IJN
Iranian Journal of Neonatology
http://ijn.mums.ac.ir

Open Access Original Article

Comparison of the Effects of Supine and Prone Positions on Oxygen Saturation and Vital Signs in Premature Infants: A Crossover Clinical Trial

Hamid Torabian[1], Saeed Alinejad[2], Akram Bayati[1], Fatemeh Rafiei[3], Sharareh Khosravi[1*]

1. Department of Nursing, School of Nursing and Midwifery, Arak University of Medical Sciences, Arak, Iran
2. Department of Pediatrics, School of Medicine, Arak University of Medical Sciences, Arak, Iran
3. Department of Biostatistics, School of Medicine, Arak University of Medical Sciences, Arak, Iran

ABSTRACT

Background: Positioning of premature newborns significantly affects their health status. However, the most suitable position remains controversial. The current study aimed to compare the effect of supine and prone positions on oxygen saturation and vital signs in premature newborns.
Methods: In this crossover clinical trial, a total of 22 newborns admitted to the Neonatal Intensive Care Unit (NICU) of Amir Kabir Hospital in Arak, Iran, were selected through purposive sampling technique, and then randomly assigned into groups 1 and 2. Newborns in group 1 were first placed in a prone position (i.e., the first period for 3 h), and then in a supine position (i.e., the second period for an additional 3 h). The reverse procedure was applied to the intervention group 2. Heart rate, respiratory rate, and oxygen saturation were measured and recorded every 15 min.
Results: The mean oxygen saturation in the prone position (96.164±0.148) was higher than in the supine position (90.479±0.513; P=0.0001). The mean heart rate in the prone position (138.24±1.87 beats/min) was lower than that in the supine position (147.48±1.597 beats/min; P=0.0001). The mean respiratory rate in the prone position (40.430±0.504 breaths/min) was lower than that in the supine position (46.773±0.685 breaths/min; P=0.0001).
Conclusion: The current study demonstrated that the prone position put the newborn admitted to NICU in a more stable condition. However, the selection of the best position must be made based on the newborn's health status and situation.

Keywords: Oxygen saturation, Position, Premature newborn, Vital signs

Introduction

Annually, approximately 15 million neonates are born preterm, and this number is rising. Complications of preterm birth are the leading causes of death among children under 5 years of age; accordingly, these complications accounted for approximately 1 million deaths in 2015. Across 184 countries, the rate of preterm birth ranges from 5% to 18% (1, 2). In a meta-analysis conducted on the related studies in Iran, the prevalence of premature birth was reported to range from 5.5% to 19.85% (3).

One of the most important nursing care practices for premature newborns is placement in the most suitable position. The results of different studies have indicated the effect of positioning on the heart rate (HR), respiratory rate (RR), arterial oxygen saturation (SaO_2), respiratory pattern, pain intensity, gastroesophageal reflux, gastric residual, salivary cortisol level, and skeletal and motor development of newborns. Placing premature newborns in the most suitable position significantly prevents the incidence of short- and long-term complications. Nurses need to consider the newborn's condition, as well as the advantages and disadvantages of each position in selecting the best position for newborns (4-7).

* *Corresponding author*: Sharareh Khosravi, Department of Nursing, School of Nursing and Midwifery, Arak University of Medical Sciences, Arak, Iran. Tel: +988634173501-7; Fax: +988634173524; Email: khosravi@arakmu.ac.ir

Please cite this paper as:
Torabian H, Alinejad S, Bayati A, Rafiei F, Khosravi Sh. Comparison of the Effects of Supine and Prone Positions on Oxygen Saturation and Vital Signs in Premature Infants: A Crossover Clinical Trial. Iranian Journal of Neonatology. 2019 Jun: 10(2). DOI: 10.22038/ijn.2019.32928.1465

Despite the association between positioning and vital functions of premature newborns, a controversy still exists about the best position (8-11). Eghbalian et al. (2014) compared the impact of supine and prone positions on SaO_2 in premature newborns with respiratory distress syndrome and observed that SaO_2 was significantly higher in a prone position (12). Oliveira et al. (2009) also evaluated the impact of a prone position on thoracoabdominal asynchrony, respiratory pattern, and mean SaO_2 in peripheral blood among premature newborns. They reported that asynchrony was significantly reduced in a prone position; however, no changes were observed in respiratory pattern and SaO_2 (13).

