http:// ijp.mums.ac.ir
Original Article (Pages: 4511-4519)

The Effect of Non-nutritive Sucking on Transcutaneous Oxygen Saturation in Neonates under the Nasal Continuous Positive Airway Pressure (CPAP)

Mousa Ahmadpour-Kacho[1], Yadollah Zahed Pasha[1], *Zoya Hahdinejad[2], Soraya Khafri[3]

[1]Professor of Pediatrics and Neonatology, Non-Communicable Pediatric Diseases Research Center, Department of Pediatrics, Babol University of Medical Sciences, Babol, Iran.
[2]Master Student of Neonatal Intensive Care Nursing, Amirkola Children's Hospital, Department of Pediatrics, Babol University of Medical Sciences, Babol, Iran.
[3]Assistant Professor of Statistics, Non-Communicable Pediatric Diseases Research Center, Department of Pediatrics, Babol University of Medical Sciences, Babol, Iran.

Abstract

Background
Several beneficial effects of non-nutritive sucking in infants, including the physiological stability, relaxation, better transition from tube feeding to oral feeding have been reported. But its effect on oxygen saturation in neonates under the Nasal Continuous Positive Airway Pressure (NCPAP) is not so clear. This study aimed to investigate the effects of non-nutritive sucking on transcutaneous oxygen saturation levels of neonates treated with NCPAP.

Materials and Methods
This quasi-experimental study was done on 25 preterm neonates, hospitalized with a diagnosis of respiratory distress, required NCPAP, in the neonatal intensive care unit (NICU) at the Ayatollah Rouhani Hospital and Babol Clinic, North of Iran. Non-nutritive sucking was elicited by a standard pacifier appropriate to their age one hour a day, and the mean oxygen saturation was measured before and after intervention by cardiopulmonary monitoring (Saadat Co., Iran). Data analyzed using SPSS-18.0 software.

Results
In the 25 cases studied, the mean oxygen saturation values before performing non-nutritive sucking was 96.31±2.88%, which was changed to 98.35±1.6% after intervention, and this increase was statistically significant (P = 0.004).Results showed that the gender, birth weight and gestational age of neonates had no effect on mean Blood oxygen saturation (SpO2) level.

Conclusion
According to the results, using the non-nutritive sucking in premature neonates under the NCPAP, can improve oxygenation.

Key Words: Continuous positive airway pressure, Newborn, Respiratory distress, Sucking behaviour.

*Please cite this article as: Ahmadpour-Kacho M, Zahed Pasha Y, Hahdinejad Z, Khafri S. The Effect of Non-nutritive Sucking on Transcutaneous Oxygen Saturation in Neonates under the Nasal Continuous Positive Airway Pressure (CPAP). Int J Pediatr 2017; 5(3): 4511-19. DOI: **10.22038/ijp.2016.7498**

***Corresponding Author*:**

Zoya Hahdinejad, Amirkola Children's Hospital, Department of Pediatrics, Babol University of Medical Sciences, Babol, Iran.

Email: zoya.hadian@yahoo.com

Received date Dec.13, 2016; Accepted date: Jan. 22, 2017

1- INTRODUCTION

Non-nutritive sucking (NNS) is a basic ability in newborn infants (1, 2), it is an oromotor behavior that originates from the early fetal period and present in the first year of life (3). Each sucking attempt consists of two parts: suction and expression. At the phase of suction, the intraoral pressure becomes negative and at the expression phase the teat is compressed between the tongue and the palate (4, 5). NNS via pacifier is an efficient intervention to stimulate and accelerate the maturation of the sucking reflex (6-9), and it has been identified ashaving many benefits for premature infants, for example it enhances the development of neonatal neurological maturation by facilitating the internal rhythms (10). It has no effect on acid and nonacid gastro-esophageal reflux in preterm neonates with symptoms of gastro-esophageal reflux (11).

