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# OCCLUSAL AND OROFACIAL MYOFUNCTIONAL EVALUATION IN CHILDREN WITH PRIMARY DENTITION, ANTERIOR OPEN BITE AND PACIFIER SUCKING HABIT

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## *ABSTRACT*

The aim of this study was to evaluate occlusal and orofacial myofunctional characteristics in children three to five years of age with anterior open bite related to a pacifier sucking habit. Sixty-nine children participated in this study: 35 with anterior open bite (Anterior Open Bite Group - AOBG) and 34 with normal occlusion (Control Group - CG). In AOBG, the mean anterior open bite was 2.96 mm, the mean overjet was 4.1 mm and the mean upper intercanine distance was 28.7 mm. In the CG, the mean overjet was 2.6 mm and the upper intercanine distance was 30.3 mm. The mean overjet was greater ($p=0.001$) in AOBG than in CG, and the mean upper intercanine distance was smaller ($p<0.001$) in AOBG. The number of children with a canine Class II relationship was greater in AOBG than in CG ($p<0.001$). Simple logistic regression analysis showed that greater overjet, smaller upper intercanine distance and Class II canine relationship coexisted with anterior open bite. In AOBG, the number of children with incompetent lips, inadequate lip tonus, lack of proper tongue rest position, inadequate cheek tonus, anterior tongue interposition during swallowing and speech was greater ($p<0.05$) than in CG. Multiple logistic regression analysis identified anterior tongue interposition during swallow and speech, as well as incompetent lips, as the main orofacial myofunctional characteristics in children with anterior open bite.

***Keywords:*** Sucking habits; Pacifier sucking; Dental arch; Primary dentition; Anterior open bite; Stomatognatic System

## *INTRODUCTION*

Open bite is the lack of vertical contact between the upper and lower teeth that can occur in the anterior or posterior area (Silva Filho, Gonçalves and Maia, 1991). It is a complex malocclusion frequently associated with functional alterations of the stomatognatic system. It is usually difficult to treat and requires a multiprofessional team involving Dentistry, Speech Therapy, Otolaryngology, Psychology and Pediatrics. An early interception of this malocclusion is important, since the treatment in adults is more elaborate and has a higher chance of reoccurrence (Champagne, 1995).

In a recent study conducted by Chevitarese, Valle and Moreira (2002) with Brazilian children, the prevalence of malocclusion in children with primary dentition was 75.8%. Anterior open bite was the most common malocclusion in the group of children 4 years to 6 years of age, in both genders. Anterior open bite was present in 12.4% of the boys and 18.7% of the girls.

The etiology of anterior open bite is multifactorial and frequently associated to growth pattern, oral breathing, swallowing disturbances and nonnutritive sucking habits (Champagne, 1995; Josell, 1995; Klocke,

Nanda and Kahl-Nieke, 2002). The prevalence of sucking habits varies according to the population studied (Helle and Haavikko, 1974). According to Larsson and Dahlin (1985), during the recent decades, the prevalence of pacifier sucking habit has greatly increased, and it seems to be more common in the West. Larsson, Ogaard and Lindsten (1992) observed that the prevalence of a pacifier sucking habit in children in Sweden and Norway increased from 45% to 70% between 1961 and 1986. The prevalence of children with this habit at 3 years of age increased from 10% to 46%. These authors assume that a pacifier sucking habit in children older than 3 years of age is related to an increase in its daily use.

According to Myllärniemi (1973), the risk of developing anterior open bite is higher when a nonnutritive sucking habit persists after 5 years of age. A 1 year-old child with a pacifier or finger sucking habit has a 4 times higher risk of developing anterior open bite than a child at the same age without these habits. The risk of developing anterior open bite in children with nonnutritive sucking habit increases with age, being 6 times higher at the age of 2, 8 times at 4 years of age, and 10 times higher at 5 years of age.

Other occlusal alterations frequently associated with nonnutritive sucking habits are increased overjet and posterior crossbite (Larsson, 1994; Warren et al., 2001; Warren and Bishara, 2002). Besides malocclusion, nonnutritive sucking habits can cause orofacial myofunctional alterations of the lips and tongue, and also abnormal swallowing and speech pattern (Bowden and Orth, 1966a; Vaidergorn, 1991; Wadsworth, Maul and Steven, 1998; Zardetto, Rodrigues and Stefani, 2002).

