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"Variáveis morfológicas e funcionais do sistema estomatognático em crianças com oclusão normal e mordida cruzada posterior: estudo longitudinal"

Tese apresentada à Faculdade de Odontologia de Piracicaba, Universidade Estadual de Campinas, como requisito para a obtenção do título de Doutor em Odontologia, Área de Concentração: Fisiologia Oral.

Orientadora: Profa. Dra. Maria Beatriz Duarte Gavião

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DEDICATÓRIA

Dedico este trabalho

ao apoio de meu marido Luiz

e à força de minha família

que me trouxeram até aqui.

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"Onde me procuras?
Estou contigo.
Não nas peregrinações ou nos ídolos,
tampouco na solidão.
Não nos templos ou mesquitas,
tampouco na Caaba ou no Kailash.
Estou contigo, ó homem,
estou contigo.
Não nas preces ou na meditação,
tampouco no jejum.
Não nos exercícios iogues ou na renúncia,
tampouco na força vital ou no corpo.
Estou contigo, ó homem,
estou contigo.
Não no espaço etéreo ou no útero da terra,
tampouco na respiração da respiração.
Procura ardentemente e descobre,
em um instante único de busca.
Kabir diz: escuta com atenção!
Onde está tua fé, lá estou."
(**Kabir Das**, poeta do norte da Índia, séc. XV)

"A vida é muito curta para ser pequena".

(Benjamim Disraeli)

RESUMO

A manutenção de condições normais da função mastigatória é determinante para o correto crescimento e desenvolvimento de suas estruturas. Assim, três estudos foram desenvolvidos com o objetivo de avaliar crianças na fase de dentição decídua completa e mista inicial com oclusão normal e mordida cruzada posterior funcional. As variáveis estudadas foram: máxima força de mordida, espessura ultra-sonográfica dos músculos masseter e porção anterior do temporal no repouso (RE) e máxima intercuspidação (MI), morfologia e assimetria facial por meio de fotografias frontais padronizadas; correlacionando-as entre si e com o índice de massa corporal (IMC) e buscando determinar as mudanças decorrentes do desenvolvimento da dentição e do tratamento da maloclusão. O primeiro estudo (transversal, n=67) buscou avaliar a influência de hábitos de sucção na presença de mordida cruzada e sua correlação com a força de mordida, morfologia e assimetria facial e variáveis corporais. Observou-se que crianças na fase inicial da dentição mista com mordida cruzada apresentaram menor força de mordida em comparação àquelas com oclusão normal. Na dentição decídua, crianças com mordida cruzada apresentaram faces proporcionalmente mais longas; não foi observada assimetria facial significativa entre os dois tipos de oclusão (teste "*t*" Student). Variáveis corporais apresentaram correlação significativa com a força de mordida apenas no grupo de dentição decídua com mordida cruzada (correlação de Pearson). Na dentição decídua, a tendência ao padrão de face longa e a ausência de aleitamento natural por pelo menos seis meses associou-se significativamente à ocorrência de mordida cruzada (regressão logística múltipla). Na dentição mista, a menor força de mordida e ausência de aleitamento natural apresentaram associação positiva com a presença da maloclusão (regressão logística univariada). Já a sucção não-nutritiva mostrou estar relacionada à ocorrência de mordida cruzada em ambas as dentições. O segundo estudo (longitudinal, n=13) examinou a força de mordida em crianças com oclusão normal da fase de dentição decídua completa (média 59,21±8,40 meses) ao início da mista (76,92±5,62), e correlacionou-a com a espessura dos músculos mastigatórios e dimensões faciais. Observou-se que a espessura muscular não diferiu significativamente entre os lados dos arcos dentários e que a espessura do músculo masseter (RE), a altura facial em relação à largura e a força de mordida aumentaram significativamente da dentição decídua à mista (teste "*t*" Student). Na dentição decídua, o masseter (RE) e o IMC foram os fatores que mais contribuíram positiva e negativamente para a magnitude da força de mordida, respectivamente. Na dentição mista, a espessura do masseter e do temporal (RE) contribuíram positiva e negativamente para sua magnitude, respectivamente (regressão múltipla stepwise). O terceiro estudo (longitudinal, n=19) observou as mudanças estruturais e funcionais decorrentes da correção da mordida cruzada após expansão maxilar lenta em crianças na fase de dentição decídua e início da mista. As crianças foram avaliadas em três fases: antes do tratamento da maloclusão (1), após a correção seguida de três meses de contenção (2) e três meses após a remoção da contenção (3). O tempo de tratamento ativo foi de 15,5 e 23,3 meses, em média, para o grupo decídua e mista, respectivamente. Os resultados mostraram que a força de mordida e a espessura do temporal (RE) aumentaram significativamente entre as fases 1, 2 e 3 em ambas as dentições (RM ANOVA). A variável idade não contribuiu para a força de mordida em ambas as dentições e o IMC influiu significativamente em sua variância apenas na fase 2 do grupo de dentição decídua (regressão linear múltipla). Além disso, a assimetria facial e o IMC não diferiram significativamente entre as fases (FRM ANOVA). Pôde-se concluir que, na amostra estudada, os hábitos de sucção tiveram um importante papel na ocorrência de mordida cruzada em crianças de pouca idade. O aumento na força de mordida da dentição decídua para o início da mista na oclusão normal relacionou-se ao aumento da espessura do músculo masseter; e a força de mordida e espessura do músculo temporal aumentaram significativamente após a correção da mordida cruzada.

Palavras-chave: ultra-sonografia, músculo masséter, músculo temporal, má-oclusão, face, força de mordida.

