15.75)	98.48 (1.71)	98.75 (1.44)
Statistic		p value	p value	p value	p value
	Between-groups	0.002	0.904	0.000	0.000
	Change over time	0.998	0.369	0.624	0.851
	Time-group interaction	0.998	0.956	0.398	0.955

SD: Standart deviation, min: Minimum

was 2.73±1.40 days. Among the preterm newborns who received respiratory support, 47.4% were on mechanical ventilation and 52.6% were on nasal CPAP. The groups were homogeneous in terms of these characteristics.

In both prone and supine positions, the means of oxygen saturation of preterm newborns in Group 2 (P/S) was found to be significantly higher than in Group 1 (S/P) (prone: F =20.22, p=0.000, supine: F=14.73, p=0.000). It was determined that the mean HR of preterm newborns in Group 1 (S/P) was significantly lower than in Group 2 (P/S) in the supine position (F=9.92, p=0.002). It was determined that there was no significant difference between the mean HR of preterm newborns in Group 1 (S/P) and those in Group 2 (P/S) in the prone position (F=0.01, p=0.904) (Table 2).

As a result of the statistical analysis in this study, the mean of oxygen saturation of the preterm newborns in the Group 1 (S/P) at the 105th minute was statistically significantly higher in prone position (t=-4.01, p=0.001) (Table 3).

It was determined that the mean of oxygen saturation of the preterm newborns in the Group 2 (P/S) at the 15th minute was statistically significantly higher in the prone position (t=-2.17, p=0.0439) (Table 4).

Discussion

The aim of this randomized controlled study was to evaluate the effect of priority of supine and prone positions on oxygen saturation and HR in preterm newborns receiving respiratory support.

In a study, preterm newborns were divided into two groups as Group 1 S/P and Group 2 P/S and oxygen saturation was compared between the groups. As a result of the study, no difference was found in terms of oxygen saturation between the groups (24). Our results were not similar to the results of the study by Chang et al. (24).

Wu et al. (35) divided 67 newborns who underwent mechanical ventilation (intubation) into two groups as the supine position

Table 3. Comparison of oxygen saturation and heart rate averages of preterm newborns in Group 1 (S/P) according to measurement time and positions (n=19)

Group	Measurement time (min)	Oxygen saturation Supine M (SD)	Prone M (SD)	t	p
Group 1 (supine/prone)	**0**	98.16 (1.42)	97.37±2.39	1.20	0.2444
	15	98.68 (1.11)	98.05±1.75	1.61	0.1241
	30	97.63±1.67	98.05±1.87	-0.85	0.4084
	45	97.79±1.78	98.11±1.91	-0.68	0.5061
	60	97.74±1.37	98.16±2.01	-0.87	0.3973
	75	97.79±1.90	98.00±1.70	-0.45	0.6587
	90	97.84±1.74	97.58±2.12	0.40	0.6915
	105	**96.95±2.041**	**98.11±1.37**	**-4.01**	**0.0008**
	120	97.42±1.81	97.79±2.25	-0.71	0.4876
		Heart rate			
		Supine M (SD)	**Prone** M (SD)	**t**	**p**
	0	136.48±19.75	141.84±14.93	-1.42	0.1733
	15	138.58±16.62	139.48±16.20	-0.29	0.7757
	30	137.21±17.81	139.58±15.34	-0.57	0.5735
	45	138.52±20.14	141.37±13.03	-0.76	0.4576
	60	138.21±21.72	140.37±14.42	-0.50	0.6229
	75	137.05±18.19	142.58±13.68	-1.40	0.1789
	90	138.42±15.89	143.63±14.92	-1.51	0.1472
	105	141.42±17.54	143.69±15.47	-0.59	0.5649
	120	139.74±17.52	142.84±15.45	-1.02	0.3217

SD: Standard deviation, min: Minimum

group and the alternating position group. The oxygen saturations at 8 and 16 hours were recorded after giving 33 of the newborns the supine position (4 hours), and after giving 34 of them the supine position (4 hours) and then the prone position (4 hours). It was found that oxygen saturation was higher in the alternating position group (first supine, then prone) than the supine position group (35).

Hough et al. (36) divided 30 preterm newborns with <32 weeks of gestation and birth weight >750 gwho underwent nasal CPAP or had spontaneous breathing into two groups including semi-prone, prone and supine positions groups. The oxygen saturation was recorded 30 minutes after each position. No difference was found between the order of positions in terms of oxygen saturation (36). Hough et al. (36) followed up preterm newborns who received nasal CPAP or had spontaneous breathing for 30 minutes after each positioning, while we followed up those who were intubated or received nasal CPAP for 120 minutes after each positioning.

