EFFECT OF PRONE POSITION AND MASSAGE ON O2 SATURATION AND HEART RATE IN PRETERM AND SMALL FOR GESTATIONAL AGE NEWBORN

By

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ABSTRACT

Background: *These days, most of the admitted infants in (NICU) are premature infants. Infant massage and prone position has been recommended for several decades to have a positive effect on preterm and small for gestational infants.*

Objectives: *We aimed to assess the effect of prone position and massage on oxygen saturation and heart rate in Preterm and small for gestational age neonate hospitalized in NICU at Al-Hussein university hospital and Dessouk general hospital.*

Patients & Methods: *This is a randomized controlled clinical study included 156 newborn was done at Al-Hussein university hospital and Dessouk general hospital during the period from April 2021 to march 2022. Complete clinical examination, history taking and laboratory investigation was done. Then all studied newborn was classified randomly into three groups: (Group I): (n=52) infants in prone position without massage, (Group II): (n=52) infants with massage therapy in prone position that was done by the researcher, (Group III): (n=52) infants as a control group in supine position (with no intervention).*

Results: *The Results showed that the Mean ± SD of gestational age was 35.5 ± 0.68 weeks; 53.2% were female and 46.8% were male, 38.5% had Pregnancy complication, Mean ± SD of postnatal age was 4.8 ± 1.95 days, and Mean ± SD of maternal age was 27.26 ± 6.4 years old. Also there was statistical significant difference in O2 saturation and heart rate between group 1 and 2 & group 2 and 3 & group 1 and 3 at 1st, 2nd, 3rd, 4th, and 5th days. Heart rate was decreasing and SaO_2 was increasing among the neonates of groups I and II compared to the neonates of group III at the subsequent 1 – 5 follow-up days.*

Conclusion: *The study revealed that prone position and infant's massage in prone position has a positive effect by reducing HR and increasing the blood oxygen saturation level in preterm and small for gestational age neonates admitted in NICU.*

Key words: *Intensive Care Units, preterm, SGA, neonatal, prone position, massage, heart rate, oxygen.*

INTRODUCTION

Preterm birth is defined as delivery before 37 completed weeks (259 days) **(Purisch and Gyamfi-Bannerman, 2017)**.

High prevalence of preterm birth is counted as a serious problem in health system in recent decades. From 1980, this trend reached 12.3% in US so that there is one preterm birth out of 8 births **(Rangey & Sheth, 2014)**.

Worldwide, of the 130 million neonates born every year, 15 million neonates are born preterm. Moreover, prematurity is still a major cause of neonatal and infant mortality and morbidity and a significant contributor to long-term adverse health outcomes **(Khasawneh and Khriesat, 2020)**.

Approximately 1 million infants die each year due to complications of preterm birth. Many survivors face a lifetime of disability, including learning disabilities and visual and hearing problems **(Frey and Klebanoff, 2016)**.

About 13% of preterm births at 32 to less than 37 weeks of gestation are reported in Egypt. This statistic may indicate a higher rate of admission to the NICU every year **(Abdelhady and Abdelwahid, 2015)**. A study by **Al gameel et al.,** conducted in Upper Egypt, indicated that 28% of the studied neonates were late preterm infants **(Algameel et al., 2020)**.

Small for gestational age (SGA): Is defined as birth weight of less than 10th percentile for gestational age **(Osuchukwu and Reed, 2022)**.

Estimates show that 32 mil-lion newborns (NBs) that are small for gestational age (SGA) are born annually in the world, corresponding to an incidence of 27% of SGA among live births in low and middle income countries **(Black, 2015)**.

Fetuses with birth weight below the 10th percentile are at increased risk of still birth and perinatal mortality; those with birth weight below the 3rd percentile being at the highest risk **(Moraitis et al., 2014)**.

Positioning of preterm infants not only has a direct impact on their neurological developments, but also can reduce the long term complications of prematurity. Positioning is an important factor associated with ventilation **(Gardner et al., 2015)**.

Although the best method of positioning for newborn babies is unknown, there is a tendency to keep the babies under mechanical

ventilation in the supine position, which mainly results in an easy view, more convenient examination of the baby and a need for periodic monitoring and intervention **(Bhandari et al., 2022)**.

