DOI: https://doi.org/10.17921/2447-8938.2020v22n4p222-228

Breastfeeding, Introduction of Food and Use of Pacifier on the Stomatognathic System of Children with Mixed Dentition

Amamentação, Introdução de Alimentos e Uso de Chupeta Interferem no Sistema Estomatognático de Crianças com Dentição Mista

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Recebido em: 02/06/2020
Aprovado em: 04/11/2020

Abstract

The objective of this study was to investigate the effects of maternal breastfeeding, artificial feeding, types of introduction of complementary food introduction and the use of bottle and pacifier on lip /tongue pressure and maximum molar bite force of school children. Thirty-five healthy children with mixed dentition (20 boys and 15 girls), aged 6-10 years, participated in this study. The children were evaluated based on anthropometry, electronic scale and portable stadiometer, feeding practices (breastfeeding, artificial feeding, introduction of complementary food), bottle and pacifier use, tongue and lips strength and molar bite force. The results were submitted to ANOVA ($p < .05$). The sample showed a predominance of children with adequate height and weight for age. In the analysis of the influence of the food introduction period, the complementary food consistency and the pacifier use; it was observed that these factors did not influence the pressures of the lips/tongue statistically. In the evaluation of the influence of bottle feeding, the data showed higher bite force for children who never used the bottle, statistically significant data for the right and left sides ($p \leq .003$ and $p \leq .001$, respectively). The authors suggest that the type of breastfeeding received by the children may have a negative impact on the stomatognathic system functioning, evidenced by the lower maximum molar bite force found in the bottle-fed children.

Keywords: Breast Feeding. Bottle Feeding. Bite Force.

Resumo

O objetivo deste estudo foi investigar os efeitos do aleitamento materno, alimentação artificial, tipos de introdução complementar de alimentos e uso de mamadeira e chupeta na pressão labial / lingual e força máxima de mordida molar em crianças em idade escolar. Participaram 35 crianças saudáveis com dentição mista (20 meninos e 15 meninas), com idades entre 6 e 10 anos. As crianças foram avaliadas com base em antropometria, balança eletrônica e estadiômetro portátil, práticas de alimentação (amamentação, alimentação artificial, introdução de alimentos complementares), uso de mamadeira e chupeta, força da língua e lábios e força de mordida molar. Os resultados foram submetidos à ANOVA ($p < 0,05$). A amostra demonstrou predominância de crianças com altura e peso adequados para a idade. Na análise da influência do período de introdução dos alimentos, da consistência do alimento complementar e do uso de chupeta, observou-se que esses fatores não influenciaram estatisticamente as pressões dos lábios / língua. Na avaliação da influência da mamadeira, os dados mostraram maior força de mordida para crianças que nunca usaram a mamadeira, dados significativos para os lados direito e esquerdo ($p \leq 0,003$ ep $\leq 0,001$, respectivamente). Os autores sugerem que o tipo de aleitamento materno recebido pelas crianças pode ter impacto negativo no funcionamento do sistema estomatognático, evidenciado pela menor força máxima de mordida molar encontrada nas crianças alimentadas com mamadeira.

Palavras-chave: *Aleitamento Materno. Alimentação Artificial Força de Mordida*

1 Introduction

The first years of life are of extreme importance for the creation and establishment of eating habits of health in the future[1,2]. Exclusive breastfeeding up to six months of age and introduction of proper food, at the right time, contributes to beneficial motor, physical and mental health[3,4].

The introduction of bottle, as well as the food supply before the necessary time, and the use of pacifiers are not beneficial for children, as these factors interfere in the stomatognathic system development[5-7]. In the morpho-functional alterations due to the inadequate teeth eruption, the neuromuscular function may be compromised, and for the human being to have a quality of life, the adequate stomatognathic system functioning becomes essential[8,9].

Thus, is of fundamental importance to understand the masticatory system functioning, as well as the correlation among the neuromuscular aspects of craniofacial development.

In the present study, the effects of breastfeeding, bottle use, introduction of complementary feeding and pacifier habit on lip and tongue pressures and the maximum molar bite force of school-age children were verified.

2 Material and Methods

2.1 Study population

This study was approved by the Research Ethics (process #. 55505316.8.0000.5419). The term of free and informed consent was signed by the children's parents or guardians.

