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The Effect of Non-nutritive Sucking on Mother's Finger on Feeding Tolerance and Attainment of Independent Oral Feeding in Preterm Infants: A Randomized Trial

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Abstract

Background

Non-nutritive sucking is part of the initial development process in preterm infants that may speed up the transition from the tube to oral feeding. The aim of this study was to evaluate the effect of non-nutritive sucking on mother's finger on feeding tolerance and attainment of independent oral feeding in preterm infants.

Materials and Methods

This single blind clinical trial was conducted on 40 preterm infants admitted to the NICU of Imam Reza Hospital, Kermanshah in 2017. In the intervention group, non-nutritive sucking was performed on the mother's finger three times a day for 10 days during the first 10 minutes of gavage. Then, the gastric residual volume, time to achieve independent oral feeding, length of hospitalization, and weight at discharge were measured. The data was analyzed using SPSS software version 24.0.

Results: According to the results, the mean of gastric residual volume was less in the intervention group (0.65±0.33) compared to the control group (2.30±0.71) (P<0.001). Time to achieve independent oral feeding in the intervention group (7.85±1.87) was less the control group (12.15±2.00) (P<0.001). On average, the infants in the intervention group were discharged from the hospital 4.5 days earlier (P<0.001). However, their weights at discharge were not significantly different from those of neonates in the control group (P>0.05).

Conclusion

The results of the study showed that non-nutritive sucking on mother's finger can be effective in improving feeding tolerance and accelerating attainment of independent oral feeding in the preterm infants, resulting in early discharge from the hospital.

Key Words: Feeding tolerance, Independent oral feeding, Infants, Non-nutritive sucking.

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1- INTRODUCTION

According to the World Health Organization (WHO), neonates born earlier than 37 weeks are considered to be preterm. Also, 15 million premature neonates are born annually around the world (1-3). Recently, with the advancement in technology, the likelihood of survival of premature infants with very low gestational age has increased (4). In order for premature neonates to be discharged from hospital, physiological stability and weight gain should be maintained through breastfeeding. One of the basic problems among premature infants is poor performance in the skills required to begin breastfeeding (5-8). In order to cope with failure of growth and weight gain and also to prevent neural disorders, long term care is required during the course of hospital stay (9, 10).

Sucking and swallowing are attained within 28 weeks of fetal development, but the coordination of these abilities will not be achieved until the gestational age of 32 to 33 weeks. That is, infants younger than 32 weeks of gestational age are not able to be effectively fed by breast, bottle or gavage (11). Also, milk intolerance is another common problem that affects premature infants, especially infants under 30 weeks of gestational age. It is a major obstacle to successful feeding of premature infants and prolongs the length of hospitalization (12). One of the main causes of milk intolerance in premature infants, especially among those with less than 34 weeks of gestational age, is hypomotility or delay in gastrointestinal movements. Gastric emptying in preterm infants is slower than that in term infants. The reason behind this, in fact, is decreased duodenal motor activity and lack of coordination between pyloric antrum of stomach and duodenum (1, 13). The premature intestinal system causes delay in gastric emptying and slows down the intestinal movements in premature infants, resulting in hypomotylity which is indicated by abdominal distention, increased stomach residual volume, and sometimes constipation (14, 15). The problems premature infants encounter when moving from tube to full oral feeding results in delayed discharge from hospital (16, 17). Designing feeding interventions facilitates the development of feeding behaviors in premature infants (18), accelerates discharge from hospital, reduces financial burden on the community, and establishes emotional relationships between the neonates and parents (19, 20). Oral support and stimulation through non-nutritive sucking (NNS) are considered to be of the most important feeding interventions (21). NNS is a basic ability in newborn infants (22, 23); it is an oromotor behavior that originates from the early fetal period and is present in the first year of life (24). Non-nutritive sucking in preterm infants is a normal part of the initial development; it is learned as habit and can speed up the transition from the gavage tube to oral feeding and, therefore, reduce the length of hospital stay (25, 26).

