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ORIGINAL ARTICLE

The Effect of Developmental Supportive Positioning on Pain from Venipuncture in Preterm Neonates Admitted to Neonatal Intensive Care Unit

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ABSTRACT

Introduction: One non-pharmacological method of pain relief is the application of developmental supportive positioning which is a useful method for achieving this goal. The aim of this study was to investigate the effects of developmental supportive positioning on the pain from venipuncture in preterm neonates admitted to the NICU. **Methods:** In this clinical trial, 54 preterm neonates admitted to the NICU were divided into control and intervention groups using the randomized block method. The neonates in the intervention group were put into developmental supportive positioning for 20 minutes, and then venipuncture was performed in both groups. Changes in the neonates' facial expressions as well as neonatal physiological parameters including heart rate, respiratory rate, and blood oxygen saturation were collected at three time points: immediately after needle insertion, two minutes and five minutes after needle removal. The collected data were analyzed using the SPSS 21 software. **Results:** The results showed a statistically significant difference between the mean scores of facial expression changes, heart rate and neonatal blood oxygen saturation at two and five minutes after needle removal in the intervention and control groups ($P < 0.05$). The comparison of the mean respiratory rate of the neonates at two and five minutes after needle removal showed no significant difference between the intervention and control groups ($P > 0.05$). **Conclusion:** It seems that developmental supportive positioning of preterm neonates has a positive effect on the relief of the pain caused by venipuncture. Considering the importance of pain control in preterm neonates, it is recommended to use this method when doing venipuncture.

Keywords: Developmental Supportive Positioning, Venipuncture, Preterm neonates, Pain

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INTRODUCTION

According to the World Health Organization statistics, 15 million neonates are born prematurely every year and this rate is increasing, with studies in 184 countries showing that the prevalence of preterm neonates is ranged from 5% to 18% (1). A review carried out by Sharifi et al. in Iran (2017) showed that the rate of preterm births is relatively high in this country. The lowest and highest prevalence rates were 5.4% in Bam and 19.85% in Tehran, respectively (2). A meta-analysis by Vakilian et al. (2015) showed that the prevalence of preterm births in Iran was 9.2% (3).

Although technological and pharmacological advances as well as scientific interventions have increased the chance of survival in preterm neonates, the prevalence of motor, communication, and perceptual disorders as well as developmental complications of low and very low birth weight neonates has not decreased (2, 4). The study by Serenius (2013) showed that 27% of the neonates born before the 27th week had severe disabilities such as cognitive disability, verbal disability, cerebral palsy, and hearing impairment (5). Moore (2012) also reported that the severity of disabilities three years after the birth of extremely preterm neonates was 13.4% (6).

Although recent advances in increased care for preterm neonates and also new treatments have increased their survival rate (7), the NICU's environmental and medical conditions such as high light and continuous noise, parental deprivation, experience of painful and stressful therapies such as surgery, blood sampling, chest tube placement, endotracheal tube insertion, and especially venipuncture are the issues that preterm neonates face with (8, 9).

A study by Courtois et al. on 495 neonates described the actual rate of neonatal venipuncture experienced by the neonates in the NICU, and showed that neonatal venipuncture was a very common process that might have neurodevelopmental effects on the neonates (9). Unrelieved pain followed by neonatal venipuncture can lead to short-term adverse effects such as decreased oxygenation, instability of hemodynamic symptoms, and temporary or long-term increased intracranial hypertension, and long-term complications such as fear, irritability, sleep disturbances, malnutrition, delayed function of the immune system, and disorder in one's emotional relationships (10, 11).

As painful processes are common in preterm neonates and there are concerns about the side effects of medications, there has recently been a growing interest in non-pharmacological interventions to alleviate the pain caused by these processes. One of the approaches is Newborn Individualized Developmental Care and Assessment Program (NIDCAP), which strives to provide a supportive and calm environment for preterm neonates (12).

Given that the studies carried out so far have focused on the impact of developmental supportive care interventions on stress measurement (15-13), and sometimes without specific procedures (16) or rarely on procedures such as blood sampling, vaccination and neonate suctioning (17, 11), the present study was designed to investigate the effect of developmental supportive positioning on pain and to measure the changes in neonates' facial expression and physiological parameters (heart rate change, percentage of oxygen saturation, and respiratory rate).

