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The Effect of Body Position on Pain Due to Nasal Continuous Positive Airway Pressure (CPAP) in Premature Neonates: A Cross-Over Clinical Trial Study

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Abstract

Background

The most common cause of admission to neonatal intensive care units (NICU) is respiratory distress syndrome. One of the respiratory assistance methods is using nasal continuous positive airway pressure (CPAP). Regarding the importance of pain control which is one of the major priorities in neonatal nursing care, this study aimed to evaluate the effect of body position on pain due to nasal CPAP in premature neonates.

Materials and Methods

In this cross-over clinical trial, 50 premature neonates who were receiving nasal CPAP admitted to the NICU of Imam Reza Hospital, Kermanshah, Iran, were included. The neonates were randomly placed at three body positions (fetal, supine, and prone positions). Pain was measured by Astrid Lindgren Children's Hospital Pain Scale Neonates (ALPS-Neo) pain assessment scale. The collected data were analyzed using the SPSS software (Version 22.0).

Results

Significant difference existed regarding pain of nasal CPAP among body positions ($p< 0.001$). Mean (SD) pain was 5.15 (0.822) in fetal position, 6.260 (0.747) in prone position and 7.326 (0.792) in supine position.

Conclusion

Body positioning in premature neonates under nasal CPAP in NICU can be effective as a non-pharmacologic method in alleviating pain due to nasal CPAP. Among the studied positions, the lowest pain score was seen in fetal position.

Key Words: Body position, Continuous positive airway pressure, Premature neonates.

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1- INTRODUCTION

Pain in newborns is a complicated, individualized, subjective, and universal finding (1). Premature neonates are usually admitted to neonatal intensive care units (NICU) to receive diagnostic and therapeutic procedures which are usually painful (2). The most common reason for admission to NICU is respiratory distress syndrome (hyaline membrane disease). About 60% of neonates with gestational age less than 30 weeks and 42% of neonates who weigh less than 1,500 grams upon birth develop this syndrome (3).

Nasal continuous positive airway pressure (CPAP) is one of the most commonly applied respiratory support treatments in such neonates (4, 5). According to the most recent report by the World Health organization (WHO), 15 million premature neonates are born annually globally (6), with an increasing trend (3). Premature neonates are more susceptible to conditions such as body temperature instability, hypoglycemia, respiratory distress, apnea, jaundice, and feeding problems when compared to term neonates (7). Premature neonates are more sensitive to pain and stress compared to term neonates. They have lower tolerability threshold for touching and express more pronounced reflexes (8).

According to a previous study, on average 14 to 25 painful procedures are done for neonates admitted to NICU. Placement of CPAP prong and nasogastric tube is one of the painful procedures (9-10). According to the evidence, placement of CPAP prong causes moderate to severe pain (11-12). Evidences show that premature neonates have deficit in their functional maturity and autonomic system. Therefore, painful and stressful experiences induced in hospitals can cause alterations in brain development and consequent behavioral and educational difficulties later in childhood (6) . Hence, pain management has a crucial role in prevention of undesired physical and psychological effects (3), and pain control is essential (13). Administration of analgesics for pain alleviation is doubtful in neonates due to insignificant effects and potential side effects. On the other hand, non-pharmacologic methods for pain control not only are accessible, inexpensive without requirement for doctor prescription, but also are more tolerated by neonates (13). Non-pharmacologic methods are likely to exercise their pain control effect via direct or indirect ways. Direct ways include blocking pain transmission pathways or activation of pain blocking pathways or modifying pain modulation pathways. Indirect effect includes decreasing pain in painful stimuli. One of the non-pharmacologic interventions for pain control, which is a sensory stimulus, is body positioning in neonates (12). In a study Ali Nejad et al. (2014), facilitated tucking has been shown to be an effective non-prescriptive method for reducing the pain of suction from the tracheal infertility (14). According to a previous study, placement of CPAP prong and nasogastric tube is one of the painful procedures (9-10). According to the evidence, placement of CPAP prong causes moderate to severe pain (11-12).

