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ORIGINAL ARTICLE

Impact of Positioning on Neonates with Respiratory Distress Syndrome

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ABSTRACT

Background: A large percentage of premature newborns are affected by respiratory distress syndrome (RDS), which has a substantial negative influence on morbidity and death. A significant association exists between neonatal positioning and clinical outcomes in infants with respiratory distress syndrome. This study aims to evaluate the effect of different neonatal positioning strategies on respiratory status improvement in neonates diagnosed with respiratory distress syndrome.

Methods: In this clinical trial interventional versus control study, 60 newborns with respiratory distress syndrome receiving oxygen therapy were treated in the neonatal intensive care units (NICU) of medical insurance hospitals in Egypt, Ministry of Health hospitals in Kuwait, and Zagazig University Hospital. Their mean age was 1 – 14 days with a male-to-female ratio ≈ of 3:1, divided into two groups (30 neonates put in a supine position and 30 neonates put in a prone position); the duration of N-CPAP, the number of prescribed doses of surfactant, the need for mechanical ventilation, time to full feed, and positive end-expiratory pressure (PEEP) were investigated in this study. **Results:** In prone postures, the results demonstrated improved oxygenation levels, as measured by arterial blood gases and oxygen saturation following **the prone** position, and a statistically significant decrease in heart rate at the second hour. There was a statistically significant decrease in CO_2 in prone positions in the 2nd hour after **the prone** position, as well as in NICU duration, duration of oxygen, MV usage, and mortality.

Conclusion: The prone position significantly improves oxygenation in neonates with respiratory distress syndrome and may be a beneficial adjunctive therapy in the NICU.

Keywords: Respiratory distress syndrome, prone position, supine position

INTRODUCTION

A large percentage of premature newborns are affected by respiratory distress syndrome (RDS), which causes considerable morbidity and mortality **[1]**.

A study by Hibbard and colleagues found that 29% of preterm newborns experience a significant respiratory illness (RDS) that requires admission to the neonatal intensive care unit **[2].**

Respiratory distress is a prevalent issue in neonates, particularly among preterm infants, and is a leading cause of morbidity in neonatal intensive care units (NICUs) **[3].**

High oxygen concentrations used to treat RDS-induced hypoxia can have a number of detrimental effects, including retinopathy and persistent lung illnesses **[4].**

When it comes to treating RDS in preterm newborns, adjuvant treatment approaches are just as crucial as oxygen supplements **[5].**

Body position enhances oxygen supply because gravity has an operational impact on cardiovascular and cardiopulmonary performance. Proper body alignment is crucial for respiratory treatment **[6].**

In infants with RDS, the prone position is a straightforward, non-invasive intervention that may enhance oxygenation **[7].**

One of the most routinely performed critical care nursing operations is positioning, which frequently serves as a focal point for coordinating other nursing duties. For preterm neonates, typical breastfeeding positions include prone, side-lying, inclined head-up, and supine. Body placement is the process of optimizing oxygen delivery in cardiopulmonary and circulatory functions, mainly by regulating the effect of gravity. All respiratory therapy should include positioning, particularly when prophylaxis is the goal **[8].**

The main technique used in neonatal critical care is prone posture. It reduces atelectasis, boosts gas exchange, and more effectively restores airflow to dependent lung sections by preventing stomach contents from entering lung volumes **[9].**

Aim of The Work

This study aims to evaluate the effect of different neonatal positioning strategies on respiratory status improvement in neonates diagnosed with respiratory distress syndrome.

METHODS

This clinical trial interventional versus control study **was carried out at Zagazig University Hospitals' NICU units. Medical insurance hospitals in Egypt and MOH hospitals in Kuwait**. Eighty-two patients were enrolled in our study; 17 of them were excluded (12 did not match our inclusion requirements, and five did not want to take part.), 5 (3 in the supine group and two in the prone positions) were lost to follow-up, so we were left with 60 patients aged below 28 days divided into two groups: Supine group 30 neonates put in the supine position and Prone group 30 neonates put in the prone position. Both genders were admitted to the NICU with RD.