ABSTRACT

Masticatory function is able to influence directly the craniofacial growth and development. In this way, three studies were carried out to evaluate morphological and functional variables of the stomatognatic system in young children with normal occlusion and functional posterior crossbite. Maximum bite force, ultrasonographic thickness of masseter and anterior portion of the temporalis muscles during rest (RE) and maximal intercuspation (MI), and facial morphology and asymmetry by frontal photographs were evaluated, and correlations with body mass index (BMI) were performed to determine morphological and functional changes during normal occlusion development and the correction of the malocclusion. The first one (transversal, n=67) evaluated the influence of sucking habits in the presence of crossbite and its correlation with bite force, facial morphology and asymmetry and body variables. Children in the early mixed dentition with crossbite showed lower bite force magnitude than those with normal occlusion. In the deciduous dentition, children with crossbite showed a long-face tendency, but it was not observed significant facial asymmetry between normal and crossbite groups (*t*-test). Body variables only presented significant correlation with bite force in the deciduous group with crossbite (Pearson correlation test). In the deciduous dentition, the long-face tendency and the absence of breast-feeding for at least 6 months were significantly associated with crossbite (logistic multiple regression). In the mixed dentition, lower bite force and absence of breast-feeding showed positive association with malocclusion (univariate logistic regression). In both stages of the dentition, nonnutritive sucking habit that persisted up to the age of three years showed to be associated with crossbite (multiple logistic regression). The second study (longitudinal, n=13) examined the bite force among children with normocclusion from the deciduous (mean 59.21months±8.40) to the early mixed stage of dentition (76.92±5.62), and its correlation with masticatory muscle thickness and facial dimensions. The results showed that muscle thickness did not differ between the sides right/left; moreover, masseter thickness (RE), facial height in relation to the width and bite force increased significantly from the deciduous to the mixed stage (*t*-test). In the deciduous dentition, the masseter (RE) and BMI were the most important factors, positive and negatively, for bite force variance, respectively. In the mixed dentition, masseter and temporal thicknesses (RE) contributed positive and negatively for its variance, respectively (stepwise multiple regression). The third study (longitudinal, n=19) evaluated the effects of treatment of functional posterior crossbite after slow maxillary expansion in children with deciduous and early mixed dentition. They were evaluated in three stages: before the start of treatment (s1), after the correction of malocclusion and three months of retention (s2), and after three months of observation (s3). The results showed that bite force and temporalis thickness (RE) increased significantly among the stages in both dentitions (RM ANOVA). Age did not contributed for bite force magnitude, and BMI contributed significantly for bite force only in deciduous group (s2) (linear regression analysis). Moreover, facial asymmetry and BMI did not differ significantly among the stages (FRM ANOVA). In the studied sample, it was observed that sucking habits played an important role in the etiology of crossbite. The increase in bite force magnitude from the deciduous to the early mixed dentition was related with the increase in masseter thickness in the normal occlusion; and bite force and temporalis thickness increased significantly with early treatment of posterior crossbite.

Key words: ultrasonography, masseter muscle, temporal muscle, malocclusion, face, bite force.

SUMÁRIO

INTRODUÇÃO

O conhecimento das influências funcionais, ambientais e genéticas sobre o crescimento e desenvolvimento craniofacial é ainda limitado e difícil de quantificar. Sabe-se que a oclusão é fator de grande importância no desenvolvimento das estruturas envolvidas e, para que haja normalidade no crescimento, é necessário propiciar adequado desenvolvimento morfológico e funcional. Uma vez que a função dos músculos mastigatórios se relaciona ao crescimento esquelético, o diagnóstico precoce de alterações musculares e dentofaciais e a quantificação de suas implicações sobre o crescimento e função das demais estruturas são de suma importância para o estabelecimento de planos de tratamento efetivos e obtenção de resultados bem sucedidos.

A mordida cruzada é a relação bucal, labial ou lingual anormal entre dentes superiores e inferiores, quando em oclusão. Pode incluir um ou mais dentes de cada arco, ser funcional ou esquelética, além de estar presente uni ou bilateralmente (Wood, 1962; Silva Filho *et al.*, 2000). A presença desta maloclusão foi associada a alterações na função mastigatória em crianças, como a assimetria da atividade dos músculos mastigatórios (Ingervall & Thilander, 1975; Alarcón *et al.*, 2000; Kecik *et al.*, 2007), menor eficiência mastigatória (Gavião *et al,* 2001), menor força de mordida (Sonnesen *et al.*, 2001; Castelo *et al.*, 2007) e alterações morfológicas musculares e esqueléticas (Kiliaridis *et al.*, 2000; Santos Pinto *et al.*, 2001; Kecik *et al.*, 2007). É um tipo de maloclusão que dificilmente apresenta autocorreção, o que justifica a necessidade de diagnóstico precoce e a orientação dos pais e responsáveis com relação aos fatores potencialmente envolvidos, como, por exemplo, a sucção não-nutritiva (labial, digital ou chupeta), o aleitamento artificial e a respiração oral (Kutin & Hawes, 1969; Silva Filho *et al.*, 2000). Segundo Betts *et al.* (1995), a mordida cruzada posterior muitas vezes está relacionada a problemas esqueléticos, e não somente a displasias dentárias, envolvendo a maxila, a mandíbula, ou ambos, de forma que o aumento significativo das dimensões cefalométricas faciais, maxilares e nasais transversais em indivíduos submetidos à expansão maxilar lenta foi observado em estudos anteriores (Brin *et al.*, 1996; Chung and Font, 2004; Machado Jr. & Crespo, 2006).

A qualidade da função mastigatória é dependente de uma série de fatores: área oclusal, número de dentes, atividade, dimensões e coordenação dos músculos mastigatórios, dimensões craniofaciais e ação da língua e dos músculos peribucais na manipulação do alimento (van der Bilt, 2002). Sabe-se que indivíduos portadores de padrão braquicefálico são caracterizados por menor altura facial anterior, menor inclinação da mandíbula, ângulo goníaco menos obtuso e paralelismo entre os planos mandibular e palatino; funcionalmente, apresentam maior espessura dos músculos mastigatórios que acompanha maior amplitude da força de mordida (Kiliaridis & Kalebo, 1991; Bakke *et al*., 1992; Braun *et al*., 1995; Raadsheer *et al*., 1996; Benington *et al*., 1999; Raadsheer *et al*., 1999). Na mastigação, observa-se atividade neuro-muscular bem integrada, que ocorre simultaneamente com a contração sincrônica dos músculos de fechamento, abertura, lateralidade e protrusão. À medida que a oclusão e a mastigação amadurecem, a anatomia de todos os componentes articulares modifica-se, para adaptar-se às mudanças dos novos padrões de oclusão, guias oclusais, profundidade da fossa articular e altura cuspídea (Moyers, 1993). A mastigação pode ser unilateral, bilateral ou bilateralmente alternada. Em sujeitos cuja oclusão é muito semelhante em ambos os lados, a mastigação é bilateralmente alternada. O padrão mastigatório sofre influência de fatores centrais e periféricos e se estabelece já na fase de dentição decídua completa (Ahlgren, 1967; Wickwire *et al*., 1981; Saitoh *et al*., 2002), proporcionando função e estímulos indispensáveis para a manutenção dos arcos dentários e estabilidade da oclusão, com estímulo funcional sobre o periodonto, músculos e articulações (Molina, 1989).