The sample size was calculated using free-access software program G* Power version 3.1.9.2 (Franz Faul, Kiel University, Kiel, Germany), specifying that the increase in the responses standard deviation from which the hypothesis was to be rejected was P = 20%, with a test power of 80%. The calculation resulted in a sample number of 35, with an error estimated at 10% and the confidence level at 90%. Thirty-five healthy children with mixed dentition (20 boys and 15 girls), aged 6 - 10 years, participated in this study.

The inclusion criteria involved healthy children with mixed dentition and age between 6 and 10 years and absence of temporomandibular joint disorder, using the Research Diagnostic Criteria for Temporomandibular Disorders (RDC / TMD)[10].

The exclusion criteria involved children born with serious diseases that could interfere with growth or malformation; children who were not accompanied by the parents/guardians or who did not authorize them to participate in the research through the term of free and informed consent; besides participants in medical treatment using corticosteroids, immunosuppressants; with a medical history of surgical intervention in less than 12 months from the beginning of the research; children in treatment for myalgias of any genesis, using anti-inflammatories and/or analgesics that could interfere in neuromuscular physiology.

2.2 Anthropometric Evaluation

For the anthropometric evaluation, the calibrated electronic scale (Wiso®, SC, Brazil) was used with a maximum capacity of 180 kg and portable stadiometer (Personal Caprice Sanny Stadiometer, SP-BR) with measuring capacity from 115 cm to 210 cm[11,12].

The children's weight was evaluated in kg and height was measured in meters (m). These data were associated with other variables such as age, and gender and children were classified according to nutritional status recommended by the World Health Organization growth reference[13].

2.3 Evaluation of introduction of food

The evaluation of introduction of food was carried out through the use and adaptation of the questionnaire described by Gonsalez et al.[14] that addresses the following topics: breastfeeding, complementary feeding, and body fat. The questionnaire was applied to those responsible for the children who effectively followed their growth, in the form of an interview.

2.4 Lip and tongue pressure

Iowa Oral Performance Instrument (IOPI Medical, Redmond, WA), which allows the measurement of the pressure applied to a closed system with an air-filled bulb coupled to a manometer was used to measure the lips and tongue pressure in kilopascal (kPa)[15].

For lip pressure analysis, the plastic bulb was positioned in the mouth vestibule, at the canine teeth region. The children were instructed to remain with their teeth in contact against each other and the bulb was pressed for three seconds by performing the suction movement. Thus, three collections were performed, and the highest value was obtained, which was considered to determine the maximum lip pressure. In tongue activity, the plastic bulb was positioned posteriorly to the upper central incisors, and the children were instructed to raise the tongue and tighten the plastic bulb against the hard palate exerting maximum pressure for three seconds. In the same way, three measurements were performed with one-minute rest between them and the highest value obtained was used to determine the maximum tongue pressure[16].

2.5 Maximal bite force analysis

Bite force was evaluated using the digital dynamometer, model IDDK (Kratos - Equipamentos Industriais Ltda., Cotia, São Paulo, Brazil), adapted to buccal conditions with capacity up to 980.66 newtons (N). The equipment was positioned at the molar region and the children were asked to bite with maximum force. Three records were obtained from each side, with an interval of two minutes between the measurements, and the force of higher value was considered in this study[17,18]. All children trained the movements before the measurement records.

2.6 Statistical analysis

In the analysis of the results, the data showed normal distribution (Komolgorov-Smirnov normality test: $p \leq .05$). The data obtained in the different evaluations were analyzed using IBM SPSS Statistics for Windows, version 22.0 (IBM SPSS, IBM Corp., Armonk, NY, USA). Values were compared by using the ANOVA, with statistical significance set at p-values $< .05$.

3 Results and Discussion

Table 1 presents the average values of the anthropometric data and gender of the research participants (14 females and 21 males). It was verified that the weight of the participating girls ranged from 24 to 59.5 kg and from 15.4 to 46.0 kg in boys. Regarding height, the female participants presented values between 1.22 and 1.52 m and males between 1.17 and 1.49 m.

