Effect of Lateral Positions versus Prone Position on Cardiorespiratory Parameters among Preterm Neonates with Respiratory Distress Syndrome

Noha Mohamed Arafa Mohamed [(1)], Maha Ebrahim Fouda Elashry [(2)], Rodaina Ahmed Mokbel [(2)]

(1) Lecturer, Pediatric Nursing, Faculty of Nursing, Alexandria University, Egypt

(2) Lecturer, Pediatric Nursing, Faculty of Nursing, Damanhour University, Egypt

Abstract

Background: Respiratory distress syndrome in neonates is life threatening and results in death from severe respiratory failure. Positioning neonates in a good body alignment is essential to improve oxygenation and reduce the need for supplemental oxygen and mechanical ventilation**. Aim of the study**: The current study aimed to determine the effect of lateral positions versus prone position on cardiorespiratory parameters among preterm neonates with respiratory distress syndrome. **Research design:** A cross-over experimental research design was utilized for this study. **Setting:** The study was conducted at the Neonatal Intensive Care Unit at Alexandria University Children's Hospital at Smouha, Egypt. **Subjects:** purposive sample of 30 preterm neonates were selected to perform the current study. **Tools:** Two tools were used for data collection, Tool I: Characteristics and cardiorespiratory parameters of preterm neonates' assessment tool, Tool II: Complication detection record. **Results:** The values of heart rate, respiratory rate and oxygen saturation improved significantly among preterm neonates in prone position than in the lateral positions after one and two hours. Respiratory distress signs were significantly lower in prone position than in lateral positions after one and two hours. There was no statistical significant difference between the three positions at zero minute, one hour and two hours regarding complications among preterm neonates. **Conclusion:** The study concluded that cardiorespiratory parameters and respiratory distress signs have improved in prone position more than in lateral positions. **Recommendations:** Prone position under nurses' supervision is recommended to be used in the routine care of preterm neonates with respiratory distress syndrome and educational programs should be conducted to nurses working at Neonatal Intensive Care Units regarding the benefits and importance of positioning of preterm neonates.

Keywords: Respiratory distress, Cardiorespiratory parameters, Preterm neonates, Lateral position and Prone position.

Introduction

Preterm neonate is defined as a neonate who is delivered before the completion of 37 weeks of gestation **(Kuppusamy and Vidhyadevi, 2016, WHO, 2018)**. The causes of prematurity are unknown but there are risk factors including high blood pressure, diabetes, tobacco smoking and vaginal infection of the mother **(WHO, 2018)**. Prematurity is a major problem associated with neonatal mortality and morbidity in developing countries **(Healthy Newborn Network HNN, 2018; Pourazar et al., 2018)**. There are 15 million preterm neonates born globally each year worldwide and this number is arising. Preterm mortality is responsible for nearly 18 deaths per 1000 live births according to the WHO estimation in 2018 **(Kuppusamy and Vidhyadevi, 2016, WHO, 2018)**. In Egypt Preterm birth complications were found to cause 38% of neonatal deaths **(Muhe et al., 2019)**.

Prematurity has lifelong impact on neonates such as temperature instability, intraventricular hemorrhage, necrotizing enterocolitis and respiratory distress syndrome (RDS) **(Kuppusamy and Vidhyadevi, 2016)**. Preterm neonates have immature lungs, poor developed cough reflex and narrow respiratory passages that lead to increasing the risk of respiratory difficulty in addition to having immature regulatory center which lead to periodic breathing, hypoventilation, and frequent periods of apnea, so they may have physiological problems such as a low respiratory rate, irregular heart rate, low level of oxygen saturation, apnea, and increased gastric residual **(Punthmatharith and Mora, 2018)**.

