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RESEARCH

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Comparison of massage and prone position on heart rate and blood oxygen saturation level in preterm neonates hospitalized in neonatal intensive care units

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Abstract

Background Many years ago, it was proposed that prone positioning and infant massage would benefit preterm and babies with low birth weight.

Aim of the work Evaluating the effectiveness of massage therapy and the neonatal prone position on the heart rate (HR) and blood oxygen saturation level (SPO2) of premature neonates in neonatal intensive care units.

Subject and methods Our study was conducted as a single-center, randomized controlled clinical trial at the NICUs of Menoufia University Hospital. After enrollment, the (240) cases were divided into group A: (80) infants with prone position, group B: (80) infants with massage therapy (as intervention groups), group C: (80) infants as a control group (without intervention).

Results Regarding group A, there was a significant difference between the first and last days of intervention regarding HR and SPO2 at 15, 30, 45, and 60 min. Regarding group B, there was a significant difference between the first and last days of intervention regarding HR and SPO2 at 15, 30, 45, and 60 min. Regarding group C, there was no significant difference between the First and last days of intervention regarding HR at 15, 30, 45, and 60 min.

Conclusion Prone position and infant's massage equally reduce Heart Rate and increase preterm babies' blood oxygen saturation level neonates admitted in NICU.

Keywords Heart rate, Intensive care units, Massage, Preterm neonates, Prone position

Background

In recent decades, preterm birth rates are increasing in many developed countries. Since 1980, this trend has increased by 12.3% in the USA, making one preterm delivery for every eight births [1].

The development of premature infants' neuro-psychomotor skills is limited by their low muscular tonicity, extended positions of their majority of limbs, neck, and thoracic region, and poor muscular tonicity [2].

Prior to 1990, approximately all neonates in the USA were positioned in the prone position. A public campaign to promote the supine posture was launched by the American Pediatrics Association in 1996 [3–5].

A study was using salivary cortisol to assess stress in premature newborn infants and the impact of prone positioning, was published in 2014 by Cândia et al. [6].

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They observed that lying on one's back significantly lowered stress.

In addition, massage is actually a type of methodical contact used to stimulate infants, its beneficial effects have been documented in numerous of investigations [7].

In a study conducted by Diego, et al. [8], a significant increase in vagal activity was noticed during the period of 15-min massage therapy. The vagal activity was interpreted from ECG as a measure of heart rate variability.

It was also seen that there was a significant increase in gastric motility in post massage period. It was postulated that massage causes increase in vagal activity, hence improved gastric motility; this leads to better absorption of nutrients resulting in better weight gain [8].

Additional benefits of massage include stimulation of the circulatory and digestive systems, improved weight gain, favorable effects on neurologic development, improved parent-infant interactions, improvements in and a decrease in the behavior related to stress, earlier release from the NICU, improved skin integrity, and improved sleeping. The benefits of massage therapy are well known, and it has no risks [9].

Method

Study design

A case–control study was carried out as a single-center at the Neonatal Intensive Care Unit of Menoufia University Hospital, randomized controlled three-group clinical trial for a period of 13 months. All patients participating in the study provided their informed consent after receiving approval from the department's and college ethical committees.

The (240) cases were progressively organized after enrolment and displayed on the random number tables to determine which group they were assigned to. Group A included 80 newborns in the prone position, group B included 80 infants who received massage therapy (as intervention groups), and group C included 80 infants who served as the control group (without intervention).

Our study included preterm neonates (32–37 weeks gestational age) admitted to the NICU with RD, weight over 1250 g, dependence on oxygen (after weaning off oxygen, the SaO2 decreased below 85%), and they were need for at least 1 week of hospitalization.

We excluded from our study infants with unstable body temperatures, congenital abnormalities or traumas such as Erb's palsy, congenital cardiac diseases, neonatal apnea, active hemorrhage, blood transfusion, and neonate with pneumothorax or under chest tubes intervention.

The procedures

The first group of infants (group A) spent an hour in a prone position. Every 15 min, a pulse oximetry device monitored their HR and oxygen saturation (SPO2) variations during this period.