Rayyani et al. (2014) compared the impact of supine and prone positions on SaO_2 in newborns admitted to Neonatal Intensive Care Unit (NICU) after being weaned from the ventilator and observed that SaO_2 was significantly higher in the prone position than in the supine position (14). On the other hand, Torabi et al. (2012) reported that a prone position was not better than a supine position in improving SaO_2 in premature newborns; in this regard, they observed that SaO_2 was significantly higher in the supine position than in the prone position (5).

It was found that placing preterm infants in the prone or supine position have effects on physiological factors, such as cardiorespiratory function, thermoregulation, oxygen saturation, and arousal from sleep (15). Regarding the importance of selecting the most appropriate position for premature newborns to improve their condition, the current study aimed to compare the impact of the supine and prone positions on SaO_2 and vital signs in this population.

Methods

This randomized crossover clinical trial was conducted on newborns admitted to the NICU of Amir Kabir Hospital, Arak, Iran. Amir Kabir Hospital is an educational hospital affiliated to Arak University of Medical Sciences, Arak, Iran. A total of 22 newborns (based on ref 16) meeting the inclusion criteria were recruited through the purposive sampling technique. The study population was assigned into intervention groups 1 and 2 through the randomized block method.

$$n = \frac{2\left(z_{1-\frac{\alpha}{2}} + z_{1-\beta}\right)^2 ({S_1}^2 + {S_2}^2)}{(d)^2}$$

α=0.05, β=0.2, S1=15.04, S2=13.09, D=12, n=22

The inclusion criteria were: 1) gestational age of 32-36 weeks, 2) chronological age of 2-28 days, 3) birth weight of ≥ 1,000 g, 4) spontaneous respiration and absence of mechanical ventilation, 5) maximum oxygen of 5 L/min when using oxygen in an incubator or hood, 6) stable body temperature, 7) lack of congenital disorders or blood disorder, 8) hemoglobin level of ≥ 9 g/dL, 9) nonuse of narcotics, corticosteroids, or surfactants, and 10) nonumbilical catheter in place. The exclusion criteria were: 1) parental refusal to continue the study, 2) transferring from NICU, 3) cardiopulmonary resuscitation, 5) inotropic support of ≥ 5 μg/kg, 6) pneumothorax, 7) peripheral edema, and 8) insertion of an umbilical catheter.

Data were collected using a questionnaire, including two sections. The first section entailed the newborns' demographic information, including diagnosis, gender, gestational age, chronological age, type of delivery, 5-min Apgar score, birth weight and height, and height and weight at the time of study. In addition, the second section consisted of a checklist to record vital signs (i.e., HR and RR) and SaO_2.

At first, all the newborns were placed in a lateral position for 30 min. Levels of SaO_2, HR, and RR were monitored and recorded during this period. Then, the newborns in group 1 were turned to a prone position, and group 2 were placed in a supine position (i.e., the first period of intervention). Levels of SaO_2, HR, and RR were recorded every 15 min in each position for 3 h. Afterward, the newborns were placed again in a lateral position for 30 min, and their studied parameters were recorded. Thereafter, the newborns' position was changed to the opposite position of the first period (i.e., prone to supine and supine to prone), and their physiologic parameters were recorded again every 15 min for 3 h (i.e., the second period of intervention; Figure 1). The newborns were placed in a nest during positioning.

