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A Single-Subject Study to Consider the Premature Infant Oral Motor Intervention Combined with Kinesio-Tape in Premature Infants with Feeding Problems

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Abstract

Background: The survival rate in premature infants (PIs) has increased, but many have medical and developmental complications. Difficulty with sucking, swallowing, and poor nourishment are common complications. This study aimed to investigate the effects of Kinesio-tape (KT) combined with premature infant oromotor intervention (PIOMI) on feeding efficiency (mean volume intake [%MV]), oromotor skills (Preterm Oral Feeding Readiness Assessment Scale [POFRAS]), and weight gain in PIs.

Methods: In this single-subject study, 5 PIs with feeding problems were received the PIOMI-KT for 7 consecutive days. The main outcome measure was the POFRAS scale. The %MV and weight gain were the secondary outcome measures. Measurements were taken before treatment (T0), after the 4th session (T1), and after the 7th session (T3).

Results: The POFRAS scores, %MV, and weight gain improved in all infants after treatment. The maximum and minimum change in level between the baseline and treatment phase was +26 and+16 for POFRAS, +54 and, +34 for %MV, +180, and +100 for weight gain. The treatment trend was upward for all infants and shown by the directions of the slopes indicated by positive values. The feeding problems were resolved in all infants after the 7th treatment session.

Conclusion: The combination therapy of PIOMI-KT improved feeding function in PIs.

Keywords: PIOMI; Kinesio-Tape, Premature, Infants, Feeding Problems

Conflicts of Interest: None declared
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Introduction

Premature birth is defined as the delivery of the fetus before 37 weeks of pregnancy(1-3). The common aetiologies of preterm birth may include multiple pregnancies, maternal infections, and chronic conditions such as diabetes and high blood pressure (4). The worldwide rate of preterm birth has continued to increase during the past 2 decades (3), and its prevalence in Iran was estimated to be 9.2% of all live births (5). Preterm birth is a significant cause of infant morbidity and mortality and may cause many problems, such as neurodevelopmental issues, cognitive, hearing, visual, and behavioral problems, and feeding problems (4, 6, 7).

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↑What is "already known" in this topic:
Difficulty with sucking and swallowing are common complications in PIs. There are several evidence-based interventions that can be used alone to improve oral feeding in PIs. There is not sufficient evidence to suggest that combining the different interventions can lead to improvement of the oral feeding skills of PIs.

→What this article adds:
This study suggests that the combination of KT plus PIOMI improved oral intake and other aspects of PIs feeding and it provides the therapist with a treatment method that appears to be effective over a fairly short period of time.

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Oral feeding is a complex phenomenon that needs sufficient function and integration of different parameters—such as oral musculature, postural control, lung function, and proper behavioral state (8). Feeding problems are commonly seen in premature infants (PIs) due to immaturity of oral motor skills and incoordination of suck-swallow-breath (9-12). Feeding problems lead to severe complications—such as malnutrition, dehydration, weight loss, and developmental deficits (13). The feeding problems must be diagnosed and treated because it is associated with mortality, increased hospital stays, and higher costs.

There are evidence-based interventions that improve feeding problems in PIs, including cue-based feeding approaches, nonnutritive sucking approaches, traditional approaches, and premature infant oral motor intervention (PIOMI) (14-21). The PIOMI improves the PI's functional response to pressure and activates movements in different parts of perioral structures, which target the rapid growth of neuronal pathways specific to feeding skills (19, 20). Overall, other studies suggest that PIOMI can be an effective intervention for improving oral feeding skills, development of oral-motor skills, swallowing function, weight gain, reduced transition days to full oral feedings in PIs, and reduction in the duration of hospitalization in PIs, especially when incorporated into a multidisciplinary feeding program (19-23).