MATERIALS AND METHODS

The study was a double blind clinical trial. The study population consisted of all preterm neonates admitted to the NICU who were qualified to enter the study. A total of 54 neonates were allocated to the intervention or control group through permuted block randomization. The inclusion criteria for this study were parental consent to let their newborns enter the research, gestational age of 28-36 weeks, stability of hemodynamic status in terms of regular heart rate, respiratory rate, body temperature, face color, activity level, and lack of musculoskeletal as well as nervous disorders. Besides, parental reluctance for continued cooperation at each stage of the study was an exclusion criterion, and the neonates who used sedatives, those who needed mechanical ventilation, and the neonates who needed any surgery were also excluded.

The neonates who met all the inclusion criteria were selected and their parents were provided with necessary information about this research project, which was registered at the International Registry of Clinical Trials, coded IRCT20170813035662N2. Provided parental consent to participate their neonates in the study, a written informed consent form was given to them to sign. The neonates could be excluded at any time if their parents were unwilling to continue the study, without any effect on their care and treatment. A demographic questionnaire, a physiological parameters registration form, and the face states registration form based on Neonatal Facial Coding System (NFCS) were used for data collection.

After recording the demographic information in the intervention group, the heart rate and arterial oxygen saturation were measured by the research assistant using a pulse oximeter, and the respiratory rate with count of abdominal movements for one full minute was also measured using a timer. Besides, the neonates' facial expressions were recorded for one minute using a fixed video camera. The neonates were then placed in the nest for 20 minutes and the developmental supportive positioning was done by placing each neonate in a lateral or prone position, arms bent and positioned close to the face, and legs bent to the abdomen. The shoulders and pelvis were rounded and the neonate retained its fetal position. After being placed in the developmental supportive position, physiological parameters and facial expressions of the neonates were measured and recorded for 1 minute by the research assistant. Immediately, venipuncture was performed on the neonate’s arm or leg by the researcher using a peripheral venous catheter No. 24 and an alcohol pad, and physiological parameters and facial expressions were measured recorded at 3 times for one minute: the first time was immediately after needle insertion, and the second and third times were two minutes and five minutes after needle removal. Finally, the films recorded by the research assistant were analyzed.

In the control group, after recording the neonates’ demographic information as well as physiological parameters and facial expressions, they were put in a routine venipuncture position for 20 minutes without any intervention and manipulation, and their physiological parameters and facial expressions were checked for one minute. Immediately after, venipuncture was performed by the research assistant on the neonate’ arm or leg using a peripheral venous catheter No. 24 and an alcohol pad, and the abovementioned factors were measured and recorded at the three times mentioned for the intervention group.

The demographic information including gender, type of delivery, gestational age, neonatal age during the study, neonatal birth weight, neonatal weight during the study, and Apgar scores at the first and fifth minutes were recorded in the demographic questionnaire by the researcher using the information in the neonates' medical records and interviewing their parents.

Neonatal physiological parameters included heart rate, respiratory rate and blood oxygen saturation. The heart rate and oxygen saturation percentage were measured using a pulse oximeter, and the respiratory rate was also measured using abdominal movements. In a pilot study, heart rate changes and oxygen saturation percentages of several neonates were first measured and compared with the pulse oximeter and the standard portable device available in the ward. Once the validity of the device was ensured, it was used for the measurements. In order to determine the reliability of the device, it was randomly compared with the other standard device in the ward during the study and for several times.

Facial expressions in this study were recorded by a camcorder, and the mean pain score was obtained based on the facial expressions using the NFCS which was used in various studies to measure pain in term and preterm neonates. The system consisted of 8 facial movements including: 1- eyebrow bump, 2- squeezing eyes, 3- deepening of nasolabial folds, 4- open lips, 5- open mouth, 6- compressing the lips, 7- tongue squeezing, and 8- chin shake.

The scoring system was such that if there was a parameter, a score of 1 was given, and in the absence of any movement in the neonate's face, a score of zero was assigned, and finally the sum of scores was calculated. A score greater than or equal to 3 indicated pain. An expert in filming was employed to shoot the videos using a Sony HDR-CX240 camera.