A pulse oximeter was utilized to evaluate the level of SaO_2. Vital signs were also electrically monitored. All instruments were provided by SAADAT™ (Pooyandegan Rah Saadat Co., Iran) and calibrated by the exclusive agent of the manufacturing company. To minimize the influence of confounding factors, such as environmental noises and excessive brightness, the interventions were performed during the night shift. The data were collected by the main researcher.

Statistical analysis

The data were analyzed in SPSS software

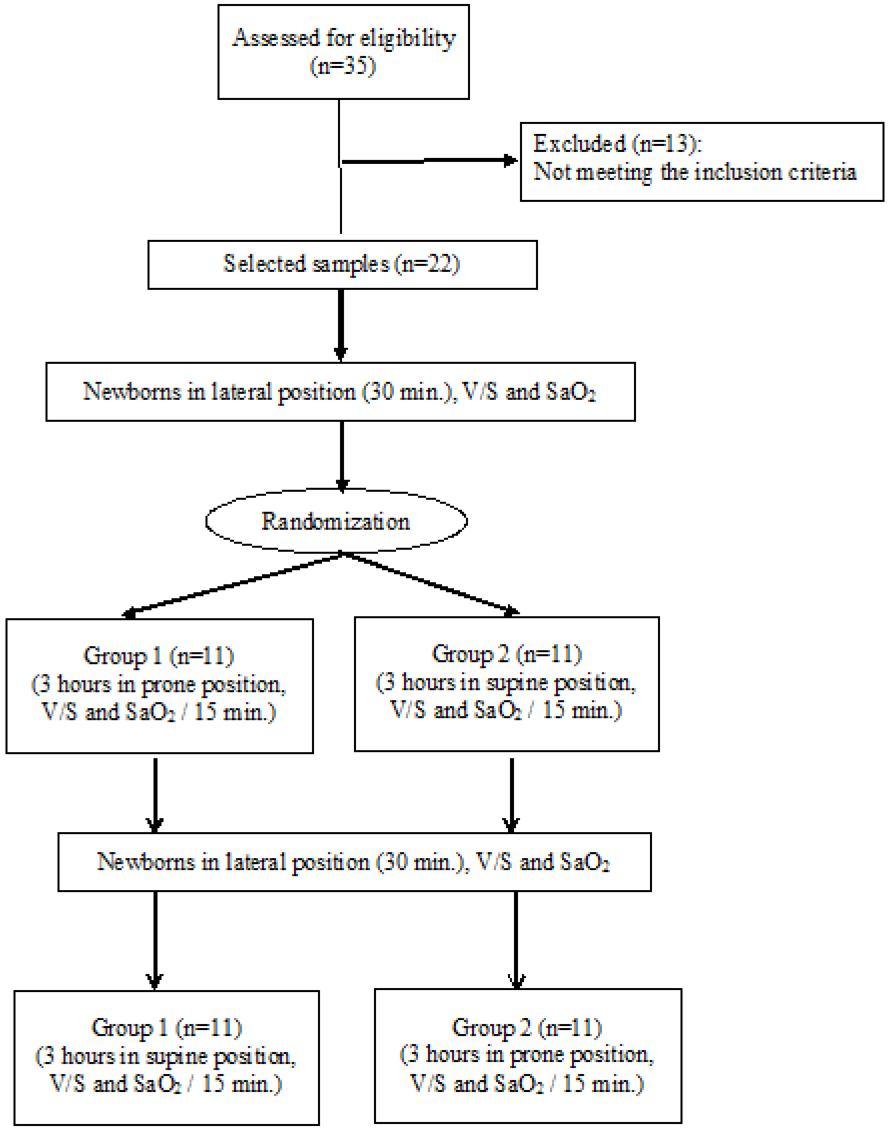

Figure 1. CONSORT flow diagram of the study process

(version 21). The normality of the data was examined using Kolmogorov-Smirnov test. Descriptive (i.e., mean, standard error, and 95% confidence interval) and inferential statistics (i.e., independent t-test and repeated-measures analysis of variance) were used for analyzing the data.

