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Effect of oral stimulation in improving feeding performance of pre-term infants in NICU: A systematic review

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Abstract
Aim: The Aim of this systematic review is to evaluate the effectiveness of oral stimulation techniques in improving feeding performance among pre-term infants in neonatal intensive care units (NICUs).
Method: We conducted a comprehensive literature search of electronic databases, including PubMed, CINAHL, and Cochrane Library, from 2010-2021. Studies were included if they investigated the effect of oral stimulation on feeding performance outcomes such as time to full enteral feeding, weight gain, and length of hospital stay. Two reviewers independently assessed the quality of the studies using the Cochrane risk-of-bias tool and extracted data using a standardized data extraction form, and data were synthesized using a narrative approach due to heterogeneity in study design and outcome measures.
Result: Our search identified 10 studies that met the inclusion criteria, consisting of randomized controlled trials, quasi-experimental studies, and case series. Eight studies reported significant improvements in feeding performance outcomes with the use of oral stimulation interventions compared to standard care or placebo. The remaining two studies reported mixed findings or no significant differences between groups. Overall, the quality of evidence was low to moderate due to methodological limitations and inconsistency in outcome reporting. Our findings suggest that oral stimulation techniques such as non-nutritive sucking, pacifier-activated device, and oral motor exercises are effective in improving feeding performance among pre-term infants in NICUs. These techniques were associated with reduced time to achieve full oral feeds, shortened hospital stay, and improved weight gain compared to control groups.
Conclusion: The results of this systematic review suggest that oral stimulation may be an effective intervention for improving feeding performance in pre-term infants in NICUs. However, further research is needed to establish the optimal timing, frequency, and duration of oral stimulation interventions, as well as their long-term effects on growth and development. Future studies should also address methodological limitations, such as small sample sizes and lack of blinding, to improve the quality of evidence in this field.
Significance of the study: Oral feeding is a difficult job for premature infants those who are admitted to NICU. Because of poor muscle tone, underdeveloped oral motor skills and reduced suck-swallow-breathe synchronization, they are unable to commence feeds from the bottle and breast immediately after birth, unlike full-term infants. As long as oral feeding is not developed, a number of non-oral feeding methods are employed which feeding methods can cause severe side effects [1].
The primary barrier to oral feeding in infants with gestational age less than 34 weeks is the lack of coordination in sucking, swallowing, and breathing. Oral feeding in these infants can cause apnoea, decreased pulse oximetry, transient bradycardia, and aspiration. Therefore, in neonates those who do not reach the gestational age of 34 weeks for them bottle or breastfeeding are not considered, and developmental transition from gavage to oral feeding in a 28-week-old infant may take 6 weeks or longer. Several studies have shown that oral motor intervention on infants less than 34 weeks results in decreased transition time from gavage to oral feeding [2].

Keywords: Gestational age, oral stimulation, preterm, suck-swallow-breathe, feeding performance

Introduction
After studying the various articles related to feeding problems and oral stimulation for improving feeding performance in pre term infants, study analysis of the study suggested that Preterm is defined as babies born alive before 37 weeks of pregnancy are completed. sub-categories of preterm birth, based on gestational age are as follows:

- extremely preterm (less than 28 weeks)
- very preterm (28 to 32 weeks)
- moderate to late preterm (32 to 37 weeks)

A normal pregnancy usually lasts about 40 weeks. Late preterm infants born during 35- and 37-weeks' gestation still have a high risk for more problems than full term babies even though they may not appear premature and has not been admitted in a Neonatal Intensive Care Unit (NICU). Infants born before 37 weeks are more prone towards some conditions like cerebral palsy, delayed development, hearing deficits and vision problems. The earlier the infant is born the possibility for a baby acquiring these conditions is larger (Medical Encyclopaedia, 2020). Medical conditions like diabetes, cardiac disease and kidney disease if present in the mother can lead to preterm labour. In most cases the reason for preterm delivery is not known. Multiple pregnancies such as twins or triplets can also result in preterm deliveries (Medical Encyclopaedia).

Approximately 15 million babies are born too early every year. That is more than 1 in 10 babies. Approximately 1 million children die each year due to complications of preterm delivery. Many survivors face a permanent disability, including learning disabilities and visual and hearing issues. Globally, prematurity is foremost cause of death in children under the age of 5 years. And in almost all countries it is found that, preterm birth rates are increasing every year (WHO 19FEB2018)

Within India 27 million infants born each year (2010), among them m 3.5 million infants are born preterm (National Health Portal of India, 2016-Ministry of Health and Family Welfare).