Among other methods that can reduce the stress level and improve cardiopulmonary function is massage, and refers to regular movements on skin to stimulate the infants. In fact, massage is a kind of methodological touch to stimulate the infant. Numerous studies have reported its positive effects **(Álvarez et al., 2017)**.

Massage can be conducted by a professional massager or the mother. In fact, advantages of massage include circulation and digestive system stimulation, better weight gain, positive effect on neurologic growth, a better infant parent's relationship, improvements and reduction of stress behavior, earlier discharge from NICU, skin integrity increase, and better sleep. Massage therapy is known as a beneficial method with no hazards **(Hansen, AR and Cloherty, 2016)**.

Previous studies suggest various positions for the infants although prone position should be administrated just in hospital and under supervision of a nurse. All studies also indicate that massage is a method to improve vital signs, weight gaining, infants 'feeding and reduce stress pressure and has positive effect on neurological growth **(Oren-Amit et al., 2017)**.

AIM OF THE WORK

The aim of this study was to assess the effect of prone position and massage on heart rate and oxygen saturation on Preterm and small for gestational age neonate hospitalized in NICU at Al-Hussein University Hospital and Dessouk General Hospital.

Sample size calculation

The sample size was calculated using the following formula:

$$n = \frac{2(Z_{\alpha} + Z_{1-\beta})^2 \sigma^2,}{\Delta^2}$$

Where **n** is the required sample size. For **Zα**, **Z** is a constant (set by convention according to the accepted **α** error and whether it is a one-sided or two-sided effect).

σ is the standard deviation (estimated) and **Δ** the difference in effect of two interventions which is required (estimated effect size).

Ethical consideration:

1. Written consent was obtained from parents of each participant before the study.

2. Approval of ethical committee in the pediatric department, college and university was obtained before the study.
3. The Parents has the right to withdraw his or her newborn from the study at any time.
4. The author declared that there is no conflict of interest regarding the study.
5. Privacy of all data will be assured.

Financial disclosure:

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PATIENTS AND METHODS

This is a randomized controlled clinical study included 156 newborn was done at Al-Hussein university hospital and Dessouk general hospital during the period from April 2021 to March 2022. They were selected by simple random method.

Inclusion criteria:

1. Preterm infant of 34-37 weeks of gestational age and small for gestational age.
2. No congenital anomalies, neurological and cardiovascular disorders.
3. No surgical problems.
4. No contraindications for touch or dermal lesion.
5. Any newborn with SaO2 of ≤ 89% on Oxihood oxygen before the prone position and massage.
6. No mothers 'addiction to cigarette, drugs and alcohol.

Exclusion criteria:

1. Infants with unstable body temperature, blood and blood products transfusion and an indication for re intubation.
2. Full-term infants (> 37 weeks) or preterm (< 33 weeks).
3. Early onset sepsis.
4. Any new born with respiratory distress grade II – III.

Plan of study:

All neonates included in the study were subsequently subjected to:

- Full medical history talking including prenatal, natal and postnatal history.
- Complete clinical examination including systemic and local examination, so that newborns with respiratory complications or major congenital anomalies were excluded.
- Revision of neonatal investigations (laboratory and imaging) in order to exclude newborns with laboratory

abnormalities e.g. bleeding tendency or surgical abnormalities e.g. pneumothorax.

- We recorded all data about all neonates included in the study on A Case Sheet.

After enrollment, the (156) cases were sequentially arranged and plotted on the random number tables to determine to which group they were assigned by systemic random method into three groups:

- **(Group I):** (52) infants in prone position without massage.
- **(Group II):** (52) infants with massage therapy in prone position (as intervention groups) that was done by the researcher.
- **(Group III):** (52) infants as a control group (with no intervention) in supine position.

Each infant underwent intervention for 5 straight days during which its HR and SPO2 were recorded by pulse oximetry as baseline, and then intervention was received (massage for 15 mint. every day for 5 days), the collected data was analyzed accurately using descriptive and inferential statistics.

The recorded HR and SPO2 were done by using pulse oximetry CONTEC model: CMS8000.