The aim of this study was to investigate the relationship between occlusal characteristics (anterior open bite, overjet, upper intercanine distance and canine relationship) and orofacial myofuncional characteristics (lip posture and tonus, tongue posture and tonus, cheek tonus, speech, mouth rest posture and swallowing pattern) in children with complete primary dentition and anterior open bite accompanied by a pacifier sucking habit.

## *PATIENTS AND METHODS*

This was a transverse analytical study. Before initiating the study, the research project was reviewed and approved by the Ethics Committee of the University of São Paulo School of Dentistry and written consent was obtained from parents.

Sixty-nine children aged 3 years to 5 years of age, with complete primary dentition, participated in this study. They were divided into 2 groups:

1) Control Group (CG): 34 children presenting clinically normal occlusion, with current or past pacifier sucking habit or that had never used a pacifier;

2) Anterior Open Bite Group (AOBG): 35 children with anterior open bite, with current or past pacifier sucking habit.

The exclusion criteria were the presence of current or past finger sucking habit, posterior crossbite and extensive caries lesions.

**Occlusal Evaluation**

Evaluation of the occlusal characteristics was accomplished by a single examiner and was performed by clinical examination, with a small metallic millimetric ruler (Bioarte®) and vernier caliper (Staedtler Mars 551 40 SKB). All the characteristics were observed and measured as described by Zardetto, Rodrigues and Stefani (2002).

To measure the degree of anterior open bite, one of the tips of the caliper was placed on the mesial border of the more protruded upper central incisor. The other tip was placed on the mesial border of the corresponding lower central incisor.

The overjet was measured with the millimetric metal ruler positioned on the buccal surface of the mesial corner of one of the lower central incisors to the incisal surface of the ipsilateral maxillary incisor. When one of the upper central incisors was more protruded than the other, the measurement was performed on the more protruded tooth.

The upper intercanine distance was measured between the cusp tips of the upper

canines. When the cusps were abraded, the center of the abraded surface was considered, as described by Ogaard, Larsson and Lindsten (1994).

The canine relationship was classified according to Foster and Hamilton (1969), on each side as follows: Class I, when the tip of the upper primary canine was in the same vertical plane of the distal surface of the lower canine; Class II, when the tip of the upper primary canine was in anterior relationship to the distal surface of the lower canine; Class III, when the tip of the upper primary canine was in posterior relationship to the distal surface of the lower canine.

**Orofacial Myofunctional Evaluation**
The orofacial myofunctional evaluation was conducted by a single examiner. This individual was a speech therapist of the University of São Paulo School of Dentistry.

A clinical evaluation was performed to verify posture of lips at rest, lip tonus, posture of tongue at rest, tongue tonus and cheek tonus, by observation and palpation, in a similar manner to the one performed by Zardetto, Rodrigues and Stefani (2002). To evaluate lip tonus, the speech therapist palpated the child's upper and lower orbicular oris muscle with her thumb and index finger. Lip tonus was classified as adequate, increased, or decreased. Cheek tonus was also classified as adequate, increased, or decreased, after palpation and clinical observation, conducted by the speech therapist using her thumb and index finger in the child's buccinator area bilaterally and simultaneously at rest, and when blowing air in and blowing air out.

The swallowing pattern was evaluated by observation, palpation and forced opening of the lips while the children drank a small cup of water. Mouth rest posture was also assessed, while children were unaware of being observed, verifying if there was continuously open or closed mouth posture. The findings were supplemented by questioning parents about this posture during the day and night (Korbmacher et al., 2004). Speech was evaluated with a word articulation test.

**Statistical Analysis**
To compare genders and sucking habits, the Chi-squared Test was used. T-Student and Chi-squared Tests were used to compare occlusal characteristics between groups.

For the orofacial myofunctional characteristics comparison, the Chi-squared Test was performed. Whenever, the Chi-squared Test was not possible, the Fisher's Exact Test was used. Besides comparing myofunctional characteristics between study groups, the association between some myofuctional variables was also performed with Chi-squared Test.

The association between anterior open bite and occlusal and orofacial myofunctional aspects was first tested by use of a logistic regression analysis. The stepwise forward selection procedure was used to obtain the final logistic regression model for the orofacial myofunctional variables.

## *RESULTS*

The distribution of children, according to gender, was homogeneous in both groups ($p=0.717$). The mean age in the AOBG was 3.74 years and in the CG was 3.85 years, without significant statistical difference ($p=0.194$).

The pacifier sucking habit was different in the two groups ($p<0.001$). In AOBG, most children (77.1%) still used the pacifier, while in CG most had abandoned the habit (55.9%) or had never used a pacifier (41.2%).