The body position of neonates not only has direct effect on neuronal development, but also can decrease significantly long-term complications of prematurity and pain due to painful procedures(15). Limited studies have been done regarding the effect of body positioning, as a behavioral intervention, on pain alleviation in neonates. Pain control is a priority in neonatal nursing care and selecting a non-pharmacologic intervention is the responsibility of nurses. Also, body positioning is an inexpensive method which is easily applicable. Therefore, this study was performed to determine the effect of body position on pain induced by nasal CPAP in premature neonates.

2- MATERIALS AND METHODS

2-1. Study design

This Cross-Over Clinical Trial study was conducted at the neonatal intensive care unit of Imam Reza Hospital in Kermanshah, Iran. The study was registered at the Iranian Registry of Clinical Trials (IRCT= 201509094617N13). The study population consisted of newborns in the neonatal intensive care unit between 25 October 2015 to 25 March 2016 were under nasal-CPAP (n-CPAP) and met the inclusion criteria.

2-2. Inclusion criteria

Infants were receiving oxygen by nasal CPAP, Apgar score at 5 minutes of higher than 7; gestational ages of 27 to 35 and birth weight of 1,000 to 2,500 gr were included in the study.

2-3. Exclusion criteria

Newborns had asphyxia during delivery, using analgesic, sedative, or anti-convulsive medications during the last 24 hours, congenital abnormalities especially at nasal region and cleft palate were not included in the study.

2-4. Samples

The study population consisted of 50 infants were under N-CPAP. The results obtained by Saki et al. (2009) (16) were used to determine sample size. According to the statistics consultant, the sample size was set at 40 (α=0.05; 90% testability); where, Z1-β represents testability of β=0.1 (Z1-β=1.28); Z1-α/2 represents 95% confidence interval (Z1-α/2=1.96); δ1 and δ2 represent an estimate of standard deviation of pain in each group; μ1 and μ2 represent minimum mean difference of pain score between groups, which indicate a significant difference. However, the sample size was raised to 50 to achieve the optimal result, referring to Saki et al. (2009)(16).

The newborns were randomly assigned to draw lots in 6 situation and 3 positions in a draw. Neonatal pain score was measured in any position and after each body position change, in order to avoid the effect of the previous body position, the neonate was left free for 15 minutes (i.e., washout period) (4). Firstly, the pain score of ten neonates were determined separately at the same time by two observers. Inter-observer agreement was determined by calculating Kappa Cohen coefficient. Coefficient value of more than 0.7 is considered to be good. Here, the Kappa coefficient was 0.8 (17) (**Figure.1**).

2-5. Data collection instruments

In this study, a multi-part information form was used. The first part included the demographic characteristics of the newborns and the second part of the checklist, which was used to assess the pain intensity of the Astrid Lindgren Children's Hospital Pain Scale Neonates (ALPS-Neo). The Personal Information Form prepared by the researchers was used to collect descriptive characteristics of the newborn (gender, gestational age, weight, delivery method, number of children previously delivered by the baby's mother, etc.).

2-5-1. The Astrid Lindgren Children's Hospital Pain Scale Neonates (ALPS-Neo)

For the first time, the ALPS-Neo scale was confirmed by Lundqvist and colleagues in 2014 (18). The ALPS-Neo pain scale has five items including facial expression (peaceful, Distressed expression May grimace slightly, Distressed expression, may cry and chin drop), breathing pattern (calm effortless breathing, slightly strained breathing or breathing pause, strained breathing fast breathing and apnea), tone of extremities (normal tone, varied tone, and flaccid), hand and foot activity (relaxed, slightly clenched fist and/or trying to grasp hand on face, Tightly clenched fingers/toes spread flaccid), and level of activity (calmly asleep/calmly awake, occasional motor restlessness, Persistent motor restlessness exhausted). The score range for each item is 0 to 2. Therefore, the total score ranges from 0 to 10. Scores lower than 5 show no pain, 5-7 show moderate pain, and scores of 7-10 show severe pain(18) (**Table.1**).

