Original Article

The Effect of Suckling and Swallowing Exercises During the Transition to Oral Feeding in Premature Infants: Randomized Controlled Study

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Abstract

Background: Underdeveloped oral structures of preterm infants cause feeding problems. Therefore, the development of sucking reflexes of premature babies should be supported. **Aim:** Investigating the effect of suck-swallow exercises during the transition to oral feeding in premature infants was the scope of this study. **Methods:** This randomized controlled trial study was conducted in the NICU of a public hospital in Istanbul. The study sample consisted of 82 premature infants. Of these infants, 41 were assigned to the intervention group and 41 to the control group. Study data were collected using the Premature Infant Data Collection Form and Early Feeding Skills Assessment Tool. Throughout the study, preterm infants in the intervention group (n = 41) were given suck-swallow exercises for 12 minutes once a day before feeding for 14 days. SPSS22 was used to analyze the data. **Results:** Male infants constituted 54.9% of the sample group. At enrollment, the gestational age of all infants was 34–37 weeks. Birth weight was 1501–2000 grams in 35.4% of the infants. Evaluation of the 5 sub-parameters of the Early Feeding Assessment Tool revealed that the post-test scores for respiratory regulation, oral motor function, swallowing coordination, feeding participation, and physiological stability were significantly higher in the intervention group than in the control group ($P < 0.005$). **Conclusion:** The results of the study showed that sucking and swallowing exercises applied to premature infants improved oral feeding skills and in this context, the use of sucking and swallowing exercises in neonatal intensive care units is recommended. **ClinicalTrials.govID:** NCT06371443.

Keywords: *Feeding, premature infant, suckling–swallowing exercise*

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Introduction

The World Health Organization (WHO) describes premature infants as those born alive before the 37th week of gestation (WHO, 2022).[1] Preterm infants face numerous challenges in the postnatal period due to their anatomical and physiological immaturity.[2] Oral structures that are not well developed create a feeding problem, one of the most important problems in infants.[3] Premature infants with oral feeding problems are often associated with delayed hospital discharge, maternal stress, and long-term health problems.[4] Oral feeding can be used for infants who are at least 32–34 weeks' gestational age, have sucking-swallow-breathing coordination, and have a respiratory rate of less than 60 per minute.[5,6] Oral feeding of premature infants is a complex process requiring the interaction of oral–motor, neurological, cardiorespiratory, and gastrointestinal systems with internal and external factors and with each other. Any problem with any of these systems can adversely affect the adequacy of the infant's oral feeding.[4]

A systematic assessment should be performed to determine whether the preterm infant is ready for oral feeding.[7] One way of assessment, oral–motor exercises (OME), refers to sensory stimulation or

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exercises that involve movement of the jaw, tongue, lips, respiratory muscles, velum, and larynx.[8,9] Oral and tactile stimuli are determined according to the infant's developmental level, and multi-sensory stimuli are provided to support the development of all systems on a broad scale to support simultaneous development and growth. There are several studies in the related literature of tactile stimulation with 12–30 minute therapeutic massage of the mouth, tongue, cheeks, lips, mandible, head, neck, and trunk muscles in premature infants to support oral motor development.[10-12]

The oral stimulation method is a care intervention performed by applying stimulation to the oral and perioral structures with a finger and then with a pacifier, where the oral-perioral stimulation intervention is applied in an individualized and planned sequence.[13] However, assessing oral feeding skills in preterm infants requires a multidisciplinary team using a valid and reliable assessment tool.[14] Oral feeding supports the premature infant's self-organization and increases feeding performance. So, plans are made to provide effective oral feeding through the use of sucking and swallowing exercises for premature infants with inadequate oral intake.[9]

Methods

This is a randomized controlled trial. This study was conducted to evaluate the effect of sucking and swallowing exercises during the transition to oral feeding in premature infants.

In this process, the study sought to answer the question, "Do suckling and swallowing exercises have an effect on the transition to oral feeding?".