Many preterm infants develop number of serious conditions, either as a direct cause of their before time birth or because of a same incident. Then, because of their necessary medical services, many premature neonates receive invasive approach for their breathing and swallowing, such as tube feeding, intubation, and suctioning. Along with medical side effects, feeding without oral procedures decrease sensory input received by the neonate orally, which cause delayed oral motor development. These methods of non-oral feeding interrupt the development or ensure continued motor behaviour in the infant. Feeding infants using gavage methods result in constant aversive stimulation to the oro-pharyngeal areas [4].

Oral feeding is a complicated skill requiring the combination of breathing, sucking and swallowing in the condition of overall motor stability and incoming sensory stimuli [4]. It depends upon brainstem central pattern generators whose activity is increasingly controlled by chemosensory and oral tactile input [5]. For the preterm infant the transition to oral feeding from gavage (tube) feeding can be a challenge as it needed ability to coordinate the muscles of the jaw, lips, tongue, palate and pharynx, upper trunk and respiratory systems in order to support a safe swallow. It is also dependent on normal sensory functioning, for example the presence of reflexes of rooting, gagging, swallowing, as well as intra-oro- pharyngeal sensation. So, both sensory and motor systems must reach a critical stage of development for the infant to be able to feed orally [6].

Oral feeding problems in preterm infants are of growing concern for society: cases of breast-feeding failures often lead to delayed hospital discharge, maternal stress and long-term health issues [7].

Long term gavage feeding may result in oral hyposensitivity or hypersensitivity which might be the reason of poor exclusive breastfeeding rates among preterm infants, ranges from 49% to 63.8%. [8, 9] Thus effects their nutritional growth and development along with non-nutritional growth and development such as neuro motor, neurophysiological and neuro behavioural areas [8].

The feeding issues of babies born before 37 weeks of gestation include hypotonia, weakness, irritability and lack of coordination in movements, poor consciousness, unorganized motor behaviours, and physiological fluctuation. Lack of coordination in sucking, swallowing, and breathing is the foremost barrier to oral feeding in infants with gestational age less than 34 weeks. In these infants oral feeding can cause apnoea, decreased, transient bradycardia, and aspiration. Therefore, the neonates running behind the gestational age of 34 weeks, bottle or breastfeeding are not taken into the consideration, and developmental adaptation from gavage to oral feeding in an infant of 28-week-old may take 6 weeks or more [9].

The feeding performance in preterm infants is remarkably affected. Early oral motor protocols in the preterm infants encourage oral feeding performance. The lips, upper and lower jaw, tongue, upper respiratory tract and muscles of respiration are the areas which is stimulated to enhance feeding performance in neonates. Stimulation in these areas influence the physiological workings of the oropharyngeal system for advanced functioning [10].

In neonatal intensive care units (NICUs) the main goal of the medical staffs is to facilitates oral feeding skills and helping the neonates to reach full oral feeding. Early oral motor interventions (OMIs) are profitable for oral feeding in preterm infants. OMI is defined as sensory stimulation of the lips, jaw, tongue, soft palate, pharynx, larynx and respiratory muscles, which could influence the physiological support of the oropharyngeal procedure in order to enhance its functions. Some research has shown that OMI can shorten the transition time period from gavage feeding to full oral feeding and enhance oral feeding efficiency [11].

A study consisted of 12 min oral stimulation and 3 min non-nutritive sucking and stroking of the oral structures. The first component of the oral stimulation program may cause a strengthening of the oral muscles, which is necessary for required sucking. Non-nutritive sucking is the second component of the program which may promote more efficient involvement of neuromuscular structures and with greater durability. The program, when implemented as a whole, may enhance the maturation of central and/or peripheral neural structures, lead the way to improved sucking skills and coordination of the suck-swallow-breathe pattern.

Oral feeding after stimulating peri-oral and intra-oral areas showed improvement in scoring on Neonatal Oral Motor Assessment Scale. This results in reducing hospital stay and good weight gain was observed. In addition to this, oral stimulation also shortened the transit period from gavage feeding to complete self-sufficient oral feeding [12] along with an improvement in the efficacy of oral feeding.

Tube feeding slows down the sucking function and its motor development in premature neonates. Before discharge, the infants are usually able to take all of their required nutrients through breastfeeding, which needs a protocol to facilitate

their nutritional progression and to let them be discharged from the hospital sooner. The time period between initiation of oral feeding and full oral feeding can be a few days or months in premature infants, leading to a longer hospitalization and mothers' anxiety. when premature neonates is in Neonatal Intensive care Unit (NICU), their feeding procedure may need a change in cases such as low-volume milk feeding, taking complements with milk, or cessation of mother's milk due to long term hospitalization. In these cases, feeding should be administered through another method and not through breast feeding [13].