Respiratory distress syndrome is considered one of the commonest problems in the first day of life and it is the most common respiratory disorder in preterm neonates **(Reuter et al., 2014, Sabzehei et al., 2017)**. Respiratory distress syndrome is also known as hyaline membrane disease which is seen primarily in preterm neonates due to deficiency of surfactant in the lungs that play an important role in decreasing surface tension in the alveoli **(Gallacher et al., 2016, Fiorenzanom et al.,2019)**. Respiratory distress syndrome is the most common reason for admission of preterm neonates to the Neonatal Intensive Care Units (NICUs) **(Pathrudu, 2015, Pourazar et al., 2018)**. In the United States in 2017, the infant mortality rate due to RDS was 11.4 per 100,000 live births **(National Center for Health Statistics, 2019)**.

The common causes of RDS include prematurity, neonatal pneumonia, transient tachypnea of neonates, cesarean section delivery, meconium aspiration syndrome and gestational diabetes **(Reuter et al., 2014)**. The sign of RDS appear few hours after birth which are characterized by tachypnea (> 60 breath\m), intercostal and subcostal retractions, nasal flaring, grunting, apnea and cyanosis **(Pathrudu, 2015, Sorte, 2018)**.

Unattended and Prolonged distress lead to hypoxemia, hypercapnia and acidosis which result in pulmonary vasoconstriction **(Pathrudu, 2015)**. So early diagnosis and treatment is important because RDS is life threatening and results in death from severe respiratory failure **(Reuter et al., 2014, Sabzehei et al., 2017)**.

In managing neonates with RDS the initial treatment is aimed at resuscitation of the neonates, decreasing work of breathing, optimizing tissue oxygenation, preventing hypoxia, hypercapnia and acidosis. There are supportive measures which vary from oxygen supplementation and positioning of neonates to various strategies of mechanical ventilation **(Pathrudu, 2015, Akbarian et al., 2016)**.

Positioning neonates in good body alignment and changing body position is essential for neonates with RDS to improve oxygenation and reduce the need for supplemental oxygen and mechanical ventilation **(Babaei et al., 2019)**. It is considered a basic neonatal nursing care and includes keeping the neonate in supine, prone, side lying and head up tilted positions **(Soniya, 2019)**. Despite the association between positioning and vital functions of neonates, controversies still exist about best position **(Torabian et al., 2019)**. Prone position improves ventilation perfusion mismatching, lung compliance, re-expansion of gravity induced atelectasis, drain of secretions from the trachea and bronchus and have lower levels of apnea **(Salih et al., 2020)**. In addition, it reduces heat loss and metabolic rate, improves neonatal sleeping, reduces gastro-esophageal reflux and gastric emptying is optimized **(Babuyeh et al., 2018).** While lateral position is beneficial for neonates comfort and development of fine motor skills. Right lateral position increases gastric emptying whereas left lateral position reduces gastric reflux (**North Devon Healthcare, 2018).**

Neonatal nurses have a crucial role in improving the quality of care of preterm neonates and providing them with comfort measures in order to improve respiratory rate, heart rate and oxygen saturation. Positioning neonates in a good body alignment and changing body position regularly are essential components that have first priority in nursing care for neonates with RDS **(Shehata, 2013, Babaei et al., 2019)**. Furthermore, it has been proposed that body positioning is an easy, practical and effective nursing intervention as compared with other invasive measures **(Salih et al., 2020)**. Therefore this study is carried out to investigate the effect of different positions on cardiorespiratory parameters of preterm neonates.

Aim of the Study

The aim of the present study was to determine the effect of lateral positions versus prone position on cardiorespiratory parameters among preterm neonates with respiratory distress syndrome.

Research Hypotheses

- Preterm neonates who are positioned on left lateral position will exhibit stable cardiorespiratory parameters than positioning on right lateral or prone position.
- Preterm neonates who are positioned on right lateral position will exhibit stable cardiorespiratory parameters than positioning on left lateral or prone position.

- Preterm neonates who are positioned on prone position will exhibit stable cardiorespiratory parameters than positioning on left lateral or right lateral position.

Operational definition:

Cardiorespiratory parameters are heart rate ranging from 120-160 beat/minute, respiratory rate ranging from 30-60 cycle/minute and oxygen saturation ranging from 90-100%

Respiratory distress syndrome is defined as any preterm neonate suffering from shallow or deep respiration, grunting, retractions, nasal flaring, chest indrawing, wheezing and cyanosis.