Non-nutritive sucking means any repetitive oral activity in which there is no response to food stimuli, like sucking on a pacifier (12-14). It promotes the infant's physiological stability, relaxes neonates during invasive procedures, reduces stress, shortens the duration of hospitalization, reduces treatment costs and improves preparation for oral feeding (9, 11, 12, 14-24), promotes attainment of full oral feeding and weight gaining (25, 26). Since respiratory distress is one of the most common diseases in premature infants and the use of non-invasive respiratory support as an appropriate method of treatment is increasing, the application of nasal continuous positive airway pressure (NCPAP) is becoming one of the most popular non-invasive modes of this type of respiratory support (27).

Continuous positive airway pressure (CPAP), is a way of making continuous positive airway pressure through the infant’s airway with spontaneous breathing during the respiratory cycle (28, 29). Various methods have been applied for CPAP, including the ventilator, CPAP machines and bubble CPAP. Nasal prong is the most common interface actions in CPAP. It provides a better view of the infant's face and mouth and also the infant be able to move easily without reducing the pharyngeal pressure. The problems of using NCPAP can be air leakage, trauma to the nose, stomach distention, tissue damage, nasal obstruction by secretions, nasopharyngeal prong kinking and the pressure loss through the open mouth (20, 23). One of the common side effects of NCPAP is the pressure loss through the open mouth (29, 30). Chin straps or pacifiers are the common methods to be ensured that infant’s mouth is closed during the CPAP application (20, 25). From the theoretical point of view, occlusion of oral cavity by a pacifier could increase intraoral pressure and preclude the pressure deflation during the respiration and/or crying. So there are few studies discussed about the effects of non-nutritive sucking on improvement of oxygenation in these infants. The present study was carried out to investigate the effects of non-nutritive sucking on transcutaneous oxygen saturation of infants under the NCPAP.

2- MATERIALS AND METHODS

2-1. Place of Study

This quasi-experimental study was done on 25 premature neonates with a gestational age less than 37 weeks, hospitalized in the neonatal intensive care unit (NICU) at the Ayatollah Rouhani Hospital and Babol Clinic from December 2013 to March 2014. The inclusion criteria were: gestational age between 28 to 37 weeks, with respiratory distress requiring NCPAP therapy and also infants who require respiratory support by NCPAP within the first 48 hours after birth. The indication for NCPAP application after the resuscitation in the delivery room for premature infants with respiratory distress

was a partial pressure of arterial oxygen (PaO_2), less than the 50 mmHg, accompanied with a pH more than 7.2 and arterial carbon dioxide tension ($PaCO_2$), less than the 55 mmHg; while receiving a fraction of inspired oxygen (FiO2), more than 60 %.Cases with disorders and conditions, such as congenital heart diseases, having facial anomalies, arterial carbon dioxide pressure greater than 60 mm Hg or PH≤7. 25, the need for endotracheal intubation, and complicated NCPAP were excluded from the study.

2-2. Intervention

We include all cases that required CPAP in first 48 hours after birth. Based on the experiences of attending neonatologists in our Neonatal Intensive Care Unit (NICU), the transcutaneous oxygen saturation was measured and recorded 5 times, with an at intervals of every 15 minutes. The pacifier was carefully placed placed in the infant mouth and due to the infant uncoordinated sucking, was held in the oral cavity with light pressure if the infant stopped sucking, the pacifier was manipulated in the neonate mouth every 5 minutes to stimulate NNS.

The study was started at 3 PM when the babies were on quiet alert state. At first the vital signs and Spo_2 were recorded 5 times every 15 minutes (i.e., at 3, 3:15, 3:30, 3:45 and 4 PM). Then NNS were provoked using a pacifier by the researcher (master student of neonatal intensive care nursing), under the supervision of the attending neonatologist. Then, SpO_2 was recorded 5 times apart (at the 5, 15, 30, 45 and 60 minutes), while the babies were sucking the pacifier. A chronometer was used to determine these intervals. The Spo_2 was recorded using by a cardiopulmonary monitoring (Saadat Co. NOVIN S 1800, Iran). An attending nurse was participated to record this parameter, while the babies were sucking the pacifier. According to the review on related studied, a checklist was prepared by researcher, which contains demographic data including: gestational age, gender, birth weight, mode of delivery, name of health center, and the illness led to respiratory distress. The severity and score of respiratory distress graded based on Silverman - Anderson scoring system (31). This scoring system evaluates the severity of respiratory distress using the signs including retractions, nasal flaring and grunting. The score varies from zero to 10. Zero indicates no respiratory distress, score 10 indicates severe respiratory distress, and a score ≥ 7 indicates an impending respiratory failure. The sample size was calculated by this formula:

