Oral feeding performance in premature infants stimulated by swallowing technical training

Desempenho da alimentação oral em recém-nascidos prematuros estimulados pela técnica treino de deglutição

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ABSTRACT

Introduction: Prematurity can affect proper development of a newborn. **Purpose:** To evaluate performance of oral feeding in preterm infants stimulated by the swallowing training technique. **Methods:** The study was conducted in a neonatal intensive care unit from March to August 2015. The study was developed as a Times Series Quasi Experiment with 14 preterm newborns (PTNB) with corrected gestational age between 30-36 weeks. The readiness to feed orally protocol for preterm infants (pre and post-swallowing training) was applied. Swallowing exercises were conducted once a day and on average for six consecutive days. **Results:** Improvement post-stimulation was observed, comparing the pre-intervention and post-intervention protocol data. Regarding oral feeding skills, 50% of preterm infants were classified as level 4. Oral feeding commenced, on average, 1 day after the end of swallowing training; the gastric tube was removed approximately 7 days after beginning oral feeding. There was a borderline inverse relationship between improvement in the readiness score and transition time from tube to full oral feeding and an inverse relationship between improvement in the readiness score and corrected gestational age. **Conclusion:** The intervention with swallowing training made it possible to improve feeding skills in 50% of the sample population, starting oral feeding and obtaining exclusive oral feeding in a short period of time, with oral readiness at early gestational ages.

Keywords: Infant, Newborn; Infant, Premature; Deglutition; Intensive Care Units, Neonatal; Speech, Language and Hearing Sciences

RESUMO

Introdução: A prematuridade pode afetar o desenvolvimento adequado do recém-nascido. **Objetivo:** Avaliar o desempenho para a alimentação via oral em recém-nascidos prematuros, estimulados pela técnica treino de deglutição. **Métodos:** A pesquisa ocorreu em uma unidade de terapia intensiva neonatal, no período de março a agosto de 2015. Trata-se de um estudo Quase Experimento de Série Temporal com 14 recém-nascidos pré-termo (RNPT), com idade gestacional corrigida entre 30-36 semanas. Foi aplicado o protocolo de avaliação da prontidão do prematuro para início da alimentação oral (pré e pós-treino de deglutição). O treino de deglutição ocorreu uma vez ao dia e, em média, durante seis dias consecutivos. **Resultados:** Verificou-se melhora pós-estimulação, comparando-se os dados do protocolo pré-intervenção e pós-intervenção. Quanto aos níveis de habilidades de alimentação por via oral, 50% dos prematuros foram classificados como nível 4. A alimentação via oral foi iniciada, em média, 1 dia após o término do treino de deglutição; a sonda alimentar foi retirada em, aproximadamente, 7 dias após o início da via oral. Houve associação inversa limítrofe entre melhora no escore de prontidão e tempo de transição da via alternativa para a via oral total e associação inversa entre melhora no escore de prontidão e idade gestacional corrigida. **Conclusão:** A intervenção com treino de deglutição possibilitou melhora na habilidade de alimentação em 50% da amostra, com início da alimentação via oral e obtenção da alimentação exclusiva via oral em um curto período de tempo, com prontidão para via oral em idades gestacionais precoces.

Palavras-chave: Recém-nascido; Prematuro; Deglutição; Unidades de Terapia Intensiva Neonatal; Fonoaudiologia

INTRODUCTION

Prematurity is one of the main triggers for neonatal complications, since it may affect the proper development of the newborn (NB)[1]. According to the World Health Organization, preterm infants (PTI) are those who have less than 37 full weeks of gestation, counted from the first day of the last menstrual cycle[2].

Suction is an important physiological function, which depends on coordination with swallowing and breathing, for safe and successful feeding[3]. Together, these functions make up the "nutritional pathway" and are responsible for the rapid and safe transport of milk from the oral cavity to the stomach[4]. The PTIs present these functions still immature and/or unco-ordinated, requiring parenteral or enteral nutrition until they are adequately prepared for effective oral feeding (OF)[5,6]. As a consequence of immaturity, preterm infants are deprived of oral experiences that favor their ability to co-ordinate suction–swallowing–breathing (SSB), since they feed by parenteral means or by gastric feeding tube[6].