Materials and Method

Materials

Study Design:

A cross-over experimental research design was used to accomplish the current study.

Setting:

The study was conducted at the Neonatal Intensive Care Unit at Alexandria University Children's Hospital at Smouha, Egypt.

Subjects:

A purposive sample of 30 preterm neonates who were admitted to the previously mentioned setting and fulfilled the following inclusion criteria comprised the study subjects**:**

Inclusion criteria

- Preterm neonates diagnosed with RDS
- Receiving enteral feeding
- Gestational age <37 weeks

Exclusion criteria

- Preterm neonate having any congenital anomalies.
- Undergoing any surgery
- Having intraventricular hemorrhage.
- Having invasive ventilator support.
- Having any condition that prevents them from being positioned in supine or prone position.

The studied sample was estimated based on Epi info program which is used to estimate the sample size using the following parameters**:**

- Total population approximately equals 100 neonates (in a period of three months)
- Confidence level 95%
- Error level 5 %
- Expected frequency 50%
- The final sample size was 30 preterm neonates (cross-over design)

Tools:

Two tools were used for data collection.

Tool I: Characteristics and cardiorespiratory parameters of preterm neonates' assessment tool

This tool was developed by the researchers after reviewing recent and relevant literature to assess characteristics and cardiorespiratory parameters of the preterm neonates **(Harika et al., 2015 and Sharma et al. 2016)**. This tool included three parts:

Part 1: Characteristics of the preterm neonates: It included: gestational age, gender, birth weight, type of delivery and duration of hospitalization.

Part 2: Cardiorespiratory parameters of preterm neonates: such as heart rate, respiratory rate and oxygen saturation (SPO_2).

Part 3: Respiratory distress signs of preterm neonates: such as respiratory depth and presence of grunting, retractions, nasal flaring, chest in drawing, wheezing and cyanosis.

Tool II: Complications' detection record

This tool was developed by the researchers after reviewing recent and relevant literature to assess complications that may arise from each position **(Sharma et al,. 2016)**. It included the following: presences of agitated cry, lethargy, vomiting, apnea and skin breakdown.

Method

- Approval from the Ethical Nursing Research Committee of the Faculty of Nursing, Alexandria University was obtained before carrying out this study.
- An official permission was obtained from the responsible authorities of the Neonatal Intensive Care Unit (NICU) at Alexandria University children's Hospital at Smouha to conduct the study after explaining its aim.

- Tool I and Tool II were developed by the researchers after thorough reviewing of current and relevant literature.
- Content validity of Tool I and Tool II were tested by five experts in the pediatric nursing field and necessary modifications were done.
- Reliability of tool I and tool II was ascertained using appropriate statistical test (r= 0.89 and 0.84, respectively).
- A pilot study was carried out on 5 neonates to test the feasibility and clarity of the tools and necessary modifications were done. These preterm neonates were excluded from the study sample.
- Preterm neonates were studied in three positions; the right lateral, left lateral and prone position in that order for 120 minutes for each position. The three positions were applied to the same neonates cross-overly.
- Neonates were placed first in right lateral position for 120 minutes then their position was changed into left lateral position for another 120 minutes and finally changed to prone position for another 120 minutes.
- The neonates were left free in routine unit position (supine position) for 15 minutes (i.e., washout period) after each position change, in order to avoid the effect of the previous body position.
- Before positioning of neonates, the researchers assessed the characteristics of the neonates using Tool I.
- Cardiorespiratory parameters including, respiratory rate, heart rate and oxygen saturation (SPO_2) were measured and recorded at zero minute (base time) immediately before positioning, and every 15 minutes by using Tool I. The average of measures was calculated after one hour and after two hours.
- Respiratory rate was measured by observing the number of breaths the neonate took in a minute. Oxygen saturation and heart rate were continually monitored by transcutaneous pulse oximeter.
- If the oxygen saturation in any position was less than 85%, or the neonate's heart rate reached above 200 or less than 100 beat per minute (b/min), or the respiratory rate increased to more than 60 cycle per minute (c/min), the neonate would return to the previous position and was immediately notified to the physician. If a desaturation occurred, the value of FIO2 was increased after physician's order.
- Respiratory distress signs were assessed and recorded three times, at zero minute (base time) immediately before positioning, after one hour and after two hours using Tool I.
- Complications were assessed and recorded three times at zero minute (base time) immediately before positioning, after one hour and after two hours using Tool II.
- Lateral position was performed with the neonates' shoulders rounded and supported, their legs were bent with a boundary against their feet and their hands were at their midline and are free to move to their face. **(North Devon Healthcare, 2018).**
- The prone position was performed with the neonates' head in midline, upper limbs adducted to the side of the chest wall, lower limbs slightly flexed (30–40º) in hips and knees and the head turned to one side **(Babaei et al., 2019).**
- Data were collected over a period of three months from the beginning of January 2020 till the end of March 2020.