A utilização da ultra-sonografia dos músculos mastigatórios, tais como o masseter e o temporal, e a mensuração da máxima força de mordida voluntária são exemplos de métodos de diagnóstico seguros e aplicáveis no estudo do desempenho da função mastigatória (Kubota *et al*., 1998; Bertram *et al*., 2003; Emshoff et al., 2003; Sonnesen & Bakke, 2007). Já a avaliação das dimensões faciais por meio de fotografias frontais padronizadas é um método importante no estudo do perfil mole que também não expõe o sujeito à radiação, fornecendo informações importantes para o estudo da influência do padrão facial sobre as funções que envolvem o sistema estomatognático (Kiliaridis & Kalebo, 1991; Ferrario *et al*., 1993; Kiliaridis *et al*., 1993; Bishara *et al*., 1995; Colombo *et* *al*., 2004; Pompei *et al*., 2005; Martins *et al*., 2006); além de ser um instrumento importante no planejamento ortodôntico e cirúrgico buco-maxilo-facial (Moreira *et al*., 2002).

Estudos sugerem que sujeitos portadores de discrepâncias oclusais e esqueléticas, além de assimetria durante as excursões mandibulares, requerem tratamento precoce (Allen *et al*., 2003; Tausche *et al*., 2004), uma vez que o côndilo é considerado zona de crescimento mandibular suscetível a alterações morfológicas (Kiliaridis, 1995; Saitoh *et al*., 2002). Sendo assim, os objetivos do presente estudo foram avaliar longitudinalmente e correlacionar a amplitude da força de mordida máxima, a espessura dos músculos mastigatórios, a morfologia facial, as variáveis corporais e a presença de hábitos de sucção em crianças com oclusão normal nas fases de dentição decídua e mista inicial e em crianças com mordida cruzada posterior funcional, antes do tratamento da maloclusão, após o período de três meses de contenção e três meses após a remoção da contenção.

CAPÍTULOS

Esta tese está baseada na Resolução CCPG UNICAMP/002/06 que regulamenta o formato alternativo para teses de Mestrado e Doutorado e permite a inserção de artigos científicos de autoria ou co-autoria do candidato. Por se tratar de pesquisa envolvendo seres humanos, o projeto de pesquisa deste trabalho foi submetido à apreciação do Comitê de Ética em Pesquisa da Faculdade de Odontologia de Piracicaba, tendo sido aprovado (Anexos 1 e 2). Sendo assim, esta tese é composta de três capítulos contendo artigos em fase de redação, conforme descrito abaixo:

CAPÍTULO 1

"Bite force, facial morphology and the prevalence of nutritive and nonnutritive sucking habits in young children with functional crossbite"; Castelo PM, Gavião MBD, Pereira LJ, Bonjardim LR. Este artigo foi submetido a *Journal of Dentistry for Children*.

CAPÍTULO 2

"Longitudinal analysis of maximal bite force in relation to masticatory muscle thickness and facial dimensions in young children with normal occlusion"; Castelo PM, Gavião MBD, Pereira LJ, Bonjardim LR. Este artigo será submetido a *Journal of Dental Research.*

CAPÍTULO 3

"Intra-individual evaluation of morphological and functional aspects of the stomatognatic system during early treatment of functional posterior crossbite"; Castelo PM, Gavião MBD, Pereira LJ, Bonjardim LR. Este artigo será submetido a *American Journal of Orthodontics and Dentofacial Orthopedics*.

CAPÍTULO 1

"Bite force, facial morphology and the prevalence of nutritive and nonnutritive sucking habits in young children with functional crossbite"

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"Bite force, facial morphology and the prevalence of nutritive and nonnutritive sucking habits in young children with functional crossbite"

SUMMARY

The aims of this study were to evaluate the influence of sucking habits on the presence of functional crossbite and its relation with maximal bilateral bite force, facial morphology and body variables, in the deciduous and early mixed dentition. 67 children of both genders (aged 3.5-7 years) were divided in four groups: deciduous-normocclusion (DecN), deciduous-crossbite (DecC), mixed-normocclusion (MixN), and mixed-crossbite (MixC). Facial morphology and asymmetry were determined by standardized frontal photographs: AFH (anterior face height), BFW (bizygomatic facial width), and FAA (facial asymmetry angle). The results showed that MixC group presented lower bite force than MixN, and AFH/BFW was significantly smaller in DecN than DecC (unpaired *t*-test). FAA did not show difference between the groups and weight and height were only significant correlated with bite force in DecC (Pearson correlation test). In the deciduous dentition, AFH/BFW and breast-feeding for at least six months were positive and negatively associated with crossbite, respectively (multiple logistic regression). In the mixed dentition, breast-feeding and bite force showed negative association (univariate logistic regression), while nonnutritive sucking (up to the age of 3 years) was a potential predictor of crossbite in all groups (multiple logistic regression). In the studied sample, sucking habits played an important role in the etiology of crossbite, which was associated with lower bite force in the mixed dentition and long-face tendency.