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

α= 0.05, **1-β**=0.8, **Z**=7.56, **Ϭ**=0.75 and **d**=0.6; the effect size was 0.6 and P-value less than 0.05 was considered statistically significant. Based on this formula the sample size calculated 23.62. According to the formula, the sample size was obtained 23.62, which was considered 25 samples.

2-3. Ethical Approval

Before performing the study process, the procedure was completely explained to the parents and an informed consent was obtained from all the subjects. The study protocol was registered under the code IRCT2014051717710N1 atwww.irct.ir and was approved by the Ethics Committee of Babol University of Medical Sciences, Iran. Moreover, informed consent was obtained from parents.

2-4. Statistical analysis

After data collection, they were entered into SPSS-18 and analyzed using the dependent t-test to examine the oxygen saturation (SpO_2) differences between before and after the intervention at the first, second, third, fourth, and fifth times, and also for all occasions, which is the average of five occasions. Paired t-test and

independent t-test were used for comparing relation between before and after intervention.

3-RESULTS

The study was performed on 25 infants. The mean gestational age was 31.96±2.7 weeks, the mean birth weight was 1,777.4±760 grams, the mean age after birth was 20.28±11 hours and mean age of mother was 26.96±4.5 years. The gender, birth weight and gestational age of neonates had no effect on the oxygenation improvement caused by non-nutritive sucking. Twelve neonates (48%) were male and the rest were female. In terms of weight, most of the infants including 9 (36%) cases were 1500-2500 grams, 5 (20%) cases had the lowest weight of below 1,000 grams and 1000-1500 grams and 6 (24%) cases were over 2500 grams. In terms of age, 15 (60%) samples were between 32-36 weeks, which had the highest age, and 10 (40%) others were between 28-32 weeks. Mode of delivery, illness led to respiratory distress and respiratory distress syndrome score based on Silverman-Anderson scoring system (31), were gathered from infants' medical records.

Twenty-two (88%) infants were born by caesarean section and the rest of them by vaginal delivery. Forteen infants (56%), had Respiratory Distress Syndrome (RDS), 3 (12%) infants had Intrauterine Growth Retardation (IUGR), and 8 (32%) cases had Transient Tachypnea of the Newborn (TTN). Regarding the Silverman-Anderson RDS score, 44% had mild respiratory distress, 40% moderate and 16% severe respiratory distress (**Table.1**). The amount of SpO_2 of infants at all occasions after using the non-nutritive sucking was higher before the intervention. The amount of oxygen saturation (SpO_2) of infants in the first, second, third, fourth, fifth times, and generally the average of all modes, using two independent t-test (**Table. 2**), showed that the amount of SpO_2 at the 95% confidence level (CI) had significant difference and the amount of SpO_2 before the intervention in all the times was lower than the after intervention, and calculated p-value was less than 0.05 (**Table.2**).

Table.3 shows the mean and standard deviation (SD) of SpO_2 both before and after intervention based on gender, weight and age. The amount of SpO_2 was investigated separately before and after the intervention, based on gender, weight and age using student's t-test and ANOVA. Student's t-test results showed that the amount of SpO_2 in both cases before and after intervention were not statistically different in terms of gender and age; at 95% CI, the SpO_2 had almost the same amount. For categorized weight by ANOVA at 95% CI, in both before and after intervention, the SpO_2 was not statistically different.

In addition, differences in the amount of SpO_2 of infants were examined before and after the intervention based on gender and pregnancy age using student's t-test. Test results showed that SpO_2 had no significant difference between male and female subjects before and after intervention and also in terms of gestational age (28-32 weeks 32-36 weeks) at 95% CI, and the difference of SpO_2 was almost identical based on gender and gestational age of babies before and after intervention.