**Occlusal Characteristics**
The mean anterior open bite was 2.96 mm (± 1.32). There was a statistically significant difference between the two groups in mean overjet ($p=0.001$), mean upper intercanine distance ($p<0.001$) and canine relationship ($p<0.001$). The mean overjet in AOBG was 4.1 mm while in CG was 2.6 mm (Figure 1).

The mean upper intercanine distance in AOBG was 28.7 mm and in CG was 30.3 mm (Figure 2). The canine relationship was different in the two groups, on right and left sides. In AOBG, 42.9% of the children presented Class I right canine relationship and 48.6% Class II. In CG, most children

(91.2%) showed Class I right canine relationship. In AOBG, 42.9% of the children presented Class I left canine relationship and 45.7% Class II. In CG, most children (85.3%) presented Class I left canine relationship. Few children presented Class III canine relationship in both groups.

In both groups, the same canine relationship tended to occur on the right and left sides (p<0,001). Table 1 shows the *odds ratio* (OR) for anterior open bite, the confidence intervals and significance values (*p*) for the occlusal variables. Children with overjet greater than 3 mm, with inadequate right and left canine relationship (Class II or III) presented higher risk of demonstrating an anterior open bite when compared to those that presented normal overjet (less than 3 mm) and Class I right and left canine relationship. On the other hand, an upper intercanine distance greater than 30 mm was statistically related to absence of anterior open bite in the appraised children.

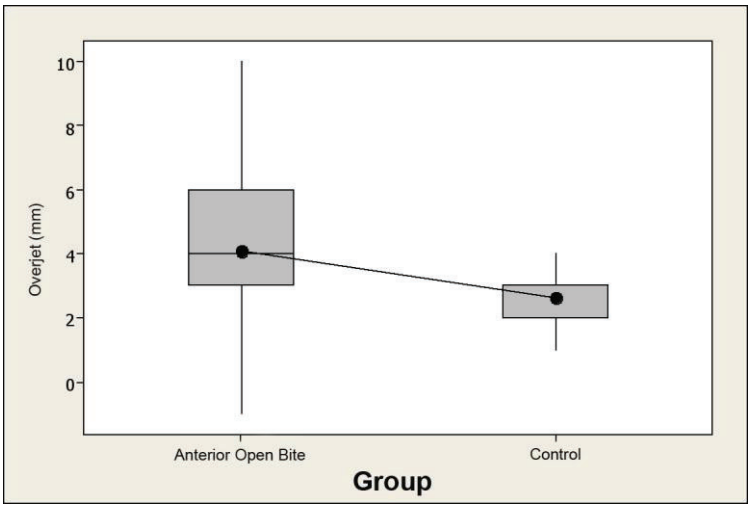


**Figure 1: Boxplot Graphic for overjet (mm) in Anterior Open Bite Group (AOBG) and Control Group (CG)**

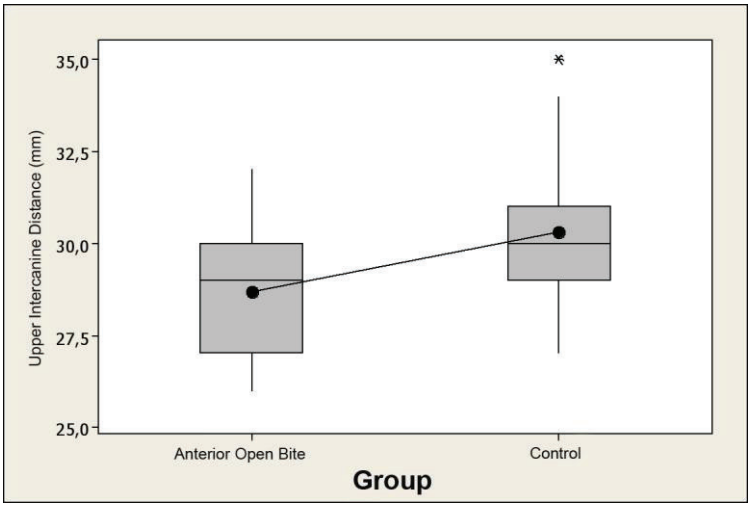


**Figure 2: Boxplot Graphic for upper intercanine distance (mm) in Anterior Open Bite Group (AOBG) and Control Group (CG)**