Table 1 - Description of the sample group, for the variables: gender (male - M and female - F), age (years), weight (kg) and height (m), obtained through a questionnaire adapted from Gonsalez (2017) and anthropometric evaluation

Children (n=35)	Gender	Age (years)	Weight (kg)	Height (m)
1	M	8	29.5	1.26
2	F	9	29.0	1.30
3	F	9	25.5	1.34
4	F	7	37.5	1.32
5	M	7	15.4	1.17
6	M	6	20.3	1.23
7	F	8	24.0	1.22
8	M	7	25.0	1.24
9	M	9	28.0	1.32
10	M	6	32.0	1.30
11	M	7	26.0	1.25
12	M	9	20.0	1.35
13	M	8	34.1	1.38
14	F	8	46.5	1.36
15	F	7	34.0	1.37
16	M	9	29.6	1.34
17	M	8	27.9	1.32
18	F	9	29.5	1.26
19	F	8	59.5	1.39
20	F	9	28.2	1.23
21	M	8	24.5	1.26
22	F	8	50.0	1.45
23	M	8	41.8	1.37
24	M	8	24.5	1.25
25	M	8	30.0	1.36
26	F	10	54.2	1.52
27	M	10	37.8	1.49
28	M	9	20.6	1.26
29	F	8	36.0	1.28
30	M	8	33.0	1.28
31	M	9	35.6	1.46
32	M	10	46.0	1.46
33	M	10	28.0	1.36
34	F	8	27.0	1.25
35	F	9	24.4	1.33

Source: Research data.

In the comparison between gender and the current nutritional status, significant differences were found between males and females, evidencing that boys had a higher percentage in the eutrophy nutritional status (60%) than girls, who exhibited in the eutrophy nutritional status (33%) and obesity (33%). Regarding height, all the participants showed adequate height for age. In the weight/age evaluation, 6% of the male participants presented low weight, 31% adequate weight and 20% overweight. The same was not observed for females who presented 3% with low weight, 20% with adequate weight and 20% with overweight (Table 2).

Table 2 - Classification of nutritional status according to the World Health Organization growth reference[13] - boys (n = 20) and girls (n = 15)

Current Nutrition Status	boys n (%)	girls n (%)	Sample group n (%)
BMI/Age			
Accentuated thinness	-	1 (7%)	1 (3%)
Thinness	2 (10%)	-	2 (6%)
Eutrophy	12 (60%)	5 (33%)	17 (48%)
Overweight	2 (10%)	3 (20%)	5 (14%)
Obesity	4 (20%)	5 (33%)	9 (26%)
Severe obesity	-	1 (7%)	1 (3%)
Height/Age			
Very short height for age	-	-	-
Short stature for age	-	-	-
Adequate height for age	20 (57%)	15 (43%)	35 (100%)
Weight/Age			
Very low weight for age	2 (6%)	1 (3%)	3 (9%)
Low weight for age	-	-	-
Appropriate weight for age	11 (31%)	7 (20%)	18 (51%)
High weight for age	7 (20%)	7 (20%)	14 (40%)
Total	20 (57%)	15 (43%)	35 (100%)

Source: Research data.

In the introduction of complementary feeding analysis, there was a considerable variability of the feeding introduction period of infants. Table 3 shows that the majority of mothers (57%) started introducing new foods to their children at around six months of age, with 66% of them introducing soft consistency food.

Table 3 - Average values of the introduction of complementary feeding age and food consistency obtained through the questionnaire adapted from Gonsalez et al.[14]

	Frequency of Children	
	N	%
Age of Introduction of Complementary Feeding		
3 months	1	3
4 months	1	3
5 months	1	3
6 months	20	57
7 months	2	6
8 months	2	6
9 months	2	6
10 months	-	-
11 months	-	-
12 months or more	6	17
Consistency of Complementary Food		
Liquid	6	17
Semi-liquid	3	9
Soft	23	66
Different consistencies	3	9
Total	**35**	**100**

Source: Research data.

In the analysis of the influence of supplementary feed consistency (soft, semi-liquid, liquid and different consistency)

on lip pressure, higher values were observed for liquid consistency and tongue pressure although not statistically significant. Regarding the bite force, the data showed a higher bite force for the children who started with the semi-liquid food consistency, for both the right and left sides, and the data were not statistically significant (Table 4).

Table 4 - Influence of complementary feeding consistency on the lip and tongue pressure (kPa) and bite force (N) (ANOVA, p < .05).