Investigations:

1. Complete blood count (CBC): HB concentration, red cell count, white cell count and platelets were done automatically by Sysmex (Kx-21N) automated hematological counter.
2. Serum Albumin Levels by automated cobas c311 analyzer - Roche.
3. Serial C-reactive protein by manual latex omega is a rapid latex agglutination test kit for the detection of C - reactive protein (CRP) in human serum.
4. Serum electrolytes: by automated cobas c311 analyzer - Roche.
5. Arterial blood gases (ABG): GEM Premier 3000 to determination of pH, PCO2, BE, HCO3, PO2, and O2saturation.

Statistical analysis

- Data fed to computer and analyzed using IMB SPSS software package version 20.0. (Armonk, NY: IBM Corp) **(Kirkpatrick LA and Feeney BC et al., 2013)**.

- Qualitative data will be described using number and percentage and tested with Chi-Square test to test the association between the variables for categorical data.
- Quantitative data will be described using mean ± standard deviation (SD) and tested with one-way ANOVA test (analysis of variance) followed by post ho Turkey's test to assess the statistical significance of the difference between each two groups.
- **The p-value significance was considered as the following:**
  - P-value ≤ 0.05: indicates significant.
  - P-value < 0.001: indicates highly significant.
  - P-value> 0.05: indicates Non-significant difference.

RESULTS

The results of our study will be demonstrated in the following tables:

Table (1): Demographic and baseline data among all studied neonates

Variable	number	Percentage %
GA (weeks)		
Mean ± SD	35.5 ± 0.68	
Median (IQR)	35 (35 – 36)	
Range	34 – 37	
Sex		
Female	83	53.2**%**
Male	73	46.8**%**
Pregnancy complication E.g. Diabetes, PROM,..etc.	60	38.5**%**
Post-natal age (days)		
Mean ± SD	4.8 ± 1.95	
Median (IQR)	5 (3 – 6)	
Range	2 – 9	
Maternal age (years)		
Mean ± SD	27.26 ± 6.4	
Median (IQR)	26 (22 – 32.75)	
Range	18 – 46	

SD: Standard deviation, IQR: Interquartile range

This table shows that: the Demographic data among all studied neonates as the mean of the gestational age was (35.5 ± 0.68), the mean of post natal age (4.8 ± 1.95) days and the mean of maternal age (27.26 ± 6.4) years and more than half (53 %) of cases are female and (46 %) are male.

Table (2): Clinical data of all studied newborn at admission:

Variables \ Groups	Group I (n=52)		Group II (n=52)		Group III (n=52)		*p*-value
	No.	%	No.	%	No.	%	
Complexion:							
Jaundice	15	28.8	17	32.7	11	21.1	0.435
Pallor	1	1.9	3	5.8	1	1.9	
pink on O_2	36	69.3	32	61.5	40	77	
Wight	2390± 269		2379± 359		2337 ± 623		0.813
Height	45.2 ± 1.85		45.8 ± 2.25		45.5 ± 1.85		0.412
Temperature	37.0 ± 0.1		37.0 ± 0.0		37.0 ± 0.0		0.589
HR	144.9 ± 10.2		144.9±10.6		147.6±9.5		0.296
RR	53.1 ± 4.6		51.5±3.6		52.1±4.9		.160
Neonatal reflexes:							
Normal	45	86.5	47	90.4	44	84.6	0.803
Poor	7	13.5	5	9.6	8	15.4	
Chest auscultation:							
Fair on o2, Equal Bilateral air entry with no adventitious sound.	33	63.5	27	51.9	37	71.1	0.161
Decrease air entry, tachypnea and mild wheezy chest..	19	36.5	25	48.1	16	28.8	
Diagnosis on admission							
RDS grad 1	26	50	24	46.2	31	59.6	0.367
RDS grad 2	26	50	28	53.8	21	40.4	
Type of O2 at admission							
Incubator	21	40.4	27	51.9	27	40.4	0.397
Oxihood	31	59.6	25	48.1	25	59.6	

This table shows: insignificant difference between the three groups regarding clinical examination.