The infants in the massage (group B) group received massages using Tiffany Field's traditional approach, which involved superficial stroking. Infants received 15 min of massage, the first five of which were spent with the infants lying on their backs being superficially stroked from head to toe. The infant's arms and legs were extended and flexed throughout the second 5 min of lying supine. The infant was massaged and again put in prone position for the last 5 min. It then underwent pulse oximetry for an hour while lying in any position.

The infant in the control group (group C) underwent an hour of non-interventional pulse oximetry monitoring.

Every infant experienced treatment for five consecutive days, its baseline HR and SPO2 were measured, after which treatment was given.

All of the infants included in the study underwent a thorough medical history that covered their prenatal, natal, and postnatal histories, as well as clinical examination that included all body systems with a review of their neonatal investigations (laboratory and imaging).

Sample size determination

The sample size was calculated based on a previous study Elsagh et al. [10], who found that SaO2 changed over time and there was significant difference between groups at the fourth day mean SaO2 was 94.8 ± 1.41 in position group, 93.88 ± 2.01 in massage group and 90.7 ± 1.41in control group. To achieve a power of 80% to detect this difference with a significance level of 5% and a confidence interval of 95%, it was estimated that 80 subjects were required in each group.

Statistical analysis

Statistical results were analyzed using the SPSS statistical package, version 22. Two types of statistics were utilized: descriptive statistics included a percentage (%), median, and standard deviation. Analytical statistics included Student's t test, Mann–Whitney test, one-way ANOVA (F test). The P value is important if $P < 0.05$.

Results

Regarding demographic data of neonates under study their mean gestational age was (34.05 ± 1.99) in group A versus (34.28 ± 1.61) in group B, and (34.2 ± 1.76) in group C, this was found to be statically non-significant ($p = 0.722$). Also, there was non-significant difference between the three studied groups regarding sex, weight, and length with ($P = 0.623$) ($p = 0.841$) and ($p = 0.536$) sequentially. The mean age for intervention was (9.55 ± 4.76) in group A versus (9.8 ± 2.38) in group B, and (11.33 ± 1.42) in group C; this was found to be statically non-significant ($p = 0.274$) (Table 1).

Results of day 1 showed that baseline HR and SPO2 did not significantly differ between the three groups. Then, when group A (the "prone position group") was compared to group C (the "control group"), a statistically significant decrease was observed in HR ($P < 0.001$) and an increase in SPO2 ($P < 0.001$) across different time interval measures (15, 30, 45, and 60 min). In addition, in comparison to group C ("control group") there was a statistically noticeable drop in HR ($P < 0.001$) and an increase in SPO2 ($P < 0.001$) for group B ("massage group") across different time interval measures (15, 30, 45, and 60 min). Despite the fact that there was no significant difference between groups A and B in terms of HR ($P > 0.05$) and SPO2 ($P > 0.05$) across various time interval measures (Table 2).

Results of day 5 showed that regarding baseline HR, there was a significant difference between group A and B ($P = 0.011$); furthermore, between group A and C ($P = 0.013$), although there was no noticeable difference among the three groups in terms of baseline SPO2 ($P > 0.05$). Comparing group A to group C across various time interval measures, a statistically significant decrease was seen in HR ($P < 0.001$) and an increase in SPO2 (P 0.001). In addition, comparing group B to group C across several time interval measures, there was a statically significant decrease in HR ($P < 0.001$) and an increase in SPO2 ($P < 0.001$). Except for SPO2 at 60 min only ($P = 0.018$), there was no significant difference among groups A and B for HR ($P > 0.05$) and SPO2 ($P > 0.05$) throughout various time interval assessments (Table 3).

Regarding group A, a significant difference was observed in SPO2 at 15, 30, 45, and 60 min as well as HR at 15, 45, and 60 min between first and last days of the intervention (Table 4).

Regarding group B, a significant difference was seen in SPO2 at 15, 30, 45, and 60 min as well as HR at 15, 30, 45, and 60 min between the first and last days of the intervention (Table 5).