Recently, noninvasive Kinesio-taping (KT) has been used to improve oral motor control, sucking, swallowing, and lip closure in different populations, such as cerebral palsy, neurological impairments, down syndrome, and PIs (24-31). Previous studies suggest that KT may be a promising tool for improving oral motor function and related outcomes. Specifically, KT appears to be effective in enhancing sucking behavior, swallowing function, tongue strength, and reducing drooling frequency and severity (24-31). Overall, while more research is needed to understand the benefits of KT for feeding and swallowing fully, these studies suggest that it may be a helpful adjunct intervention for patients with various conditions that affect these functions (29, 31).

The effect of the combination of varied methods—such as PIOMI, NNF, and oral support—has been investigated in PIs, and these studies showed that multimodal intervention is more effective than unimodal intervention for acquiring oral feeding in PIs because of a synergistic/additive effect on feeding parameters (14-16, 18, 32, 33), but the impact of PIOMI plus KT has not been examined in PIS suffering from feeding problems.

Therefore, this study aimed to investigate the effects of KT-PIOMI on feeding efficiency (mean volume intake [%MV]), oromotor skills (Preterm Oral Feeding Readiness Assessment Scale [POFRAS] outcomes), and weight gain in PIs in PIs admitted to the neonatal intensive care unit (NICU).

Methods

Study Design

This research used an A-B single-subject design to evaluate 5 PIs with feeding problems. The ethical committee of Iran University of Medical Sciences approved the study (ethics code: IR.IUMS.REC.1400.479). All parents of PIs gave written consent for participation in the study. Interventions were applied by only 1 researcher, who was an expert in the treatment of feeding problems in PIs. The therapist was blinded to the outcomes of the assessments. The assessor was another researcher who evaluated outcome measures in the assessment phases.

Participants

Five PIs with feeding problems were included in the research. All participants received regular Kangaroo mother care (KMC). Convenience sampling was used to involve PIs in this study. The inclusion criteria were as follows: (1) gestational age at birth between 30-34weeks; (2) physiological stability; (3) Apgar score ≥5 at 5minutes after birth; (4) birth weight between 1000 and 1500g; (5) not receiving mechanical ventilation; (6) no severe or chronic medical status or congenital anomalies; and (7) having feeding problems according to medical report and assessment of experienced speech therapist in the NICU section. The PIs received both OG tube feeding and beginning oral feeding, with a minimum of at least 1 mL of oral feeding. Infants were given their breast milk or pasteurized donor breast milk stored in the human milk bank of Akbarabadi Hospital. The infants could receive oxygen by oxyhood or nasal prong, if needed during the stimulation. The exclusion criteria were as follows :(1) transfer the PIs to another medical center; (2) physiological instability of respiratory and heart rates, oxygen saturation (SPO2), temperature, and skin color during the intervention; and (3) having any skin allergies after the KT.

A speech therapist collected demographic data of PIs. The POFRAS, %MV, and weight gain were administered to the evaluation of oral feeding readiness before intervention (T0), after the end of the 4th intervention session (T1), and after the end of intervention sessions (T2). Therefore, there were 3 assessment phases: 1 evaluation was administered pretreatment, and 2 evaluations were performed during the intervention phases.

Interventions

The PIs received PIOMI-KT for 7 continuous days. Each intervention session commenced with PIOMI, and KT was applied after that in the same session.

PIOMI, as an oral-motor protocol, stimulates orofacial structures (cheeks, lips, gums & tongue) according to 8 steps to improve the functional response to pressure and movements in the targeted structures. This prefeeding protocol is designed specifically for PIs (19), and it limits the stimulation to 5 minutes to protect PIs from experiencing behavioral or physiologic distress. In this research, the PIOMI was provided for 5 minutes once per day over 7 consecutive days and was delivered 30 minutes before feeding.