Hough et al. (37) found that there was no difference between the order of semi-prone, prone and supine positions in terms of oxygen saturation of preterm newborns who were intubated or breathing spontaneously. Wu et al. (35) determined that the oxygen saturation of the preterm newborn who was given the prone position first was higher.

Although the finding obtained at the 15th minute in our study did not seem to be significant; the finding obtained at the 75th minute after waiting for 60 minutes following positioning was significant. So, the finding obtained at the 15th minute can be evaluated as the finding obtained at the 75th minute. This situation supports that the finding obtained at the 15th minute is a significant finding and that oxygen saturation is higher in the prone position. In addition, when looking at the positions of preterm newborns in the groups; it was observed that those in Group 1 (S/P) were in the prone position at the 105th minute and those in Group 2 (P/S) were in the prone position at the 15th minute. This situation highlights the importance of the positive effect of prone position on oxygen saturation.

In line with these results obtained in our research; it was observed that preterm newborns who received respiratory support in the prone position first had higher oxygen saturation in this position and the prone position kept the oxygen saturation stable. In addition, it was determined that the oxygen saturation was higher and stability continued during the period of supine position in preterm newborns who were given supine position

Table 4. Comparison of oxygen saturation and heart rate averages of preterm newborns in Group 2 (P/S) according to measurement time and positions (n=19)

Group	Measurement time (min)	Oxygen saturation Supine M (SD)	Prone M (SD)	t	p
Group 2 (prone/supine)	0	98.11±2.26	98.74±1.69	-1.43	0.1690
	15	**98.32±1.86**	**99.00±1.15**	**-2.17**	**0.0439**
	30	98.53±1.78	98.79±0.92	-0.62	0.5433
	45	98.84±1.42	98.79±1.44	0.12	0.9093
	60	98.42±1.64	98.90±1.29	-1.69	0.1075
	75	98.79±1.27	98.58±1.54	0.57	0.5778
	90	98.58±1.71	98.90±1.29	-0.92	0.3686
	105	98.37±1.64	98.84±1.61	-1.49	0.1545
	120	98.42±1.87	98.21±1.90	0.39	0.6975
		Heart rate Supine M (SD)	Prone M (SD)	t	p
	0	142.68±14.84	136.31±15.22	2.09	0.0513
	15	145.32±16.44	137.90±12.78	2.10	0.0505
	30	**144.84±13.88**	**138.37±12.76**	**2.77**	**0.0126**
	45	145.48±17.97	141.74±15.66	1.36	0.1917
	60	144.95±17.56	141.11±15.08	1.41	0.1755
	75	144.05±15.54	144.11±16.88	-0.02	0.9822
	90	142.68±14.73	144.11±18.42	-0.47	0.6474
	105	142.42±16.20	146.16±17.56	-1.28	0.2164
	120	146.37±17.77	147.37±15.95	-0.30	0.7671

SD: Standard deviation, min: Minimum

after prone. However, it was observed that oxygen saturation of preterm newborns who received respiratory support in the supine position was not stable for 3 hours. As a result, it is suggested that preterm newborns who receive respiratory support should be given the prone position first and that they can remain in the prone position after 3 hours.

In line with the results, it was determined in our study that the HR of preterm newborns in group 1, who was given the supine position first, was lower. When the literature was examined, it was determined in the studies that the order of the position did not affect the HR (36,37).

Study Limitations

The limitation of the present study was that it was not possible to control the noise due to the personnel and devices. The sample size was limited due to the fact that the study was conducted in a single center.

Conclusion

The results showed that the method of first prone then supine positioning was effective in increasing oxygen saturation but ineffective in reducing HR. Prone position may be preferred primarily to increase oxygenation of preterm newborns receiving respiratory support in the NICU.

Ethics

Ethics Committee Approval: The study was approved by the Institutional Review Board of the University (IRB no: 2015-41) and was conducted in compliance with the Helsinki Declaration.

Informed Consent: The parents were informed about the objective, plan, and period of the study, and their written and verbal consents were received.

Peer-review: Externally peer reviewed.

Authorship Contributions

Surgical and Medical Practices: S.B., Concept: S.B., E.E., Design: S.B., E.E., Data Collection or Processing: S.B., Analysis or Interpretation: S.B., E.E., Literature Search: S.B., Writing: S.B., E.E.

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