This study was conducted at the neonatal intensive care unit in a public hospital in Istanbul between December 2021 and June 2022. Only the infants meeting the inclusion criteria, whose parents consented to the study, were included in the study sample. After performing a power analysis, the number of subjects to be involved in the study was determined. The power of the test was calculated using the G*Power 3.1 program. Aras Doğan *et al*.,[7] in a similar study, calculated the size of the effect of the difference between groups in terms of feeding as 0.737. When the power of the study was calculated, it was calculated that a total of 82 subjects, 41 per group, would be required to exceed the 95% power at the 5% significance level for an effect size of 0.737 (df = 80; t = 1.664). 41 in each group, the study was completed with 82 infants. The flow chart developed by the investigator was based on the Consolidated Standards for Reporting Trials (CONSORT) checklist [Figure 1].

The infants included in the study were randomized through the randomization table created by "https://www.calculatorsoup.com": To avoid bias, the subjects were randomly allocated to the groups by matching with the randomization table according to patient registration number and order of arrival.

Inclusion criteria of the study

- Babies born in 34–37 weeks of gestation and babies born before 34 weeks of gestation, and reach 34 weeks of gestation
- Premature infants with stable vital signs
- Babies who do not latch on to the nipple and suckle
- Infants with a length of stay of 14 days or more in the NICU.

Exclusion criteria of the study

- Intubated infants
- Infants with multiple anomalies
- Infants with asphyxia.

Data collection tools

Data were collected using the Premature Infant Data Collection Form and the Early Feeding Skills Assessment Tool.[15]

In the premature infant data collection form developed by the researchers, descriptive information (gender, mode of delivery, birth week, etc.) of the infants was included. To assess the early feeding skills, we used 'The early feeding skills assessment tool' (EFS) developed by Thoyre, Shaker, and Pridham[16] in 2005 and adapted to Turkish by Aykanat Girgin *et al*.[14] This scale reliably assesses skills contributing to safe and successful oral feeding of preterm infants in 5 sub-dimensions, including respiratory regulation, oral motor function, swallowing coordination, feeding participation, and physiological stability. The validity Cronbach's alpha value of the scale is 0.81. Each sub-dimension is scored separately. Each item can be assigned 1, 2, or 3 points, where 1 point indicates the lowest skill level or high frequency of problems; 2 points indicates emerging/occasionally observed skills or occasionally observed problems; and 3 points indicates mature skills or no problems. Once the total scores are recorded, the appropriate option is determined, and the newborn is followed up for feeding. Higher scores on the scale indicate more mature feeding skills.[14] For this study, we found the Cronbach's alpha value of the scale as 0.96.

Data collection

Before the Procedure: Firstly, informed consent was obtained from the parents of the infants in the intervention and control groups meeting inclusion criteria and had low sucking success. After that, the premature infant identification form was completed. Then, the

sucking activity of premature infants was evaluated with the Early Feeding Skills (EFS) Measurement Tool. Infants who did not perform the sucking reflex were included in the study group.

Order of Procedures: Oral motor stimulation exercises developed by Fucile were applied by the researcher to the infants in the intervention group who needed sucking-swallowing exercises according to the Early Feeding Skills Measurement Tool for 14 days, once a day for 12 minutes before feeding. The process took about 15 minutes. The infants in the control group did not receive any application.

After the Procedure: The infants in both groups were evaluated again 14 days after according to the Early Feeding Skills (EFS) Measurement Tool.

Data analysis

The data collected in the study were analyzed using SPSS (Statistical Package for Social Sciences) 22.0 for Windows software. Numbers, percentages, means, and standard deviations were used as descriptive statistical methods to analyze the data. Using Chi-square and *t*-tests, Kurtosis and skewness values were examined to determine whether the study variables were normally distributed or not.

Ethical considerations related to the study

The study was conducted after obtaining the necessary permissions from the Non-Interventional Clinical Research Ethics Committee of Istanbul Medipol University (Decision number: 1054, date: 26.10.2021) and the hospital in which the study was going to be conducted, and parents who consented their children to participate in the study. Infants enrolled in the study were not exposed to any practices or procedures without parents' consent.