In general, the researchers came to the conclusion that oral stimulation and non-nutritional sucking prior to the primary feeding could greatly affect oral feeding skills of the infant. Also, after oral stimulation, a high percentage of the restless newborns relaxed and fell asleep (27). So far, few studies have been conducted on the treatment of feeding problems in premature infants. Also, there is no study carried out on the effect of non-nutritive sucking on milk intolerance in infants; therefore there is an urgent need for scientific research in this regard. Considering the importance of the subject-matter and lack of scientific research in this area in Iran, the researchers decided to investigate the effect of non-nutritive sucking on mother's finger on feeding tolerance and attainment of independent

oral feeding in preterm infants admitted to the neonatal intensive care unit.

2- MATERIALS AND METHODS

2-1. Study design and population

This study is a single blind clinical trial conducted on 40 preterm infants with gestational aged 26-34 weeks from 21st of September 2017 to 22st of November 2017 in the neonatal intensive care unit (NICU) of Imam Reza Hospital in Kermanshah, Iran. In this study, infants were randomly divided into the two groups of non-nutritive sucking (n=20), and control (n=20). This study was carried out after obtaining the license from Kermanshah University of Medical Sciences' ethic committee with the registration number of IR.KUMS.REC.1396.693 and being registered in the Iranian center of clinical trial with the registration number of IRCTID: IRCT20151220025619N4.

2-2. Methods

The sample size was determined by this formula:

$$n = \frac{(z_{1-\alpha/2} + z_{1-\beta})^2 * (\sigma_1^2 + \sigma_2^2)}{(\bar{x}_{1-} \bar{x}_2)^2}$$

Here, α=0.05, Z1-α/2=1.96, β=0.1, and P-value less than 0.05 was considered statistically significant. According to the formula, the sample size obtained was 16 in each group, and the overall number of samples was considered to be 40. Then infants were randomly divided into the two groups of non-nutritive sucking, and control. The preparation and completion of the checklist for these groups were performed by a research assistant who had not been informed of neither the randomized allocation of the groups or the aim of the study.

2-3. Measuring tools

Data was collected using a data collection form made by the researchers. Weight and age of the infant at the beginning of oral feeding and its outcomes including gastric residual volume at one and two hours after feeding as well as time to attain in dependent oral feeding were assessed and recorded in the data collection form by the researcher assistant, on daily biases. Since the study was conducted as a single blind randomized trial, the assistant was not aware of the types of the groups. Also, infant characteristics such as gender, gestational age, birth weight, Apgar score, weight at discharge, and length of hospitalization were recorded in a data collection form made by the researchers. The data were collected based on the existing medical records of infants in the NICU.

2-4. Inclusion and exclusion criteria

The entrance criteria for the present study were: the age of 26 to 34 gestational weeks defined by the pregnancy ultrasound, oral-gastric tube feeding, physiological stability determined by neonatal physician, no congenital malformations of jaw and mouth, no serious heart and lung diseases, no asphyxia at birth, and not taking opiate drugs. In case of neuromuscular and cardiovascular diseases, congenital malformations, grade 3 and 4 intraventricular hemorrhage, necrotizing enterocolitis, Nothing Per Oral (NPO), decline of Blood Oxygen Saturation (SPO2) (less than 85%) by more than 2 times, tachycardia (more than 180 beats per minute) or bradycardia (less than 90 beats per minute), the neonates would be excluded from the study.

2-5. Intervention

At first, the parents were presented with the research objectives and the manner of conducting it and then written informed consents were obtained from them, and those infants who met the entrance criteria were enrolled under the supervision of the specialists. Then feeding tube was placed for neonates with regard to the national

NICU guidelines. Routine care was conducted for all infants. Neonates in the control group did not receive any intervention and were fed by feeding tube every 2 hours. In the intervention group, a daily non-nutritive sucking program was carried out for the infants; the intervention began before feeding the infant with a feeding tube. Before the intervention, the mothers were required to wash their hands with water and soap for 2 minutes or more and then dry them (28). Before performing the intervention, the mothers were trained on how to wash hands. The training and evaluation were carried out by the researcher assistant.