After administering PIOMI, the speech therapist continued the intervention with the application of the KT. Because of the fragile and soft skin of PIs, the paper-off tension (15%tension) was applied. After the skins of the PIs were cleaned with an alcohol pad and the evaporation of alcohol, the KT was used for the Masseter, Mylohyoid-Sternohyoid muscles and the orbicularis oris (upper &

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Figure 1. KT applied for the Orbicularis oris muscles(upper&lower)

Figure 2. KT applied for the Masseter muscle

lower) (Figures1-3). Table 1 shows the details of the KT provided by a speech therapist (26). The nurses, speech therapist, and families observed no allergy event during the intervention period. The speech therapist checked the tapes throughout the day until the subsequent application of KT. KT was provided once per day over 7 consecutive days and was delivered after PIOMI.

Outcome Measures

This research used the Preterm Oral Feeding Readiness Assessment Scale (POFRAS) as the primary outcome measure. The %MV and weight gain were measured as the secondary outcome measures.

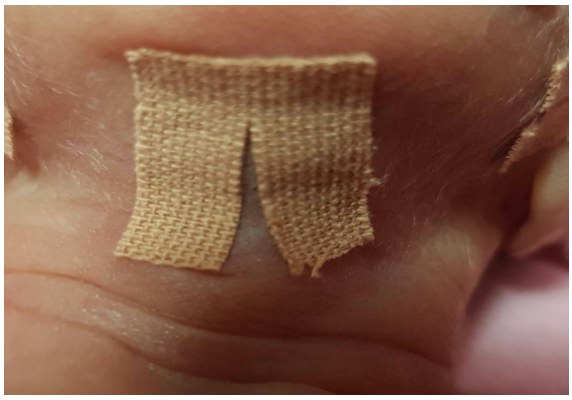

Figure 3. KT applied for the Mylohyoid-Sternohyoid muscles

The POFRAS, as a valid and reliable tool, was applied to assess the oral feeding readiness in PIs (34). It consists of 18 items relating to corrected gestational age (GA), behavioral state, posture and tone, gag reflex, tongue movement, tongue cupping, jaw movements, and state. Each item of the POFRAS was scored from 0 to 2, with a maximum score of 36 (34).

To calculate the %MV, first, the mean volume of oral intake was calculated according to the average amount of oral intake during the first 5 minutes of 2 consecutive feedings.“After raw MVs were collected, the percentage of raw MV in proportion to the prescribed volume was calculated to provide a more accurate measure of individual new-born efficiency”(35). The %MV was measured for assessment phases.

Weight gain (g) was measured by a digital balance sensitive to 1 g. Weight was measured on a calibrated infant scale without diapers and clothes. The same trained nurse weighed the infants every day before feeding. The weight gain was recorded in the assessment phases.

Data Analysis

A methodologist performed the data analysis. Visual analysis was applied for data interpretation. The level was calculated for the differences between the baseline and intervention phases. To quantify the trend, slopes were computed using SPSS Statistics Version 22 (SPSS Inc).

Table 1. Details of the Kinesio-taping(KT) provided by a speech therapist

Muscle	Description of KT type	Anchor site	Application
Orbicularis Oris(upper&lower)	Two I-type tapes With pulling force of about 15%to the bilateral corner of the mouth	The midpoint of both tapes and lips	Lip closure facilitation because of the shrinking direction
Masseter	The tape half in width and two-thirds of a grid in length was separated into 3 ends under 15%pulling force over the masseter muscle	The lower border of the zygomatic arch and elongated to the coronoid process of the mandible bone	Jaw movement facilitation
Mylohyoid- ternohyoid	One-quarter of a Y-type tape one-fourth in width and two-thirds of a grid in length	The posterior border of the symphysis of the mandible by separating the 2ends to prevent direct taping on the hyoid bone	Hyoid bone elevation facilitation through inhibiting the Sternohyoid muscle but facilitating the mylohyoid muscle

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Results

A total of 6 PIs were included in the study according to the inclusion criteria, but 1 premature infant was excluded from the study because it was transferred to other medical centers. In general, 5 PIs with feeding problems (2 men and 3 women, GA between 30-31.6 weeks) were included and completed the combination intervention. The time between GA at birth and initiation of intervention ranged from 6 to 20 days (Table 2). The POFRAS scores ranged from 6 to 13, the %MV ranged from 21 to 30, and the weight ranged from 1010 to 1400 g at pretreatment (Table 3).