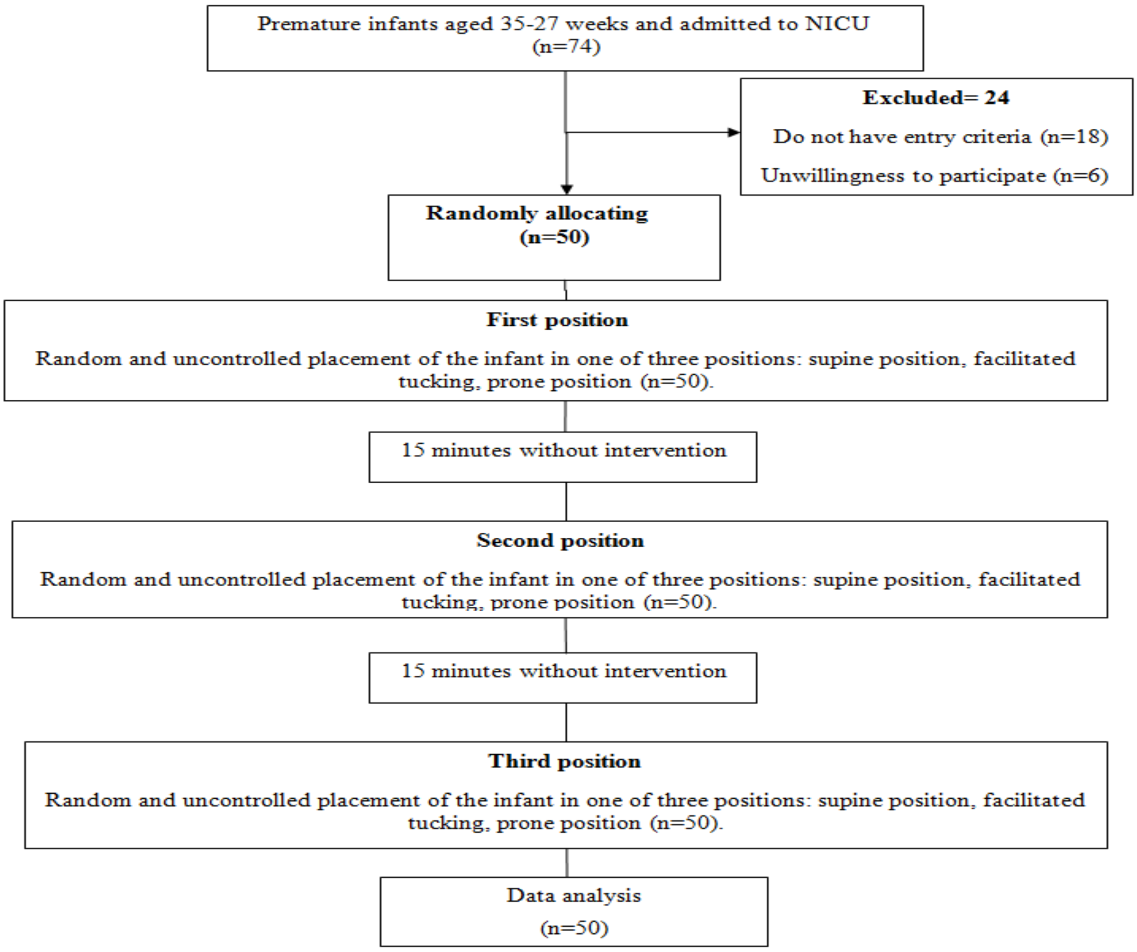

Fig.1: Consort diagram.

Table-1: Astrid Lindgren Children's Hospital Pain Scale Neonates (ALPS-NEO) (18).

Variables	0	1	2
Facial Expression	Peaceful	Distressed expression May grimace slightly	Distressed expression, may cry Chin drop
Breathing Pattern	Calm effortless breathing	Slightly strained breathing Breathing pauses	Strained breathing Fast breathing Apneas
Tone of Extremities	Normal tone	Varied tone	Tense or flaccid
Hand/Foot Activity	Relaxed	Slightly clenched May try to grasp Hand on face	Tightly clenched Fingers/toes spread Flaccid
Level of Activity	Calmly awake Calmly asleep	Occasional motor restlessness	Persistent motor restlessness Exhausted

2-5. Procedure

Before study initiation, the objectives of the study were explained to the parents of neonates and if they agreed, written informed consent was obtained. Then the neonates were randomly placed by trained nurse in one of the body positions including facilitated tucking, prone, and supine positions (**Figures 2-4**). Each neonate experienced all positions. In order to prevent bias, the order of body positioning for each neonate was selected randomly. Note that this is a crossover study in which an individual acts as its control group (19).