The inclusion criteria were included neonates diagnosed with respiratory distress syndrome (RDS), aged below 28 days, need > 21% supplementation of Oxygen and Preterm from 32 weeks and full term. Exclusion criteria were neonates with congenital heart disease (Excluded by Echo examination), neonates with other apparent congenital anomalies, neonates with severe sepsis (Hypotension, oliguria, poor suckling, tachypnea, tachycardia, WBC count abnormality, ↑CRP, thrombocytopenia) (European Medicines Agency) **[10]**, neonates in unstable condition for prone position (gastroschisis, exophthalmos, unstable fracture) and neonates with Cephalohematoma.

All neonates were randomly divided into two groups: one group placed in the prone position and the other in the supine position.

All patients underwent complete history-taking by Using the file records, including (a complete history of pregnancy history, mode of delivery, gestational age, birth weight, and any associated complication) as well as clinical examination for increased work of breathing, cyanosis, and grunting, Lab investigations (Hb, WBCs, PLTs, Bilirubin, ALT, AST, Creatinine). Respiratory data (O_2 saturation, CO_2 saturation, PH).

After all newborns were stabilized by necessary resuscitation, they were divided into two groups, one with a prominent supine posture and the other with a prominent prone position. **The infants were continuously monitored, with oxygen saturation levels (SpO2) measured every 30 minutes over a 6-hour period**. Along with the enrolled newborns' clinical and laboratory data, demographic information **w**as also gathered.

Ethics Considerations:

Written informed consent was obtained from the patients or first-degree relatives of the patient, and the study was approved by the research ethical committee of the Faculty of Medicine, Zagazig University (International Review Board) ZU-IRB #11057-11-9-2023. The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

STATISTICAL ANALYSIS

After the data was entered into the computer, SPSS software version 20 was used for statistical analysis, employing chi-square tests and independent t-tests to assess significance. Numbers and percentages were used to describe the qualitative data. The distribution's normality was verified using the Kolmogorov-Smirnov test. The phrases range (minimum and maximum), mean, standard deviation, median, and interquartile range (IQR) were used to characterize quantitative data. The significance of the obtained results was evaluated at the 5% level using P values of p>0.01 and p≤0.05.

RESULTS

Table 1 revealed that there was no statistically significant difference between the groups under study in the neonates' baseline data.

Table 2 shows that the method of oxygen administration did not show a statistically significant difference between the studied groups.

Table 3 shown that lying prone reduced the respiratory rate in a statistically meaningful way at 1st and 2nd hour after prominent position.

Table 4 showed that lying prone caused a statistically significant drop in heart rate at 2nd hour.

Table 5 Oxygen saturation (SpO2) significantly improved in the prone-positioned group compared to the supine group ($p < 0.05$) in prone postures during 1st and 2nd hours following the prominent position. In the two hours following prominent posture, there was a statistically significant drop in CO_2 in prone positions.

Table 6 demonstrated a statistically significant reduction in the length of time spent in the NICU, the amount of time spent on oxygen therapy, and the use of MV in the prone position.

Table 7 showed a statistically significant decrease in the death rate among the prone-lying patients.

Table 1: Comparison between studied cases according to baseline data

	Supine Position (n = 30)		Prone position (n = 30)		Test of Sig.	P
Age (days)						
Range.	1 – 14		1 – 13		t= 0.169	0.866
Mean ± SD.	4.93 ± 3.49		4.8 ± 2.54			
Gender	No.	%	No.	%		
Female	6	20.0	10	33.3	χ2= 1.364	0.243
Male	24	80.0	20	66.7		
Neonate gestational age (weeks)	No.	%	No.	%		
32-37	15	50.0	15	50.0	χ2= 0.370	0.831
37-42	13	43.3	14	46.7		
>42	2	6.7	1	3.3		
Weight according to GA						
SGA	10	33.3	10	33.3	χ2= 0.0	1.0
AGA	18	60.0	18	60.0		
LGA	2	6.7	2	6.7		
Mode of delivery						
Caesarian section	25	83.3	25	83.3	χ2= 0.0	1.0
Vaginal delivery	5	16.7	5	16.7		
Apgar score						
Range.	0 - 3		0 - 3		t= 0.43	0.699
Mean ± SD.	1.8 ± 0.887		1.7 ± 0.915			