SHORT TITLE: "Sucking behavior and masticatory function"
KEY WORDS: bite force, face, sucking behavior, malocclusion

INTRODUCTION

Breast-feeding encourages normal growth and development of the alveolar processes and stomatognatic structures, correct intermaxillary relationship and nose breathing (Malandris & Mahoney, 2004). If suck needs is not satisfied during regular feeding, it may be fulfilled by a sucking habit. Some studies have reported the effects of persistent nonnutritive sucking on sagittal and vertical dimensions of the maxilla and the mandible, dependent on the intensity, frequency, and the duration of the habit (Larsson, 2001; Katz *et al*., 2004).

Posterior crossbite occurs frequently in children, as a result of genetic or environmental influences (for ex., nonnutritive sucking habits and mouth breathing), or a combination of both, and has been associated with asymmetrical growth and function of the hard structures and muscles (Tsarapatsani *et al*., 1999; Sonnesen *et al*., 2001; Allen *et al*., 2003; Castelo *et al*., 2007). Betts *et al*. (1995) stated that a posterior crossbite does not confine itself to dental displasias but is more often related to an underlying skeletal problem.

Dental occlusion, functional pain, craniofacial morphology and the size of masticatory muscles are the main factors that influence the magnitude of the bite force (Sonnesen *et al*., 2001). Craniofacial morphology evaluation is an important tool in clinical practice and research, and can be achieved with different approaches, including photographic analyses, which is an inexpensive method, does not expose the patient to potentially harmful radiation, and can provide the external craniofacial structures evaluation, including the contribution of muscles and adipose tissue (Ferrario *et al*., 1993).

The purpose of this study was to evaluate the association of sucking habits with the presence of normocclusion and posterior crossbite among children in the deciduous and early mixed dentition, and its relation with maximum bite force, facial dimensions and asymmetry.

MATERIALS AND METHODS

The study comprised 67 healthy children of both genders aged from 3.5 to 7 years, who were to start treatment in the Department of Pediatric Dentistry, Piracicaba Dental School, State University of Campinas, Piracicaba, SP, BR and from day care centers of Piracicaba. All children and their parents consented to participate in the study, which was approved by the Ethics Committee of our institution (protocols n. 147/2001 and 148/2002). They were selected after a complete anamneses and clinical examination, when body weight and height, morphological occlusion, stage of the dentition (deciduous/early mixed dentition) and the presence of unilateral posterior crossbite (functional, involving canine and deciduous molars) were verified. The inclusion criterion for early mixed dentition was the eruption of the first molar and/or permanent incisors (Šlaj *et al*., 2003). Children with bilateral/skeletal crossbite, structure or number alterations of the teeth and oral tissues, severe obstruction of upper airways, history of orthodontic treatment, and open/deep bite were excluded, and they were distributed in four groups: DecN - deciduous-normocclusion, DecC - deciduous-crossbite, MixN – mixed-normocclusion, and MixC – mixed-crossbite (Tables 1 and 2). Those with normocclusion did not present signs and/or symptoms of temporomandibular dysfunction (Castelo *et al*., 2005), nether deviation of median line.

The data regarding the history, presence and duration of sucking habits were obtained from the parents, considering the following parameters:

- breast-feeding over a period of at least six months (with the presence or absence of bottle-feeding);
- bottle-feeding for one year or more;
- nonnutritive sucking habit (pacifier or thumb sucking) that persisted up to the age of three years. The first author (PMC) performed all assessments and measurements, thus eliminating the possible inter-observer differences.

Facial Morphometry by photographic evaluation

Facial dimensions were determined by measuring standardized frontal photographs (10x15 cm), taken with a digital camera and automatic flash (Canon EOS 3000 V), fixed on a tripod, according to Ferrario *et al*., 1993; Bishara *et al*., 1995; Pompei *et al*., 2005 and Martins *et al*., 2006. The children remained in the standing position in front of a white background, under a natural light and in relaxed position, with about 20 cm of leg distance in order to give more stability. The head was positioned with the saggital and Frankfort plans perpendicular and parallel to the horizontal plan, respectively. The distance camera-background was found by given the best focus. The dimensions were hand traced on acetate paper and measured using digital caliper (Digimatic 500, Mitutoyo Corporation, Japan), with a accuracy of 0.01mm and are detailed in Figures 1 and 2. The use of dimensions ratios and printed photographs were considered to reduce errors.

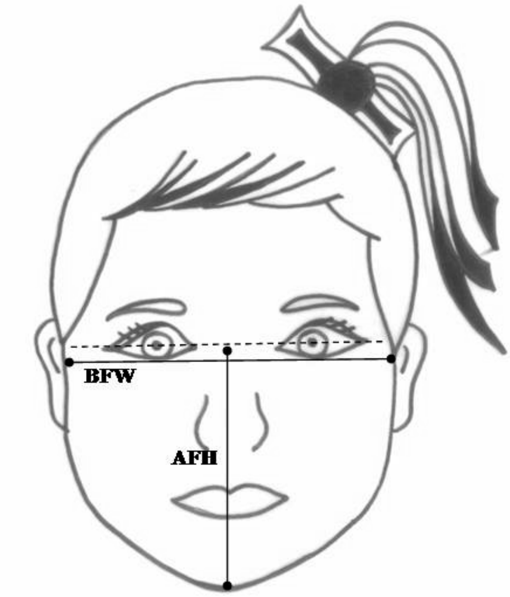

Fig. 1. Facial dimensions: AFH, anterior face height (the linear distance between the interpupillary plane and the inferior margin of the menton); BFW, bizygomatic facial width (the linear distance between the bilateral most exterior points of the zygomatic arches).