In this context, PTIs need a specialized multi-professional team. By means of orofacial stimuli, speech therapist can aid in the transition from tube feeding to total oral feeding safely and efficiently, reducing hospitalization time with full oral feeding abilities acquired at the time of discharge[1], that is, exclusive and safe oral feeding. Some techniques for intervention in PTIs are described in the literature: non-nutritive sucking (NNS)[7], sensory-motor-oral stimulation (SMOS)[6,8,9] and swallowing exercises (SE)[10], among others. There are variations in the methods of application for all techniques and scarce scientific evidence in the comparison between them[6,7,8,9,10,11,12]. Moreover, there is a lack of systematic and scientific data on the benefit or harm of these techniques, during the period of hospitalization of PTNB and after hospital discharge[1].

NNS consists of the insertion a gloved finger (5th digit) into the oral cavity of the newborn, touching the incisive papilla, where the suction reflex is triggered[7,8]. This stimulus is main-tained prior to oral feeding, or concomitant to gavage feeding, to promote coordination of sucking and swallowing and to accelerate maturation of the reflexes involved. Studies point to an improvement on the onset and duration of the first nutritive suction, as well as weight gain, due to better efficiency and reduction of the transition time from tube to OF[6,13].

SMOS consists of slow and deep touches and motions, with a gloved finger along the cheeks, lips and gums for approxima-tely one minute in each structure, with the implementation of NNS at the end of the procedure[8]. This stimulation helps in the activation of the muscles involved in the suction process, improving its efficiency[14]. As a result, the suckling rate and the volume of ingested milk increase, favoring weight gain and reducing the transition time from tube to OF, which decreases hospitalization time[6].

Swallowing exercises consist of oral administration of a minimal volume of gustatory stimulus (0.05 ml) with a 1.0 ml syringe, directly to the medial posterior part of the tongue, prompting the swallowing reflex[10]. This type of intervention has not yet been studied in the literature for the evaluation of oral feeding performance and progression. A prospective stu-dy compared the application of SE in a group of PTIs with a group without intervention. The authors verified acceleration in exclusive OF, as well as changes in OF skills, with impro-vements in the transition from tube to OF in very low birth weight infants[10]. However, this technique was poorly evalu-ated, despite the good results presented[10]. In this context, the present study aimed to analyze the OF performance of PTIs stimulated by swallowing exercises. For that, the oral feeding skills were evaluated using the parameters of proficiency and milk transfer rates during the first oral feeding.

METHODS

This is a Time Series Quasi Experiment, which included 14 PTIs admitted to the neonatal intensive care unit of a public maternity hospital in Porto Alegre (RS). Data collection took place in the period of March to August 2015, with consecutive convenience samples, as approved by the Ethics and Research Committee of the *Irmandade Santa Casa de Misericórdia de Porto Alegre*, under Protocol No. 39742014.0.0000.5335. All those responsible for the subjects signed the Free and Informed Consent Term (FICT).

The inclusion criteria incorporated: clinical evaluation performed by the medical team with available medical records; clinical stability, characterized by the neonatologist's evaluation of oxygen saturation (SPO2), heart rate (HR) and respiratory frequencies (RF); infants were released for initiation of oral stimulation, when in stable clinical condition (defined by the medical team); corrected gestational age (CGA) between 30-36 weeks; term of informed consent signed by a legal guardian. The exclusion criteria comprised of: CGA <30 or ≥37 weeks; neuropaths; genetic syndromes; craniofacial malformations; use of tracheostomy; intracranial hemorrhage to any degree; neonatal asphyxia; unresolved respiratory disease; unresolved neonatal sepsis; PTIs who were not granted permission to participate by legal guardians.

After the clearance from the medical team for oral sti-mulation, the PTIs that met the inclusion criteria previously described were included in the study. Data from the electronic records was collected for the newborns and the mothers to characterize the sample. Data such as gestational age (GA), CGA, birth weight, APGAR in the first and fifth minutes of life, maternal age, type of delivery, days of life and gender of the NB were collected.

For evaluation procedures and speech-language interven-tion, materials such as gloves, syringes and catheters were used, these items was readily available in the unit and commonly used by the teams. The formulas (milk) used for swallowing

exercises were in accordance with the one prescribed for each patient by the medical team, ranging from maternal milk to milk formula.