As shown in Table 3, the POFRAS scores improved in all PIs after the intervention. Participants 4 and 5 showed the most significant improvement after the 4th intervention session (T1). Moreover, participants 1 and 3 showed the most significant improvement after the end of the intervention sessions (T2). The maximum and minimum change in level between the baseline and intervention phases was +26 and +16 observed in participants 4 and 2, respectively. The treatment trend was upward, as shown by the directions of the slopes, which were indicated by positive values (+8-+13) (Figure 4).

All participants' %MV of oral intake (Table 3) improved

Table 2. Dempgraphic characteristics of participants

Partici-pant	Sex	GA*at birth (week + day)	Weight at birth (g)	Apgar score (5min)	PMA**at initiation of intervention (week+day)	participants' initial feeding problems
1	Female	31+6	1200	7	34+5	Weakness of:behavioral state, posture, tone,oral reflexes, lip and tongue movement,tongue cupping, sucking, jaw movement.
2	Female	31+4	1000	6	32+3	Weakness of:behavioral state, posture, tone, oral reflexes, tongue movement,sucking strain, maintenance of sucking rhythm, jaw movement.
3	Female	31+2	1480	7	32+5	Weakness of:posture, tone, oral reflexes, tongue movement, maintenance of sucking rhythm,jaw movement.
4	Male	30	1400	9	32	Weakness of:behavioral state, posture, tone, oral reflexes,lip and tongue movement, tongue cupping, maintenance of sucking rhythm,sucking strain, jaw movement.
5	Male	31	1200	8	32 6	Weakness of:behavioral state,tone, oral reflexes,tongue movement and cupping, sucking strain

*Gestational Age
**Post-Menstrual Age

Table 3. POFRAS*score, %MV**, weight at T0, T1 & T2

Participants	1	2	3	4	5
POFRAS score					
T_0	7	13	13	6	13
T_1	17	22	25	25	26
T_2	31	29	36	32	34
%MV					
T_0	21	29	26	25	30
T_1	45	36	50	46	53
T_2	75	80	60	78	68
Weight					
T_0	1250	1010	1300	1400	1180
T_1	1290	1100	1355	1510	1200
T_2	1350	1160	1400	1580	1290

*Preterm Oral Feeding Readiness Assessment Scale
**Percent of Mean Volume intake

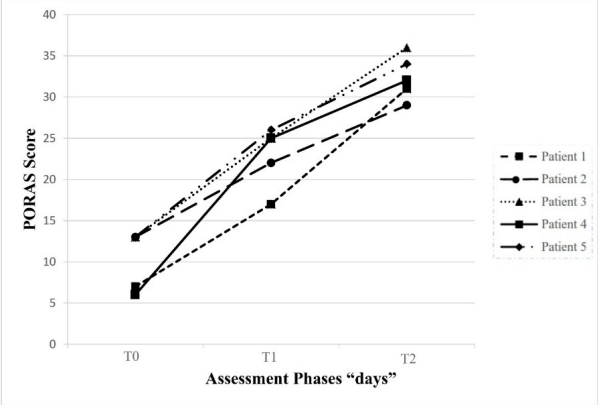

Figure 4. POFRAS score trend among participants across assessment phases following the combined PIOMI-KT treatment approach.
*Trend was upward after combined therapy (Slopes values: participant1:+12, participant2:+8, participant3:+11.5, and participant4:+13, participant5:+10.5).

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after the intervention. Participants 1 and 3 significantly improved after the 4th intervention session (T1). Moreover, participants 2 and 4 showed the most significant improvement after the intervention sessions (T2) ended. The maximum and minimum change in level between the baseline and intervention phases was +54 and +34 observed in participants 1 and 3, respectively. The treatment trend was upward, as shown by the slopes' directions, indicated by positive values (+17-+27) (Figure 5).