SD: Standard deviation χ2: Chi-square test t: student t-test
p: p-value for comparing between studied groups *: Statistically significant at p ≤ 0.05

Table 2: Comparison between studied cases according to the method of oxygen administration

Method of oxygen administration	Supine Position (n = 30)		Prone position (n = 30)		Test of Sig.	P
	No.	%	No.	%		
Nasal cannula	20	66.7	21	70.0	$\chi2$= 0.615	0.735
CPAP	5	16.7	6	20.0		
Mechanical ventilator	5	16.7	3	10.0		

$\chi2$: Chi-square test p: p-value for comparing between studied groups
*: Statistically significant at $p \leq 0.05$

Table 3: Comparison between studied cases according to respiratory rate

	Supine Position (n = 30)	Prone position (n = 30)	Test of Sig.	p
Baseline				
Range (breath/min)	52 – 70	51 – 68	t=0.271	0.788
Mean ± SD.	60.07 ± 5.38	59.7 ± 5.11		
1st hour				
Range (breath/min)	51 – 70	46 – 66	t=3.000	<0.001*
Mean ± SD.	59.8 ± 5.35	55.63 ± 5.41		
2nd hour				
Range (breath/min)	51 – 70	43 – 66	t=4.108	<0.001*
Mean ± SD.	59.7 ± 5.39	53.67 ± 5.97		
p(F)	<0.001*	<0.001*		

SD: Standard deviation t: student t-test F: repeated measures ANOVA
p: p-value for comparing between studied groups *: Statistically significant at $p \leq 0.05$

Table 4: Comparison between studied cases according to heart rate

	Supine Position (n = 30)	Prone position (n = 30)	Test of Sig.	P
Baseline				
Range. (beat/min)	119 – 183	119 – 182	t=0.140	0.899
Mean ± SD.	150.87 ± 22.32	150.13±18.16		
1st hour				
Range. (beat/min)	118 – 183	112 – 179	t=0.628	0.532
Mean ± SD.	149.87 ± 22.36	146.53 ± 18.56		
2nd hour				
Range. (beat/min)	113 – 183	87 – 154	t=3.955	<0.001*
Mean ± SD.	146.57 ± 22.42	123.67 ± 22.43		
p(F)	<0.001*	<0.001*		

SD: Standard deviation t: student t-test F: repeated measures ANOVA
p: p-value for comparing between studied groups *: Statistically significant at $p \leq 0.05$

Table 5: Comparison between studied cases according to O2 saturation and CO2

	Supine Position (n = 30)	Prone position (n = 30)	Test of Sig.	P
Baseline				
Range (%).	86 – 96	85 – 95	t=0.288	0.774
Mean ± SD.	90.6 ± 2.91	90.4 ± 2.91		
1st hour				
Range.	88 – 100	92 – 100	t=2.367	0.021*
Mean ± SD.	93.93 ± 4.18	96.03 ± 2.48		
2nd hour				
Range.	90 – 100	94 – 100	t=2.260	0.028*
Mean ± SD.	95.93 ± 3.08	97.43 ± 1.92		
p(F)	<0.001*	<0.001*		
CO2				
Baseline				
Range (mmHg).	37 – 49	37 – 49	t=0.033	0.973
Mean ± SD.	43.07 ± 3.95	43.03 ± 3.78		
1st hour				
Range.	34 – 44	32 – 44	t=1.623	0.110
Mean ± SD.	39.4 ± 3.04	38.1 ± 3.17		
2nd hour				
Range.	34 – 43	32 – 42	t=2.550	0.013*
Mean ± SD.	38.13 ± 2.58	36.23 ± 3.16		
p(F)	<0.001*	<0.001*		

SD: Standard deviation t: student t-test F: repeated measures ANOVA

p: p-value for comparing between studied group *: Statistically significant at $p \leq 0.05$