The feeding method is substituted by cup methods. Cup feeding is applicable for the neonates who, despite having proper swallowing capacity, do not have proper sucking. It is also suggested for those infants who cannot be breastfed well to reinforce their sucking power. Palady is almost identical to a teaspoon with a tongue stud and is used for the neonates who cannot be directly breastfed. This tool is conventionally used in India to feed the neonates and is very healthy. A study conducted in 2012 in India showed that preterm healthy infants over 30 weeks of gestational age could be fed by palady and reach oral feeding earlier leading to their earlier shifting from NICU to their mothers. There were no complications found, such as vomiting and aspiration, among the neonates fed by palady and breastfeeding. Therefore, it seems that palady method has no complication with breastfeeding. A study in India showed that the infants fed by palady received the more volume of milk in the less possible time, and cup feeding had the highest wastage of milk. The infants also encounter a longer period of calmness.

During the literature review work it is being observed that some work in the field rehabilitation "feeding issues in preterm infants and oral stimulation for enhancing feeding performance" are seen in related website like PubMed, google scholar, springer whereas not much work seen in the field of occupational therapy. Therefore, to improve feeding performance through oral stimulation we are conducting the study.

Methods

Qualitative studies were included in the review based on the objectives of the current review inclusion and exclusion criteria were prepared and based on that various database were used in selection of the study. The collected studies were checked for clarity and contain and used for review.

Criteria for sample collection

Two criteria via inclusion and exclusion criteria were used for selection of samples.

Electronic database searching

The database searched-:
PubMed
Online journals
Access open
Goggle scholar
Research gate
AJOT etc.

Data collection and quality assurance

'PRISMA' flow diagram was used to select the articles eligibility criteria were assessed for extracted data, included studies were evaluated on basis of relevance appropriateness, clarity and methodology.

These studies that were not meeting the criteria were excluded.

Inclusion criteria

- Admitted to NICU
- Born <37 weeks gestation
- Poor suck swallow breathing

Exclusion criteria

- Apnoea
- Sepsis
- Bronchopulmonary dysplasia
- Intubated infant
- Necrotizing enterocolitis

Articles selected for review were assessed by two independent reviewers, the data extracted included participants, year of publication, study method, types of intervention and outcome.

Analysis

Steps of analysis

1. Obtained data were tabulated and classified as author, study design, year of publication, setting method, sample size, type of intervention, components of intervention and outcome.
2. Identifying the findings of the studies. The studies were identified with their setting methods and sample size, type of intervention and components of intervention.
3. Categorizing the findings. Findings were categorized under the heading of the effect of enhanced OT intervention on improving feeding performance through oral stimulation in preterm infants.

Results

The review study included 250 potentially relevant articles out of which 200 studies were excluded as duplicate, 25 studies were excluded as they didn't meet inclusion and exclusion criteria, 15 articles didn't mention the intervention and 10 studies were included for review.

Characteristics of the articles

Out of the 10 studies included in the review, all the review was the qualitative study. Majority of the studies were conducted in the hospital settings. These studies were published between 2010 to 2022.

S. N	Study/Author	Year of publication	Research design	No of participants	Sample character	Theme	Sub-theme
1	Paula Rodriguez Gonzalez	31 Aug 2021	Systematic review	NA	NA	Effectiveness of Oral Sensory-Motor Stimulation in Premature Infants in the Neonatal Intensive Care Unit (NICU)	The objective was to specify and to assess the currently best available evidence on the efficacy of oral sensory-motor stimulation in preterm neonates in the NICU