Ethical considerations

The current study was approved by the Ethics Committee of Arak University of Medical Sciences (Code no. IR.ARAKMU.REC.1395.150, date: July 18, 2016). The newborns were enrolled in the study as soon as their parents signed the written informed consent form. The parents were free to withdraw their newborn from the study at any time. The ethical principles for medical research established by the Iranian Ministry of Health and Medical Education were considered by the researchers throughout the study. The study was registered in the Iranian Registry of Clinical Trials (Code no. IRCT2017041633471N1).

Results

Table 1 summarizes the newborns' characteristics.

The effect of period and the interaction between period and the intervention were investigated for all variables under study, and no effects were seen. The comparison of SaO_2 between the two positions revealed that the mean SaO_2 in the prone position (96.164±0.148) was higher than that in the supine position

Table 1. Demographic characteristics of the newborns

Variable	Percent (number)
Gender	
Male	45.5 (10)
Female	54.5 (12)
Type of delivery	
Cesarean section	40.9 (9)
Natural vaginal delivery	59.1 (13)
Diagnosis	
Respiratory distress syndrome	36.4 (8)
Transient tachypnea of the newborn	18.2 (4)
Hyperbilirubinemia	18.2 (4)
Sepsis-induced hyperbilirubinemia	13.6 (3)
Pneumonia	9.1 (2)
Sepsis	4.5 (1)
Gestational age (week)	
32-33	31.8 (7)
33-34	18.2 (4)
34-35	40.9 (9)
35-36	9.1 (2)
Mean age (days)	10.38±9.69
Mean birth weight (g)	2297.72±693.75
Mean weight at the time of the study (g)	2293.63±652.1
5-min Apgar score	
4	4.5 (1)
5	9.1 (2)
6	18.2 (4)
7	31.8 (7)
8	27.3 (6)
9	9.1 (2)

Table 2. Comparison of the modified mean oxygen saturation, heart rate, and respiratory rate between the two positions

Variable	Groups	Mean±SD		95%CI		P-value
				Lower limit	Upper limit	
Oxygen saturation	Prone	96.164	0.148	95.856	96.473	0.0001
	Supine	90.479	0.513	89.412	91.456	
Heart rate	Prone	138.24	1.187	135.773	140.710	0.0001
	Supine	147.48	1.597	144.162	150.803	
Respiratory rate	Prone	40.430	0.504	39.382	41.478	0.0001
	Supine	46.773	0.685	45.348	48.197	

Table 3. Oxygen saturation changes in both periods of the study

Oxygen saturation	(Pone-supine) (First period)		P-value	(Supine-prone) (Second period)		P-value
	Prone	Supine		Supine	Prone	
	Mean±SD	Mean±SD		Mean±SD	Mean±SD	
Before	90.27±1.61	89.91±1.7	0.61	91.72±1.9	91.45±1.9	0.74
15 minutes	92.18±3.21	93.72±2.6	0.23	90.54±4.18	91.45±3.11	0.56
1 Hours	96.36±1.36	90.36±5.7	0.002	90.09±2.3	96±2.28	0.0001
2 Hours	98.09±1.81	90.45±4.43	0.0001	88.27±2.79	98.09±1.92	0.0001
3 Hours	98.81±1.88	92.45±3.64	0.0004	89.45±2.11	98.54±1.63	0.0001
Repeated measures ANOVA	F=18.17 P=0.0001	F=2.672 P=0.037		F=1.579 0.203=P	F=16.728 P=0.0001	

(90.479±0.513; P=0.0001) (Table 2). It was also found that SaO_2 was significantly increased over time in the prone position during both periods of the study (P=0.0001; Table 3).