Ethical considerations:

Informed written consent was obtained from the neonates' parents to participate in the research after explaining its aim. The privacy of premature neonates was considered and confidentiality of the collected data was assured. Parents had the right to refuse the participation of their neonates and to withdraw from the study at any time.

Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) Qualitative data were described using number and percent. Quantitative data were described using range (minimum and maximum), mean, and standard deviation. Significance of the obtained results was judged at the 5% level.

The used tests were

1- **ANOVA with repeated measures:** For normally distributed quantitative variables, to compare between more than two periods or stages

2- **Friedman test:** For abnormally distributed quantitative variables, to compare between more than two periods or stages

Table (1): Distribution of the studied neonates according to their characteristics (N = 30)

Characteristics of neonates	No.	%
Gender		
Male	14	46.7
Female	16	53.3
Gestational age (week)		
Min. – Max.	30.0 – 36.0	
Mean ± SD.	33.67 ± 2.04	
Birth weight (gm)		
Min. – Max.	1100.0 – 2040.0	
Mean ± SD.	1618.2 ± 320.9	
Mode of delivery		
Caesarian section	30	100.0
Normal vaginal delivery	0	0.0
Duration of hospitalization		
Min. – Max.	10.0 – 60.0	
Mean ± SD.	27.77 ± 14.95	

Table (I) illustrates distribution of neonates according to their characteristics. It is revealed from the table that more than half (53.3%) of neonates were females. The mean gestational age among neonates was 33.67 ± 2.04 and the mean birth weight was 1618.2 ± 320.9.

Regarding mode of delivery, it is observed that all neonates were born by caesarian section. The same table also clarifies that the mean duration of hospitalization among neonates was 27.77 ± 14.95.

Table (2): Mean score of cardiorespiratory parameters of the studied neonates in the three positions

Cardiorespiratory parameters	Right Lateral position			Left Lateral position			Prone position			F (p) between the three positions in each period		
	At 0minute	After 1hour	After 2hours	At 0minute	After 1hour	After 2hours	At 0minute	After 1hour	After 2hours	At 0minute	After 1hour	After 2hours
	Mean± SD	Mean± SD	Mean± SD	Mean± SD	Mean± SD	Mean± SD	Mean± SD	Mean± SD	Mean± SD			
Heart Rate (HR)	144.9± 17.1	142.2±17.3	141.5±18.3	144.3± 15.3	142.4±16.4	143.3±16.9	143.7± 12.8	137.9±11.5	137.1±12.3	2.620 (0.114)	4.795* (0.012*)	6.257* (0.003*)
Respiratory Rate (RR)	51.7±8.3	50.7±7.6	49.9±7.6	51.0±7.6	50.4±7.8	50.2±7.5	50.6±4.1	46.6±4.0	46.4±4.2	3.011 (0.123)	8.191* (0.001*)	7.196* (0.002*)
O_2 Saturation	94.9±5.5	94.7±5.6	94.8±5.6	94.8±5.8	94.9±5.9	94.9±5.7	95.6±4.3	97.7±4.4	97.8±4.2	2.442 (0.101*)	10.466* (<0.001*)	11.402* (<0.001*)