Results

In the study cohort, 54.9% of the babies were male. 81.7% were born by cesarean delivery. 42.7% were born at 31–34 weeks of gestation. 35.4% had a birth

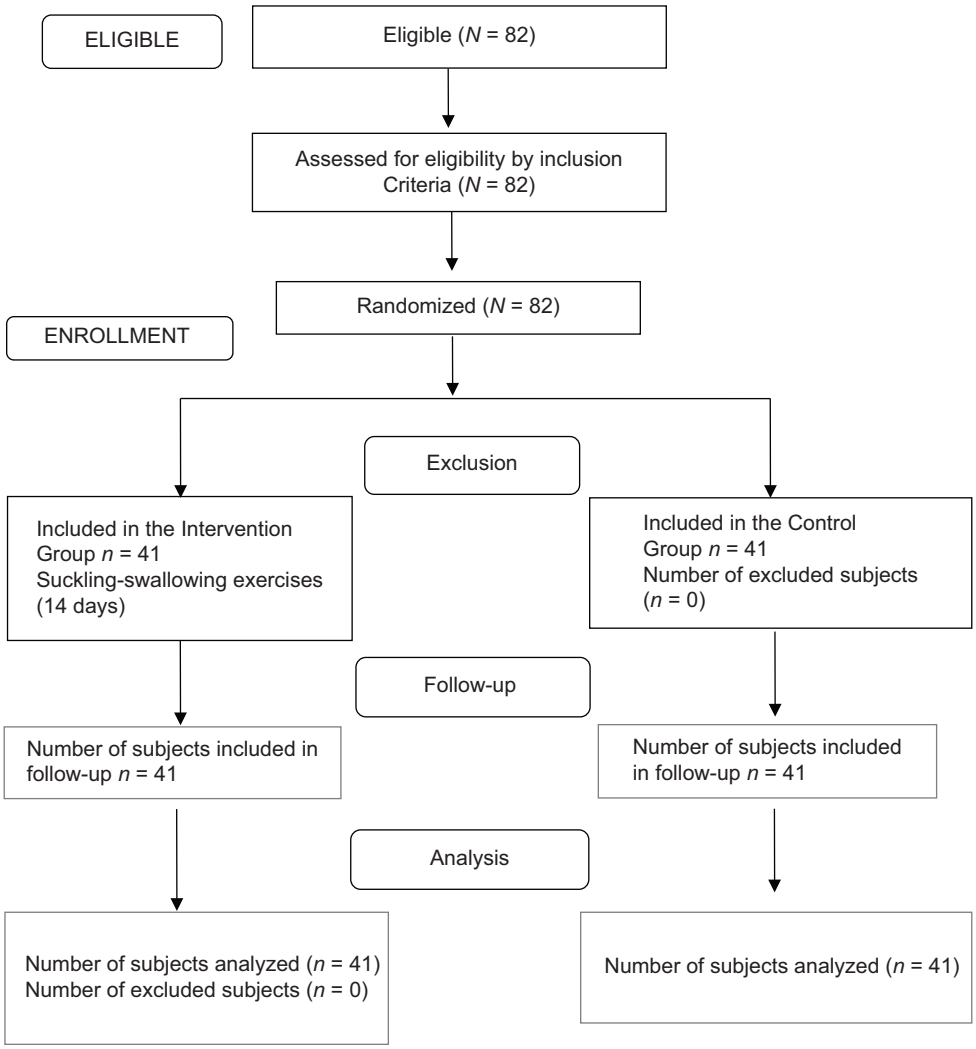

Figure 1: Flow chart of the study sample (CONSORT)

Table 1: Descriptive characteristics (*n*=82)