**Table 1: Logistic regression, between occlusal variables and anterior open bite**

| Variable | OR | 95%Confidence Interval | p |
|---|---|---|---|
| **upper intercanine distance** | | | |
| ≤ 30 mm | 1.00 | | |
| > 30 mm | 0.21 | 0.06 – 0.73 | 0.008* |
| **overjet** | | | |
| ≤ 3 mm | 1.00 | | |
| > 3 mm | 8.70 | 2.71 – 27.90 | < 0.001* |
| **right canine relationship** | | | |
| Class I | 1.00 | | |
| Class II / III | 13.78 | 3.53 – 53.74 | < 0.001* |
| **left canine relationship** | | | |
| Class I | 1.00 | | |
| Class II / III | 7.73 | 2.42 – 24.70 | < 0.001* |

* statistically significant at 5%

**Orofacial Myofunctional Characteristics**
Table 2 presents the results of the orofacial myofunctional characteristics found in both groups. Children in AOBG presented higher prevalence of inadequate lip and tongue posture at rest and alteration of lip tonus (increased or decreased). They also showed a higher prevalence of decreased cheek tonus. Increased cheek tonus was not found in these children.

Almost all children in both groups presented abnormal swallowing pattern. Swallowing was considered abnormal when anterior tongue interposition, tongue pressure against anterior teeth, perioral muscle contraction, head movement and/or absence of masseter muscle contraction were observed. There was only statistically significant difference between groups for the occurrence of anterior tongue interposition (more frequent in AOBG, $p<0.001$)) and tongue pressure against anterior teeth during swallowing (more frequent in CG, $p=0.004$).

No significant difference was identified between the groups regarding mouth rest posture.

The prevalence of speech disorder was high in both groups, without significant difference. Speech disorder was diagnosed when the child showed anterior tongue interposition, language alterations and articulatory or phonological disturbances. The occurrence of anterior tongue interposition during speech was statistically more frequent in AOBG compared to CG ($p<0.001$). No statistically significance difference was identified between the groups regarding the other speech alterations (language alterations and articulatory or phonological disturbances).

Table 3 shows the *odds ratio* (OR), confidence intervals and significance values (p) for the orofacial myofunctional variables. The main risk indicators for anterior open bite were incompetent lips at rest, altered lip tonus, lack of proper tongue rest posture, altered cheek tonus**,** anterior tongue interposition during swallowing and anterior tongue interposition during speech. On the other hand, tongue pressure against anterior teeth was a factor statistically related to the absence of anterior open bite in the appraised children.

**Table 2: Children distribution, according to orofacial myofunctional characteristics, in Anterior Open Bite Group (AOBG) and Control Group (CG)**

| Variable | Anterior Open Bite Group | Control Group | p |
|---|---|---|---|
| **lip rest posture** | | | |
| competent | 40.0% | 64.7% | |
| incompetent | 60.0% | 35.3% | 0.040* |
| **lip tonus** | | | |
| adequate | 31.4% | 64.7% | |
| decreased/increased | 65.7% / 2.9% | 32.4% / 2.9% | 0.006* |
| **tongue rest posture** | | | |
| papillae / mouth floor | 0 / 34.3% | 5.8% / 70.6% | |
| leaning / interposed | 17.1% / 48.6% | 11.8% / 11.8% | < 0.001* |
| **tongue tonus** | | | |
| adequate | 48.6% | 50.0% | |
| decreased | 51.4% | 50.0% | 0.906 |
| **cheek tonus** | | | |
| adequate | 57.1% | 82.4% | |
| decreased | 42.9% | 17.6% | 0.023* |
| **swallowing pattern** | | | |
| normal | 0 | 5.9% | |
| altered | 100.0% | 94.1% | 0.239 |
| **anterior tongue interposition (swallowing liquid)** | | | |
| no | 8.6% | 67.7% | |
| yes | 91.4% | 32.3% | < 0.001* |
| **tongue pressure against anterior teeth (swallowing liquid)** | | | |
| no | 91.4% | 61.8% | |
| yes | 8.6% | 38.2% | 0.004* |
| **perioral muscle activity (swallowing liquid)** | | | |
| no | 28.6% | 23.5% | |
| yes | 71.4% | 76.5% | 0.633 |
| **masseter muscle activity (swallowing liquid)** | | | |
| no | 31.4% | 35.3% | |
| yes | 68.6% | 64.7% | 0.733 |
| **head movement (swallowing liquid)** | | | |
| no | 91.4% | 94.1% | |
| yes | 8.6% | 5.9% | 0.999 |
| **mouth rest posture** | | | |
| closed | 31.4% | 47.1% | |
| open | 20.0% / 48.6% | 8.8% / 44.1% | 0.268 |
| **speech** | | | |
| normal | 5.7% | 20.6% | |
| altered | 94.3% | 79.4% | 0.067 |
| **anterior tongue interposition (during speech)** | | | |
| no | 14.3% | 61.8% | |
| yes | 85.7% | 38.2% | < 0.001* |
| **other speech disturbances** | | | |
| no | 40.0% | 38.2% | |
| yes | 60.0% | 61.8% | 0.881 |