To avoid bias in this study, after the intervention, each neonate's film was evaluated by a research assistant who had previously received necessary training in neonatal pain rating based on the facial expression coding criterion, and was included in the relevant checklist. In this study, blinding was done by the participants and the outcome evaluator, and the study was therefore double blind.

The independent t-test or its nonparametric test (i.e. Mann-Whitney test) was used to compare the mean score of a quantitative variable in the two groups. The change trend of a quantitative variable over time was investigated using repeated measures ANOVA. The data were analyzed using the SPSS software (version 21) at a significance level of 0.05.

RESULTS

Of the 56 infants studied, one was excluded from the study due to non-compliance with the inclusion criteria and one due to parental rejection to participation, and 54 infants were randomly assigned to the control and intervention groups (Figure 1).

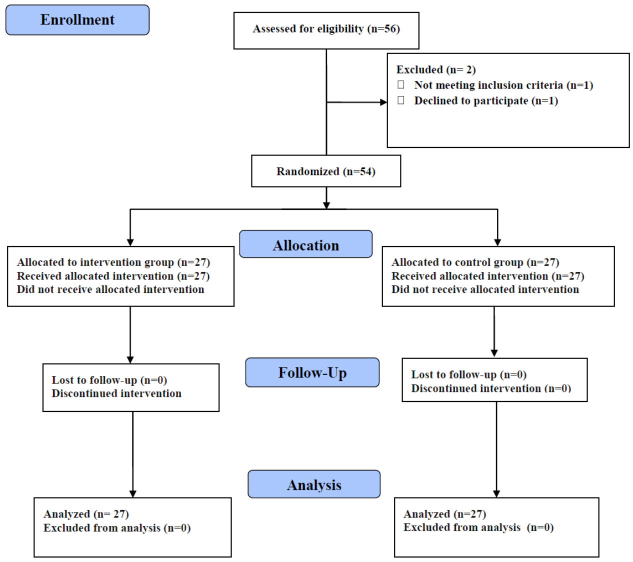

Figure 1: CONSORT Flowchart

There was no statistically significant difference between the intervention and control groups in terms of demographic variables and Apgar scores at first and fifth minutes (Table I).

There was a statistically significant difference between the mean scores of changes in neonatal facial expressions in both control and intervention groups (P <0.001). Bonferroni post hoc test in the control group showed a significant difference between all pairs of times except second time and third time (P = 0.28), third time and first time (P= 0.134), and second time and first time (P= 0.178). As can be seen, at the second and third time points the mean score of the intervention group was significantly lower than that of the control group (P

Table I: Frequency distribution of demographic variables in control and intervention groups

Variables	Control group (Mean±SD)	Intervention group (Mean±SD)	P-Value
First minute Apgar	7.78±2.4	7.48±1.7	0.56
Fifth minute Apgar	7.9±1.4	7.9±1.7	1
Gestational age (Week)	33.48±3.8	33±2.8	0.57
Age of neonate (Day)	11.4±16.4	8.3±13.7	0.44
Baby weight at birth (gr)	2177.8±882.1	1951.5±685.2	0.29
Baby weight during the study(gr)	2202.9±883.4	1992.8±666.2	0.33
	N (%)	*N* (%)	
Sex			
Female	10(18.5)	16(29.6)	0.1
Male	17(31.5)	11(20.4)	
Type of delivery			
Cesarean section	20(40)	18(36)	0.73
NVD*	7(14)	5(10)	

*Normal vaginal delivery

<0.001) (Table II).

The change trend of mean heart rate in the control group was statistically significant (P <0.001). Bonferroni post hoc test showed a significant difference between all pairs of times except second time and third time (P = 0.052). The trend of changes in mean heart rate in the intervention group was statistically significant (P = 0.01). Bonferroni post hoc test showed a difference between all pairs of times (P <0.001). The comparison of mean neonatal heart rate at all times between the intervention and control groups was also significant. In other words, the mean neonatal heart rate in the intervention group was significantly lower than in the control group (Table III).