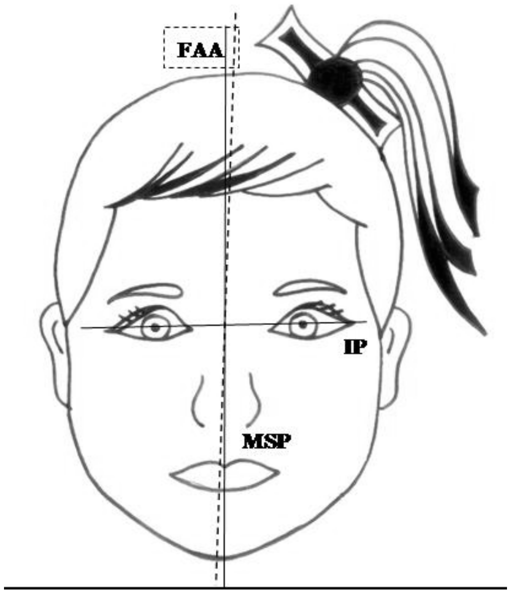

Fig. 2. IP, interpupillary plane; MSP, midsagittal plane (solid line formed by soft tissue nasion and soft tissue subnasale); facial asymmetry angle (FAA) determination: angle formed by a perpendicular line to the interpupillary plane with the midsagittal plane.

Maximum bite force measurement

Maximum bite force was assessed with a pressurized transducer tube constructed with a flexible material (10mm diameter), and connected to a sensor element (MPX5700 Motorola, Texas, USA) (for more details, see Castelo *et al.*, 2007). The tube was placed bilaterally over the deciduous molars, and the recordings were performed three times, with an interval of two minutes. The final value was determined as the average of the three measurements (accuracy of 0.1 N). The children were seated in an upright position with the head in natural posture and they were instructed to bite the tube as forcefully as possible. The measurements were transferred to a computer in pounds per square inch (PSI) and converted into Newton (N) (Excel, Microsoft).

Statistics

Logistic regression models with the binary endpoint of crossbite (yes, no) were fit to evaluate the association between the presence of crossbite as the dependent variable and the following independent variables: bite force, AFH/BFW, FAA, and nutritive and nonnutritive sucking habits, controlling for age, weight and height. First, univariate models identified a set of variables that were independently associated with the presence of crossbite in each stage of dentition. Following, the variables that were significant were taken as potential predictors of crossbite and were used as covariates in multivariate logistic regression analysis.

The correlations between bite force and age, weight, height, and AFH/BFW were estimated by the four groups using the Pearson correlation coefficient. Fisher's exact test was applied for verifying the differences in proportions of children with crossbite and normocclusion, considering the nutritive and nonnutritive sucking habits. All calculated p values were two-sided, and values less than 0.05 were considered statistically significant. The statistic analysis was performed using Intercooled Stata 7.0, Texas, USA.

RESULTS

Tables 1, 2, 3, and 4 show the sample distribution according to the type and stage of the occlusion and the descriptive statistics of the variables studied. The MixC group presented bite force values significantly smaller than group MixN, whereas in the deciduous dentition, AFH/BFW ratio was significantly smaller in DecN group ($p<0.05$). Body variables were only significant correlated with bite force in DecC group.

AFH/BFW ratio, nonnutritive habits and breast-feeding were the major independent predictors of crossbite in deciduous dentition, as demonstrated by the multiple logistic regressions ($p<0.05$). In univariate analyses, children in the mixed dentition with lower bite force and the absence of breast-feeding were significantly more likely to have a posterior crossbite; but they can not be considered predictors of this malocclusion, due to the no significant levels reached in the multiple logistic models. By multivariable analyses, nonnutritive sucking habits were also significantly associated with the presence of crossbite in the mixed groups, that is, nonnutrive sucking can predict the establishment of this malocclusion in both evaluated dentition phases. Fisher's exact test showed significant association between sucking habits and crossbite in both stages of the dentition. Bottle-feeding for one year or more was highly prevalent in both groups of the mixed dentition; for this reason, this variable was not considered in the logistic regression analyses.

Table 1. Average (SD) for age, body variables, facial dimensions ratio (AFH/BFW), facial asymmetry angle (FAA) and maximum bite force (BF) for deciduous groups and the results of statistical analyses.

Group	DecC	DecN	Logistic regression	
n	19	19	Univariate analysis	Multivariable analysis
	Mean (SD)	Mean (SD)	*p*-value	*p*-value
Age (months)	59.47 (7.21)	58.42 (8.50)	NS	NA
Weight (Kg)	19.34 † (2.25)	19.79 (4.17)	NS	NA
Height (m)	1.10 † (0.06)	1.09 (0.07)	NS	NA
AFH/BFW	0.78* (0.03)	0.75* (0.03)	0.038	0.016
FAA (°)	0.92 (0.58)	0.58 (0.53)	NS	NA
BF (N)	277.75 (53.27)	280.46 (48.31)	NS	NA

. DecC, deciduous-crossbite; DecN, deciduous- normal occlusion.

* p <0.05 unpaired t-test for AFH/BFW comparison

† p <0.05 Pearson correlation test between BF and body variables

NA indicates not applicable; NS, not significant.

Table 2. Average (SD) for age, body variables, facial dimensions ratio (AFH/BFW), facial asymmetry angle (FAA) and maximum bite force (BF) for mixed groups and the results of statistical analyses.

Group	MixC	MixN	Logistic regression	
n	16	13	Univariate analysis	Multivariable analysis
	Mean (SD)	Mean (SD)	*p*-value	*p*-value
Age (months)	73.25 (7.28)	72.69 (6.17)	NS	NA
Weight (Kg)	23.31 (5.81)	25.72 (4.65)	NS	NA
Height (m)	1.18 (0.07)	1.18 (0.05)	NS	NA
AFH/BFW	0.78 (0.05)	0.75 (0.03)	NS	NA
FAA (°)	1.25 (0.52)	0.85 (0.55)	NS	NA
BF (N)	316.42* (52.16)	352.81* (23.67)	0.045	NS

MixC, mixed-crossbite; MixN, mixed-normal occlusion.

***** p <0.05 unpaired *t*-test for BF comparison

NA indicates not applicable; NS, not significant.

Table 3. Sample distribution according to nutritive and nonnutritive sucking habits and the results of statistical analysis for deciduous groups.