Regarding HR at 15, 30, 45, and 60 min for group C, there was no significant difference between the first and last days of the intervention. However, at only 45 and 60 min, there was a significant change in SPO2 (Table 6).

Discussion

The majority of neonates who are admitted to neonatal intensive care units (NICU) are premature newborns. For several decades, it has been suggested that prone positioning and infant massage are beneficial for preterm and babies born underweight [11].

In recent decades, the high rate of premature births has been noted as a major issue in the healthcare system. In the USA, this tendency has risen to 12.3% since 1980, with one preterm birth for every eight deliveries [12].

In a study published by Cândia et al. [6], the authors examined the effects of prone positioning on salivary cortisol measurements of stress in premature newborn infants. They discovered that lying down in a prone position reduces stress significantly.

Massage which is one of the techniques that can stimulate infants, help in lower stress levels, enhance cardiovascular function, improving growth of premature and underweight newborns [10].

Castral et al. [13] reported that, according to a study on the collection of blood from newborns' heels, infants who had been massaged for 15 min prior to the sample had less crying and a lower spike in their HR than the control group.

Infant massage lowers cortisol and norepinephrine levels in the blood, which lowers stress levels. Either the

Table 1 Demographic and clinical characteristics of the three studied groups

Variables	Group A ($n = 80$)	Group B ($n = 80$)	Group C ($n = 80$)	*F*	*P* value
Gestational age (weeks) Mean ± SD	34.05 ± 1.99	34.28 ± 1.61	34.2 ± 1.76	0.325	0.722
Gender					
Female	32 (40%)	36 (45%)	38 (47.5%)	χ^2 .946	0.623
Male	48 (60%)	44 (55%)	42 (52.5%)		
Weight (kg) Mean ± SD	2.19 ± 0.467	2.21 ± 0.416	2.17 ± 0.459	0.174	0.841
Length(cm) Mean ± SD	44.39 ± 2.78	44.79 ± 1.99	44.44 ± 2.55	0.625	0.536
Age at intervention (days) Mean ± SD	9.55 ± 4.76	9.8 ± 2.38	11.33 ± 1.42	KW 2.59	0.274

χ^2 chi square test, *KW* Kruskal–Wallis test

Table 2 HR and SPO_2 measures at day 1 between the three studied groups

Day 1	Group A (*n* = 80)	Group B (*n* = 80)	Group C (*n* = 80)	*F*	*P* value
Baseline HR Mean ± SD	151.38 ± 4.37	151.6 ± 4.26	152.28 ± 3.73	1.03	A vs. B = 0.731 A vs. C = 0.169 B vs. C = 0.302
HR at 15 min Mean ± SD	146.41 ± 4.73	146.35 ± 4.26	151.65 ± 4.46	**12.8**	A vs. B = 0.930 **A vs. C < 0.001** **B vs. C < 0.001**
HR at 30 min Mean ± SD	141.05 ± 4.91	141.3 ± 5.42	151.3 ± 5.26	**101**	A vs. B = 0.761 **A vs. C < 0.001** **B vs. C < 0.001**
HR at 45 min Mean ± SD	138.4 ± 4.67	138.1 ± 5.0	151.2 ± 6.01	**162**	A vs. B = 0.718 **A vs. C < 0.001** **B vs. C < 0.001**
HR at 60 min Mean ± SD	137.33 ± 5.87	137.53 ± 4.63	151.35 ± 5.67	**176**	A vs. B = 0.816 **A vs. C < 0.001** **B vs. C < 0.001**
^rF	**.001**	**.001**	**.0412**		
Baseline SPO_2 Mean ± SD	91.18 ± 1.1	91.38 ± 1.05	91.5 ± 1.27	1.64	A vs. B = 0.270 A vs. C = 0.074 B vs. C = 0.490
SPO_2 at 15 min Mean ± SD	93.0 ± 1.92	93.05 ± 1.39	91.6 ± 1.09	**24**	A vs. B = 0.834 **A vs. C < 0.001** **B vs. C < 0.001**
SPO_2 at 30 min Mean ± SD	94.98 ± 1.62	94.9 ± 1.71	91.56 ± 1.16	**132**	A vs. B = 0.754 **A vs. C < 0.001** **B vs. C < 0.001**
SPO_2 at 45 min Mean ± SD	95.23 ± 2.11	95.58 ± 1.95	91.23 ± 1.18	**146**	A vs. B = 0.217 **A vs. C < 0.001** **B vs. C < 0.001**
SPO_2 at 60 min Mean ± SD	95.55 ± 1.99	95.6 ± 1.93	91.23 ± 1.45	**153**	A vs. B = 0.862 **A vs. C < 0.001** **B vs. C < 0.001**
^rF	**.001**	**.001**	.146		