Table II: Between and within group comparison of mean infant facial expressions at different times after venipuncture in the intervention and control groups

Group	Time 1* Mean±SD	Time 2** Mean±SD	Time 3*** Mean±SD	F****	P-Value
Control	4.63±1.08	3.07±1.77	2.37±1.88	68.25	<0.001
Intervention	3.93±1.77	0.48±1.09	0.19±0.39	90.14	<0.001
P-Value	0.089	<0.001	<0.001		

* Time 1: Immediately after needle insertion
** Time 2: Two minute after needle removal
*** Time 3: Five minute after needle removal
**** ANOVA with Repeated Measurement

Table III: Between and within group comparison of mean neonatal heart rate at different times after venipuncture in the intervention and control groups

Group	Time 1* Mean±SD	Time 2** Mean±SD	Time 3*** Mean±SD	F****	P-Value
Control	173.7±25.78	160±24.51	153.11±24.68	46.80	<0.001
Intervention	153.89±18.44	140.96±14.15	132.33±15.18	17.15	0.01
P-Value	0.002	<0.001	<0.001		

* Time 1: Immediately after needle insertion
** Time 2: Two minute after needle removal
*** Time 3: Five minute after needle removal
**** ANOVA with Repeated Measurement

The results showed that there was a significant difference in the change trends of mean neonatal respiratory rate from the first to the third time in both the control (P = 0.001) and intervention groups (P = 0.002). In the control group, Bonferroni post hoc test showed a significant difference between the first time and all other times (Table IV).

There was a statistically significant difference in the change trend of mean neonatal blood oxygen saturation in the control and intervention groups. In the control group, Bonferroni post hoc test showed a significant

Table IV: Between and within group comparison of mean neonatal respiratory rate at different times after venipuncture in the intervention and control groups

Group	Time 1* Mean±SD	Time 2** Mean±SD	Time 3*** Mean±SD	F****	P-Value
Control	73.29±11.94	44.85±9.85	44.85±9.33	7.149	<0.001
Intervention	45.41±10.96	48.33±7.57	49.78±9.17	5.62	0.002
P-Value	0.012	0.151	0.056		

* Time 1: Immediately after needle insertion
** Time 2: Two minute after needle removal
*** Time 3: Five minute after needle removal
**** ANOVA with Repeated Measurement

difference between all pairs of times except the first and third times (P = 0.951). In the intervention group, the difference between the second and third times was also significant (P= 0.004). The results showed a significant difference between the intervention and control groups at all times, so that the mean blood oxygen saturation percentage was significantly higher in the intervention group than in the control group (Table V).

Table V: Between and within group comparison of mean neonatal blood oxygen saturation percentage at different times times after venipuncture in the intervention and control groups

Group	Time 1* Mean±SD	Time 2** Mean±SD	Time 3*** Mean±SD	F****	P-Value
Control	90.25±5.89	91.93±4.85	94.07±4.63	10.005	<0.001
Intervention	96.37±2.95	96.82±2.34	97.29±2.38	12.6	0.002
P-Value	<0.001	<0.001	0.007		

* Time 1: Immediately after needle insertion
** Time 2: Two minute after needle removal
*** Time 3: Five minute after needle removal
**** ANOVA with Repeated Measurement

DISCUSSION

The results of this study showed that there was a significant difference in the mean neonatal facial expression changes between different times after venipuncture in the intervention and control groups. One of the causes of facial changes in the two groups could be the perception of neonatal pain during venipuncture; those in the intervention group experienced less pain in the second and third times. It seems that the infants in the control group felt more pain due to the lack of development supportive positioning during venipuncture two and five minutes after the needle was removed.

A study conducted by Holsti (2004) on 44 newborns with the gestational age of <32 weeks to evaluate the impact of developmental supportive care on acute pain in premature infants in three phases indicated that in NIDCAP, the score of facial expression change significantly reduced in the intervention group, showing the significant effect of developmental supportive positioning on neonatal pain (11).

Johnston et al. (2000) studied 28-31 weeks preterm infants and showed a significant decrease in facial expression due to venipuncture after kangaroo mother care for 15 minutes. Although the type of intervention and the age of the infants in their study were different from those in the present research, the results of both studies suggested that the use of supportive interventions could be effective in reducing neonatal pain in painful procedures (18).