Also, the ANOVA test at 95% CI, for the difference of SpO_2 before and after intervention compared to categorized weight showed that the difference was almost the same and had no significant difference with each other. Results showed that the difference of mean SpO_2 before and after the intervention was significant (**Figure.1**).

Table-1: Descriptive of demographic variables of premature infants required Nasal Continuous Airway Pressure

Variables	Sub-type	Number (%)
Gender	Male	12(48%)
	Female	13(52%)
Weight (gr)	<1000	5(20%)
	1000-1500	5(20%)
	1500-2500	9(36%)
	>2500	6(24%)
Gestational age (weeks)	28-32	10(40%)
	33-36	15(60%)
Mode of Delivery	C/S	22(88%)
	NVD	3(12%)
Illness led to respiratory distress	RDS	14(56%)
	IUGR	3(12%)
	TTN	8(32%)
RDS Score (Silverman - Anderson scoring system)	Mild	11(44%)
	Moderate	10(40%)
	Severe	4(16%)

C/S: Caesarean section; NVD: Normal vaginal delivery; RDS score: Respiratory distress syndrome score; IUGR: Intrauterine growth restriction; TTN: Transient tachypnea of the newborn.

Table-2: The peripheral oxygen saturation of the treated neonates with nasal continuous airway pressure. , before and after the non-nutritive sucking

Time	Situation	Mean ± Standard deviation	Number	P-value
First time	Before	95.56±4.90	25	0.004
	After	98.40±1.68	25	
Second time	Before	96.44±3.25	25	0.004
	After	98.80±1.95	25	
Third time	Before	96.48±2.55	25	0.002
	After	98.48±1.41	25	
Forth time	Before	96.64±2.87	25	0.004
	After	98.12±2.06	25	
Fifth time	Before	96.44±2.78	25	0.026
	After	98.68±1.70	25	
Total	Before	96.31±2.88	25	0.004
	After	98.35±1.60	25	

Table-3: The comparison of peripheral oxygen saturation based on sex, weight and age of infants before and after intervention

Variables		Before	After	Difference
Gender	Male	96.49±2.02	98.29±1.68	1.8±1.87
	Female	96.11±3.6	98.41±1.59	2.3±3.17
P-value		0.75	0.85	0.6
Weight (gr)	<1000	95.6±2.4	99.08±0.41	3.4±2.1
	1000-1500	96.7±2	98.36±1.75	1.6±1.5
	1500-2500	97.5±1.94	98.64±1.62	1.1±1.4
	>2500	94.66±4.39	97.3±1.88	2.63±4.26
P-value		0.36	0.34	0.4
Gestational age (weeks)	28-32	96.12±1.8	98.08±1.71	1.96±1.58
	33-36	96.44±3.47	98.5±1.56	2.09±3.06
P-value		0.79	0.5	0.9

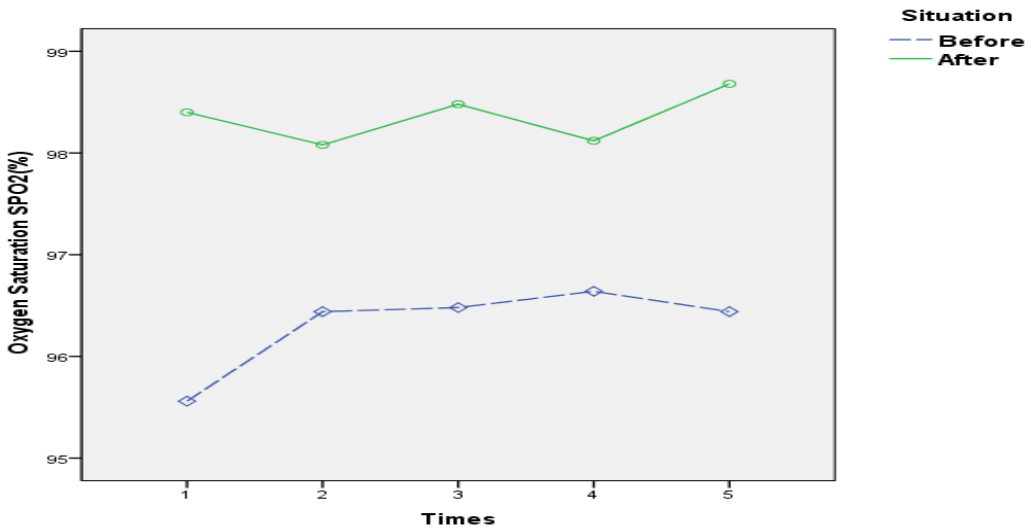

Fig.1: The comparison of mean oxygen saturation (SpO_2) in premature infants before and after intervention.