* statistically significant at 5%

**Table 3: Logistic regression between orofacial myofunctional variables and anterior open bite**

| Variable | OR | 95% Confidence Interval | p |
|---|---|---|---|
| **lip rest posture** | | | |
| competent | 1.00 | | |
| incompetent | 2.75 | 1.04 – 7.30 | 0.039* |
| **lip tonus** | | | |
| adequate | 1.00 | | |
| decreased/increased | 4.00 | 1.47 – 10.90 | 0.005* |
| **tongue rest posture** | | | |
| papillae / mouth floor | 1.00 | | |
| leaning / interposed | 6.23 | 2.17 – 17.91 | < 0.001* |
| **tongue tonus** | | | |
| adequate | 1.00 | | |
| decreased | 1.06 | 0.41 – 2.72 | 0.906 |
| **cheek tonus** | | | |
| adequate | 1.00 | | |
| decreased | 3.50 | 1.16 – 10.59 | 0.021* |
| **anterior tongue interposition (swallowing liquid)** | | | |
| no | 1.00 | | |
| yes | 22.3 | 5.59 – 89.05 | < 0.001* |
| **tongue pressure against anterior teeth (swallowing liquid)** | | | |
| no | 1.00 | | |
| yes | 0.15 | 0.04 – 0.60 | 0.003* |
| **perioral muscle activity (swallowing liquid)** | | | |
| no | 1.00 | | |
| yes | 0.77 | 0.26 – 2.26 | 0.633 |
| **masseter muscle activity (swallowing liquid)** | | | |
| no | 1.00 | | |
| yes | 1.19 | 0.44 – 3.24 | 0.733 |
| **head movement (swallowing liquid)** | | | |
| no | 1.00 | | |
| yes | 1.50 | 0.23 – 9.59 | 0.666 |
| **mouth rest posture** | | | |
| closed | 1.00 | | |
| open | 1.94 | 0.73 – 5.17 | 0.183 |
| **speech** | | | |
| normal | 1.00 | | |
| altered | 4.28 | 0.82 – 22.31 | 0.060 |
| **anterior tongue interposition (during speech)** | | | |
| no | 1.00 | | |
| yes | 9.69 | 3.00 – 31.31 | < 0.001* |
| **other speech disturbances** | | | |
| no | 1.00 | | |
| yes | 0.93 | 0.35 – 2.44 | 0.881 |

* statistically significant at 5%

**Table 4: Multiple logistic regression model (forward stepwise) of anterior open bite and orofacial myofunctional variables**

| Variable | Coefficient | OR | 95% Confidence Interval | p |
|---|---|---|---|---|
| **anterior tongue interposition (swallowing liquid)** | | | | |
| no | reference | 1.00 | | |
| yes | 2.94 | 18.97 | 3.70 – 97.22 | <0.001* |
| **anterior tongue interposition (during speech)** | | | | |
| no | reference | 1.00 | | |
| yes | 2.22 | 9.24 | 1.85 – 46.23 | 0.007* |
| **lip rest posture** | | | | |
| competent | reference | 1.00 | | |
| incompetent | 0.79 | 6.23 | 1.33 – 29.17 | 0.020* |
| **constant** | -4.30 | | | <0.001 |

* statistically significant at 5%

Table 4 displays the final model of the multiple logistic regression analysis and the adjusted *odds ratio* (OR) for the orofacial myofunctional variables. The orofacial myofunctional characteristics associated with anterior open bite were anterior tongue interposition during swallowing and speech and lip incompetence.