Characteristics		Intervention		Control		Total		*P*
		n	%	*n*	%	*n*	%	
Gender of the infant	Female	17	41.5	20	48.8	37	45.1	X^2=0.443
	Male	24	58.5	21	51.2	45	54.9	*P*=0.329
Type of delivery	Normal spontaneous birth	8	19.5	7	17.1	15	18.3	X^2=0.082
	Cesarean section	33	80.5	34	82.9	67	81.7	*P*=0.500
Gestational age at birth	28–31 weeks	9	22.0	5	12.2	14	17.1	X^2=2.885
	31–34 weeks	19	46.3	16	39.0	35	42.7	*P*=0.236
	34–37 weeks	13	31.7	20	48.8	33	40.2	
Birth weight of the infant	<1000 g	2	4.9	0	0.0	2	2.4	X^2=8.367
	1000–1500 g	8	19.5	5	12.2	13	15.9	*P*=0.079
	1501–2000 g	17	41.5	12	29.3	29	35.4	
	2000–2500 g	10	24.4	11	26.8	21	25.6	
	>2501 g	4	9.8	13	31.7	17	20.7	
Baseline weight of the infant at enrollment	1000–1500 g	2	4.9	3	7.3	5	6.1	X^2=6.710
	1501–2000 g	20	48.8	11	26.8	31	37.8	*P*=0.082
	2001–2500 g	13	31.7	12	29.3	25	30.5	
	>2501 g	6	14.6	15	36.6	21	25.6	
Phototherapy in the last 24 hours	Yes	0	0.0	4	9.8	4	4.9	X^2=4.205
	No	41	100.0	37	90.2	78	95.1	*P*=0.058
Oxygen support during the study	No	32	78.0	35	85.4	67	81.7	X^2=0.734
	Yes	9	22.0	6	14.6	15	18.3	*P*=0.284
Oxygen support	O_2 by hood	1	11.1	1	16.7	2	13.3	X^2=0.096
	O_2 in the isolette	8	88.9	5	83.3	13	86.7	*P*=0.657

Chi-square analysis

Table 2: Differentiation of early feeding skills scores by group (*n*=82)

Test	Intervention (*n*=41)	Control (*n*=41)	*t*[a]	*P*
Pre-test	36.390+8.823	39.390+9.828	−1.454	0.150
Post-test	55.585+3.138	47.585+5.950	7.615	<0.001
t[b]	−15.906	−9.318		
P	<0.001	<0.001		

[a]Independent groups *t*-test; [b]Dependent groups *t*-test

weight between 1501 and 2000 g. Of the premature infants, 95.1% did not receive phototherapy support in the last 24 hours. 81.7% did not receive oxygen support during the study. 86.7% received in-incubator O_2 support [Table 1].

Infants' post-test scores for early feeding skills were significantly different between groups ($t_{(80)}$ = 7.615; $P < 0.001$). Post-test scores for early feeding skills were higher in the intervention group ($\bar{x}$ = 55.585) compared to the control group ($\bar{x}$ = 47.585). There were no significant differences between groups in infants' pretest scores for early feeding skills ($P > 0.05$) [Table 2].

The pretest respiratory regulation scores of the premature infants in the study sample indicated a significant difference between the groups ($P < 0.05$). The control group's pretest scores on respiratory regulation ($\bar{x}$ = 10.220) were higher than the intervention group's ($\bar{x}$ = 9.049), [Table 3].

A significant difference was found between the groups in the posttest scores of respiratory regulation, oral motor function, swallowing coordination, participation in feeding and physiological stability of premature infants ($P < 0.001$). The post-test respiratory regulation scores ($\bar{x}$ = 14.659), oral motor function scores ($\bar{x}$ = 11.585), swallowing function scores ($\bar{x}$ = 11.829), feeding participation scores ($\bar{x}$ = 5.756), and physiological stability scores ($\bar{x}$ = 11.756) of the premature infants in the intervention group were higher than the scores of the control group [Table 3].

Discussion

Sucking activity begins in the first 7–8 weeks of fetal life; however, sucking and swallowing are not completely regular from 28 to 32–34 weeks of gestation.[17] To safely begin oral feeding, the respiratory rate should be less than 60 per minute, and there should be a gag reflex to minimize the risk of aspiration. A successful oral feeding requires active suck–swallow coordination, very little leakage during bottle feeding, and completion of feeding within 15–30 minutes.[18]

Table 3: Intergroup comparison of scale scores (*n*=82)