4- DISCUSSION

The present study, which was done to determine the effect of nonnutritive, sucking on the oxygenation state of a premature neonate under the NCPAP, showed that non-nutritive sucking in this group of infants, could improve oxygenation. Most of the study regarding the non-nutritive sucking focused on its effect on oxygenation after the extubation and/or during the tube feeding, but to use it as a device to prevent nasopharyngeal pressure collapse during the NCPAP therapy is less available.

A study in 2013 by Fischer et al. on 32 infants investigated the oxygen saturation of infants with and without blocking the nostril. Nasal CPAP was provided using a tube with internal diameters of 2.5-3.5 mm. A neonatal monitor was used for routine cardiorespiratory monitoring and also to measure SpO_2 and respiratory rate (RR). The SpO_2 and RR were measured in 1-minute intervals over two 10-minute periods, with and without nostril contralateral occlusion. Oxygen saturation in neonates with oxygen saturation less than 93%, significantly increased by closing the nostrils and decreased the respiratory rate, which is consistent with our results (32). Although, closing the nostrils in Fischer's study increased the peripheral blood saturation and reduced respiratory rate, the nasal obstruction was not pleasant for the infant and may have caused anxiety. However, in the present study, non-nutritive sucking had no complication for the infant and its use is more applicable and available in clinical practice. In a study in 2014 by Kamhawy et al. found that the use of non-nutritive sucking increased the peripheral oxygenation significantly in the preterm infants fed with a nasogastric tube. In this study, the time of peripheral oxygen saturation measurement was after the separation from the CPAP device and ventilator, while in our study,$SpO_2$was measured at a time when the neonates were on CPAP (23).

A study conducted in 2005 by Joung et al. showed that non-nutritive sucking by pacifiers in 32 preterm infants increased the peripheral oxygen saturation level which is compatible with the result of our study, but this study has not been done on the infants with respiratory problems under the NCPAP (33). Burroughs in 1978 studied the non-nutritive sucking in 11 premature infants showed that using a pacifier to provoke sucking could improve the level of oxygen saturation and transcutaneous oxygen tensionin these neonates (34). In a study conducted in 2002 by Morren et al. to investigate the effect of NNS on heart rate, abdominal respiration and arterial oxygen saturation of 20 neonates showed that no impact of non-nutritive sucking on peripheral or cerebral oxygenation was found (35).These results were also reported in a study of Dipietro et al. in1994.They studied the behavioral and physiologic effect of NNS during gavage feeding in 36 stable preterm infants and concluded that provision of a pacifier during the gavage feeding could not alter the reductions in heart period, vagal tone and oxygen saturation (36). One of the limitations in our study was the inability to assess and record the nasopharyngeal pressure. Sometimes, the SpO_2 of some infants was exceeded from the recommended range, which in response the $FIO_2$was decreased by an attending nurse.

5- CONCLUSION

The results of this study showed that the use of non-nutritive sucking improves oxygen saturation in the infants under NCPAP. Since no negative effect has been reported about the using of non-nutritive sucking on preterm and high-risk infants (2), and since also does not require any expensive equipment, it can be used as a low cost and effective nursing care in the neonatal intensive care.

6- CONFLICT OF INTEREST

No competing interests are involved in the study.

7- ACKNOWLEDGEMENT

This study is part of a Master Thesis of neonatal intensive care nursing student. The authors would like to thank following for their great cooperation in this study, our colleagues at the Research Center of Amirkola Children's Hospital, Vice-Chancellery for research of Babol

University of Medical Sciences and the staffs of the Neonatal Intensive Care Unit of Babol Clinic, Amirkola Children's Hospital and Ayatollah Rouhani Hospital specially Dr.M Hagshnas and Dr. Z Akbarian for their kind cooperation and also Dr Evangeline Foronda for the English editing assistance.