$P \leq 0.05$ sig.; $P < 0.001$ highly sig.; $P > 0.05$ non-sig

mother or a trained massage therapist can perform the massage. In reality, the benefits of massage include faster weight gain, stimulation of the circulatory and digestive systems, improvements and reduction of stress behavior, better infant-parent interactions, improved neurologic development, earlier NICU discharge, increased skin integrity, and better sleep. The benefits of massage therapy are well established, and it poses minimal risks [14].

While previous studies recommended a variety of postures for newborns, the prone position should only be done in hospitals and under the supervision of a nurse. Additionally, all studies show that massage can help with vital signs, weight gain, infant feeding, stress reduction, and has favorable impacts neurological development. These techniques appear to be useful for enhancing the comfort and health of premature infants. For health care professionals, they are both simple and affordable [15].

In order to enhance the health of premature neonates admitted to NICUs, our work aimed to assess the effectiveness of neonatal prone position and massage therapy in lowering HR and increasing the newborns' blood SPO2.

The Neonatal Intensive Care Unit of Menoufia University Hospital hosted a single-center, randomized, and controlled, three-group clinical trial that lasted 13 months.

Following enrollment, the 240 cases were organized progressively and plotted on random number tables to determine which group they were assigned to. Group A included (80) infants in the prone position; group B included (80) infants who received massage therapy (as intervention groups); and group C included (80) infants who served as the control group (with no intervention).

The first group of infants (group A) spent an hour in a prone position. Every 15 min, a pulse oximetry device monitored their HR and SPO2 variations during this period.

With the use of Tiffany Field's traditional technique, the infants in massage (group B) were stroked superficially. Infants received 15 min of massage, the first five of which

Table 3 HR and SPO_2 measures at day 5 between the three groups

Day 5	Group A ($n=80$)	Group B ($n=80$)	Group C ($n=80$)	*F*	*P* value
Baseline HR Mean ± SD	148.2 ± 5.05	150.18 ± 5.96	150.15 ± 3.33	**4.27**	**A vs. B = 0.011** **A vs. C = 0.013** B vs. C = 0.974
HR at 15 min Mean ± SD	143.55 ± 5.17	144.18 ± 5.73	150.55 ± 4.02	**48**	A vs. B = 0.432 **A vs. C < 0.001** **B vs. C < 0.001**
HR at 30 min Mean ± SD	139.88 ± 5.09	139.0 ± 5.77	151.18 ± 4.69	**136**	A vs. B = 0.289 **A vs. C < 0.001** **B vs. C < 0.001**
HR at 45 min Mean ± SD	136.0 ± 5.83	134.85 ± 6.02	151.53 ± 5.61	**205**	A vs. B = 0.213 **A vs. C < 0.001** **B vs. C < 0.001**
HR at 60 min Mean ± SD	134.35 ± 5.29	133.88 ± 5.95	151.91 ± 5.09	**284**	A vs. B = 0.582 **A vs. C < 0.001** **B vs. C < 0.001**
ʳF	**.001**	**.001**	.527		
Baseline SPO_2 Mean ± SD	91.93 ± 0.911	91.9 ± 1.67	91.35 ± 1.28	**4.83**	A vs. B = 0.905 A vs. C = 0.006 B vs. C = 0.009
SPO_2 at 15 min Mean ± SD	94.15 ± 1.36	94.15 ± 2.03	91.28 ± 1.46	**82**	A vs. B = 1.000 **A vs. C < 0.001** **B vs. C < 0.001**
SPO_2 at 30 min Mean ± SD	96.03 ± 1.47	95.65 ± 2.12	91.5 ± 1.53	**169**	A vs. B = 0.171 **A vs. C < 0.001** **B vs. C < 0.001**
SPO_2 at 45 min Mean ± SD	96.5 ± 1.54	96.3 ± 2.59	91.98 ± 1.74	**126**	A vs. B = 0.535 **A vs. C < 0.001** **B vs. C < 0.001**
SPO_2 at 60 min Mean ± SD	96.95 ± 1.49	96.28 ± 2.35	91.93 ± 1.38	**185**	**A vs. B = 0.018** **A vs. C < 0.001** **B vs. C < 0.001**
ʳF	**.001**	**.001**	**.029**		