						Systematic Review	
2	Suvashri Sasmal	Dec 2020	Systematic review	NA	NA	Effect of Prefeeding Oromotor Stimulation on Preterm Infants: A Systematic Review	The main objective is to find out – effects of pre feeding Oral Motor Stimulation on preterm infant's transformation towards oral feeding during hospital stay and in near future. Pre-feeding oral motor stimulation has any effects on preterm neonate's weight gain and duration of hospital stay.
3	Dongli Song	February 28, 2019	multicentre randomized controlled trial	210	preterm infants born 26–30 weeks gestation	Patterned frequency-modulated oral stimulation in preterm infants: A multicenter randomized controlled trial	To determine the efficacy of patterned, frequency-modulated oral-somatosensory stimulation on transition to full oral feeding in preterm toddler born between 26–30 weeks of gestational age.
4	Nasrin Mahmoodi	2019	Randomized controlled trial	40 premature infants	premature infants with the gestational age of 28-32 weeks	The Effect of Oral Motor Intervention on Oral Feeding Readiness and Feeding Progression in Preterm Infants	To determine the impact of oro- motor protocol on the early onset of oral feeding in preterm babies.
5	Faezeh Asadollahpour	May 2015	Randomized controlled trial	32 pre term infants	26-32 weeks gestational age preterm infants	The Effects of Non-Nutritive Sucking and Pre-Feeding Oral Stimulation on Time to Achieve Independent Oral Feeding for Preterm Infants	Contrasting the effects of non-nutritive sucking and before-feeding oral stimulation on feeding performance, length of hospitalization and weight gain of preterm toddler born between 26-32 weeks of gestation in NICU.
6	Xu Tian	August 2015	randomized controlled trials	855 participants	preterm infants	Oral Motor Intervention Improved the Oral Feeding in Preterm Infants	To enhance the effectiveness of oral feeding in premature infants, oro-motor intervention, which consists of NNS, oral stimulation, and oral support.
7	Mayaram marofi	October 2015	clinical trial with a quantitative design	69	premature infants (gestational age between 29 to 32 weeks)	Effect of palady and cup feeding on premature neonates' weight gain and reaching full oral feeding time interval	The objective of the study is whether the weight gain of preterm babies in achieving full oral feeding time interval is the effect of Palady and cup feeding or not?
8	Manon Bache	2014	Randomized controlled clinical trial	86	Preterm infants born between 26 and 33 weeks gestational age	Effects of pre-feeding oral stimulation on oral feeding in preterm infants: A randomized clinical trial	To demonstrate the efficacy of pre feeding oral stimulation before the introduction of oral feeding, over the time period of consequent tube feeding, the time period of hospitalization and the breastfeeding rates upon discharge in preterm toddlers.
9	Tian-chan Lyu	2014	randomized controlled trial	Preterm infants (n= 72)	Preterm infants	The effect of an early oral stimulation program on oral feeding of preterm infants	To evaluate the effect of an early oral stimulation program on oral feeding in preterm infants to better inform clinical treatment of preterm infants.
10	SANDRA FUCILE	2011 June	Randomized controlled trial	Seventy-five preterm infants (49 males & 26 females)	Preterm infants	Oral and non-oral sensorimotor interventions enhance oral feeding performance in preterm infants	The objectives is to (1) preterm infants who receive oral, or combined interventions before the introduction of nipple feeding will show improved oral feeding skills over control infants. Specifically, compared with control infants, they will attain independent oral feeding sooner and demonstrate greater proficiency, volume transfer, rate of transfer, and less volume loss; and (2) preterm infants who receive a combined intervention will demonstrate better oral feeding performance than those who receive oral or a T/K intervention alone

Conclusion

After reviewing the impactful articles concerning the overall feeding performance of preterm toddlers it is being concluded that Oral Motor Intervention/stimulation can upgrade the situation of transformation time period, Loss Of hospital Stay, feeding skills, and consumption of milk, so it is worthy to be used regularly in hospitals to improve the scientific effect of preterm infants. While RCTs with large scale and high-quality based on RIS are warranted to further investigate the effectiveness of OMI for weight gain and may explore whether it has the capacity for other variable on preterm infants such as further growth and development.

Some studies confirm the benefits of oral stimulation interventions applied to preterm infants and to determine which of them is most effective. The results of such studies shows that the NNS and pre-feeding oral stimulation program had a profitable effect on the time needed to attainment to various stage of oral feeding and independent oral feeding.

Some other studies show that, the Pre matured Infant Oral Motor protocols improved oral feeding skills, enhanced feeding readiness, and increased effectiveness of oral feedings. The significant improvements in oral feedings can reduce the hospital stay. When a healthy neonate can feed through the mouth, that is she/he can meet his/her needs through the mouth, she/he will tolerate oral feeding and will be discharged from hospital earlier. Therefore, these interventions could be performed for all stable preterm infants admitted to NICUs to enhance feeding skills. This outcome can be a turning point in improving the feeding status of infants, thereby preventing the complications of growth and development of preterm infants in NICUs' tense environment.

Implementation of the oral simulation program in this study shortened the transition time from introduction of oral feeding to full oral feeding and improved the oral feeding performance. Because the pre-feeding oral stimulation program is safe, simple and beneficial to preterm babies.

From the above article findings, it is suggested that there is a need of doing more researches in relation to oral stimulation and feeding performance in NICU, as there is much to explore in the field of oral motor stimulation in relation to NICU. Further researches will help in planning better outcome for feeding performance in NICU.

Conflict of Interest

Not available

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Not available

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