In terms of HR, the mean HR in the prone position (138.24±1.187) was lower than that in the supine position (147.48±1.597; P=0.0001; Table 2). It was also found that HR was significantly decreased over time (P=0.0001) in the prone position during both periods of the study (Table 4). The mean RR in the prone position (40.430±0.504) was also lower than that in the supine position (46.773±0.685; P=0.0001; Table 2). It was also found that RR was significantly decreased over time in the prone position in both research periods (P=0.0001; Table 5).

Table 4. Heart rate changes in both periods of the study

Heart rate	(Pone-supine)		P-value	(Supine-prone)		P-value
	Prone	Supine		Supine	Prone	
	Mean±SD	Mean±SD		Mean±SD	Mean±SD	
Before	140.9±7.09	141.18±6.67	0.92	145.27±3.7	145.45±3.55	0.91
15 minutes	148.72±14.16	148.81±10.3	0.98	148.36±6.07	147.9±7.13	0.872
1 Hours	141.36±11.35	148.18±10.17	0.15	147.36±7.33	140.18±5.17	0.015
2 Hours	133.45±7.72	147.9±10.71	0.001	147.72±5.13	132.9±4.57	0.0001
3 Hours	133.27±4.96	149.63±10.23	0.0001	147±5.47	133.36±3.47	0.0001
Repeated measures ANOVA	F=8.635 P=0.003	F=1.788 P=0.185		F=1.325 P=0.280	27.451= F P=0.0001	

Table 5. Respiratory rate changes in both periods of the study

Respiratory Rate	(Pone-supine)		P-value	(Supine-prone)		P-value
	Prone	Supine		Supine	Prone	
	Mean±SD	Mean±SD		Mean±SD	Mean±SD	
Before	44.18±7.05	44.18±6.94	0.999	91.72±1.9	91.45±1.9	0.940
15 minutes	46.27±3.84	46±4.6	0.882	90.54±4.18	91.45±3.11	0.753
1 Hours	41±2.75	46.9±3.01	0.0001	90.09±2.3	96±2.28	0.033
2 Hours	37.45±3.33	47.45±4.59	0.0001	88.27±2.79	98.09±1.92	0.0001
3 Hours	36.09±6.94	46.45±4.2	0.00004	89.45±2.11	97.54±1.63	0.0001
Repeated measures ANOVA	F=14.058 P=0.0001	F=0.617 P=0.588		F=2.328 0.063=P	15.861=F P=0.0001	

Discussion

This crossover clinical trial aimed to evaluate the effect of prone and supine positions on SaO_2, HR, and RR in premature newborns. The results showed that the mean SaO_2 in the prone position was significantly higher than that in the supine position. In agreement with the results of the current study, Eghbalian et al. (2014) showed that the level of SaO_2 in premature newborns placed in the prone position was significantly higher than that in premature newborns placed in the supine position (12). Malagoli et al. (2012) also evaluated the effect of prone positioning on oxygenation in premature newborns during weaning from a ventilator. They reported that SaO_2 was significantly higher in the prone position than in the supine position (17).

Akbarian Rad et al. (2016) evaluated the effect of prone, supine, and lateral positions on SaO_2 in very low birth weight newborns. They observed better oxygenation in the prone position than in the other two positions (18). On the other hand, Yin et al. (2016) compared three positions (i.e., supine, lateral, and semi-prone) in premature newborns under continuous positive airway pressure (CPAP) and indicated that the mean SaO_2 was not significantly different among the evaluated positions (10). Their results can be attributed to the fact that the studied newborns received assisted respiration treatment. Furthermore, in contrast to the results of the current study, Torabi et al., investigating premature newborns, showed that the mean SaO_2 in the supine position was significantly higher than that in the prone position (5). This difference can be attributed to the short duration of positioning (i.e., 30 min).

The results of the current study indicated that the mean HR in the prone position was significantly lower than that in the supine position. Ghorbani et al. (2013) compared the effect of the prone position on HR in newborns under nasal CPAP and indicated that the HR was significantly higher in the prone position than that in the supine position (16). In another study, Yin et al. (2016) compared three positions (i.e., supine, lateral, and semi-prone) in premature newborns under CPAP and showed that the mean HR and HR variations were not different among the studied positions (10).