To verify the relationship between some orofacial myofunctional variables, they were analyzed two-by-two. The following grouping was performed:

* lip posture and lip tonus (p=0.021)
* tongue posture and tongue tonus (p=0.900)
* tongue posture and anterior tongue interposition during swallowing (p<0.001)
* tongue posture and anterior tongue interposition during speech (p=0.001)
*anterior tongue interposition during swallowing and anterior tongue interposition during speech (p<0.001)
* lip posture and tongue posture (p=0.933)
* lip posture and cheek tonus (p=0.305)
* tongue posture and cheek tonus (p=0.0016)

## *DISCUSSION*

Several authors have identified association between nonnutritive sucking habits and anterior open bite (Katz, Rosenblatt and Gondim, 2004; Myllärniemi, 1973). The mean anterior open bite in the appraised children was larger than the one measured by Adair, Milano and Dushku (1992) (0.81 mm and 0.41mm, respectively for conventional and anatomic pacifier). However, it was smaller than that observed by Zardetto, Rodrigues and Stefani (2002) (6.5mm and 5.2mm, for conventional and anatomic pacifier, respectively).

The mean overjet in CG is in agreement with the normal characteristics of the primary dentition described by Ravn (1975) and Woon (1988). An increase in the mean overjet in AOBG is in agreement with several authors that studied occlusion in children with nonnutritive sucking habits (Adair, Milano and Dushku, 1992; Bowden and Orth, 1966b; Myllärniemi, 1973).

In the study conducted by Warren and Bishara (2002), the mean overjet in children with a pacifier sucking habit up to 4 years of age was 2.5 mm and 2.1 mm in children that maintained this habit after 4 years of age. In the group of children that used a pacifier for more than 4 years of age, Warren and Bishara (2002) did not find an overjet larger than 4 mm. This differs from the results of the present study, in which overjet was measured up to 10 mm in AOBG (Figure 2).

The decrease in the mean upper intercanine distance can be explained by the muscular

activity caused by nonnutritive sucking habit with a pacifier. When the pacifier is in the child's mouth, the teat occupies the upper part of the anterior and middle part of the mouth thus forcing the tongue to a lower position. In the upper jaw, the teeth in the canine area lack palatal support from the tongue during the sucking activity of the cheeks. This reduces the arch width and increases the risk of a transverse malrelation between the upper and lower arches. The low tongue position widens the lower jaw in the same area enhancing the probability of the development of a posterior crossbite, as described by Larsson (1986, 1994).

The results obtained from the two-by-two analysis of the orofacial myofunctional variables confirmed that children with appropriate tongue rest position usually presented with normal cheek tonus. On the other hand, those with lack of proper tongue rest posture frequently presented alteration of cheek tonus.

In the appraised sample, the difference between the mean upper intercanine distance in the CG and AOBG was 1.6 mm. Although statically significant, this may not be clinically relevant, as mentioned by Adair, Milano and Dushku (1992) and Warren et al. (2001). However, it would be interesting to follow up these children and verify if this difference becomes more accentuated with time and if these children develop posterior crossbite as they grow older.

The longitudinal study performed by Warren et al. (2001) offers important contributions. These authors observed that the reduction in the upper intercanine distance and the increase in the lower intercanine distance became more accentuated in children with nonnutritive sucking habit present after 4 years of age compared to those that had abandoned the sucking habit before 4 years of age.

The canine relationship and the terminal plane relationship of the primary second molars are indicative of the saggital relationship between the upper and lower arches (Adair, Milano and Dushku, 1992). The higher prevalence of canine Class II relationship in AOBG is in agreement with Nanda, Khan and Anand (1972), Warren and Bishara (2002) and Warren et al. (2001), who identified a high prevalence of canine Class II relationship in children with nonnutritive sucking habits. Specifically related to pacifier, Warren and Bishara (2002) found that 50% of the children that maintained this habit until 4 years of age, showed canine Class II relationship. On the other hand, Adair, Milano and Dushku (1992) found a prevalence of 90% for canine Class I relationship. No statistical difference was found between children that had never used pacifier and those that used anatomic or conventional models. Even so, these authors emphasized that the prevalence of canine Class II relationship was larger in the group of children that used the pacifier for longer periods of time. Bowden and Orth (1966a) did not find difference in canine relationship between children with pacifier or finger sucking habit and those without nonnutritive sucking habits. The canine relationship tended to be the same on the right and left sides, similar to the findings of Ravn (1975), Alhaija and Qudeimat (2003) and Keski-Nisula et al. (2003).

Table 1 presents the logistic regression analysis for the occlusal variables. The results should be interpreted with caution, because it is not possible to establish cause and effect relationship between anterior open bite, increased overjet, decreased upper intercanine distance and higher prevalence of canine Class II. In fact, these occlusal alterations coexist in children and are related to pacifier sucking habit.