The weight values (Table 3) improved in all participants after an intervention. Participants 2 and 4 showed the most significant improvement after the 4th intervention session (T1). Moreover, participants 4 and 5 showed the most significant improvement after the end of the intervention sessions (T2). The maximum and minimum change in level between the baseline and intervention phases was +180 and +100, observed in participants 4 and 1, respectively. The treatment trend was upward, as shown by the slopes' directions, indicated by positive values (+50-+90) (Figure 6).

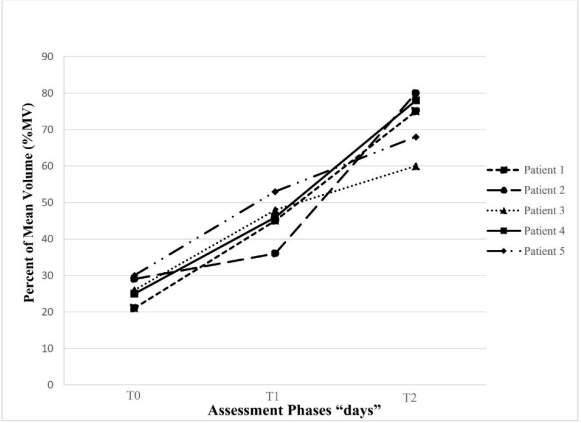

Figure 5. Percent of Mean Volume intake(%MV) trend among participants across assessment phases following the combined PIOMI-KT treatment approach.
*Trend was upward after combined therapy (Slopes values: participant1:+27, participant2:+25.5, participant3:+17, and participant4:+26.5, participant5:+19).

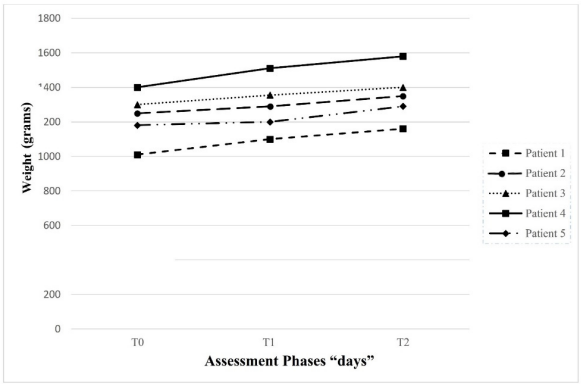

Figure 6. Weight gain trend among participants across assessment phases following the combined PIOMI-KT treatment approach.
*Trend was upward after combined therapy (Slopes values: participant1:+75, participant2:+50, participant3:+50, and participant4:+90, participant5:+55).

Discussion

The present study findings support the usefulness of the combined intervention of PIOMI plus KT for feeding problems in PIs. The results of this study are in agreement with Fucile et al (2011) and Jaywant and Kale (2020), which showed that the multimodal approaches could have an additive effect on the improvement of oral feeding skills in PIs (14, 32).

Our findings showed that POFRAS scores improved in the PIs, indicating improvements in oromotor skills after PIOMI-KT intervention. The most significant improvements were obtained after patients received PIOMI in combination with KT on the fourth day. Moreover, dose-response evidence has shown that the more days of PIOMI, the greater the positive effect (33, 35). PIs with the lowest scores on POFRAS pretreatment (participants1 and 4) showed the most significant improvements after treatment sessions compared with baseline. These results indicate that PIs with more severe feeding problems may profit more from combination intervention.