F: F test (ANOVA) with repeated measures

p: p value for comparing between RT Lateral position, LT Lateral position and Prone position in each period

*: Statistically significant at $p \leq 0.05$

Table (2) demonstrates the mean score of cardiorespiratory parameters of the studied neonates in the three positions. It was found that at zero minute, the mean values of heart rate were 144.9 ± 17.1 b/min, 144.3 ± 15.3 b/min and 143.7± 12.8 b/min in right lateral position, left lateral position and prone position, respectively. There was no statistical significant difference between the three positions. After one hour, the mean values of heart rate were 142.2±17.3 b/min in right lateral position, 142.4±16.4 b/min in left lateral position and declined to 137.9±11.5 b/min in prone position with a statistical significant difference between the three positions (p=0.012). After two hours, the mean values of heart rate were 141.5±18.3 b/min in right lateral position, 143.3±16.9 b/min in left lateral position and declined to 137.1±12.3 b/min in prone position. A statistical significant difference was found between the three positions (p=0.003).

Regarding respiratory rate, the table reveals that the mean values of respiratory rate at 0 minute were 51.7±8.3 c/min, 51.0±7.6 c/min and 50.6±4.1 c/min in right lateral position, left lateral position and prone position, respectively. There was no statistical significant difference between the three positions. After one hour, the mean values of respiratory rate were 50.7±7.6 c/min in right lateral position, 50.4±7.8 c/min in left lateral position and declined to 46.6±4.0 c/min in prone position. There was a statistical significant difference between the three positions (p=0.001). After two hours, the mean values of respiratory rate were 49.9±7.6 c/min in right lateral position, 50.2±7.5 c/min in left lateral position and declined to 46.4±4.2 c/min in prone position with a statistical significant difference between the three positions (p=0.002).

Regarding oxygen saturation, the table shows that the mean values of oxygen saturation at 0 minute were 94.9±5.5, 94.8±5.8 and 95.6±4.3 in right lateral position, left lateral position and prone position, respectively. There was no statistical significant difference between the three positions. After one hour, the mean values of oxygen saturation were 94.7±5.6 in right lateral position, 94.9±5.9 in left lateral position and increased to 97.7±4.4 in prone position. A statistical significant difference was found between the three positions (p<0.001). After two hours, the mean values of oxygen saturation were 94.8±5.6 in right lateral position, 94.9±5.7 in left lateral position and increased to 97.8±4.2 in prone position with a statistical significant difference between the three positions (p<0.001).

Table (3): Distribution of the studied neonates according to respiratory distress signs in the three positions (N=30)