Table (3): Baseline laboratory data of all studied newborn

Groups / Lab. data	Group I (n=52) Mean ± SD	Group II (n=52) Mean ± SD	Group III (n=52) Mean ± SD	*p*-value
CBC				
RBCs *(10^6/µl)	4.4 ± 1.6	4.4 ± 1.7	4.8 ± 1.5	0.342
HB (gm/dl)	15.5 ± 6.4	14.4 ± 3.8	16.6 ± 3.5	0.065
Platelets *(10^3/µl)	265.5 ± 101.4	222.0 ± 103.5	257.0 ± 102.7	0.075
WBCs *(10^3/µl)	10.7 ± 4.4	12.1 ± 2.7	10.6 ± 3.2	0.054
S. albumin (gm/dl)	3.7 ± 0.3	3.6 ± 0.3	3.7 ± 0.3	0.663
S. Electrolytes				
Na^+ (mEq/l)	140.2 ± 15.2	137.8 ± 29.4	129.0 ± 33.7	0.09
K^+ (mEq/l)	3.9 ± 0.6	3.9 ± 0.3	3.8 ± 0.2	0.251
Ca^{++} (mg/dl)	8.9 ± 0.4	9.1 ± 0.5	14.1 ± 21.2	0.058
RBG (mg/dl)	88.3 ± 17.1	83.5 ± 13.1	82.9 ± 12.9	0.119
ABG				
PH	7.4 ± 0.1	7.4 ± 0.0	7.4 ± 0.0	0.486
PO2	59.7 ± 18.8	65.8 ± 16.1	63.9 ± 6.5	0.102
PCO2	39.2 ± 4.7	38.4 ± 2.2	39.3 ± 4.2	0.376
HCO3	24.9 ± 13.4	20.6 ± 7.1	21.5 ± 8.4	0.073
O2 saturation	91.98 ± 7.163	91.33 ± 8.184	91.16 ± 7.554	0.85

This table shows: insignificant difference between the three groups regarding laboratory data as CBC, serum albumin, serum electrolyte and arterial blood gases.

Table (4): Follow up of oxygen saturation (SaO_2) by pulse oximetry at the baseline and time among the studied groups

Groups / Days	Group I (n=52) Mean ± SD	Group II (n=52) Mean ± SD	Group III (n=52) Mean ± SD	*p*-value
Baseline	91.98 ± 6.163	91.33 ± 1.184	91.16 ± 4.554	0.616
1st day	93.50 ± 1.462[a]	93.28 ± 1.538[a]	92.77 ± 1.262 [a]	<0.001*
2nd day	93.71 ± 1.348[a]	94.79 ± 1.377[a]	92.87 ± 1.253 [a]	<0.001*
3rd day	94.27 ± 1.345[a]	94.50 ± 1.502[b]	92.85 ± 1.144[ab]	<0.001*
4th day	95.08 ± 1.100[a]	94.81 ± 1.103[b]	92.75 ± 1.007 [ab]	<0.001*
5th day	95.15 ± 1.055[a]	95.53 ± 1.366[b]	92.71 ± 1.143 [ab]	<0.001*
Time 0 – 5 diff.	3.17 ± 1.037 [a]	4.110 ± 1.223[b]	1.55 ± 0.76 [ab]	<0.001*

This table shows that: SaO_2 was increasing among the neonates of groups I and II compared to the neonates of group III at the subsequent 1 – 5 follow-up days.

Table (5): Follow up of heart rate by pulse oximetry at the baseline and time among the studied groups

Groups / Days	Group I (n=) Mean ± SD	Group II (n=) Mean ± SD	Group III (n=) Mean ± SD	*p*-value
Baseline	149.52 ± 9.106	149.54 ± 6.530	149.08 ± 10.188	0.955
1st day	144.85 ± 6.801 [a]	143.69 ± 6.70 [b]	148.92 ± 10.352 [ab]	<0.001*
2nd day	140.21 ± 6.216 [a]	140.54 ± 7.49 [b]	148.65 ± 10.362 [ab]	<0.001*
3rd day	139.40 ± 7.951 [a]	140.21 ± 9.39[b]	148.79 ± 10.863 [ab]	<0.001*
4th day	140.13 ± 7.428 [a]	139.56 ± 8.48[b]	147.29 ± 9.236 [ab]	<0.001*
5th day	139.10 ± 12.628 [a]	135.75 ± 8.02[b]	146.67 ± 10.308 [ab]	<0.001*
Time 0 – 5 diff.	10.41 ± 8.23 [a]	13.79 ± 6.701[b]	2.4038 ± 4.15984 [ab]	<0.001*

This table shows that: HR was significantly decreasing among the neonates of groups I and II compared to the neonates of group III along the five follow-up days.