During the speech-language evaluation, the readiness protocol to start oral feeding[15] was conducted by a speech therapist with experience in this evaluation and without knowledge of the future intervention, in order not to influence the pre and post-intervention scores. The protocol evaluated the categories of CGA at the time of evaluation, state of behavioral organization (assessment of state of consciousness, tonus and body posture), oral posture, oral reflexes and NNS characteristics (strength, rhythm, tongue and jaw movement), as well as observation of signs of stress (crying, skin coloration, body movement among others). Each category consisted of items with performance variations, which received scores of 0 to 2, with the total sum of the protocol ranging from 0 to 36. The items, with their respective variations of performance, are defined in the instructional guide of the Protocol, standardizing the assessment[15].

SE commenced soon after the inclusion and evaluation of PTIs. The PTIs received the stimulus (SE) once a day for at least five days and at most ten (a method adapted from that established in the research of Lau & Smith, 2012)[10]. Follow-up was performed by another speech therapist, who was unaware of the results of the initial and final evaluation of the PTIs.

SEs were performed 15 minutes before the scheduled administration of the prescribed diet for the PTNBs, in the incubator, or heated crib. The initial technique consisted of NNS stimulation (suction using a gloved fifth digit) for two minutes. Based on an earlier study[10], the SE was carried out as follows: the PTNB was offered a volume of 0.05-0.2 ml of the type of milk prescribed by the medical team through a syringe of 1.0 ml directly on the posterior-medial part of the tongue, approximately at the junction of the palate (hard and soft). Infants were initially offered 0.05 ml and the volume was increased in 0.05 ml increments to a maximum of 0.2 ml, or until the swallowing reflex was observed without adverse events. Once the minimum volume needed to start the swallowing reflex was identified, this volume was used for the entire duration of the exercise and noted as a reference for each newborn, as standardized in a previous study[10]. The SE was conducted every 30 seconds of the 15 minute program, or as tolerated. After the intervention, the PTI was left under the supervision of the nursing team to be fed according to medical prescription.

When the infant was cleared for full OF, the evaluation of prematurity protocol was reapplied[15], by a speech therapist with no prior knowledge of the intervention. After the protocol was applied, the direct score calculation was done. The protocol establishes that a score ≥28 indicates PTNB eligibility for the initiation of OF[15,16].

The feeding skills assessment was performed at the time of the first feeding, using the "finger-feeding" technique. A short gastric tube attached to the examiner's gloved fifth digit was attached to a 20 ml disposable syringe with a plunger. The tube was placed in the newborns oral cavity, who sucked the examiner's finger, extracting the milk[16,17,18].

Feeding performance was assessed by overall transfer (OT,% ml taken during a prescribed feeding / ml), proficiency (PRO,% ml taken during the first 5 min/ml prescribed) and milk transfer rate (TR, ml/min)[10], verified at the time of the first oral feeding, with premature infants being monitored for SpO_2, HR and RF, all remaining stable.

From these variables, four levels of OF feeding skills were delineated by PRO (≥30% or <30%) and TR (≥1.5 or <1.5 ml/min): level 1, most immature, defined by PRO <30% and TR <1.5 ml/min; level 2, PRO <30% and TR ≥1.5 ml/min; level 3, PRO ≥30% and TR <1.5 ml/min and level 4, most mature, PRO ≥30% and TR ≥1.5 ml/min[10].

The following aspects regarding the evolution of feeding skills were observed and recorded: how many days did the infants take to start OF after the intervention period (SE), how long did total OF take after the end of SE (or the removal of the gastric tube) and the transition time for tube to total/exclusive OF. The weight of the infants during the transition was also verified in the records of the nursing staff.

Statistical analysis

The collected data was entered into a database in Microsoft Excel 2010 program and forwarded for statistical analysis. Continuous variables were summarized using mean and standard deviation, or median and interquartile range. Categorical variables were expressed using absolute and relative frequencies.

In the comparisons of the categorical parameters before and after the intervention, the McNemar chi-square test was applied. For the continuous variables, the Student's t-test was used for paired samples.

The association between continuous variables was assessed by the Pearson or Spearman correlation coefficients.

The significance level adopted was 5% (p 0.05) and all analysis was performed using the SPSS program, version 21.0.

RESULTS

The mean weight of NBs at the time of the evaluation was 1,564 (±285) grams and, in the reevaluation, was 1,765 (±260) grams. In this period, weight gain (201±111 grams) was considered statistically significant (p<0.001). The characterization of the sample is described in Table 1.