The findings of this study regarding the difference in the mean neonatal heart rate after venipuncture at all time points showed that neonatal heart rate in the intervention group was significantly lower than in the control group. It seems that due to the use of developmental supportive care in the intervention group, the infants had less pain and consequently lower heart rate, which ultimately resulted in no significant difference in the mean heart rate changes in the intervention group. In the study by Vosoghi et al. (2011) aimed to investigate the effect of thought deviation on physiological parameters and severity of pain from venipuncture in 3-6-year-old children admitted to the emergency department, the results showed that in terms of physiological parameters, there was a statistically significant difference between the mean heart rates in both groups before and after the intervention, which is consistent with the results of the present study (19). Although the age groups of the samples in these two studies are different, it seems that using age-appropriate supportive interventions in infants and children can be effective in reducing pain during painful processes.

The results of the study by Ghorbani et al. (2013) showed that neonatal support positioning was effective on heart rate of premature infants treated with noninvasive ventilation, so that the heart rate was much lower when supporting the infant in the prone position than supine position, indicating a decrease in the stress level due to neonatal pain in this condition. In this regard, it is consistent with the results of the present study. In prone position, neonatal respiratory and heart rates are lower and the infant in this position is calmer; thus, it is one of the effective ways to reduce neonatal stress during pain (20).

In this study, the comparison of the mean neonatal respiratory rates at all times between the intervention and control groups showed that only the mean neonatal respiratory rate at the first time was significantly different, as the respiratory rate was lower in the intervention group than in the control group. It seems that in the first time, i.e. immediately after needle insertion, the infants in the intervention group were calmer and had lower respiratory rates than the control group due to receiving developmental supportive care before needle insertion. Although the respiratory rates at two and five minutes after needle removal in both groups were not significantly different, they were lower in the control group at both times than in the intervention group. According to the researcher's observations in the recorded video, it seems that as the control group did not use developmental supportive care, they felt more pain and cried more because of the greater pain intensity. Therefore, they had more respiratory failure than the intervention group and as a result, respiratory rate was lower in the control group at both times.

Edraki et al. (2015) conducted a study aimed to investigate the effect of maternal attachment behaviors on physiological parameters in preterm infants, and showed that the mean respiratory rate measured over three consecutive days was lower in the intervention group than in the control group, which was statistically significant. The cause of respiratory rate differences in their study was the kangaroo care in the intervention group. They investigated the effect of kangaroo care on physiological parameters of preterm infants in general and not in a painful procedure. The results are in line with those of the present study with respect to the first time, which is immediately after needle insertion. In other words, in our study, the mean respiratory rate was lower in the intervention group than the control group at the time of needle insertion due to receiving the supportive care (21).

Regarding the mean neonatal oxygen saturation percentages at different times after venipuncture, a significant difference was found between the intervention and control groups. The change trend was such that in both groups, oxygen saturation increased from immediately after needle insertion to 5 minutes after needle removal. In their study, Mirzarahimi et al. (2013) found that arterial oxygen saturation in newborns was significantly higher after heel prick blood sampling, whereas heart rate was significantly increased after heel prick blood sampling. During blood sampling, oxygen saturation decreases due to the induced tachycardia and the greater need of the heart for blood supply during diastole, but it does not reach an abnormal level. However, after blood sampling, oxygen saturation level increases with a decrease in heart rate. This pattern was also visible in the present study (22). Immediately after needle insertion, both groups had lower oxygen saturation, and their heart rates were greater than in the second and fifth minutes after needle removal. As time passed and the heart rate decreased gradually within two and five minutes after needle removal, oxygen saturation increased in both groups but the increase was greater in the intervention group than in the control group.

The results of the study by Vosoghi et al. (2011) also showed that there was no significant difference in the arterial oxygen saturation in the intervention group before and after venipuncture, but a significant difference was observed in the control group. The percentage of oxygen saturation in the control group was lower than in the intervention group. Besides, there was no significant difference between the two groups in terms of the mean arterial blood oxygen level before the intervention, but after the intervention, a significant difference was observed ($p < 0.05$) (19).

CONCLUSION

According to the results, developmental supportive positioning of preterm infants seems to have a positive effect on relieving the pain caused by venipuncture in preterm infants admitted to NICU. It can be stated that putting the infant in a developmental supportive position reduces his/her pain and relaxes him/her during venipuncture. Based on the findings of the present study and those of other studies conducted on this issue, it is recommended to consider the use of supportive care to reduce pain in premature infants, given the multitude of painful processes in neonatal intensive care units.

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