$P \le 0.05$ sig.; $P < 0.001$ highly sig.; $P > 0.05$ non-sig

were spent with the infants lying on their backs being superficially stroked from head to toe. The infant's arms and legs were extended and flexed throughout the second five minutes of lying supine. The baby received massage therapy in the final 5 min while being laid back down in the prone position. After that, it spent an hour in no specific position during pulse oximetry.

The newborns in the control group (group C) underwent an hour-long pulse oximetry recording without any intervention.

Each newborn got treatment for five consecutive days; SPO2 and baseline HR were measured during that time. After the intervention, the data was accurately evaluated using descriptive and inferential statistics.

- At day 1 of intervention, Regarding baseline HR and baseline SPO2, there was no discernible difference between the three groups. Then, when group A (the group in the prone position) was compared to group C (the control group), a statistically significant decrease was observed in HR ($P < 0.001$) and a rise in SPO2 ($P < 0.001$) across several time interval assessments (15, 30, 45, and 60 min). In addition, in comparison to group C, the "control group," there was a significantly significant decrease in HR (*P* 0.001) and an increase in SPO2 (*P* 0.001) for group B, the "massage group" (15, 30, 45, and 60 min). While the HR ($P > 0.05$) and SPO2 ($P > 0.05$) throughout various time interval measures did not significantly differ between groups A and B.

Supporting our results Elsagh et al. [10] carried out a similar study revealed a notable difference in HR values between the first and fifth days at various time points. The HR decreases, and the infant becomes more at ease as time passes since the intervention day. However, according to Yates et al. [15], infants' heart rates did not vary during massage or 30 min after it. We conducted a 5-day Tiffany Field, but Yates et al. only used a 1-day

Table 4 HR and SPO_2 differences between the first and last days of intervention among group A

Group A	Day 1	Day 5	Paired Sample *t* test	*P* value
Baseline HR Mean ± SD	151.38 ± 4.37	148.25 ± 5.08	**3.94**	**0.001**
HR at 15 min Mean ± SD	146.41 ± 4.73	143.55 ± 5.19	**3.62**	**0.001**
HR at 30 min Mean ± SD	141.05 ± 4.91	139.88 ± 5.12	1.31	0.199
HR at 45 min Mean ± SD	138.4 ± 4.67	136.0 ± 5.87	**2.91**	**0.006**
HR at 60 min Mean ± SD	137.33 ± 5.87	134.38 ± 5.31	**3.25**	**0.002**
Baseline SPO_2 Mean ± SD	91.18 ± 1.1	91.93 ± 0.917	**3.41**	**0.002**
SPO_2 at 15 min Mean ± SD	90.97 ± 13.42	94.15 ± 1.37	**1.49**	**0.144**
SPO_2 at 30 min Mean ± SD	94.98 ± 1.62	96.03 ± 1.48	**3.387**	**0.002**
SPO_2 at 45 min Mean ± SD	95.23 ± 2.11	96.5 ± 1.66	**3.427**	**0.001**
SPO_2 at 60 min Mean ± SD	95.55 ± 2.01	96.95 ± 1.5	**3.749**	**0.001**