In the analysis of the pre-stimulation and post-stimulation data, post-stimulation improvement (p<0.001) was observed. There was evolution in the readiness score, starting from no PTNB with a score ≥28 before SE, to 78.6% of preterm infants with a score ≥28 (cut-off point) at the end of SE.

Regarding the evaluation of the total protocol score, there was a general positive progression after stimulation, with an increase of 11.3 points (95% CI: 8.1 to 14.5).

The preterm infants took, on average, 1 (1-3) days to initiate OF after the intervention (SE) and 7 (5-11) days for the withdrawal of the gastric tube after the commencement of the OF, obtaining full OF.

Table 1. Analysis of the PTNB sample population

Variables*	n=14
GA (weeks)	32.6±1.3
CGA (weeks)	34.4±0.8
Birth weight (g)	1.538±387
APGAR1	8 (5–9)
APGAR5	9 (8–9)
Maternal age (years)	28.1±8.5
Days since births	12 (5–15)
Gender of NB	
Male	9 (64.3)
Female	5 (35.7)
Type of delivery	
Normal	4 (28,6)
Cesarian section	10 (71.4)
Duration of stimulation(days)	6 (5–10)

*Continuous variables expressed using average and standard deviation or median (25-75 percentile); categorical variables expressed by n (%)
Subtitle: GA = gestational age; CGA = corrected gestational age; APGAR1 = APGAR in the 1st min; APGAR5 = APGAR in the 5th min; NB = newborn

In the analysis of the preterm readiness protocol[15], there was improvement after intervention in 8 parameters (44.4% of the variables analyzed), as shown in Table 2.

Regarding oral feeding performance, 9 patients presented TR ≥1.5 ml (64.3%). The mean OT was 27.7% (SD=13.4%). Seven subjects (50%) had PRO ≥30%.

From these parameters, the following findings were obtained regarding the levels of oral feeding abilities: 5 (35.7%) preterm infants classified as level 1 (most immature); 2 (14.3%), level 2; 7 (50%), level 4 (most mature). No premature infants presented level 3.

The median volume that triggered the swallowing reflex was 0.1 ml (Percentis 25-75: 0.1-0.15).

There was an inverse association (rs=-0.592, p=0.026) between improvement in the readiness score and CGA, that is, patients who were stimulated with a lower CGA showed a marked improvement in the readiness score (Figure 1).

There was an borderline inverse association (rs=-0.474; p=0.087) between improvement in the readiness score and transition time from tube to full OF, that is, the more accentuated the improvement in the readiness score, the shorter the transition time from tube to full OF (Figure 2).

DISCUSSION

Oral feeding is a complex physiological process for NBs,

Table 2. Behavioral comparisons to evaluate the readiness of the preterm infants to begin oral feeding pre and post-intervention in the total sample

Variables**	Expected Pattern	n=14		p-value
			Post	
State of consciousness	Alert	2 (14.3)	5 (35.7)	0.453
Global posture	Flexor tone	1 (7.1)	8 (57.1)	0.016*
Global tonus	Normotonic	2 (14.3)	9 (64.3)	0.016*
Lip posture	Closed	10 (71.4)	13 (92.9)	0.375
Tongue posture	Flat	13 (92.9)	13 (92.9)	1.000
Search reflex	Present	2 (14.3)	6 (42.9)	0.289
Suction reflex	Present	4 (28.6)	13 (92.9)	0.004*
Bite reflex	Present	6 (42.9)	11 (78.6)	0.063
Vomit reflex	Present	7 (50.0)	11 (78.6)	0.125
Tongue movement	Adequate	9 (64.3)	13 (92.9)	0.125
Jaw movement	Adequate	8 (57.1)	13 (92.9)	0.063
Rolling of the tongue	Present	9 (64.3)	14 (100)	0.063
Force of suction	Strong	0 (0.0)	13 (92.9)	<0.001*
Suctions per pause	5 a 8 s/p	0 (0.0)	9 (64.3)	0.004*
Maintaining rhythm	Rythmic	0 (0.0)	12 (85.7)	<0.001*
Maintaining alert state	Yes	1 (7.1)	6 (42.9)	0.125
Signs of stress	Absent	1 (7.1)	9 (64.3)	0.008*
Total points	≥28	18.8±4.5	30.2±4.0	<0.001*