The findings showed that the MV increased for all PIs across the assessment phases. Participant 2 (with the lowest Apgar score at 5 min and lowest weight at birth) obtained the most insufficient improvement after the fourth intervention session (T1). Lower weight at birth in participant 2 may have resulted in less ability to suck and coordinate efficient feedings at T1 (36). However, the participant consumed a greater %MV than other participants at T2, which shows greater feeding efficiency. This can be because combination intervention assists in the entrainment of afferent pathways that facilitate later feeding. These findings may imply the evidence that the combination of PIOMI with KT had a beneficial effect on the neuromuscular development of promotor skills and accelerated independent and full oral feeding.

The results of our study demonstrated that weight gain was improved over time in all participants. The more significant weight gain was observed for participants 2 and 4 after the 4th intervention session (T1) and for participants 4 and 5 after the 7th intervention session (T2). Participants 2 and 5 have the lowest weight at birth among participants included in the study. Infants with low birth weight may be at greater risk for nutritional feeding maturation problems (37). Hence, weight gain among these infants may contribute to the progression of oral feeding (38).

POFRAS scores, %MV, and weight improved in all participants after the 7th treatment session of combination therapy. These findings suggest that the 7 intervention sessions of combination therapy effectively improved the outcome measures of the study in PIs. According to the findings related to the POFRAS, we can conclude that combined intervention effectively ensures feeding readiness in our PIs and enhances promotor skills and feeding success. In other words, our findings indicated that the level of oral feeding readiness is improved by adding KT to the PIOMI. These results must be confirmed with more studies using high-quality designs with a large sample of PIs.

The possible reason for the effectiveness of a combined intervention is that, on the one hand, PIOMI enhances the sensitivity of the oral muscles, improves oral action and

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power, activates the sucking reflex, provides assisted movement to trigger muscle contraction and movement against resistance to build strength, thereby improving nutritive sucking. Also, PIOMI focuses on increasing functional response to pressure and movement and control movement for the lips, cheeks, jaw, and tongue (19, 39). The improvement may also be explained by the additive facilitatory effects of KT on muscle tone. Previous reports using KT in different populations (neurological disorders, cerebral palsy, down's syndrome, intellectual impairment, and chronic hyper-salivation) found improvement in muscle tone, oral motor control, sucking, swallowing, and lip closure (24-31). Indeed, KT puts a constant pulling force on the skin that subsequently activates the mechanoreceptors. Therefore, it can affect the excitability of motor neurons and consequently improve neuromuscular functions (40, 41).

Simultaneous use of PIOMI-KT can have a synergist effect, provide sensory input, and integrate sensory-motor pathways. The combined impact of PIOMI and KT may leverage early neural plasticity in the preterm brain and translate into improvements in feeding function.

Limitations

The main limitation of this study could be that a PIOMI and KT-only groups were not included. Therefore, it was impossible to compare the effects of combination intervention with PIOMI or KT. Second, the sample size was small, and a large group study is needed to generalize the results. Third, a long-term follow-up is required to assess the possible long-term effect of PIOMI-KT. A further prospective study with a larger sample size, long-term follow-up, and comparison group design is required to validate the findings. Fourth, KMC—as an alternative approach—was applied for PIs in the NICU of Akbarabadi Hospital. KMC may have affected study findings, as it accelerates neurobehavioral development and growth in PIs (42, 43).

Conclusion

This study suggests that the combination of KT-PIOMI improved oral intake and other aspects of PIs feeding, such as oromotor skills, feeding efficiency, and weight gain. This finding that PIs benefited from KT plus PIOMI is essential because it provides the therapist with a treatment method that appears to be effective over a relatively short period of time.

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Ethical Approval

This study has been approved by the Research Ethics Committee at Iran University of Medical Sciences.

Authors contributions

All authors contributed to the study's conception and design. E.N. contributed to data collection, interpretation of data, and writing of the manuscript; L.G.H. contributed to the writing of the manuscript, interpretation of data, and statistical analysis; R.S. and M.T. contributed to analysis and the first draft of the manuscript; A.B., N.M., and B.L. contributed to study conception and the first draft of the manuscript. All authors read and approved the final manuscript.

Conflict of Interests

The authors declare that they have no competing interests.

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