Clinical Condition	Feed Type - Number of Children	Average	Standard Deviation (±)	p value
Lip pressure	Soft - 23 Semi-liquid - 3 Liquid - 6 Different consistencies - 3	14.26 17.00 17.16 15.00	6.06 5.00 4.91 8.71	.69
Tongue pressure	Soft - 23 Semi-liquid - 3 Liquid - 6 Different consistencies - 3	31.17 31.00 29.00 30.66	14.38 18.52 14.51 8.32	.99
Right molar bite force	Soft - 23 Semi-liquid - 3 Liquid - 6 Different consistencies - 3	180 320 210 300	9.51 16.87 10.27 9.27	.09
Left molar bite force	Soft - 23 Semi-liquid - 3 Liquid - 6 Different consistencies - 3	180 290 190 270	9.76 9.50 10.43 5.89	.18

Source: Research data.

Sample data for lip and tongue pressure (kPa) and bite force (N), according to the bottle use and the pacifiers use are described in Tables 5 and 6, respectively.

As observed in Table 5, in the analysis of the influence of bottle feeding on lip and tongue pressure, the results identified higher pressure of these structures for the children who used the bottle, without statistically significant difference. Regarding bite force (N), the data showed a higher bite force for children who never used the bottle, significant data for the right and left sides (p = .003 and p = .001, respectively).

Table 5 - Influence of bottle feeding on lip and tongue pressure (kPa) and bite force (N).Total sample (p < .05).

Clinical Condition	Number of children for bottle-feeding use	Average	Standard Deviation (±)	p value
Lip pressure	28 Yes 07 No	16.03 15.57	5.84 3.95	
Tongue pressure	28 Yes 07 No	30.03 24.85	13.55 8.25	
Right molar bite force	28 Yes 07 No	200 330	9.20 10.94	
Left molar bite force	28 Yes 07 No	170 330	8.14 9.71	

Source: Research data.

In the analysis of the influence of pacifier use on lip and tongue pressure, the data showed higher lip and lingual pressure for children who did not use a pacifier. Regarding the bite force, a higher bite force was observed on the right and left sides for children who did not use a pacifier, without statistical significance (Table 6).

Table 6 - Influence of pacifier use on the lip and tongue pressure (kPa) and bite force (N). Total sample (p < .05)

Clinical Condition	Number of Children Using Pacifiers	Average	Standard Deviation (±)	p value
Lip pressure	19 Yes 16 No	15.78 16.42	5.52 5.57	
Tongue pressure	19 Yes 16 No	27.94 34.00	11.45 16.19	
Right molar bite force	19 Yes 16 No	190 230	13.82 10.40	
Left molar bite force	19 Yes 16 No	190 210	8.67 11.74	

Source: Research data.

In this study, it was evident that boys presented a higher percentage in nutritional status and eutrophic girls in nutritional status of eutrophy and obesity. Regarding height and weight, correlated with age, all children had adequate stature and weight. Children at preschool ages consume twice as much fruit juice and milk daily as recommended for this age group; also, children do not ingest adequate amounts of water, and all these factors contribute to overweight in 80% of children, regardless of gender.[19] Most children born with low weight at preschool age show a recovery in height over the years, and boys have acquired a higher rate of overweight / obesity than girls.[20] Thus, the data in the study herein diverge from those found in literature, who found these results relating the results obtained with the children to the mother's height, which was not carried out in the present study and this may have interfered with the results obtained here. In this study, this type of correlation was not verified.

Breastfeeding and complementary feeding correlate directly with growth. The results of this study demonstrated

that 57% of the children were introduced to complementary feeding at six months of age. These data are in line with the World Health Organization, which indicates exclusive breastfeeding in the first six months of life, followed by the introduction of complementary food along with breastfeeding until two years of age or more.[21]

Inadequate diet in childhood can generate significant risks of nutritional disorder, such as overweight, obesity, nutritional deficiencies such as anemia and iron deficiency.[22] The results of this study showed that 66% of the children received soft consistency food in complementary feeding.