	Test	Intervention (*n*=41)	Control (*n*=41)	*t*[a]	*P*
Differentiation of respiratory regulation scores by group	Pre-test	9.049±2.302	10.220±2.851	-2.046	0.044
	Post-test	14.659±1.039	12.024±1.930	7.695	<0.001
	t[b]	-17.136	-7.772		
	P	<0.001	<0.001		
Differentiation of oral motor function scores by group	Pre-test	7.122±1.720	7.000±2.156	0.283	0.778
	Post-test	11.585±0.894	9.415±1.673	7.328	<0.001
	t[b]	-17.708	-10.310		
	P	<0.001	<0.001		
Differentiation of swallowing coordination scores by group	Pre-test	8.244±2.596	9.317±2.392	-1.947	0.055
	Post-test	11.829±0.543	10.902±1.281	4.266	<0.001
	t[b]	-9.258	-6.422		
	P	<0.001	<0.001		
Differentiation of participation in feeding scores by group	Pre-test	3.098±0.889	3.244±1.261	-0.607	0.545
	Post-test	5.756±0.538	4.488±0.810	8.353	<0.001
	t[b]	-21.439	-8.967		
	P	<0.001	<0.001		
Differentiation of physiological stability scores by group	Pre-test	8.878±2.135	9.610±2.023	-1.593	0.115
	Post-test	11.756±0.699	10.756±0.943	5.455	<0.001
	t[b]	-9.380	-4.811		
	P	<0.001	<0.001		

[a]Independent groups *t*-test; [b]Dependent groups *t*-test

The Early Feeding Skills Assessment Tool (EFS), designed to address areas of concern in the skills of preterm infants transitioning to oral feeding, facilitates the planning of feeding interventions and assesses feeding skills. During the transition to oral feeding, the feeding skills of premature infants should be assessed to organize and implement appropriate interventions to improve these skills.[19]

In the study, there were no statistical differences between the groups and in the descriptive characteristics of the infants forming the sample of study sample, which indicated that the groups were homogeneously distributed. In terms of early feeding skills, no statistically significant difference was found between the pretest scores of the groups; however, in the intervention group, the post-test scores were significantly higher compared to the control group. The literature indicates that the methods used in combination are effective in the transition to total oral feeding.[20] One study reported that interventions combining oral stimulation with tactile/kinesthetic stimulation affected the transition to independent oral feeding positively and improved feeding skills.[21] Lau and Smith found that swallowing exercise was an effective intervention in facilitating the transition to independent oral feeding.[22] Recent studies show that controlled exercises applied to the oral structures contribute to a better adaptation of the premature infant to extrauterine life and to the safe feeding of these newborns. We observed that the suckling and swallowing exercises used in our study had a positive effect on the feeding skills of the intervention group. Our findings support the results of other studies in the literature.

Effective and safe feeding requires not only an efficient suckling ability but also proper coordination of suckling, swallowing, and respiration, which involves the functional interaction of the lips, jaw, tongue, palate, pharynx, larynx, and esophagus. According to a study on the development of cue-based feeding, when an infant has difficulty coordinating breathing and sucking, the initial typical rhythmic sucking changes to irregular, arrhythmic sucking. It is suggested that this form of sucking indicates breathing problem rather than the ability to use oral motor structures for sucking.[23] In our study, in the control group, the infants had high pretest scores, while in the intervention group, the infants had high post-test scores. This indicates that the exercises we are supporting the infants' breathing regulation.

When pretest and posttest scores were compared within and between groups, oral motor function scores were significantly higher in favor of posttest scores in the intervention group. A study conducted to evaluate the benefit of an oral stimulation intervention on sucking skills development in premature infants found that the stimulation resulted in better oral feeding outcomes by improving infants' sucking skills.[15] In the study of oral and non-oral sensorimotor interventions in Fucile *et al*.,[21] it was observed that preterm infants given combined sensorimotor interventions started independent

oral feeding earlier than those who did not receive such interventions. The exercises performed in this setting contributed to a more voluminous feeding of the infants and a reduction in the loss of breast milk during suckling. In the study titled "Impact of Oral Sensory Motor Stimulation on Feeding Performance, Length of Hospital Stay, and Weight Gain of Preterm Infants in NICU," it was reported that feeding was improved in preterm infants through sucking and swallowing exercises and those patients were discharged from the hospital earlier.[10] There are studies with similar results in terms of hospital stay for preterm infants with and without the use of oral motor stimulation (OMS).[24-26] In our study, we observed that sucking and swallowing exercises supported the transition of premature infants to oral feeding and improved their sucking activity.