Initially, the neonates were placed inside the nest. Nasal CPAP prongs were inserted by trained nurse inside the neonate's nose. The prong size was selected based on weight and gestational age of the neonate using a specific ruler. The prongs were inserted inside the nostrils in a way that it did not compress the nasal septum. The tapes of the prongs were fixed to the neonate's cap to avoid oxygen leak or prong displacement. In addition, cotton pads were placed under the tapes on the neonate's face to avoid irritation of the skin. One hour later, after the physiologic state of the neonate was determined to be stable the first studied body position was applied randomly. The neonate was placed at the first particular body position for 30 minutes. During this time, a video was recorded using a camera (Sony DCR SR45 Hybrid). During the video recording, behavioral responses of the neonate were recorded. After each body position change, in order to avoid the effect of the previous body position, the neonate was left free for 15 minutes (i.e., washout period) (4).

Then, the neonate was placed in the second and third body positions as described earlier 30 minutes for each body position and relevant washout periods of 15 minutes. The pain measurements were done as described earlier. At the end, the videos were reviewed by a trained nurse to measure pain using the ALPS-Neo scale.

Fig.2: The Supine position.

Fig.3: The Prone position.

Fig.4: The Facilitated tucking position.

2-6. Data analysis

The analyses were done using the SPSS software for Windows (version 22.0). Descriptive indices including mean and its standard deviation (SD), frequency, and percentage were used to express the data. For analytic analyses, the repeated measurement analysis of variance (ANOVA), t-test and Repeated Measure analysis were used. The significance level was set at 0.05. In order to determine the effect of demographic and background variables (age and gender) on pain, the Chi-squared test was used.

2-7. Ethical considerations

Approval was received from Kermanshah University medical Sciences Ethics Committee, and official permission from the hospital where the study was conducted was obtained. Additionally, informed written consent was obtained from each family included in the study.

3- RESULTS

The results of this study showed that of 50 premature neonates studied, there were 15 girl neonates (30%), and 25 boy neonates (75%). Mean (±SD) gestational age was 31.76 (±2.09) weeks. Mean (±SD) age of the neonates was 1.42 (0.95) days. Mean (±SD) birth weight was 1,760

(±522.42) grams. Mean (±SD) Apgar score at 5 minutes was 8.32 (±0.91). Mean (±SD) maternal age was 29.86 (±5.87) years (**Table.1**). The Results of ANOVA and t-tests showed that none of the demographic and background variables have not a statistically significant association with the pain score of different positions (P>0.05). The **Table.2** show the results of repeated measure analysis which has compared the pain scores in different periods of time in three positions supine position, prone position and facilitated tucking. As can be seen, in all different periods of time, the mean of pain scores in the Facilitated position has been lower than the other two positions, indeed this difference was statistically significant (P<0.001) (**Table.3**). The **Figure.5** also show the mean of pain scores in in different periods of time in three positions supine position, prone position and facilitated tucking. In fact, this figure confirms the results of **Table.2**.

Table.3 also shows the results of the comparison of pairwise mean of pain scores at different times in 3 positions. As can be seen, all of them have significant differences.