First, the amount of gastric residual was measured by a syringe attached to the feeding tube and the volume was given to the nurse responsible for taking care of the infant who was going to be registered in infant feeding form. In order to perform non-nutritive sucking, the mother was required to place her little finger into the infant's mouth and non-nutritive sucking would begin by the infant. Five minutes before feeding infant by feeding tube, the mother placed her little finger in the infant's mouth and by moving a finger, the infant's sucking reflex was stimulated. Then the sucking would get started and continued for 5 minutes and at the same time, the infant would be fed through a feeding tube. In order to prevent energy loss and with regard to the previous studies, the duration of the intervention was considered to be 10 minutes (28, 29). Then, one and two hours after the feeding process, the gastric residual volume would be measured and recorded in both groups. Being performed twice a day, the intervention period lasted 10 consecutive days. Time to achieve 1, 4, and 8 time independent oral feeding per day was recorded. The criterion for achieving independent oral feeding was 8 time oral feeding (breast or syringe feeding) per day.

2-6. Statistical analyses

The independent-samples t-test and Chi-square tests were, respectively, employed for the analysis of quantitative and qualitative variables in baseline. Considering the quantitative nature of the data and their normal distribution, Repeated Measure ANOVA test was used to compare the means of gastric residual volume in the two groups of intervention and control at different time periods. Finally, the data were analyzed using SPSS software (version 24.0). The results were considered significant at $P<0.05$ level.

2-7. Ethical considerations

Approval was received from Kermanshah University medical Sciences Ethics Committee (ID-number: IR.KUMS.REC.1396.693), 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

In Neonatal Intensive Care Unit of hospitals, there are many premature infants and their families struggling with feeding and swallowing problems (30). The aim of this study was to evaluate the effect of non-nutritive sucking on mother's finger on feeding tolerance and attainment of independent oral feeding in preterm infants. The present study was conducted on 40 preterm infants admitted to the NICU of Imam Reza hospital in the city of Kermanshah, Iran. These infants were randomly divided into the two groups of non-nutritive sucking (n=20), and control (n=20). The number of the preterm infants in each group was 20. **Table.1, 2** shows the baseline characteristics of the preterm infants with the division of the groups before the intervention. The Independent-Samples t-test and Chi-square tests were used, respectively, for the analysis of quantitative and qualitative variables in

baseline. As it is shown, of the total 40 neonates studied, 22 infants were female and 18 were male. The mean weight of neonates in the intervention and control groups was 1637±601.38 grams and 1612.5±530.61 grams, respectively. Most of the infants (50%) in each group had the gestational age of 32-34 weeks. Also, there was no significant statistical difference between the two groups in terms of baseline variables of the infants' birth weight (gr), the first and fifth–minute APGAR score, gender, gestational age (week), birth order, Oxygen (O2) therapy, mother's age, having working mother, maternal education, and type of delivery (P>0.05); the lack of significant difference can be a reason that randomization process has occurred correctly **(Table.1, 2).**

Table-1: Determination and Comparison of the Birth weight and Apgar Score of the Newborns Under Study in Two Groups of Intervention and Control.

Variables	Group	Number	Mean ± S.D	P-value
Birth weight (gr)	Intervention	20	1637±601.38	0.892
	Control	20	1612.5±530.61	
First-minute Apgar	Intervention	20	6.15 ±1.23	0.297
	Control	20	5.75 ±1.16	
Fifth-minute Apgar	Intervention	20	7.60 ±1.05	0.355
	Control	20	7.30 ±0.98	

SD: Standard deviation.

Table-2: Determination and Comparison of the Baseline Characteristics of the Newborns under Study in Two Groups of Intervention and Control.