8- REFERENCES

1. Grassi A, Cecchi F, Sgherri G, Guzzetta A, Gagliardi L, Laschi C. Sensorized pacifier to evaluate non-nutritive sucking in newborns. Medical engineering & physics 2016;38:398-402.

2. Pinelli J, Symington A, Ciliska D. Nonnutritive Sucking in High-Risk Infants: Benign Intervention or Legitimate Therapy? Journal of Obstetric, Gynecologic, & Neonatal Nursing 2002;31(5):582-91.

3. Miller JL, Sonies BC, Macedonia C. Emergence of oropharyngeal, laryngeal and swallowing activity in the developing fetal upper aerodigestive tract: an ultrasound evaluation. Early human development 2003;71(1):61-87.

4. Sameroff AJ. The components of sucking in the human newborn. Journal of experimental child psychology 1968;6:607-23.

5. Dubignon J, Campbell D. Sucking in the newborn during a feed. Journal of experimental child psychology 1969;7:282-98.

6. Daley HK, Kennedy CM. Meta analysis: Effects of interventions on premature infants feeding. The Journal of perinatal & neonatal nursing 2000;14(3):62-77.

7. Fucile S, Gisel E, Lau C. Oral stimulation accelerates the transition from tube to oral feeding in preterm infants. The Journal of Pediatrics 2002;141(2):230-6.

8. Fucile S, Gisel E, Lau C. Effect of an oral stimulation program on sucking skill maturation of preterm infants. Developmental Medicine & Child Neurology 2005;47(03):158-62.

9. Rocha AD, Moreira MEL, Pimenta HP, Ramos JRM, Lucena SL. A randomized study of the efficacy of sensory-motor-oral stimulation and non-nutritive sucking in very low birthweight infant. Early human development 2007;83(6):385-8.

10. Standley JM, Cassidy J, Grant R, Cevasco A, Szuch C, Nguyen J, et al. The effect of music reinforcement for non-nutritive sucking on nipple feeding of premature infants. Pediatric nursing 2010;36(3):138-45.

11. Corvaglia L, Martini S, Corrado MF, Mariani E, Legnani E, Bosi I, et al. Does the Use of Pacifier Affect Gastro-Esophageal Reflux in Preterm Infants? The Journal of Pediatrics 2016;172:205-8.

12. Assadollahpoor F, Soleimani F, Yadegar F, Younesian S. The Effect of Nonnutritive Sucking on Achievement of Full Oral Feeding in Preterm Infants. Quarterly Journal of Rehabilitation 2013;13(5):121-7.

13. Harding C. An evaluation of the benefits of non-nutritive sucking for premature infants as described in the literature. Archives of disease in childhood 2009;94(8):636-40.

14. Stumm SL, Barlow SM, Estep M, Lee J, Cannon S, Carlson J, et al. Respiratory distress syndrome degrades the fine structure of the non-nutritive suck in preterm infants. Journal of Neonatal Nursing 2008;14(1):9-16.

15. Thakkar P, Arora K, Goyal K, Das R, Javadekar B, Aiyer S, et al. To evaluate and compare the efficacy of combined sucrose and non-nutritive sucking for analgesia in newborns undergoing minor painful procedure: a randomized controlled trial. Journal of Perinatology 2016;36(1):67-70.

16. Liaw J-J, Yang L, Lee C-M, Fan H-C, Chang Y-C, Cheng L-P. Effects of combined use of non-nutritive sucking, oral sucrose, and facilitated tucking on infant behavioural states across heel-stick procedures: A prospective, randomised controlled trial. International Journal of Nursing Studies 2013;50(7):883-94.

17. Liu MF, Lin KC, Chou YH, Lee TY. Using non-nutritive sucking and oral glucose solution with neonates to relieve pain: a randomised controlled trial. Journal of clinical nursing 2010;19(11-12):1604-11.

18. Estep M, Barlow SM, Vantipalli R, Finan D, Lee J. Non-nutritive suck parameters

in preterm infants with RDS. Journal of Neonatal Nursing 2008;14(1):28-34.