Table-1: The relationship between mean pain score in the fetal position, supine position and prone position with demographic variables in participants

Variables	Variable category	Fetal group		Supine group		Prone group	
		Mean ± SD	P-value	Mean ±SD	P-value	Mean ± SD	P-value
Gender	Girl	5.26 ±0.60	0.529	7.28 ±0.76	0.828	6.08 ±0.84	0.294
	Boy	5.10±0.90		7.34 ±0.80		6.33 ±0.70	
Age	A few hours	5.09±0.87	0.675	7.28±0.79	0.759	6.20±0.76	0.670
	1-3 days	5.19 ±0.79		7.35±0.80		6.29±0.74	
Gestational Age, (week)	27-30	5±0.87	0.726	7.33±0.97	0.976	5.92±0.96	0.152
	30-33	5.18±0.94		7.34 ±0.62		6.42±0.57	
	33-35	5.24±0.58		7.28±0.89		6.31±0.71	
Birth weight, gram	1000-1500	5.14±0.93	0.966	7.31±0.765	0.953	6.08±0.86	0.357
	1500-2000	5.20±0.95		7.38±0.90		6.25±0.64	
	2000-2500	5.12±0.60		7.29±0.78		6.44±0.67	

SD: Standard deviation.

Table-2: Mean (SD) pain (due to nasal CPAP prong insertion) scores at different time points based on the three studied body positions among 50 premature neonates

Body position/ pain score	10 minutes I Mean ± SD	10 minutes II Mean± SD	10 minutes III Mean ± SD	P- value
Supine	0.96 ±7.62	0.92±7.42	0.91± 6.94	<0.001
Prone	0.97 ±6.48	0.76 ±6.22	0.92 ±6.08	
Facilitated tucking	0.86 ±5.54	0.95 ± 5.02	0.90 ±4.90	

SD: Standard deviation.

Table-3: Comparison of pain (due to nasal CPAP prong insertion) scores among the three studied body positions

Position/ Pain Score		Mean difference ± Standard deviation	P-value
Supine position	Prone position	1.06 ± 0.09	<0.001
	Facilitated tucking position	2.17 ± 0.11	<0.001
Prone position	Supine position	-1.06 ± 0.09	<0.001
	Facilitated tucking position	1.10 ± 0.13	<0.001
Facilitated tucking position	Supine position	2.17 ± 0.11-	<0.001
	Prone position	1.10 ± 0.13-	<0.001

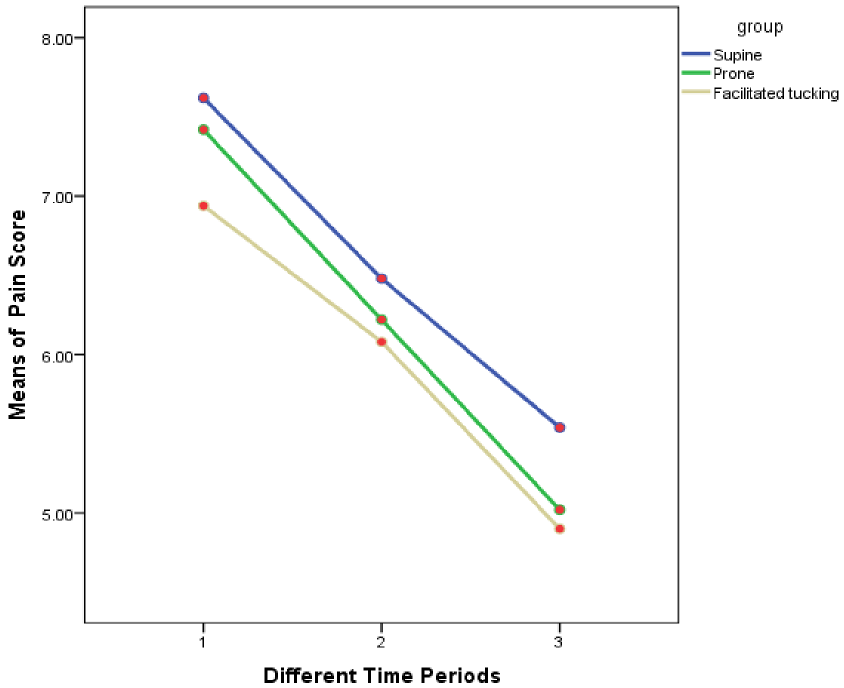

Fig.5: Mean of pain scores of NCPAP in different periods of time in the different positions.