Variables		Intervention Number (%)	Control Number (%)	P-value
Gender	Girl	12 (60)	10 (50)	0.376
	Boy	8 (40)	10 (50)	
Gestational Age (week)	26- 28	3 (15)	3 (15)	1.00
	29-31	7 (35)	7 (35)	
	32-34	10 (50)	10 (50)	
Birth Order	1	8 (40)	4 (20)	0.089
	2	5 (25)	9 (45)	
	3	3 (15)	7 (35)	
	4	3 (15)	0 (0)	
	>4	1(5)	0 (0)	
O2 therapy	Yes	13 (65)	10 (50)	0.262
	No	7 (35)	10 (50)	
Mother (Age)	<20	2 (10)	1 (5)	0.379
	20 -25	7 (35)	3 (15)	
	25-30	3 (15)	8 (40)	
	30-35	5 (25)	5 (25)	
	>35	3 (15)	3 (15)	
Working Mother	Yes	2 (10)	2 (10)	1.00
	No	18 (90)	18 (90)	
Maternal Education	Illiterate	1(5)	1(5)	0.787
	Under diploma	11(55)	14(70)	
	Diploma	5(25)	3(15)	
	Academic	3(15)	2(10)	
Type of Delivery	NVD	16 (80	15 (75)	0.705
	CS	4 (20)	5 (75)	

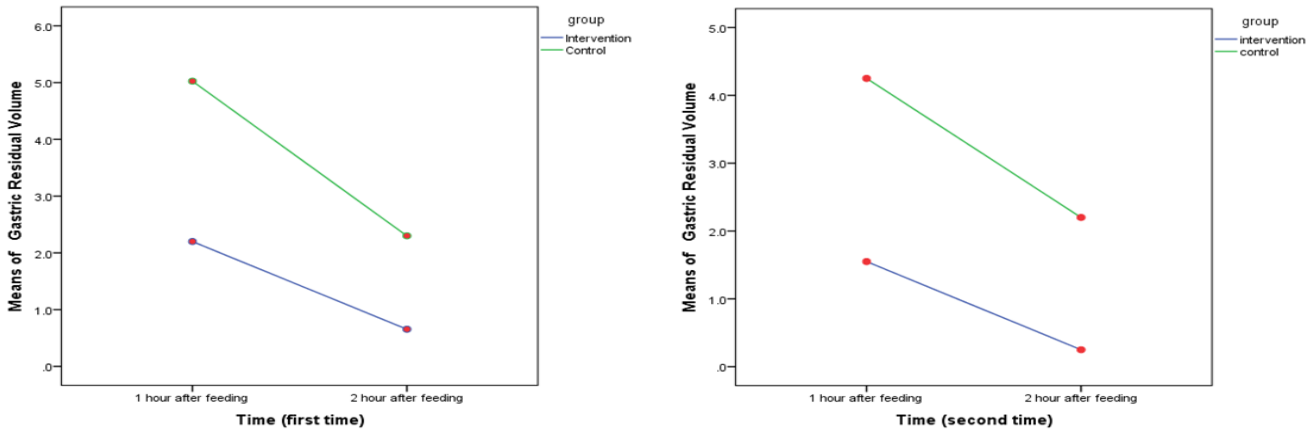
NVD: Normal Vaginal Delivery; CS: Caesarean Section.

Considering the quantitative nature of the data and their normal distribution, Repeated Measure ANOVA test was used to compare the means of gastric residual volume between the two groups of intervention and control at different time periods. **Table.3** shows the mean of gastric residual volume between the two groups of intervention and control at different time periods **(***first time***).** As shown, there was a significant statistical difference in the two groups regarding the mean of changes of this variable (P<0.001); so that, the mean of gastric residual volume in the intervention group was lower than that in the control group. **Figure.1A** confirms this statement. **Table.3** also shows the mean of gastric residual volume between the two groups at different time periods **(***second time***)**. As indicated, there was a significant statistical difference in the two groups regarding the mean of changes (P<0.001); so that the mean of gastric residual volume in the intervention group was lower than the control group. **Figure.1B** illustrates this statement. Also, the results of independent-sample t-test showed that the mean of variables of gavage volume (CC), time to 1 time independent oral feeding (per day), time to 4 time independent oral feeding (per day), time to 8 time independent oral feeding (per day), time between 1 and 8 times of independent oral feeding (per day), length of hospitalization (per day), and age at the beginning of oral feeding(per day) between the two groups of intervention and control have statistically significant difference (P<0.05) **(Table.4).**

Table-3: The Means of Gastric Residual Volume in Two Groups of Intervention and Control at Different Time Periods.