While the pre-test swallowing coordination scores in our study were higher in the control group, the post-test scores were higher in the intervention group. In a study conducted to determine the developmental coordination of sucking, swallowing, and breathing in premature infants, it was reported that swallowing coordination did not develop in premature infants less than 34 weeks gestational age and was not fully developed even in those born at 36 weeks.[27] Suck-swallow exercises provide a supportive practice to improve the undeveloped suck-swallow-respiratory coordination of premature infants. In our study, the infants in the intervention group achieved more controlled swallowing at the end of 14 days, while those in the control group developed respiratory problems due to irregular swallowing. A study of oral feeding adequacy in healthy preterm infants by Bertoncelli *et al*.[20] reported that the exercises performed on preterm infants affected suckling, breathing, and swallowing coordination as well as feeding skills, specifically the number of sucking activities and the ability to suck on each attempt. The data from this study show that sucking-swallowing exercises applied to premature infants, as suggested by other studies, improve swallowing coordination in infants.

The intervention group was significantly more likely to participate in feeding than the control group. An infant who has reached a sufficient level of oral-motor development for oral feeding will seek out the nipple when the lips are caressed, insert the nipple into the mouth, and position the tongue to create a sucking rhythm that facilitates proper feeding.[28] The infant's ability to begin sucking in an organized and regular rhythm immediately after grasping the nipple is considered part of oral motor function.[29,30]

In McCain's[31] study, "Promotion of preterm infant nipple feeding with non-nutritive sucking," sucking and swallowing exercises given to infants resulted in fewer behavioral changes during feeding and produced calmer and alert states during feeding. The study found no difference between the infants fed after nonnutritive suckling and the infants in the control group. In our study, we observed that, in the intervention group, the exercises performed enabled the infants in this group to remain awake and to suckle more during the feeding process, while in the control group, the participation in the feeding process was weak due to the inactive state of remaining awake. These results show that the applied exercises improve the sucking reflexes of the infants, develop and strengthen their swallowing skills, help them to suck better and participate in feeding. White-Traut *et al*.[32] reported that exercises applied to premature infants improved their wakefulness during the feeding process and produced positive neurobehavioral outcomes, suggesting that this method can be used as a feeding support intervention, and this finding supports our study findings.

In our study, the physiological stability post-test scores of the premature infants were noticeably higher in the intervention group than in the control group. A newborn's heart rate is usually between 120 and 160 beats per minute. Although this rate can be as high as 170–180 per minute immediately after birth, it returns to normal within 24 hours. These values may vary depending on the newborn's sleep, wakefulness, feeding, and stress conditions. The oxygen saturation of an infant receiving oxygen should be closely monitored during feeding. The infant's cardiovascular functions should also be closely monitored during oral feeding. Studies have reported that suck-swallow exercises are effective in regulating oxygen saturation levels in preterm infants fed orally.[17,18,33]

A study by Pickler *et al*. examining the efficacy of non-nutritive suckling on behavioral structure and feeding efficiency in premature infants showed that oxygen saturation level was observed to be higher in preterm infants with a history of exercise than in those without a history of exercise.[34] The study supports the results of our study that the physiological parameters of the infants (heart rate-oxygen saturation) are more stable with the exercises we used.

Limitations of the study

Only premature infants in the neonatal intensive care unit of the selected hospital were included in the study. Therefore, the results cannot be generalized to the general population.

Conclusion

As a result of the data collected in the study, we found that sucking and swallowing exercises have a positive

effect during the period of transition to oral feeding in premature infants. In light of the results of this study, we recommend the use of sucking-swallowing training for premature infants, the routine provision of training in NICUs, and comprehensive randomized controlled clinical trials with larger numbers of patients as part of evidence-based care.

Ethical considerations of the study

The study was conducted after obtaining the necessary permissions from Istanbul Medipol University, Non-Interventional Clinical Research Ethics Committee (decision number: 1054, date: 26.10.2021) and the hospital where the study was to be conducted, as well as the informed consent of the parents who consented their children to participate in the study. Infants enrolled in the study were not exposed to practices or procedures that would violate patient rights, that parents would consider inappropriate, or that would adversely affect the patient.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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