Respiratory distress signs	Right Lateral position						Left Lateral position						Prone position						Fr (p) between the three positions in each period		
	At 0minute		After 1hour		After 2hours		At 0minute		After 1hour		After 2hours		At 0minute		After 1hour		After 2hours		At 0minute	After 1hour	After 2hours
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%			
R. Depth																					
Normal	23	76.7	18	60.0	19	63.3	26	86.7	17	56.7	17	56.7	25	83.3	26	86.7	26	86.7	3.131	14.33*	13.33*
Shallow	5	16.6	5	16.7	5	16.7	3	10.0	7	23.3	7	23.3	2	6.7	0	0.0	0	0.0	(0.258)	(<0.001*)	(<0.001*)
Deep	2	6.7	7	23.3	6	20.0	1	3.3	6	20.0	6	20.0	3	10.0	4	13.3	4	13.3			
Grunting																					
Absent	22	73.3	22	73.3	25	83.3	22	73.3	24	80.0	26	86.7	21	70.0	24	80.0	27	90.0	0.667	2.000	3.000
Present	8	26.7	8	26.7	5	16.7	8	26.7	6	20.0	4	13.3	9	30.0	6	20.0	3	10.0	(0.717)	(0.368)	(0.223)
Retractions																					
Absent	16	53.3	15	50.0	19	63.3	16	53.3	20	66.7	18	60.0	20	66.7	25	83.3	27	90.0	2.667	12.500*	14.600*
Present	14	46.7	15	50.0	11	36.7	14	46.7	10	33.3	12	40.0	10	33.3	5	16.7	3	10.0	(0.264)	(0.002*)	(0.001*)
Nasal flaring																					
Absent	16	53.3	16	53.3	22	73.3	18	60.0	19	63.3	21	70.0	20	66.7	24	80.0	26	86.7	2.182	9.800*	6.000*
Present	14	46.7	14	46.7	8	26.7	12	40.0	11	36.7	9	30.0	10	33.3	6	20.0	4	13.3	(0.336)	(0.007*)	(0.050*)
Chest indrawing																					
Absent	24	80.0	24	80.0	25	83.3	22	73.3	25	83.3	24	80.0	22	73.3	26	86.7	27	90.0	2.667	3.000	4.667
Present	6	20.0	6	20.0	5	16.7	8	26.7	5	16.7	6	20.0	8	26.7	4	13.3	3	10.0	(0.264)	(0.223)	(0.097)
Wheezing																					
Absent	18	60.0	18	60.0	21	70.0	16	53.3	21	70.0	21	70.0	19	63.3	27	90.0	26	86.7	1.077	9.692 *	4.545
Present	12	40.0	12	40.0	9	30.0	14	46.7	9	30.0	9	30.0	11	36.7	3	10.0	4	13.3	(0.584)	(0.008*)	(0.103)
Cyanosis																					
Absent	29	96.7	30	100	30	100	30	100	30	100	30	100	30	100	30	100	30	100	2.000	–	–
Present	1	3.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	(0.368)		

Fr: **Friedman test**

p: p value for comparing between RT Lateral position, LT Lateral position and Prone position in each period

*: Statistically significant at p ≤ 0.05

Table (3) shows the distribution of the studied neonates regarding respiratory distress signs in the three positions. It is clear from the table that in prone position, the majority of neonates (86.7%) had normal respiratory depth after one hour compared to 60% and 56.7% of neonates in right and left lateral positions, respectively. A statistical significant difference was found between the three positions ($p<0.001$). Furthermore, the same percent of neonates (86.7%) in prone position had normal respiratory depth after two hours compared to 63.3% and 56.7% of neonates in right and left lateral positions, respectively. A statistical significant difference was found between the three positions ($p<0.001$).

Concerning chest retractions, it is observed from the table that only 16.7% of neonates in prone position had chest retractions after one hour compared to 50% and 33.3% of neonates in right and left lateral positions, respectively. A statistical significant difference was found between the three positions ($p =0.002$).The table also reveals that most of the neonates (90%) in prone position had no chest retractions after two hours compared to 63.3% and 60% of neonates in right and left lateral positions, respectively. There was a statistical significant difference between the three positions ($p=0.001$).

Regarding nasal flaring, it is observed from the table that 20% of neonates in prone position had nasal flaring after one hour compared to 46.7% and 36.7% of neonates in right and left lateral positions, respectively. There was a statistical significant difference between the three positions ($p=0.007$). The table also reveals that the majority of neonates (86.7%) in prone position had no nasal flaring after two hours compared to 73.3% and 70% of neonates in right and left lateral positions, respectively. A statistical significant difference was found between the three positions ($p=0.050$)

The table also reveals that only 10% of neonates in prone position had wheezy chest after one hour compared to 40% and 30% of neonates in right and left lateral positions, respectively and there was a statistical significant difference between the three positions ($p=0.008$).