Time	Group	Number	Mean	SD	P-value	Figure
1 hour after feeding (first time)	Intervention	20	2.2	0.71	<0.001	1A
	Control	20	5.02	0.92		
2 hour after feeding (first time)	Intervention	20	0.65	0.33		
	Control	20	2.30	0.71		
1 hour after feeding (second time)	Intervention	20	1.55	0.58	<0.001	1B
	Control	20	4.25	0.85		
2 hour after feeding (second time)	Intervention	20	0.25	0.25		
	Control	20	2.2	0.82		

SD: Standard Deviation.



1A **1B**

Fig.1: The Means of Gastric Residual Volume in Two Groups of Intervention and Control at Different Time Periods.

Table-4: Determination and Comparison of The Other Important Variables in Two Groups of Intervention and Control.

Variables	Group	Number	Mean (SD)	P-value
Gavage Volume (CC)	Intervention	20	17.50 (2.24)	0.590
	Control	20	17.05 (2.95)	
Time to 1 Independent Oral Feeding (Day)	Intervention	20	3.80 (1.24)	0.001
	Control	20	5.25 (1.07)	
Time to 4 Independent Oral Feeding (Day)	Intervention	20	5.60 (1.67)	0.001
	Control	20	8.55 (1.5)	
Time to 8 Independent Oral Feeding (Day)	Intervention	20	7.85 (1.87)	0.001
	Control	20	12.15 (2.00)	
Time between 1 and 8 Independent Oral Feeding (Day)	Intervention	20	4.05 (1.09)	0.001
	Control	20	6.90 (1.33)	
Length of Hospitalization (Day)	Intervention	20	14.60 (3.05)	0.001
	Control	20	18.95 (3.82)	
Weight of Discharge Time (gr)	Intervention	20	1940 (589.96)	0.436
	Control	20	1802.50 (511.31)	
Age of Nutrition Start (Day)	Intervention	20	2.65 (0.74)	0.682
	Control	20	2.75 (0.78)	
Age of Oral Nutrition Start (Day)	Intervention	20	3.85 (1.35)	0.001
	Control	20	5.20 (1.00)	
Weight of Oral Nutrition Start (gr)	Intervention	20	1575 (549.28)	0.917
	Control	20	1575.50 (507.38)	

4- DISCUSSION

Premature infants and their families in neonatal intensive care unit struggle with the common problems of feeding and swallowing (30). The present study was conducted as a randomized clinical trial to evaluate the effect of non-nutritive sucking on mother's finger on feeding tolerance and attainment of independent oral feeding in preterm infants admitted to neonatal intensive care unit. The results of this study showed that there is no significant relationship between the two groups of non-nutritive sucking and control in terms of the variables of the infant's birth weight (gr), first and fifth-minute Apgar score, gender, gestational age, birth order, O2 therapy, mother's age, having working mother, maternal education, type of delivery, and age at the beginning of oral feeding. Valizadeh et al. also achieved similar results in their study conducted in 2014 (29). In the present study, the mean gastric residual volume in the non-nutritive sucking group was significantly lower than that in the control group. Mohagheghi et al. in 2012 evaluated the effect of the oral motor interventions and non- nutritive sucking on feeding tolerance in premature born infants. They performed 5 minutes oral motor sensory stimulation and non-nutritive sucking 15 minutes before gavage for seven days in the experimental group. The results of their study showed that the rate of oral feeding tolerance in the NNS group was higher than that in the control group (31). In 2017, Fazli et al. carried out a study with the aim of "Comparing the Effect of Non-nutritive Sucking and Abdominal Massage on Feeding Tolerance in Preterm Newborns", the results did not show any statistically significant difference between the intervention groups in terms of gastric residuals; the feeding tolerance was generally higher among the newborns in the non-nutritive sucking group than those in the other groups (32). Also, Yue et al., in 2003 performed a study to evaluate the effects of intermittent nasogastric feeding with nonnutritive sucking on nutrient and gastrointestinal tract transit time in premature infants; they

found that gastric residual volume in the non-nutritive sucking group was lower than that of the control group (33). Although the method employed in each study is different, the results of all these studies are consistent with those of the present study. The results of our study showed that time to achieve 1, 4, and 8 time independent oral feeding in the non-nutritive sucking group was significantly lower than that in the control group. Also, the interval between 1 and 8 time independent oral feeding in the intervention group was less than that in the control group. In a study by Valizadeh et al. in 2014, they found that comparing to the control group, time to achieve independent oral feeding was significantly lower in both the non-nutritive and oral massage groups (29).