Table 6: Comparison between studied cases according to respiratory support

	Supine Position (n = 30)		Prone position (n = 30)		Test of Sig.	P
NICU duration (days)						
Range.	3 – 18		3 – 12		U=310.0	0.035*
Median (IQR)	7 (4 – 9)		4 (4 – 5.75)			
Duration of Oxygen (min)						
Range.	80 – 120		65 – 118		t=2.785	0.007*
Mean ± SD.	101.47±11.38		91.27±16.52			
MV usage	No.	%	No.	%		
No	23	76.7	28	93.3	$\chi2$=4.320	0.038*
Yes	7	23.3	2	6.7		
Cause for MV						
Respiratory distress syndrome	3	10.0	2	6.7	$\chi2$=5.920	0.205
Sepsis	2	6.7	0	0.0		
Birth asphyxia	1	3.3	0	0.0		
Meconium aspiration syndrome	2	6.7	0	0.0		
Time of Breastfeeding regain (days)						

	Supine Position (n = 30)	Prone position (n = 30)	Test of Sig.	P
Range.	1 – 7	1 – 7	U= 394.0	0.394
Median (IQR)	2.5 (2 – 4)	2.5 (2 – 3)		

χ2: Chi-square test t: student t-test U: Mann-Whitney test
p: p-value for comparing between studied groups *: Statistically significant at p ≤ 0.05

Table 7: Comparison between studied cases according to mortality

Mortality	Supine	N=30	Prone	N=30	χ2	P
No	22	73.3	28	93.3	4.32*	0.038*
Yes	8	26.6	2	6.7		

SD: Standard deviation χ2: Chi-square test t: student t-test
U: Mann-Whitney test p: p-value for comparing between studied groups
*: Statistically significant at p ≤ 0.05

DISCUSSION

This intervention and control study did not differ in any statistically meaningful ways regarding their gestational age, birth weight, Apgar score, and medical diagnosis. Concerning neonatal diagnosis on admission. The first line of treatment for infants with respiratory distress syndrome (RDS) focuses on resuscitation, minimizing respiratory effort, maximizing tissue oxygenation, and avoiding hypoxia, hypercapnia, and acidosis. Supportive measures range from placing newborns and providing extra oxygen to different mechanical ventilation systems **[11].**

In order to effectively treat newborns with respiratory distress syndrome, proper posture is essential. It has a major impact on their breathing, tissue oxygenation, and overall wellness. Nonetheless, there is ongoing debate on the ideal stance **[12].**

There is still debate over the ideal posture for premature babies, even though placement and critical functions have been linked **[13]**. Previous studies have demonstrated that prone positioning can improve lung function by increasing functional residual capacity and promoting uniform lung aeration. **Oliveira et al. [14]** also evaluated the impact of a prone position on thoracoabdominal asynchrony, respiratory pattern, and mean SaO2 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 SaO2.

After being weaned off of the ventilator, babies admitted to the Neonatal Intensive Care Unit (NICU) were seen to have different serum oxygen levels (SaO2). These observations were made by **Eghbalian et al. [13].** The results showed that the prone position produced substantially more SaO2 than the supine posture did. However, a supine position was found to have significantly higher SaO2 than a prone position by **Torabian et al. [15],** who reported that a prone position was not better than a supine position in improving SaO2 in premature newborns; in this regard, they observed that SaO2 was significantly higher in the supine position than in the prone position (can be explained by the extremely low number of cases included in their study which made their results inconclusive).

Kornecki et al. concluded that oxygenation was found to be significantly superior in the prone position than in the supine position. They justified that prone ventilation however is not yet a standard practice and it is reasonable to assume that optimized initial ventilation would lead to improved results in terms of shortened duration of ventilation and improved survival **[16]**.

Our findings showed that in terms of the respiratory rate at the first and second hours, In the prone position, there was a considerable statistical improvement.

The present study's findings, which showed that premature babies had more normal respiration when lying prone and that the mean respiratory rate (RR) was considerably higher when lying supine and laterally than when lying prone, are in line with those of the investigation carried out by **Yin et al. [17]**.

Salih et al. [11] Additionally, there was a significant difference in the oxygen saturation, heart rate, and respiratory rate (p-value: 0.000, p-value: 0.001) between the prone and supine positions (p-value: 0.000) in his investigation. Once the baby was in the prone position, these parameters started to improve.

Furthermore, in 2015, **Vafaienejad et al.** found that the prone position reduced heart rate and respiration in comparison to the supine position when studying the impact of the two positions on the respiratory condition of preterm infants with acute respiratory distress syndrome who were treated with the INSURE protocol **[18].**

Based on the first and second hour's heart rate, the findings of our investigation showed a significant statistical improvement in the prone position.