Table (4): Distribution of the studied neonates according to detected complications in the three positions (N=30)

Complications	Right Lateral position						Left Lateral position						Prone position						Fr (p) between the three positions in each period		
	At 0minute		After 1hour		After 2hours		At 0minute		After 1hour		After 2hours		At 0minute		After 1hour		After 2hours		At 0minute	After 1hour	After 2hours
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%			
Agitated cry																					
Absent	11	36.7	19	63.3	22	73.3	12	40.0	17	56.7	21	70.0	22	73.3	20	66.7	24	80.0	9.789^{*} (0.007^{*})	0.700 (0.705)	0.875 (0.646)
Present	19	63.3	11	36.7	8	26.7	18	60.0	13	43.3	9	30.0	8	26.7	10	33.3	6	20.0			
Lethargy																					
Absent	28	93.3	27	90.0	29	96.7	26	86.7	29	96.7	30	100	28	93.3	30	100	30	100	4.000 (0.135)	4.667 (0.097)	2.000 (0.368)
Present	2	6.7	3	10.0	1	3.3	4	13.3	1	3.3	0	0.0	2	6.7	0	0.0	0	0.0			
Vomiting																					
Absent	14	46.7	20	66.7	24	80.0	12	40.0	19	63.3	24	80.0	13	43.3	23	76.7	27	90.0	0.400 (0.819)	1.368 (0.504)	1.800 (0.407)
Present	16	53.3	10	33.3	6	20.0	18	60.0	11	36.7	6	20.0	17	56.7	7	23.3	3	10.0			
Apnea																					
Absent	25	83.3	24	80.0	27	90.0	24	80.0	27	90.0	28	93.3	25	83.3	28	93.3	28	93.3	0.667 (0.717)	5.200 (0.074)	0.667 (0.717)
Present	5	16.7	6	20.0	3	10.0	6	20.0	3	10.0	2	6.7	5	16.7	2	6.7	2	6.7			
Skin breakdown																					
Absent	30	100	30	100	30	100	30	100	30	100	30	100	30	100	30	100	30	100	–	–	–
Present	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0			

Fr: Friedman test

p: p value for comparing between RT Lateral position, LT Lateral position and Prone position in each period

*: Statistically significant at $p \leq 0.05$

Table (4) portrays the distribution of the studied neonates according to occurrence of complications in the three positions. It is clear from the table that nearly three quarters (73.3%) of neonates had no agitated cry at zero minute in prone position compared to 36.7% and 40% of neonates in right and left lateral positions, respectively with a statistical significant difference between the three positions (p=0.007). The table also reveals that there were no statistical significant differences between the three positions at zero minute, one hour and two hours regarding lethargy, vomiting, apnea and skin breakdown.

Discussion

Respiratory distress syndrome is a common disorder seen in preterm neonates that causes physiological problems such as a low respiration rate, irregular heart rate, low level of oxygen saturation and apnea (**Punthmatharith and Mora 2018**). Proper positioning is crucial in management of neonates with respiratory distress syndrome. It significantly affects their health status, their ventilation and oxygenation of tissues. However, the most suitable position remains controversial **(Salih et al., (2020)**

The results of the current study revealed that the mean heart rate in the prone position after one and two hours was significantly lower than that in the lateral positions. This result is consistent with **Torabian et al., (2019**) who performed a study in Iran and found that the mean heart rate of preterm neonates in the prone position was significantly lower than that in the supine position. **Akbarian et al., (2016)** also indicated better heart rate in the prone position than that in the supine and lateral positions among very low birth weight neonates in their study which was implemented in Iran too. In contrast **Yin et al., (2016)** who executed a study in Taiwan to compare three positions (i.e., supine, lateral, and semi-prone) in preterm neonates under continuous positive airway pressure (CPAP) found that the mean heart rate were not different among the studied positions. Furthermore, the finding of the current study is incongruent with the results of another study accomplished in the United States by **Ma et al., (2015**) who evaluated the impact of different positions on cardiac output in preterm neonates and found that placing the newborn in the prone position reduces cardiac output and increases heart rate.

In the existing study, it was observed that the mean respiratory rate (RR) was significantly lower in the prone position after one and two hours than that in the lateral positions. This decrease in respiratory rate in prone position might be due to the better pulling down of the diaphragm leading to greater lung expansion and thus better oxygenation which occurs with postural change. The results of the study held by **Yin et al., (2016)** is in line with the results of the current study as they reported that the mean RR was significantly higher in the supine and lateral positions than in the semi-prone position and premature neonates exhibited more normal respiration in the prone position.