Table (6): Predictors of the increase in O_2 saturation over the time using linear mixed model

Parameter	Beta	Std. Error	T test	p-value	95% CI	
Intercept	92.37287	4.931938	18.73	<0.001*	82.62908	102.1167
Group=1	1.244143	0.202351	6.148	<0.001*	0.844365	1.64392
Group=2	1.605962	0.206917	7.761	<0.001*	1.197166	2.014759
Group=3	0[b]	0	.	.	.	.
None	-0.43315	0.175161	-2.473	0.015*	-0.7792	-0.08709
Pregnancy complication	0[b]	0	.	.	.	.
GA (weeks)	0.00045	0.137032	0.003	0.997	-0.27028	0.271178
Maternal age (years)	0.002839	0.012908	0.22	0.826	-0.02266	0.028341
Post-natal age (days)	-0.15157	0.044295	-3.422	0.001*	-0.23908	-0.06406
Follow up Time (days)	0.346706	0.024248	14.298	<0.001*	0.298956	0.394455

Beta: Regression coefficient. Repeated covariance type is ARMA. Superscripted b indicates reference categories. *: Significant p-value at 0.05 level.

This table shows that: the neonates in group I and II were more likely to have 1.24 and 1.6 higher in SaO_2 over the time than those in group III ($p < 0.001$) adjusted to the other predictors in the model. Additionally the effect of follow-up time was also significant, adjusted to the other predictors in the model, where

neonates were more likely to have 0.3467 increases in SaO_2 with each follow-up point ($p<0.001$) and post natal age was negatively associated with the increase in SaO_2, where with every increase in post natal age by 1 day at time of intervention, the SaO_2 decreased by .15 ($p= .001$) this means that early intervention was better.

Table (7): Predictors of the decrease in HR over the time using linear mixed model

Parameter	Beta	Std. Error	T test	p-value	95% CI	
Intercept	226.016483	33.393701	6.768	<0.001*	160.0308	292.003
Group=1	-6.633485	1.370253	-4.841	<0.001*	-9.341122	-3.925848
Group=2	-7.100064	1.401167	-5.067	<0.001*	-9.868787	-4.33134
Group=3	0[b]	0	.	.	.	.
None	1.059587	1.18613	0.893	0.373	-1.284222	3.403397
Pregnancy complication	0[b]	0	.	.	.	.
GA (weeks)	-1.843492	0.927929	-1.987	0.049*	-3.677092	-0.009892
Maternal age (years)	-0.193289	0.08741	-2.211	0.029*	-0.366011	-0.020566
Post-natal age (days)	-0.977954	0.299952	-3.26	0.001*	-1.570663	-0.385245
Time(days)	-1.119586	0.101766	-11.002	<0.001*	-1.320613	-0.918559

Beta: Regression coefficient. Repeated covariance type is unstructured. Superscripted b indicates reference categories. *: Significant p-value at 0.05 level.

This table shows that: the neonates in group I and group II were more likely to have 6.6 and 7.1 lower in HR over the time than those in group III ($p <0.001$) adjusted to the other predictors in the model. Additionally, the effect of follow-up time was also significant adjusted to the other predictors in the model, where neonates were more likely to have 1.119586 decrease in HR with each follow-up point ($p<0.001$), Also higher GA, post-natal age, and maternal age were associated with lower HR.

DISCUSSION

This was a randomized clinical study that was done in NICU at Al-Hussein university hospital and Dessouk general hospital during the period from April 2021 to march 2022; the study was carried out on a total of the 156 newborn which were classified into three groups (each group 52 cases); (group I): prone position, (Group II): massage therapy with prone position and (Group III): control group.

In this study, we aimed to assess the effect of prone position and massage on heart rate and SaO2 in Preterm and SGA neonate hospitalized in NICU.

Analysis of our findings revealed that the Mean ± SD of gestational age was 35.5 ± 0.68 weeks; 53.2% were female and 46.8% were male, 38.5% had Pregnancy complication, Mean ± SD of postnatal age was 4.8 ± 1.95 days, and Mean ± SD of maternal age was 27.26 ± 6.4 years old.