This outcome is in line with the findings of **Torabian et al.,** who discovered during their research in Iran that preterm neonates' mean heart rates were significantly less than in the supine position when lying down **[14].**

In their Iranian study, **Akbarian et al.** similarly found that prone posture was associated with a lower heart rate than supine and lateral orientations in neonates with very low birth weight **[19].**

We found in our study that, in terms of O2 saturation at the first and second hours, In the prone position, there was a statistically significant improvement.

This result was consistent with Babaei et al. findings, which showed that there was a significant variation in SpO2 between the supine and prone positions **[20]**.

Additionally, the present findings appear to be in line with those of **Brunherotti et al.**, who stated that the lateral postures and the prone position had the highest mean and showed the lowest degree of oxygen saturation in a Brazilian study of preterm neonates **[21].**

Compared to the supine position, more oxygenation was achieved in the prone position in hospitalized preterm infants with RDS, according to research by **Eghbalian et al. [12].** At the conclusion of the three-hour monitoring and for two positions, this difference was statistically significant.

As well as **Jahani et al.** claimed that lying flat raises blood oxygen saturation and arterial blood oxygen concentration. **[22]**.

Moreover, contrary to the findings of the present investigation, **Yin et al. [17]** showed that the average SaO2 did not differ statistically significantly between the three analyzed postures (supine, lateral, and semi-prone). The fact that our study excluded participants younger than 32 weeks old due to our prediction that prone posture is exceedingly difficult and not well tolerated at younger premature ages may have contributed to this discrepancy. His age group began at 28 weeks prematurely.

According to our research, the prone posture showed a statistically significant benefit for CO2 at 1st and 2nd hours.

Eghbalian et al. showed that premature newborns' level of CO2 was substantially lower when lying prone than when lying supine, which is in line with the results of the present study **[12].**

Pronation reduces MAP and CO, whereas resting supine reverses this effect, according to research by **Loi et al. [23]**.

After being weaned off of their ventilator, babies were admitted to the Neonatal Intensive Care Unit (NICU), **Eghbalian et al.** looked at the effect on SaO2 of lying supine and prone. They found that the prone position created substantially less CO2 than the supine posture **[12]**.

In this study, no statistically significant difference was found in the duration of oxygen therapy between the prone and supine groups ($p = 0.27$).

This result is consistent with that of **Sharma et al.,** they came to the conclusion that the prone posture increases oxygen saturation, heart rate, and respiratory rate in premature neonates undergoing respiratory distress, and reduces the amount of time that oxygen is present without producing any problems such as apnea or vomiting **[24]**.

The current results also align with those of **Akbarian et al.,** who looked into the effects of supine, prone, and lateral positions on SaO2 in newborns with low birth weights and found that the prone position had better oxygenation than the other two. Based on these results, it may be less necessary for premature newborns to breathe deeply when in a prone position **[19]**.

The results of the present investigation were similar to those of **Das et al.** comparative investigation into the effects of oxygen saturation on babies with RD when they were placed in a prone versus supine position. For three hours, each baby with RD was placed in the supine position; after that, they spent six hours in the prone position. Throughout this time, their oxygen saturation and respiratory rate (RR) were recorded every two hours. According to these authors, in infants with RD, the prone posture increases SpO2 and reduces RD in comparison to the supine position **[25]**.

In thirty weaned neonates off a ventilator, **Yao et al.** did a study. The findings indicated that the babies' oxygenation was better. For the first nine hours following the newborns' weaning off of the mechanical ventilator, they were more comfortable in the prone position than the supine position **[26].**

Our findings align with those of **Smith et al. [27]** and **De Luca et al. [28],** who also reported improved oxygenation and reduced work of breathing in neonates placed in the prone position

In terms of mortality in the group in the prone position, our study also revealed a statistically significant improvement.

This finding is consistent with that of **Munshi et al. [29],** who noted that if possible, the patient should be kept in a prone position for twelve hours per day is likely to lower the risk of mortality for babies experiencing respiratory distress. Additionally, a second study by Gattinoni Marini et al. discovered that using a prone stance for twelve hours or longer per day yielded the biggest benefit **[30].**

The meta-analysis, according to **Tabula et al., [31]** did not corroborate the claim that lying prone reduces mortality, with the exception of the ICU mortality rate for all patients with respiratory distress ranging from mild to severe. They also discovered that ventilation raises the possibility of airway obstruction when a person is prone**.** Based on their research, only patients with moderate to severe RDS were advised to be positioned prone.