The ideal lip posture at rest is one with the lips maintained in soft contact, and the inferior lip covers the upper incisors about 2 mm (Padovan, 1976). The ideal lip posture at rest was observed in most children in the CG. In AOBG, most presented with incompetent lips. This is in agreement with Bowden and Orth (1966a) who also observed a higher prevalence of lip incompetence in children with pacifier and finger sucking habit.

Besides the alteration in lip posture, children in AOBG also presented higher prevalence of altered lip tonus when compared to CG. The two-by-two analysis indicated that children with incompetent lips tended to present inadequate lip tonus. Neiva and Wertzner (1996b) affirmed that the inadequate lip posture interferes with the muscular conditions and can cause alteration in its tonus and mobility.

In relation to tongue rest position, most children in AOBG presented lack of proper tongue rest posture, while in CG most presented proper posture. Classically, the ideal posture for the tongue at rest is leaning against the palatine papillae (Padovan, 1976). However, authors like Neiva and Wertzner (1996a) also consider acceptable the position in which the posterior of the tongue slightly touches the palate while the tip is at rest on the mouth floor. Lack of proper tongue rest posture occurs when it is interposed between upper and lower arches and/or when it is leaning against the incisors (Bertolini and Paschoal, 2001; Neiva and Wertzner, 1996a; Padovan, 1976; Wadsworth, Maul and Stevens, 1998).

In the study of Wadsworth, Maul and Stevens (1998), lack of proper tongue rest posture was found in 59% of children and it was related to anterior open bite. Kawamura et al. (2003) also observed that, in children with anterior open bite, the tip and the back of the tongue were in an anterior and lower position at rest. Hanson and Peachey (1991) affirmed that, if the tongue is leaning against the incisors or interposed between the arches at rest, it will probably continue to project forwards during mastication, swallowing and speech. This explains the relationship between tongue rest position and the occurrence of tongue interposition during swallowing and speech, which had also been identified by Hale et al. (1988) and Wadsworth, Maul and Stevens (1998).

Wadsworth, Maul and Stevens (1998) observed that lack of proper tongue rest posture was statistically related to incompetent lips at rest. However, Neiva and Wertzner (1996a) did not find a relationship between the posture of lips and tongue at rest, because tongue posture on the mouth floor prevailed in children with incompetent lips and also competent lips. Data presented here did not show a relationship between the tongue and lip posture at rest.

Most children in both groups presented normal cheek tonus. However, the prevalence of decreased cheek tonus was higher in AOBG compared to CG. Although Marchesan (1993) affirmed that, when the child has a high frequency sucking habit for long periods of time the buccinator muscle becomes more active, hypertonic cheeks were not found. The explanation for these results can be related to the fact that many children did not actually suck the pacifier while it was inside the mouth, but just maintained it in the mouth, as mentioned by Lindsten, Larsson and Ogaard (1996). Labiszewska-Jaruzelska and Pisulska (1966) mentioned that the balance of lips, cheeks and tongue could be altered in children with anterior open bite and other malocclusions (Angle Class II or III). However, the results presented here did not identify a relationship between the posture of lips and tongue tonus nor between lip posture and cheek tonus.

Almost all children in both groups presented abnormal swallowing pattern. However, some swallowing characteristics, may undergo spontaneous improvement as these children grow up.

In AOBG, most children presented anterior tongue interposition during swallowing while in CG, most did not. Children with anterior tongue interposition showed 22 times higher risk of presenting an anterior open bite. These data are in agreement with Larsson (1986, 1994), Silva Filho, Gonçalves and Maia (1991) and Wadsworth, Maul and Stevens (1998) who also identified an association between anterior open bite and anterior tongue interposition during swallowing.

Wadsworth, Maul and Stevens (1998) pointed out that the statistically significant relationship between lack of proper tongue rest posture and anterior tongue interposition during swallowing in children with anterior open bite is not enough to prove a direct causal relationship among those variables. Therefore, it is not possible to conclude that the orofacial myofuncional alteration caused the malocclusion or if the function of the tongue is altered due to the malocclusion. According to Hanson and Peachey (1991), anterior tongue interposition and anterior open bite occurred together, and therefore, it is a mistake to attribute cause and effect relation between these phenomena.

It is necessary to understand the orofacial myofunctional alterations that occur in the swallowing pattern of young children. Facial growth and development is associated with maturation of the oral motor sensory system, and results in an increase in the space of the oral cavity as the child grows. This favors the correct position of the tongue, since it assumes a more posterior position, ceasing its interposing between the arches (Bertolini

and Paschoal, 2001; Gellin, 1978; Pierce, 1988).