Furthermore, Ma et al. (2015) evaluated the impact of different positions on cardiac output in premature newborns. They found no significant differences in HR among the studied positions; however, the stroke volume and cardiac output showed significant reductions in the prone position (7). Akbarian Rad et al. (2016) indicated better variations in HR in the prone position than that in the supine and lateral positions. However, in the mentioned study, the mean HR showed no significant difference among the studied positions (18). This difference can be associated with the inclusion of very low birth weight newborns.

In the current study, it was observed that the mean RR was significantly lower in the prone position than that in the supine position. Yin et al. (2016) showed that the mean RR was significantly higher in the supine and lateral positions than in the semi-prone position. They concluded that premature newborns exhibited more normal respiration in the semi-prone position (10). On the other hand, Malagoli et al. (2012) indicated that RR was significantly higher and peak airway pressure was significantly lower in the prone position (17).

Oliveira et al. (2009) evaluated the impact of prone position on thoracoabdominal asynchrony in premature newborns and indicated that prone position significantly reduced such asynchrony without influencing the oxygenation pattern or SpO_2 level (13). Gouna et al. (2013) investigating premature newborns receiving positive-pressure oxygen found that left-lateral and prone positions could improve the pulmonary function (19). It must be noticed that in their study the newborns were under positive pressure oxygen.

The findings of the present study can be useful for nurses in selecting the best position for premature newborns based on their condition. In line with Pourazar et al. (2017), the selection of the best position, development of standard positioning guidelines for premature infants, and education of nurses to improve the quality of care in NICUs (20) could be mentioned as some of the applications of the present study.

Conclusion

As the findings of the present study indicated, in the prone position, SaO_2 was significantly higher, and HR and RR values were significantly lower than in the supine position. Although in either positions, the measured variables were within the normal range, it can be said that the newborns in the prone position were in a more stable condition than in the supine position in terms of the ranges of HR, RR, and SaO_2. Consequently, this position can be recommended for the newborns admitted to NICUs. It must be considered that the newborns were studied in NICU under monitoring; however, the prone position is not recommended for newborns at home.

Study Limitations

It should be considered that the results of the current study cannot be generalized to all premature newborns since our study was conducted on 22 newborns with a birth weight of > 1,000 g and gestational age of 32-36 weeks who were not under mechanical ventilation or CPAP. Therefore, it is recommended to perform further similar studies on a larger sample of premature newborns.

Acknowledgments

The authors thank the parents of newborns participating in the study. They also wish to thank the authorities of Amir Kabir Hospital of Arak as well as the NICU staff, particularly Mrs. Davari and Mrs. Zarrinfar, for their cooperation.

Funding

This study was extracted from a master's thesis in pediatric nursing submitted to the Arak University of Medical Sciences and was financially supported by the Deputy of Research and Technology of Arak University of Medical Sciences.

Conflicts of interests

The authors declare no conflict of interest in this study.