The analysis of influence of food consistency on the lips and the tongue pressure showed higher values for the lips pressure in the introduction of liquid food (17.16 kPa), regarding the tongue pressure, the highest values were observed with soft food (31.17 kPa), with no statistical difference among the groups. Although there was no statistical difference, these results are worrying. Both the lips and the tongue have the function, among others, to direct the food to be swallowed, aiding the masticatory process. When receiving a liquid diet during infancy, it is probable that there was a higher stimulation of the orbicularis muscles towards such food, whereas soft, more consistent diet required a higher tongue muscles performance in the swallowing mechanism.[23]

When introducing a liquid diet after the 6 months of age, the stimuli for the tongue muscles decreased which can lead to dysfunctions in the speech and the own masticatory system.[24] The lack of tongue muscles stimulation does not provide adequate mechanical stimulation for the temporomandibular joint development, which may impair the stomatognathic system.[16] Therefore, the introduced soft or pasty food leads to a mechanical stimulus and consequently to the correct development of the masticatory system structures.

The results of this study showed that the children who received a soft diet presented the highest tongue pressure value (31.17 kPa), but this value is much lower when compared to those of Potter and Short,[16] who demonstrated for children aged 6 and 10 years old 45.8 and 58 kPa, respectively. Perhaps, the soft diet received by the children of this research was not thick enough to require a higher tongue muscles performance, resulting in lower tongue pressure values. The results of this study are similar to those of Kurabeishi et al.[25] who found values of 31.1 ± 5.7 kPa in children with type 2 skeletal rating based on the cephalometric analysis, and divergent when compared to children with types 1 and 3 skeletal classification, 35.6 ± 4.9 and 37.0 ± 5.5 kPa, respectively.

As previously reported, the lip pressure results for children receiving a liquid diet as complementary food introduction were 17.16 kPa whereas the values for those receiving a soft diet were 14.26 kPa, with no statistical difference between the groups. The results of this study are lower than those found by Van Lierde et al.[26] who verified that the pressure exerted by the lips in children with and without a cleft lip and unilateral palate were respectively 21.6 ± 5.5 and 20.7 ± 5.5, evidencing the need to re-evaluate the introduction of complementary food in children.

In the evaluation of the influence of food consistency, this study demonstrated a higher bite force (180N), for both sides, for the children who started the food introduction with a soft consistency diet. The bite force found here is like that of Palinkas et al.[18] who found in the right 177±16N and the left 170±14N molar region. On the other hand, the results of this study are in disagreement with those of Kaya et al.[27] who evaluated the bite force in children between 12 and 14 years of age and found that on the left side the bite force was 158.52±71.87N and the right side 197.28± 92.14N. The results of this study demonstrated that the soft food diet approach resulted in a balance of bite force, thus allowing a better stomatognathic system functioning.

The movements during suction promote tonicity and correct tongue posture, preventing it from becoming hypotonic. The lack of this muscular effort generates propensity to muscular dysfunctions, overloading the entire stomatognathic system.[8,9]

The results of this study showed that children who used bottle had higher values of lip pressure (16kPa) and tongue (30kPa) compared to those who did not use it. These results, although not statistically significant, were not expected. Perhaps the time-of-use factor may have interfered with the results obtained. In this study, the questionnaire applied did not allow to evaluate the time the children used the bottle.

However, regardless of time, bottle feeding affected the maximum bite force, since the children who did not use it showed a significantly higher bite force, both for the right side and the left side ($p = .003$ and $p = .001$, respectively) when compared to the children who used it, demonstrating that this lactation method causes changes in the stomatognathic system. This assertion is in agreement with the literature, which reports that the use of this alternative method for breastfeeding does not promote complete neuromotor stimulation for craniofacial development, mainly of the stomatognathic system; it may induce the installation of malocclusions with significant myofunctional changes and induce compensatory habits such as finger or pacifier use.[28]

The results of this research evidenced a higher pressure of the lips and tongue muscles and higher bite force for children who did not use a pacifier, data with no statistical difference and in agreement with the literature.[9] The suction of artificial nozzles causes a decrease in the lips and tongue tonicity, promoting changes in muscle posture, with direct effects on the correct face development, being able to develop atypical swallowing and change the respiratory pattern to buccal or mixed.[29,30]

It is possible to cite as limitations of this research, the fact that the children's skeletal profile was not analyzed, the time of use of bottle and pacifier and the types of nozzles used by the children. Given the above, it is possible to partially

accept the null hypothesis of this investigation because the bottle-fed children presented significantly lower values for the maximum molar bite force than breastfed children.

4 Conclusion

The results suggest that the type of breastfeeding received by the children may have a negative impact on the stomatognathic system functioning, evidenced by the lower maximum molar bite force found in the bottle-fed children.

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