Any abnormal tongue position during swallowing, such as pressuring against the teeth, instead of leaning against the palatine papillae, right behind the incisors, should be considered an atypical pressure (Padovan, 1976). Vaidergorn (1991) verified that 10.4% of children with pacifier sucking habit showed tongue pressure against the lingual surfaces of the upper incisors. The results presented here showed low prevalence of tongue pressure against the teeth during swallowing in children with anterior open bite. This can be explained by the fact that the majority of the children interposed the tongue between the upper and lower arches.

According to Bertolini and Paschoal (2001), the evaluation of the swallowing pattern should not involve only tongue interposition or tongue pressure against teeth, but also the dynamics of the tongue's movement during swallowing. The use of cineradiographic (Kawamura et al., 2003) and electropalatographic images (Cayley et al., 2000) are some alternatives that can be used for this evaluation.

There was a high prevalence of perioral muscle contraction during swallowing in both groups. Although Padovan (1976) mentioned that perioral muscle activity should not occur during swallowing and that any contraction of the perioral muscles is an indication of deviation from normal, it is possible to imagine that this muscular activity is part of the development of a mature swallowing pattern. Nanda, Khan and Anand (1972) believe that perioral muscle activity during swallowing can prevent an increase of the overjet in children with anterior tongue interposition.

Padovan (1976) affirmed that some children move their head forward to help swallow food. In the appraised sample, most children, in both groups, did not present head movement during swallowing, reflecting characteristics of normal swallowing.

Most children presented masseter muscle contraction during swallowing, which is also a normal characteristic. The activity of this muscle is necessary to elevate the lower jaw and promote teeth contact during swallowing (Padovan, 1976). Neiva and Wertzner (1996a) verified that 86.2% of the children presented strong contraction of the masseter muscle during swallowing, even those with anterior tongue interposition.

Although the prevalence of closed mouth rest posture in the present study was higher in CG compared to AOBG, the difference was not statistically significant. The high prevalence of open mouth rest posture was noted. This may be related to the high prevalence of respiratory disease in preschool children. Benicio et al. (2000) found that 49.6% of children up to 5 years of age, showed some type of sign and/or symptom, such as nasal congestion and runny nose, related to respiratory disease (flu or cold) or allergy. Another fact that was also interesting was the high prevalence of speech alteration in both groups. Approximately 60% of the children, in both groups, presented some type of speech disturbances (language alterations, and /or articulatory and phonological disturbances). The complete acquisition of sound articulations and phonemes in children do not occur before 7 years of age and may also be related to social-economical-cultural factors, including stimulations and communicative interactions, in addition to occlusal and orofacial dysfunctions (Neiva and Wertzner, 1996a).

Neiva and Wertzner (1996b) considered that there was a relationship between the presence of orofacial myofunctional alterations and phono-articulatory disturbances. Wadsworth, Maul and Stevens (1998) verified that 29.8% of children with phono-articulatory disturbances presented with anterior open bite. The results of the current study confirmed the relationship between the occurrence of anterior tongue interposition during speech and the presence of anterior open bite, since the majority of children in AOBG presented anterior tongue interposition during speech.

Table 3 shows that incompetent lips, altered lip tonus, lack of proper tongue rest posture, altered cheek tonus, anterior tongue interposition during swallowing and speech were risk indicators for anterior open bite. According to the data in Table 4, the main orofacial myofunctional characteristics related to anterior open bite, in the appraised children were anterior tongue interposition during swallowing and speech, and lip incompetence at rest.

These data should be interpreted with caution, since it can not be established if the form of the dental arches influences function or vice-versa because both are intimately related. The forces that maintain teeth in balance depend on adequate morphology, function and posture (Yamaguchi and Sueishi, 2003). Oral functions, breathing, mastication, swallowing and speech are extremely important in growth and development of the orofacial structures. These functions may cause structural modifications and interfere in the form of the orofacial structures during growth and development.

## *CONCLUSIONS AND RECOMMENDATIONS*

Children with anterior open bite associated with a pacifier sucking habit presented with a larger overjet, smaller upper intercanine distance and higher prevalence of canine Class II relationship compared to children without anterior open bite. The main orofacial myofunctional characteristics related to anterior open bite were: anterior tongue interposition during swallowing and speech and incompetent lips at rest.

Due to the great occlusal and orofacial myofunctional alterations caused by the use of the pacifier, it is necessary to alert parents that children should interrupt this habit as early as possible, preferably before 3 years of age.

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