Group	DecC	DecN	Fisher's Exact test	Logistic regression	
n	19	19		Univariate analysis	Multivariable analysis
	n (%)	n (%)	*p*-value	*p*-value	*p*-value
Nonnutritive sucking habit	10 (52.6%)	3 (15.8%)	0.022	0.022	0.049
Breast-feeding	7 (36.8%)	15 (79.0%)	0.007	0.012	0.040
Bottle-feeding	18 (94.7%)	16 (84.2%)	0.354	NS	NA

DecC, deciduous-crossbite; DecN, deciduous- normal occlusion.

NA indicates not applicable; NS, not significant.

Table 4. Sample distribution according to nutritive and nonnutritive sucking habits and the results of statistical analysis for mixed groups.

Group	MixC	MixN	Fisher's Exact test	Logistic regression	
n	16	13		Univariate analysis	Multivariable analysis
	n (%)	n (%)	*p*-value	*p*-value	*p*-value
Nonnutritive sucking habit	13 (81.3%)	3 (23.1%)	0.003	0.004	0.020
Breast-feeding	4 (25.0%)	10 (76.9%)	0.009	0.009	NS
Bottle-feeding	16 (100.0%)	12 (92.3%)	0.002	NA	NA

MixC, mixed-crossbite; MixN, mixed-normal occlusion.

NA indicates not applicable; NS, not significant.

DISCUSSION

Bite force is one of the components of the chewing function and it is influenced by the relationship of hard and soft structures of the craniofacial complex, including muscles, maxilla, mandible and dental occlusion. Therefore, the conditions of these components will influence masticatory efficiency. Possible etiologies of crossbites include prolonged retention or premature loss of deciduous teeth, crowding, palatal cleft, genetic control, arch deficiencies, abnormalities in tooth anatomy or eruption sequence, non-nutritive sucking habits, oral respiration during critical growth periods, and temporomandibular disorders (Allen *et al*., 2003). Since an untreated crossbite is thought to be detrimental for function (Pinto *et al*., 2001; Malandris & Mahoney, 2004), the early diagnosis and functional examination must be considered in clinical practice.

Legovic & Ostric (1991) emphasized the importance of unfavorable factors on the growth and development of the oral and facial structures, as well as the influence of favorable factors, such breast-feeding that places beneficial orthopedic forces on the jaws. A reduced electromyographic activity for the masseter muscle in bottle-fed babies may be observed when compared with those breast-fed (Inoue *et al*., 1995). According to the results found, the absence of breast-feeding showed to be a potential predictor for no crossbite development in the deciduous phase. Moreover, the prevalence of nonnutritive sucking habits among children with crossbite was higher than those with normal occlusion, and the statistical analysis showed a positive and significant association between the habit and the presence of crossbite in both stages of the dentition. These findings are in agreement with Katz *et al*. (2004), who emphasized the need for attention to the magnitude of malocclusion in childhood. Larsson (2001) observed the development of interfering contacts in deciduous canines and midline shift among pacifier- and digit-suckers; in these cases, the author conclude that parents should be instructed to reduce the “in the mouth time” of the habit. This effect occurs because when the teat of the pacifier is kept in the mouth, the tongue will be forced to a lower position in the anterior part of the mouth, thereby reducing the palatal support of the upper primary canines and molars against the pressure of the cheeks, resulting in a narrower upper arch (Larsson, 1986). The use of bottle-feeding for one year or more was too high in the sample studied, what could interfere in the determination of its influence in the presence of malocclusion.

In accordance with previous studies, there was significant difference in the maximum bite force between children with and without crossbite in the mixed dentition (Sonnesen *et al*., 2001), but not in the deciduous dentition (Rentes *et al*., 2002; Yawaka *et al*., 2003; Kamegai *et al*., 2005), that is, a posterior crossbite that persists may cause alterations in muscle dimensions and strength during the eruption and establishment of the permanent dentition (Kiliaridis *et al*., 2000; Sonnesen *et al*., 2001; Kamegai *et al*., 2005). Children in the deciduous dentition with a long-face tendency were more likely to have crossbite, agreeing with Allen *et al*. (2003), who observed among children in the mixed dentition, that those with longer lower face height and smaller effective maxillary to mandibular skeletal width ratio were associated with the presence of crossbite, what suggests that craniofacial asymmetries may be due to the malocclusion. Children from the MixC group also presented longer faces, but this find was not significant. However, Katz *et al*. (2004) did not find significant difference in facial morphology in preschool children with crossbite. According to the authors, the importance of genetic factors in the etiology of malocclusions would seem to be less than environmental factors.

A divergence of the occlusal plane and orbit or globe asymmetries from the horizontal axis may be related to a posterior crossbite, but they are not always easily detected because soft tissues and posture can compensate these imbalances (Padwa *et al*., 1997). FAA measurements of the crossbite groups were higher than the normocclusion groups, although not statistically significant. According to previous studies, young children with unilateral crossbite present a longer mandibular ramus, a more posterior and superiorly positioned condyles in the glenoid fossa on the crossbite side (Myers *et al*., 1980; Pinto *et al*., 2001), and an inherent pattern of jaw movement (Brin *et al*., 1996; Throckmorton *et al*., 2001). Since function influences the dimensions and shape of muscles and hard structures (Raadsheer *et al*., 1996; Tuxen *et al*., 1999; Kitai *et al*., 2002), the postural asymmetry that exists in the crossbite would be expected to contribute to facial asymmetry that may be evident in older ages than the sample studied. By photographic evaluations, Pompei *et al*. (2005) did not find significant differences in asymmetry between interpupillary and commisure planes.

Past studies observed that subjects with strong or thick mandibular elevator muscles have wider transversal head dimensions, and tendencies towards a rectangular shape of the face (Kiliaridis, 1995; Raadsheer *et al*., 1996; Rasheed *et al*., 1996; Kiliaridis *et al*., 2003). Further, it was showed that masticatory muscles volume exert influence on the size of their adjacent local skeletal sites where the muscles are inserted and on the muscle force is exerted (Kitai *et al*., 2002), and a significant correlation between bite force and craniofacial morphology may be observed in boys and girls (Ingervall & Thilander, 1975; Ingervall & Minder, 1997). This study showed no significant correlations between facial morphology and the magnitude of bite force, which could be attributed to the difference in age and methodologies on comparing the mentioned studies. Gender differences for facial morphology and bite force were not considered, since this variable becomes significant at older ages (Oueis *et al*., 2002; Sonnesen *et al*., 2001; Kamegai *et al*., 2005). Only in DecC group, weight and height were significantly correlated with bite force; the influence of body variables on the magnitude of bite force seems to be controversial in the literature, mainly in young subjects (Rentes *et al*., 2002).