$P \leq 0.05$ sig.; $P < 0.001$ highly sig.; $P > 0.05$ non-sig

Table 5 HR and SPO_2 differences between the first and last days of intervention among group B

Group B	Day 1	Day 5	Paired Sample t test	*P* value
Baseline HR Mean ± SD	151.6 ± 4.29	150.18 ± 5.99	**1.664**	**0.104**
HR at 15 min Mean ± SD	146.35 ± 4.29	144.18 ± 5.77	**2.314**	**0.026**
HR at 30 min Mean ± SD	141.3 ± 5.45	139.0 ± 5.8	**2.202**	**0.034**
HR at 45 min Mean ± SD	138.1 ± 5.03	134.85 ± 6.06	**3.381**	**0.002**
HR at 60 min Mean ± SD	137.53 ± 4.67	133.88 ± 5.98	**3.381**	**0.002**
Baseline SPO_2 Mean ± SD	91.38 ± 1.05	91.9 ± 1.68	**1.705**	**0.096**
SPO_2 at 15 min Mean ± SD	93.05 ± 1.39	94.15 ± 2.04	**3.397**	**0.002**
SPO_2 at 30 min Mean ± SD	94.9 ± 1.72	95.65 ± 2.13	**2.346**	**0.024**
SPO_2 at 45 min Mean ± SD	95.58 ± 1.96	96.3 ± 2.6	**1.73**	**0.092**
SPO_2 at 60 min Mean ± SD	95.6 ± 1.94	96.28 ± 2.36	**1.73**	**0.092**

$P \leq 0.05$ sig.; $P < 0.001$ highly sig.; $P > 0.05$ non-sig

Table 6 HR and SPO_2 differences between the first and last days of intervention among group C

Group C	Day 1	Day 5	Paired Sample *t* test	*P* value
Baseline HR Mean ± SD	152.28 ± 3.73	150.23 ± 3.32	**2.87**	**0.007**
HR at 15 min Mean ± SD	151.65 ± 4.49	150.53 ± 4.06	1.34	0.187
HR at 30 min Mean ± SD	151.3 ± 5.29	151.1 ± 4.75	0.225	0.823
HR at 45 min Mean ± SD	151.2 ± 6.04	151.5 ± 5.64	0.284	0.778
HR at 60 min Mean ± SD	151.35 ± 5.67	151.8 ± 5.07	0.434	0.667
Baseline SPO_2 Mean ± SD	91.43 ± 1.34	91.37 ± 1.28	0.177	0.86
SPO_2 at 15 min Mean ± SD	91.6 ± 1.1	91.17 ± 1.39	1.46	0.152
SPO_2 at 30 min Mean ± SD	91.6 ± 1.15	91.4 ± 1.64	0.609	0.546
SPO_2 at 45 min Mean ± SD	91.25 ± 1.17	92.1 ± 1.75	**3.026**	**0.004**
SPO_2 at 60 min Mean ± SD	91.2 ± 1.49	91.9 ± 1.41	**2.197**	**0.034**

$P \leq 0.05$ sig.; $P < 0.001$ highly sig.; $P > 0.05$ non-sig

massage for each infant. This variation in approach may be what led to the contentious results.

- At day 5, regarding baseline HR, there was a noticeable distinction among group A and group B ($P = 0.011$), also between group A and group C ($P = 0.013$), but baseline SPO2 was not significantly different among the three groups ($P > 0.05$). Meanwhile comparing group A to group C across several time interval measures, there was a statistically significant decrease in HR ($P < 0.001$) and an increase in SPO2 ($P < 0.001$). Additionally, when comparing group B to group C across several time interval measures, a statistically significant drop was seen in HR ($P < 0.001$) and an elevation in SPO2 ($P < 0.001$). Except for SPO2 at 60 min only ($P = 0.018$), there was no significant difference between groups A and B for HR ($P > 0.05$) and SPO2 ($P > 0.05$) throughout the various time interval measures.