The study provided further evidence that the prone position provided improvement in the physiological parameters for high-risk neonates with nasal cannula, NCPAP, and mechanical ventilators.

This result is consistent with **Babuyeh et al. [32]** investigation on the effects of prone positioning on the blood oxygen saturation and heart rates of premature babies on mechanical breathing; the mean heart rate did not differ significantly between the supine and prone positions, but the mean SpO2 did. The prone position was found to have a greater positive effect on heart rate and SpO2 than the supine position **[32].**

Comparably, **Borenstein [33],** who looks into it? Position's influence on premature neonates requiring respiratory support's oxygenation instability was demonstrated by SpO2 histograms, which indicated that the oxygenation of preterm infants receiving respiratory assistance varied depending on whether they were placed prone or supine. This proves the stability of oxygenation. Furthermore, **Jahani et al. [22]** claimed that elevated blood oxygen saturation and arterial blood oxygen concentration are caused by the prone position. Accept these outcomes. Prone positioning has been found to improve patients' oxygenation status when they have respiratory issues **[22]**.

Compared to the other two positions, they found that the prone position had superior oxygenation. Regularity, **Gonçalves de Oliveira et al. [34]** and **Jarus et al. [35]** revealed that to reduce pulmonary expansion and increase oxygenation, babies can be placed in the prone position, even the sickest ones. Additionally, **Patil et al. [36]** found that prone laying increased oxygen saturation higher than supine and side-lying postures when they examined the impact of prone positioning on oxygen saturation in patients experiencing acute respiratory failure who were on mechanical ventilation **[19].**

Rezaeian et al. [37], who investigated how laying supine and prone affected premature neonates' oxygen saturation after they were weaned off of mechanical ventilation in the **NICU, and Eghbalian [12],** who conducted research When supine and prone positions were evaluated for their impact on arterial oxygenation in preterm infants, the prone position produced significantly higher oxygen saturation than the supine position. **Eghbalian et al. [12]** found that SaO2 was significantly higher in the prone position than in the supine position when comparing the effects of supine and prone positions on SaO2 in newborns admitted to the Neonatal Intensive Care Unit (NICU) after being weaned off the ventilator. These findings are consistent with the current study's findings. Demonstrated that compared to premature newborns placed in the supine position, those placed in the prone position had a significantly higher level of SaO2. The respiratory rates in the supine and prone positions were the same. However, **Malagoli et al. [38]** asserted that the supine position had a higher oxygen saturation **[12, 37].**

Unlike the findings of the present investigation, **Torabian et al. [14],** an examination of premature babies revealed that the supine posture had a significantly higher mean SaO2 while the prone position had a significantly lower mean HR. **Rivas-Fernandez et al. [39]** discovered, however, that the prone posture only slightly increased oxygenation in newborns undergoing mechanical ventilation.

Yin et al. [17] conducted a comparison of three positions (supine, lateral, and semi-prone) when receiving Continuous Positive Airway Pressure (CPAP) as a premature infant. The findings showed that while the mean SaO2 for the locations under evaluation did not significantly differ, there was a difference in mean HR and HR variations, and the RR was more stable. Furthermore, it was demonstrated by **Akbarian Rad et al. [19]** that the prone posture exhibited greater HR variability than the supine and lateral orientations.

When examining the effects of the prone posture on neonates receiving nasal continuous positive airway pressure **[14,17,19,39], Ghorbani et al. [40]** discovered a substantial difference in heart rate between the supine and prone positions.

All things considered, a prone position reduced mortality and increased respiratory rate, heart rate, oxygen saturation, CO2, length of stay in the critical care unit, oxygen duration, and usage of mechanical ventilation. These findings are consistent with earlier data from other studies.

CONCLUSION

Our study suggests that the prone position significantly improves oxygenation in neonates with respiratory distress syndrome and may be a beneficial adjunctive therapy in the NICU.

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