4- DISCUSSION

The objective of the current study was to determine the effect of three body positions on pain induced by inserting prong of nasal CPAP among a sample of premature neonates admitted to NICU. The obtained results showed that a significant difference existed regarding pain between prone and supine positions; pain score was lower in prone position. In a former study by Saki et al. in 2009 showed that pain during venous blood drawing was different among body positions and pain was less severe in prone position compared to supine position (16). Another study by Grunau et al. in 2004 showed that in prone position neonates fell more comfortable and experience deeper sleep in comparison to supine position. In this position, the neonates are more resistant to environmental stressful factors and experience less pain during painful procedures (20). These are compatible with our findings. The results also showed that pain score during painful procedures in facilitated tucking position were lower than in supine position. In a former study in Shahid Hasheminejad Hospital, with the objective of studying the effect of facilitated tucking position on pain and physiologic indices during venous blood drawing in premature neonates, it was reported that pain severity was lower in intervention group (i.e., fetal position) compared to control group (3). These results are in agreements with what we observed here regarding facilitated tucking position. According to our findings, pain score in facilitated tucking position was lower than in prone position. Grunau et al. (2004) concluded that placement in prone position is not a sufficient environmental comfort intervention for painful invasive procedures such as heel lance for blood sampling in the NICU. Neonates require other environmental supports to promote coping with this stressful event (20). Through a systematic review, Yamada et al. in 2008 asserted that although Cignacco et al. cited the review by Prasopkittikun and Tilokskulchai, they did not include the use of positioning, maternal holding or touching in their summary of recommended strategies (21-23).

Two additional studies did not support the use of positioning for procedural pain. This difference may be painful due to differences in the type of procedure. Prasopkittikun and Tilokskulchai (22) reported that swaddling, maternal holding; touching and positioning were effective nonpharmacological interventions that reduced pain using validated pain assessment measures in preterm and term infants undergoing a heel lance. The authors advised the use of a combination of these interventions because their effectiveness may vary across infants.

Nonpharmacological pain interventions, including the use of pacifiers or NNS, swaddling, facilitated tucking, and breast milk or breastfeeding had higher levels of support for reducing pain during single painful events. However, the crucial issue of whether these interventions could be used repeatedly was not addressed in existing reviews (21). Moreover, Reyhani et al. in 2012 concluded that facilitated tucking position could cause changes in heart rate and saturation of arterial blood and pain relief for infants in the experimental group compared to the control group. Therefore, it can be used as a method for pain relief caused by arterial blood taking (3). The results of the current study showed that in premature neonates who were receiving nasal CPAP facilitated tucking position yielded the lowest pain score in comparison to prone and supine positions. In a study by Liaw et al. in 2011, a significant relationship existed between pain score, physiologic indices, and facilitated tucking position with regular care. No significant association was observed between demographic variables (age, gender, gestational age, birth weight, etc) and pain due to nasal CPAP prong insertion (24). In a study by Cignacco et al.(2007) factors such as gestational age or neonate health were not found to have effect on non-pharmacological interventions (23).

In another study by Karimi et al. (2012), neonatal weight and the time of the last feeding did not have effect on pain response (25-26). These findings are compatible with our findings. One of the strengths of this study was cross-over design applied. As each neonate acted like control for him/herself, individual differences in pain response were controlled. Of limitations we encountered is that the neonates had intravenous line in one of their limbs which caused movement limitation. This could affect pain scoring when assessing limb activity. So, it is recommended to conduct further studies to compare pain score yielded by ALPS-Neo with other pain measurement instruments.

4-1. Clinical application

Non-medical interventions and especially the placement of neonates in facilitated tucking or prone position as a new science in the nursing care can be an effective step in improving care provided by nurses.

5- CONCLUSION

The findings of the current study support the efficacy of body positioning for premature neonates who were receiving nasal CPAP admitted to NICU. Among different body positions, fetal position had the greatest effect on pain alleviation followed by prone and supine positions. Therefore, in the first place, the facilitated tucking position and then the prone position were used to reduce the pain in the neonates under the N- CPAP as a non-invasive and no fee method.

6- CONFLICT OF INTEREST

The authors declare lack of any type of conflict of interests with this manuscript.

7- ACKNOWLEDGMENTS

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