*Significant values (p<0.05) – McNemar´s chi-squared test; ** expressed by n (%)
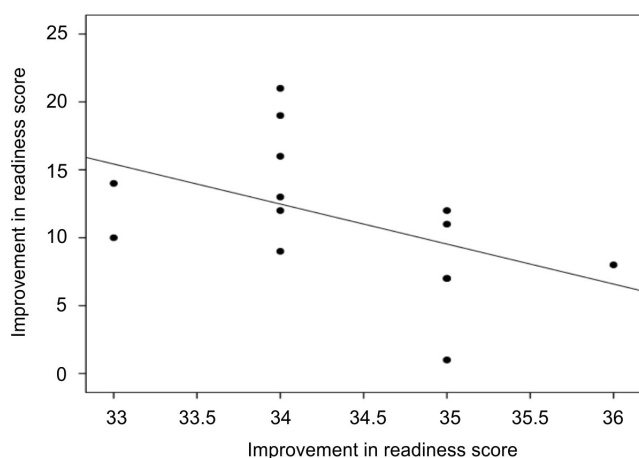**Subtitle:** s/p = suction/pause

Figure 1. Association between the improvement in the readiness score for oral feeding and corrected gestational age
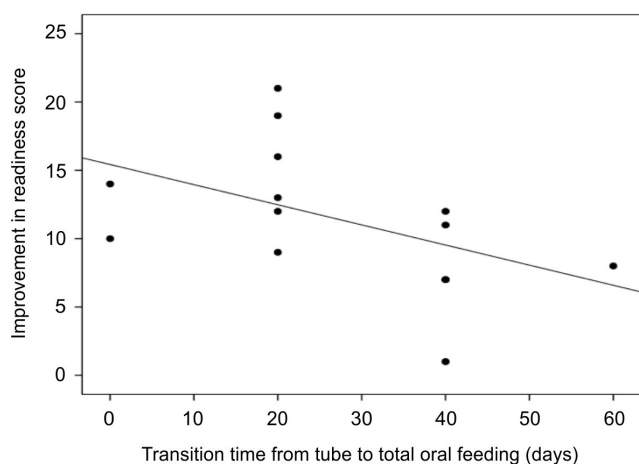

Figure 2. Association between the improvement in the readiness score for commencement of oral feeding and the transition time from the gastric tube feeding to the total oral feeding

requiring efficient coordination of the S-S-B sequence[3]. For preterm infants before 34 weeks of gestation, this sequence is more complex, difficult and uncoordinated, they tend to suck and breathe with an irregular deglutition pattern[5]. Consequently, the intervention of a speech therapist with specific therapeutic techniques is necessary to assist in the maturation of the sensorimotor-oral system in PTNB[1]. The current study evaluated SE as a form of oral stimulation and the performance of oral feeding in PTNB, analyzing the oral feeding abilities presented.

Weight gain is relevant for the progression to OF in PTNBs, and it is important that the speech therapist is aware of the medical and nutritional prescriptions in relation to the energy needs of this group[19]. Also, weight gain is one of the criteria adopted by neonatologists for the discharge of PTNB, and oral feeding may promote greater weight gain[14]. In the current study, the PTNB presented weight gain when comparing the evaluation and reevaluation phases, confirming findings from the literature and showing that stimulation does

not negatively interfere in this parameter, until total OF is reached[14,20].

The term "oral feeding readiness" is best related to the ability of the PTNB to coordinate suctioning, swallowing and breathing, in a safe and efficient way[21]. The protocol for assessing the readiness of PTIs is a validated instrument to verify the readiness for the transition from tube to OF, the cut-off point being defined at 28 points[15]. Analyzing the pre-stimulation and post-stimulation data, post-stimulation improvement was observed, with increase in the total score and overall improvement observed in the sample, which was 11.3 points. In a previous study, the pre-term readiness score was lower in the control group (CG), when compared to the stimulation group (SG) (NNS) at the beginning of the OF[22]. Another study verified a statistically significant difference between the scores of the first and second evaluation of PTNBs[23]. Speech therapy intervention through different stimuli, assist in the readiness of the PTNB for the commencement of OF. In the same study, improvement was also observed after the intervention in eight parameters, favoring the readiness to initiate OF. In a study that compared the behavior of PTNBs in the first and second applications of the readiness assessment protocol, behavioral variation was verified in 11 parameters[23].