In agreement with our findings, the study of **Elsagh et al., 2019** which aimed to determine the effects of neonatal massage and prone positioning in preterm infants on Heart Rate (HR), and Oxygen Saturation (O_2Sa) results showed that 46.70% of the subjects were male. The lowest age was 33 weeks and the highest was 37 weeks. The mean and SD of age and weight was 34.75 (0.94) weeks and 2206.62 (395.71) gram respectively.

While **Ramezani et al., 2017** reported that infants belonged to the gestational age of 26-34 weeks with a mean age of 32.96 weeks. They were mostly males (62.2%). About 64% of them were born through cesarean section (C/S). The group's mean of birth weight was almost 1970 gram. The mean score of Apgar for the group was 9.

In the current study, there was statistical significant difference in O_2 saturation between group 1 and 2 & group 2 and 3 & group 1 and 3 at 1st, 2nd, 3rd, 4th and 5th days. SaO2 was increasing among the neonates of groups I and II compared to the neonates of group III at the subsequent 1 – 5 follow-up days.

Elsagh et al., 2019 showed a significant difference in SaO_2 in different groups so that it was more in massage group and prone position group compared to control group, while the difference between massage and prone position group was not significant.

Ghorbani et al., 2013 also clearly stated that the infants in prone position significantly had a higher SaO_2, compared to supine position.

On the other hand, **Ammari et al., 2009** reported that the increase of body temperature in prone position leads to hyperventilation and enhances the respiration rate that consequently results in lower CO_2 in infants' blood. Meanwhile, she reported no specific idea about changes of SaO_2.

In addition to above findings, we found that there was significant difference in heart rate

between group 1 and 2 & group 2 and 3 & group 1 and 3 at 1st, 2nd, 3rd, 4th, and 5th days. HR was significantly decreasing among the neonates of groups I and II compared to the neonates of group III along the five follow-up days.

In comparison with our findings, the study of **Cândia et al., 2014** reported that the mean HR was 150.8±18.00 (minimum/maximum: 119/186) at baseline versus 146.5±17.12 (114/175) after prone positioning, with no significant difference between measurements (p=0.17). Neither the SatO2 (94.69±3% versus 95.56±2.22%; p=0.33) nor Temp. Measurements (36.72 versus 36.73; p=0.75) exhibited significant differences before and after the intervention.

Ghorbani et al., 2013 reported a significant difference in HR after infants' position changes from prone, compared to supine.

Also these results agree with **Field et al., 2008** & **Diego et al., 2014** who mentioned that physiologic conducted parameters included heart rate variability (HRV) showed significant improvements after massage. But this result is opposite to that of **(Lee, 2005)** who stated that there were no significant differences in heart rate after massage. However, this may be due to frequency of massage improving the circulation is reflected in the pulse variation.

This finding therefore supports previous studies that reported that oxygen saturation of infants remain within the safe limits during the massage sessions. Also **Ramezani et al., 2017** reported that there was no significant difference in oxygen saturation (p=.13) of infants before and after massage across the 5 days of intervention but respiratory (p=.004) rate and heart rate (p=.003) were reduced after massage.

CONCLUSION

The study revealed that prone position and infant's massage in prone position has a positive effect by reducing HR and increasing the blood oxygen saturation level in preterm and SGA neonates admitted in NICU. We found a significant decrease in HR and increase in SPO2 that was more apparent with massage in prone position group, with statically significant difference between both groups compared to the control group.

RECOMMENDATIONS

1. Using the prone position and neonatal massage as a two natural free interventions to reduce HR and improve blood SaO_2 level.

2. Nurses in NICU should receive training program related to massage therapy and good positioning to improve their practice regarding general condition of premature and SGA infants during hospitalization.
3. Mothers should receive training program related to massage therapy and good positioning to improve their practice regarding general condition of premature and SGA infants after discharge from NICU.
4. Further studies to be conducted with a larger sample size in different research settings and communities to determine the optimal frequency, techniques, duration and effect of massage therapy on other body system

LIMITATION OF THE STUDY

1. Difficulty in satisfaction of parents to participant.
2. Discontinuity of the massage for 15 minutes in some newborn due to intolerance of some newborn.

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