In the studied sample, it was observed that sucking habits played an important role in the presence of crossbite, and such condition was related with a decrease in bite force magnitude and long-face tendency. Skeletal or functional alteration related to a posterior crossbite would be a reason for early intervention for the elimination of factors inhibiting dental arch development and provide skeletal correction while the child is still growing (Allen *et al*., 2003; Tausche *et al*., 2004). But controversy still exists in the literature as to the most appropriate time to treat this condition (Turpin, 2004), and future studies are needed to assess long-term outcomes and analyze costs and possible side effects of the interventions.

CONCLUSIONS

In the studied sample, sucking habits played an important role in the occurrence of functional crossbite, and this condition was related with a decrease in bite force magnitude and a long-face tendency.

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CAPÍTULO 2

"Longitudinal analysis of maximal bite force in relation to masticatory muscle thickness and facial dimensions in young children with normal occlusion"

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"Longitudinal analysis of maximal bite force in relation to masticatory muscle thickness and facial dimensions in young children with normal occlusion"

ABSTRACT

The present study examined bilateral bite force in 13 children with normal occlusion from complete deciduous (I) to early mixed dentition (II), and correlated with ultrasonographic masticatory muscle thickness and facial dimensions assessed by standardized frontal photographs: anterior facial (AFH) and lower face height (LFH), and bizygomatic width (BFW). Bite force was examined with pressurized tube. Children with oral tissues/temporomandibular abnormalities, or deviation of midline were excluded. Muscle thickness did not differ between the right/left sides. Masseter at rest, AFH/BFW ratio and bite force increased significantly from stage I to II. Multiple regression stepwise analysis showed that masseter thickness at rest and body mass index at stage I, and masseter and temporalis thicknesses at stage II were the most important factors for bite force; facial dimensions showed no significant correlation. In this sample, the increase in bite force between the stages was related with the increase in masseter muscle thickness.

KEY WORDS: bite force, ultrasonography, masseter muscle, temporal muscle, face

INTRODUCTION

Maximal voluntary bite force is one of the components of chewing function and it has a relationship with many variables – variation in jaw muscle size and craniofacial morphology, for example, which is related with muscle orientation. It has also been reported that some conditions, such malocclusion, dental caries and signs and symptoms of temporomandibular dysfunction may influence masticatory performance (García-Morales *et al*., 2003; Kamegai *et al*., 2005; Sonnesen & Bakke, 2005). The study of soft tissues, particularly the facial and mandibular muscles, and their relation with occlusion and dentoalveolar growth and development, are relevant to the clinical outcome. Weak masticatory muscles could be one of the reasons for the development of jaw deformity (Kiliaridis, 1995), once normal muscle function is needed to maintain a normal face (Miller *et al*., 2004).

Ultrasonographic and photographic analyses are inexpensive, do not expose the patient to potentially harmful radiation, and may assess the muscle function and the relationship among external craniofacial structures, respectively, with accurate measurements (Ferrario *et al*., 1993; Bishara *et al*., 1995; Kiliaridis *et al*., 2003). The study of subjects with normal occlusion can provide evidences and parameters for the physiological mechanisms of masticatory function. Moreover, the final aim of a clinical practice is normocclusion. Thus, the purposes of the present study were to examine longitudinally the magnitude of bite force and its relation with masticatory muscle thickness, facial dimensions, and body variables from deciduous to early mixed dentition.

MATERIAL AND METHODS

The sample comprised 13 children of both genders, aged 3.5-6 years, with normal occlusion who were to start treatment in the Department of Pediatric Dentistry. Morphological and functional variables of the stomatognatic system were followed longitudinally from the deciduous to the early mixed dentition. All children and their parents consented to participate in the study (Ethics Committee protocols. 147/2001, 148/2002), and they were selected after a complete anamneses and clinical examination, when morphological occlusion were verified. Children with form/structure/number alterations of teeth and oral tissues, severe obstruction of upper airways, history of previous orthodontic treatment, temporomandibular dysfunction (Castelo *et al.*, 2005), midline deviation, or parafunctional habits were excluded. Weight and height were determined using anthropological scale, and the body mass index (BMI) was calculated as weight/height^2 (Kg/m^2). Two analyses were done: I-complete deciduous dentition (mean age 60.23±7.79 months) and II-early mixed dentition (mean 76.92±5.62). The inclusion criterion for early mixed dentition was the eruption of the first molar and/or permanent incisors (Šlaj *et al.*, 2003).

Measurement of Masticatory Muscle Thickness

The ultrasonographic thickness of the masseter and anterior portion of the temporalis muscle were measured bilaterally (Just Vision Toshiba™, Japan, 56 mm/10 MHz), while the children were seated upright, with their heads in a natural position. The recordings were performed twice with the muscle at rest (RE) and in maximal intercuspation (MI), and it corresponded to the most bulky part of the muscle image; the final value was obtained from the mean of both (accuracy of 0.1 mm). The recording site was determined by palpation, following the orientations: masseter - level halfway between the zygomatic arch and gonial angle; anterior portion of the temporalis muscle - in front of the anterior border of the hairline.

Bite Force Measurement

Maximum bite force was assessed with a pressurized transducer tube (diameter of 10 mm) constructed with a flexible material, and connected to a sensor element (MPX5700 Motorola, Texas, USA). The children were seated in an upright position with head in natural posture and the tube was placed bilaterally at the deciduous molars; then, they were instructed to bite the tube as forcefully as possible. Three measurements were done and transferred to a computer in Basic language in pounds per square inch (PSI). The difference between maximum and minimum pressures was calculated and later converted into Newton (N), taking in account the area of the tube. The final value was determined as the average of the measurements, with an accuracy of 0.1 N (for more details, see Castelo *et al.*, 2007).