The PTIs of this study stimulated by SE took on average, one day to initiate OF and seven days to remove the gastric tube after the start of OF, these findings were similar to those of other studies[10,24]. In a study performed with PTNBs divided into three groups, the time (in days) for the transition from initial OF to total OF was similar for the CG (21±2) and the SG (NNS) (19±2) and lower for the EG (SE) (15±2)[10]. The experimental protocol of another study reduced the time for PTNBs to reach full OF (5±4.2 days), compared to 10±3.1 days for the CG[24]. These findings show how much stimulation assists in obtaining OF safely and efficiently. The early introduction of oral feeding accelerates the transition from tube to total OF, which allows early OF to be performed and also offers practice opportunities that improve oral motor skills necessary for safe and successful feeding[25].

In the present study, regarding the performance of oral feeding, the OT average was 27.7%; nine PTNBs presented TR ≥1.5 ml and seven obtained PRO ≥30%. Some studies have used similar parameters for OF performance evaluation[10,20,25,26,27]. One study published results with a significant increase in OT and TR, within the SG and the CG, from the introduction of OF to the first successful OF (p≤0,03)[25]. Another study found an average feeding competence of 1.7 (±1.3) ml/min[20].

Oral feeding skills are measured by proficiency (PRO) and transfer rate (TR), which reflect, respectively, the minimum fatigue/ability to feed orally in the first five minutes of feeding and the resistance to OF of the prescribed volume. From these two variables (PRO and TR), four levels of oral feeding skills are defined[4,26,28,29]. Our findings were favorable to an adequate level of feeding skills, compared to those found in the literature. There

was a higher occurrence of PTNBs classified as level 4 (most mature), when compared to previous studies, which presented a frequency between 16% and 31% of the sample population at this level[10,26,28]. This fact can be explained by the fact that the study sample of this study had a larger CGA (30-36 weeks) than that identified in the other studies (28-36 weeks)[10,26,28].

However, there was an inverse association between improvement in the readiness score and CGA. Indicating that patients who were stimulated with a lower CGA, had a marked improvement in the readiness score. Previous studies have shown an increase in the readiness score in the SG, regardless of the progression of CGA, with an increase in this score, even in early CGAs[16]. In another study, subjects who received early OF were able to reach oral feeding milestones significantly earlier than their control group peers (34.5±1.6 vs. 36.0±1.5 weeks, respectively)[25].

In the present study, the median volume that triggered the swallowing reflex was 0.1 ml, this was in agreement with the literature findings[10,30]. In a previous study, the PTNBs of the swallowing group received a standardized volume of 0.05-0.2 ml, and it was verified that the efficiency of OF improved with the increase of the bolus size and frequency of swallowing[10]. Another study found that the mean volume for the swallowing reflex in PTNBs was 0.14 (±0.06) ml while the volume for full-term infants was 0.22 (±0.07) ml[30]. The frequent administration of a minimum OF volume by trained professional can help to elicit the swallowing reflex in PTNB and, consequently, may influence S-S-B coordination.

The borderline inverse association between improvement in the readiness score and the transition time from tube to full OF showed that PTIs who showed marked improvement in the readiness score took less time to transition from tube to full OF. This is interesting and may influence hospitalization time, but should be compared to a control group. A study, for example, randomized PTNBs for SG and CG, verifying that the transitional time from tube to OF was 26.8 (±12.3) days for SG and 38.4 (±14.0) days for the CG[25]. Another study observed that the OF readiness score was lower in the CG when compared to the SG (NNS), and the transition time from the gastric tube to OF was lower in the SG (three days) when compared to the CG (five days)[22]. In a previous study, the SG (NNS) presented a mean of readiness for OF of 32.8 (±1.0) and median time of transition from the gastric to OF of three (2-5) days[16].

The limitations of this study were the reduced number of PTNBs included in the intervention, the lack of comparison with a control group or with other stimulation techniques, and the adaptation of the materials to evaluate feeding skills. This last limitation can be justified by the fact that the neonatal unit has the title of "Hospital Amigo da Criança", in which the use of feeding bottles and pacifiers for the evaluation of feeding abilities is prohibited. As a result, attention should be paid to the generalization of the findings of the present study, which are preliminary and require further study.

CONCLUSION

Intervention with swallowing training allowed good performance in oral feeding skills, as well as aiding the commencement of oral feeding and obtaining exclusive oral feeding in a short period of time, with oral readiness at early corrected gestational ages. Although swallowing exercises have shown good results, more research is still needed, with larger samples, comparing this intervention with other already established techniques.

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