Optimal oxygenation plays an important role in the neonatal period. Therefore, it is important to maintain proper oxygen saturation level based on the gestational age (**Babaei et al., 2019)**. The results of the present study showed that the oxygen saturation in the prone position after 1 and 2 hours was significantly higher than that in the lateral positions. This result might be explained in the light of that the higher efficacy of the diaphragm during its contraction generates more strength and improves ventilation which optimizes gas exchange. Furthermore, **Salih et al., (2020)** mentioned that the movement of the chest wall and the synchronization between thorax and abdomen are higher in prone position leading to better oxygenation. This finding was congruent with the findings of **Babaei et al., (2019)** who reported that the SpO2 in the prone position was significantly higher than that in the supine position. Also the current results apparently go in line with the results of **Brunherotti et al., (2014)** who reported that the highest mean of oxygen saturation was observed in the prone position while the lowest level was observed in the lateral positions among preterm neonates in a study done in Brazil. Moreover the present results are in harmony with the results of **Akbarian et al., (2016)** who evaluated the effect of prone, supine, and lateral positions on SaO2 in low birth weight neonates and observed better oxygenation in the prone position than in the two other positions. These results indicate that prone position can reduce the need for a high inspiratory oxygen concentration in preterm neonates. Furthermore, incongruent to the results of the current study, **Yin et al., (2016)** indicated that the mean SaO2 was not significantly different among the three evaluated positions (i.e, supine, lateral, and semi-prone). The current study also was in contrast with a number of studies accomplished by **Hough et al., (2016)** , **Balali et al., (2017)**, and **Santos et al., (2017)** who showed that there was no significant difference between mean arterial oxygen saturation in the supine and prone positions.

The findings of the current study indicated significant improvement of respiratory distress signs as respiratory depth, chest retraction, nasal flaring and wheezing in preterm neonates in prone position. This result might be related to that the prone position may affect preterm neonates' respiratory mechanisms, leading to changes in gas exchange due to the decreased pressure of abdominal organs on diaphragm letting it moves freely. This finding is in line with the study of **Babaei, et al., (2019)** who reported that prone position increases the tidal volume and the functional residual capacity, resulting in stabilization of the chest wall with more synchrony between thorax and abdomen. Moreover this finding is also supported by (**Thabet and Zaki 2018)** who reported that the diaphragm acts as the main muscle when preterm neonates breathe and that expiratory muscles are responsible for generating more strength in prone position.

Surprisingly, on investigating the preterm neonates' complications regarding positioning, it was found that agitated cry has improved as soon as placing neonates in prone position (at zero minute). This result can be attributed to the fact that neonate with respiratory complications when placed in prone position, their respiratory and heart rates reduced, so their tachypnea and tachycardia improved and they became more stable and calm. This result is in accordance with a study performed by **Sharma et al., (2016)** in India, who reported that the prone position is best for preterm neonates and resulted in improved oxygenation and more organized sleep-rest patterns and also they exhibit less physical activity and energy expenditure when placed in the prone position.

In this study, there was an improvement in mean cardiorespiratory outcome and respiratory distress signs in prone position. This finding is congruent with **Sharma et al., (2016),** who concluded that the prone position leads to an improvement in heart rate, respiratory rate, oxygen saturation, and respiratory distress among preterm neonates with respiratory distress, without any complications such as apnea or vomiting as compared to other positions.

Conclusion

The findings of the present study concluded that, in the prone position, oxygen saturation was significantly higher than in the lateral positions. The heart rate and respiratory rate values were significantly lower in prone position than in the lateral positions and respiratory distress syndrome was lower in prone position compared to right and left lateral positions.

Recommendations

In the light of the findings of the current study, the following are recommended:

1- Prone position should be incorporated into the routine nursing care of preterm neonates with respiratory distress as it is a safe, simple, noninvasive method that can help in improving cardiorespiratory parameters and reducing respiratory distress signs.

2- Educational and training programs should be conducted for all neonatology nurses working at the neonatal intensive care units regarding the benefits and importance of positioning of preterm neonates.

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