There was a significant difference between different days in our study for baseline HR, and serial HR at 15, 45, and 60, and baseline SPO2, SPO2 at 15, 30, 45, and 60 for group A when measuring HR and SPO2 at various times.

SPO2 changed with time ($p = 0.02$), and there was a significant distinction among groups ($p < 0.001$) the control with prone position and massage groups differed significantly, according to the results of the Bonferroni post hoc analysis. Results revealed that both the prone position and massage reduced HR and increased SPO2 to the same extent. Similar findings were reported by Smith et al. [9], who investigated how massage affected the vagal response. Additionally, Field [16] advanced the idea that a massage with medium pressure enhances vagal activity and lessens tension.

In our study, there was a significant difference in HR at intervals of 15, 30, 45, and 60 min as well as SPO2 at 15 and 30 min between the first and last days of the intervention for group B. However, when compared to group A, there were highly significant differences in group A's HR at 15 min and spo2 at 45 and 60 min between the first and last days of the intervention. Changes were therefore more noticeable in group A, the "prone position group," but throughout the intervention days, there was statistically no distinction among the two groups.

With regard to group C, the baseline HR and SPO2 at 45 and 60 min only significantly differ between various days.

Ammari et al. [17] countered our findings by claiming that newborns in the prone position have higher basal temperatures, which cause peripheral vasodilatation, which raises cardiac output and, consequently, higher HR. However, they neglected metabolism in favor of concentrating on body temperature and vascular alterations.

On the contrary, the prone position decreased cardiac output, according to Ma et al. [3]. Therefore, it is noteworthy that studies on the prone position's impact on newborns' heart rates during sleep have produced contradictory results.

Proving our results Oishi et al. [18] in a control trial study pointed out the benefits of the prone position, including improved O2 saturation and greater lung function, and recommended that.

According to a study by Ramezani et al. [19], massage can lessen tension and energy use, which in turn reduces the oxygen reliance during the early weeks of preterm newborns being treated in the NICU.

In contrast, Harrison et al. [20] evaluated the effects of massage on oxygen saturation and suggested that massage might lower it. This discrepancy between our study and Harrison's could be attributed to variations in touch frequency, subject ages, and clinical conditions that may be related to an outdated technique.

The findings demonstrate a significant decrease in heart rates following intervention, which was also confirmed by investigations by Modercine et al. [21]. According to these results, massage enhances newborns' comfort, lowers their stress levels, and helps them remain calm while in the hospital.

Elsagh et al. [10] found a significant difference in SPO2 between groups, with non-significant differences between position groups and massage, but the distinction between massage and position groups being greater than the control. That supports our study as well.

According to our findings, there was a significant difference in HR and SPO2 across various time interval measures between groups A and C, and between groups B and C. However, across several time interval measures on various days, there was no discernible difference in HR and SPO2 among groups A and B, "the two interventional groups."

As a result of this study, we can conclude that both massage and prone posture significantly reduced HR and increased SPO2 when compared to the control.

We demonstrated two simple, effective, and cost-free approaches for caring for hospitalized neonates that do not require any specialized equipment. These techniques are recommended for use by caregivers in order to reduce the challenges of caring for a premature newborn in a NICU.

Conclusion

Prone positioning and infant massage equally reduced heart rate and raised blood oxygen saturation levels. The prone position group showed a greater decrease in HR and a rise in SPO2, However, a statistically significant distinction among the two groups was not present. For the care of neonates who are being treated in hospitals, these two natural, practical, and cost-free therapies can be used.

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Authors' contributions
HME participated in data interpretation, study coordination, drafting, and and revision of the manuscript. GME involved in data interpretation and revision of the manuscript. MZE shared in data interpretation and revision process. ZSA shared in data interpretation and revision process, and is the corresponding author. All authors read and approved the final version of the manuscript.

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Availability of data and materials
The datasets generated during and/or analyzed during the current study are available from corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Protocol was reviewed and approved by the Ethics Committee at the Faculty of Medicine at Menoufia University with IRB approval number 10/2020PEDI. Informed written consent was obtained from all enrolled children's parents after explaining all the study's benefits and risks.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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