19. Lappi H, Valkonen-Korhonen M, Georgiadis S, Tarvainen MP, Tarkka IM, Karjalainen PA, et al. Effects of nutritive and non-nutritive sucking on infant heart rate variability during the first 6 months of life. Infant Behavior and Development 2007;30(4):546-56.

20. Barlow SM. Oral and respiratory control for preterm feeding. Current opinion in otolaryngology & head and neck surgery 2009;17(3):179.

21. Breton S, Steinwender S. Timing introduction and transition to oral feeding in preterm infants: current trends and practice. Newborn and Infant Nursing Reviews 2008;8(3):153-9.

22. Mirzarahimi M, Mehrnoush N, Shahizadeh S, Samadi N, Amani F. Effect of non-nutritive sucking and leg massage on physiological and behavioral indicators of pain following heel blood sampling in term neonates. International Journal of Advanced Nursing Studies 2013;2(2):74.

23. Kamhawy H, Holditch-Davis D, Alsharkawy S, Alrafay S, Corazzini K. Non-nutritive Sucking for Preterm Infants in Egypt. Journal of Obstetric, Gynecologic, & Neonatal Nursing 2014;43(3):330-40.

24. Zhang Y, Lyu T, Hu X, Shi P, Cao Y, Latour JM. Effect of nonnutritive sucking and oral stimulation on feeding performance in preterm infants: A randomized controlled trial. Pediatric Critical Care Medicine 2014;15(7):608-14.

25. Khalessi N, Nazi S, Shariat M, Saboteh M, Farahani Z. The Effects of Pre-feeding Oral Stimulations and Non-nutritive Sucking on Physical Growth and Independent Oral Feeding of Preterm Infants. Iranian Journal of Neonatology IJN 2015;6:25-9.

26. Asadollahpour F, Yadegari F, Soleimani F, Khalesi N. The effects of non-nutritive sucking and pre-feeding oral stimulation on time to achieve independent oral feeding for preterm infants. Iranian journal of pediatrics 2015;25:3.

27. Goldsmith JP, Karotkin E. Assisted ventilation of the neonate: Elsevier Health Sciences; 2010.

28. Chan K, Chan H. The Use of Bubble CPAP in Premature Infants: Local Experience. HK J Paediatr 2007;12(2):86-92.

29. Bonner KM, Mainous RO. The nursing care of the infant receiving bubble CPAP therapy. Advances in Neonatal Care 2008;8(2):78-95.

30. De Paoli A, Morley C, Davis P. Nasal CPAP for neonates: what do we know in 2003? Archives of Disease in Childhood-Fetal and Neonatal Edition 2003;88(3):F168-F72.

31. Silverman WA, Andersen DH. A controlled clinical trial of effects of water mist on obstructive respiratory signs, death rate and necropsy findings among premature infants. Pediatrics 1956;17(1):1-10.

32. Fischer HS, Roehr CC, Proquitté H, Schmalisch G. Influence of nose and mouth leaks on peripheral oxygen saturation during continuous positive airway pressure in neonates. World Journal of Pediatrics 2013;9(4):318-22.

33. Joung KH, Yoo IY, Cho SC. Effect of non-nutritive sucking on the oxygen saturation level and behavioral state of preterm infants during tube feeding. Journal of the Korean Society of Neonatology 2006;13(1):75-82.

34. Burroughs AK, Asonye UO, Anderson-Shanklin GC, Vidyasagar D. The effect of nonnutritive sucking on transcutaneous oxygen tension in noncrying, preterrn neonates. Research in nursing & health 1978;1(2):69-75.

35. Morren G, Van Huffel S, Helon I, Naulaers G, Daniels H, Devlieger H, et al. Effects of non-nutritive sucking on heart rate, respiration and oxygenation: a model-based signal processing approach. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology 2002;132(1):97-106.

36. Dipietro JA, Cusson RM, Caughy MOB, Fox NA. Behavioral and physiologic effects of nonnutritive sucking during gavage feeding in preterm infants. Pediatric Research 1994;36(2):207-14.