References

1. Word Health Organization. Media Centre. Preterm birth. Fact sheet. Geneva: Word Health Organization; 2017.
2. Howson CP, Kinney MV, McDougall L, Lawn JE. Born too soon: preterm birth matters. Reprod Health. 2013; 10(1):S1.
3. Sharifi N, Khazaeian S, Pakzad R, Fathnezhad Kazemi A, Chehreh H. Investigating the prevalence of preterm birth in Iranian population: a systematic review and meta-analysis. J Caring Sci. 2017; 6(4):371-80.
4. Picheansathian W, Woragidpoonpol P, Baosoung C. Positioning of preterm infants for optimal physiological development: a systematic review. JBI Database Syst Rev Implementat Rep. 2009; 7(7):224-59.
5. Torabi Z, Ghaheri V, Falak Aflaki B. The effect of body position on the arterial oxygen saturation of healthy premature neonate: a clinical trial. J Mazandaran Univ Med Sci. 2012; 22(86):234-42. (Persian)
6. Candia MF, Osaku EF, Leite MA, Toccolini B, Costa NL, Teixeira SN, et al. Influencia do posicionamentoempronasobre o estresse no recem-nascidoprematuroavaliada pela dosage de cortisol salivar: um estudopiloto. Rev Bras Ter Intensiva. 2014; 26(2):169-75.
7. Ma M, Noori S, Maarek JM, Holschneider DP, Rubinstein EH, Seri I. Prone positioning decreases cardiac output and increases systemic vascular resistance in neonates. J Perinatol. 2015; 35(6): 424-7.
8. Blair PS, Platt MW, Smith IJ, Fleming PJ. Sudden neonate death syndrome and sleeping position in pre-term and low birth weight neonates: an opportunity for targeted intervention. Arch Dis Child. 2006; 91(2):101-6.
9. Poets CF, von Bodman A. Placing preterm neonates

for sleep: first prone, then supine. Arch Dis Child Fetal Neonatal Ed. 2007; 92(5):F331-2.
10. Yin T, Yuh YS, Liaw JJ, Chen YY, Wang KW. Semi-prone position can influence variability in respiratory rate of premature neonates using nasal CPAP. J Pediatr Nurs. 2016; 31(2):e167-74.
11. Sahni R, Schulze KF, Ohira-Kist K, Kashyap S, Myers MM, Fifer WP. Interactions among peripheral perfusion, cardiac activity, oxygen saturation, thermal profile and body position in growing low birth weight neonates. Acta Paediatr. 2010; 99(1):135-9.
12. Eghbalian F. A comparison of supine and prone positioning on improves arterial oxygenation in premature neonates. J Neonatal Perinatal Med. 2014; 7(4):273-7.
13. Oliveira TG, Rego MA, Pereira NC, Vaz LO, Franca DC, Vieira DS, et al. Prone position and reduced thoracoabdominal asynchrony in preterm newborn. J Pediatr. 2009; 85(5):443-8.
14. Rezaeian M, SheikhFathollahi F, Abdolkarimi M, Niknafs M, Bahman-Bijari M, Niknafs P, et al. Comparison of supine and prone positions on oxygen saturation in preterm neonates after weaning from mechanical ventilation in NICU of Afzalipour Hospital of Kerman in 2014. J Rafsanjan Univ Med Sci. 2014; 13(9):885-95. (Persian)
15. King C, Norton D. Does therapeutic positioning of preterm infants impact upon optimal health outcomes? A literature review. J Neonatal Nurs. 2017; 23(5):218-22.
16. Ghorbani F, Asadollahi M, Valizadeh S. Comparison of sleep positioning on cardiorespiratory rate in noninvasive ventilated premature neonates. Nurs Midwifery Stud. 2013; 2(2):182-7.
17. Malagoli RD, Santos FF, Oliveira EA, Bouzada MC. Influence of prone position on oxigenation, respiratory rate and muscle strength in preterm neonates being weaned from mechanical ventilation. Rev Paulista Pediatr. 2012; 30(2):251-6.
18. Akbarian Rad Z, Haghshenas Mojaveri M, Hajiahmadi M, Ghanbarpour A, Mirshahi S. The effect of position on oxygen saturation and heart rate in very low birth weight neonates. Caspian J Pediatr. 2016; 2(2):153-7.
19. Gouna G, Rakza T, Kuissi E, Pennaforte T, Mur S, Storme L. Positioning effects on lung function and breathing pattern in premature newborns. J Pediatr. 2013; 162(6):1133-7.
20. Pourazar F, Borimnejad L, Mohaghaghi P, Haghani H. Comparison of the effects of prone and supine positions on abdominal distention in the premature infants receiving nasal continuous positive airway pressure (NCPAP). Iran J Neonatol. 2018; 9(1):7-12.