In several other studies, the positive impact of non-nutritive sucking on independent oral feeding in preterm infants has been mentioned (4, 11). The results of these studies are, also, consistent with those of the present study. However, in a study by Khalessi et al. in 2015, conducted to investigate "The effect of oral stimulation along with non-nutritive sucking (NNS) on independent oral feeding initiation and weight gain in preterm infants" and the results showed that time to achieve for 1, 4 and 8 time independent oral feeding in the NNS group was not significantly different from the control group (34). The conflicting results may be due to the difference in gestational age of the newborns and the intervention method employed for the studies. Also, the results of this study showed that the length of hospitalization among infants in the NNS group was significantly lower than that in the control group. On average, the infants in the intervention group were discharged from the hospital 4.5 days earlier than those in the control group. It is likely that the effect of non-nutritional sucking on the length of hospitalization is due to its impact on the feeding skills of the infant (28). This has a significant impact on reducing the financial burden on families, hospitals and government. Another benefit of early discharge from hospital is the reduction of anxiety and stress in the mother, infant and family, leading to more interaction between the infant and the parents (30). In a review study done by Johnston in 2017, the results showed that non-nutritive sucking had a positive effect on reducing the length of hospitalization in preterm infants (35). In another study conducted in 2013, Mahmoudi et al. investigated the effect of sensory movement around the mouth and its relation to the reduction of length of hospital stay in preterm infants (36).

In other studies, the positive effect of non-nutritive sucking and oral stimulation on the reduction of the length of hospitalization in preterm infants has been mentioned (4, 22, 37). The above-mentioned studies are in line with the present study. However, in some other studies, such as those performed by Valizadeh et al. (29), Yue et al. (33), and Fucile et al. (38) it was found that non-nutritive sucking and oral stimulation have no positive effect on the length of hospitalization in preterm infants. The results of these studies are not in line with present study. The cause of this may be the differences in the sample size, gestational age, and type of intervention. Other results of the present indicated that although the weight at discharge was higher among neonates in the NNS group, the difference was not significant. Behnam Voshani et al. in their study in 2013 showed that non-nutritive sucking had no significant effect on neonatal weight gain. They concluded that probably non-nutritive sucking in the long time will increase the weight of the infants (28). In another study carried out by Zhang et al., in 2014 with the aim of investigating the effect of non- nutritive sucking and oral stimulation on feeding

performance in preterm infants, the results showed that there was no significant difference between the intervention and control groups in weight gain of premature infants (39). Also, Yue et al. (33), and Johnston (35) achieved similar results in their studies. The results of this study are consistent with all of the above-mentioned studies; However, Keshavarz et al. in their study concluded that the weight gain of infants in the non-nutritive sucking group was significantly more than that in the control group; this conclusion is not consistent with the results of this study (40). It is likely that the conflicting results due to differences in the type of intervention and method employed for the studies.

4-1. Limitations of the study

The presence and participation of the mothers were the strengths of this study, but some mothers with low self-esteem could not cooperate well in the research, posing a limitation to the study. The other limitation to this study was the unstable physiological status of the preterm infant, and the researchers had no control over it. It is suggested that further studies be done in this field. It, also, should be noted that the researchers did not follow-up the subjects after discharge from hospital.

5- CONCLUSION

The results of the present study showed that non-nutritive sucking on the mother's finger can be an effective way to enhance the feeding tolerance in the preterm infants. Also, non-nutritive sucking on the mother's finger accelerates attainment of independent oral feeding in preterm infants and leads to early discharge from hospital, which, by turn, reduces the financial burden on families and the community, and decreases complications of long-term hospitalization such as infections. Therefore, it is recommended that this study and its low cost procedure be taught to mothers in the NICU.

6- CONFLICT OF INTEREST: None.

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