Facial Dimensions

Facial dimensions were determined by measuring frontal photographs (10x15 cm), taken with standardized method according to Ferrario *et al.*, 1993; Bishara *et al.*, 1995 and Martins *et al.*, 2006. The subjects were standing up in front of the digital camera (Canon EOS 3000 V), under natural light against a light background, with teeth in maximal intercuspation and Frankfort plan parallel to the floor. Five images were obtained from each subject, and the best one was chosen for the measurements. The dimensions were hand traced on acetate paper and measured using digital caliper (accuracy of 0.01 mm) (Fig. 1). Later, the facial dimensions ratios were calculated: anterior face height/bizygomatic facial width (AFH/BFW) and lower face height/anterior face height LFH/AFH, once the proportions are more reliable and eliminate the enlargement of the images.

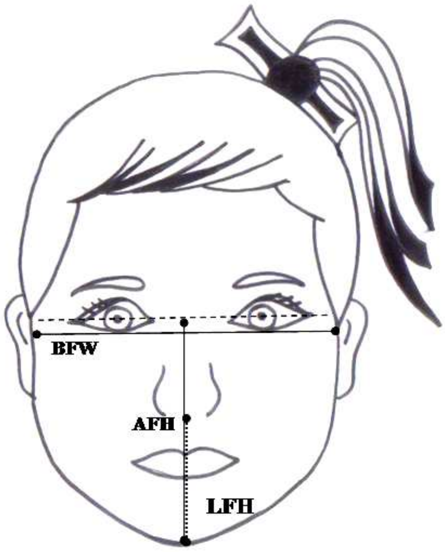

Figure 1. Facial dimensions determination: AFH (anterior face height - the linear distance between the interpupillary plane and the inferior margin of the menton); BFW (bizygomatic facial width - the linear distance between the bilateral most exterior points of the zygomatic arches); LFH (lower face height - the linear distance between the subnasale and the inferior margin of the menton).

Measurement errors

The reliability of the measurements for muscle thickness (only the left side was chosen), bite force and facial dimensions was determined on 15 randomly selected children not included in this study using the same method as in the present investigation by the first author (PMC) (Castelo *et al.*, 2007). Two repeated measurements (x_1, x_2), at interval from 7 to 30 days, were taking and the differences between the two set of measurements were calculated by the Dahlberg's formula: Method Error (ME) = $\sqrt{\Sigma(x_1 - x_2)^2/2n}$. In addition, these methods were already tested in our laboratory with good results (Rentes *et al.*, 2002; Bonjardim *et al.*, 2005; Pereira *et al.*, 2007) .The results are shown in Table 1.

Table 1. Error of the method (ME) for masticatory muscle thickness (mm), bite force (N), and facial dimensions (mm) assessed on repeated measurements of 15 subjects.

Variable	ME
Left masseter / resting	0.53
Left masseter / maximal intercuspal position	0.36
Left temporalis / resting	0.09
Left temporalis / maximal intercuspal position	0.15
Bite force	16.28
Facial dimensions	1.20

Statistics

Statistical analysis was performed using Intercooled Stata 7.0, Texas, USA; and *p* values less than 0.05 were considered statistically significant. ANOVA was performed to test the difference in muscle thickness between the sides of the dental arches (right/left), normality was assessed using Shapiro-Wilks *W*-test, and Spearman's correlation coefficients were determined between bite force and facial dimensions ratios.

The percentage changes (%) between stages I and II were calculated, considering the values in stage II less the values in stage I multiplied by 100, and divided by the value in stage II. Paired *t*-test analyzed the difference in bite force, muscle thickness, BMI, and facial dimensions ratios between the stages. Multiple regression analysis with backward stepwise elimination determined the relationship between bite force as the dependent variable, and muscle thickness, age, BMI, and facial dimensions ratios as the independent variables.

RESULTS

The averages, standard deviation (SD) and percentage changes of all variables are presented in Table 2. Because the muscle thickness on the left/right sides did not differ significantly, the thicknesses were expressed as the mean of both values, and bite force values presented normal distribution. The bite force, masseter thickness (RE), AFH/BFW ratio, weight and height increased significantly from the stage I to II; while LFH/AFH and BMI did not differ significantly between the stages. In accordance with Figure 2, it is possible to verify the trend lines for the increase in bite force related to masseter thickness (RE). Spearman's correlation coefficients were not significant between bite force magnitude and facial morphology in both stages ($p>0.05$).

Stepwise multiple regression analysis showed that at stage I, the masseter thickness (RE) and BMI were the most important factors for the magnitude of bite force. At stage II, the most important factors were the masseter and temporalis thicknesses (RE) ($p<0.05$). According to the results found, the increase in masseter thickness was accompanied by an increase in bite force magnitude, while the temporalis muscle thickness showed negative relation with its magnitude (Table 3).

Table 2. Means (±SD) for bite force (N), ultrasonographic thickness (mm) of masseter (Mm) and anterior portion of the temporalis muscle (Tm) during maximal intercuspal position (MI) and resting (RE), weight (Kg), height (m), age (months), BMI (Kg/m^2), and facial dimensions ratios for both stages of dentition.

Stage	I Deciduous dentition	II Early mixed dentition	Differences	
	Mean±SD	Mean±SD	*p* – value (*t* test)	% of change
Bite force	287.00±50.63	326.27±37.74	<0.01	14.51%
MmRE	9.47±0.95	10.11±0.93	<0.05	6.69%
MmMI	11.03±1.15	11.40±0.99	NS	2.91%
TmRE	2.73±0.24	2.88±0.22	NS	6.44%
TmMI	3.51±0.27	3.54±0.28	NS	0.51%
Weight	19.97±4.31	23.86±4.22	<0.01	18.68%
Height	1.10±0.07	1.20±0.05	<0.0001	9.07%
Age	59.21±8.40	76.92±5.62	<0.0001	29.35%
BMI	16.60±2.21	16.41±1.84	NS	-0.41%
AFH/BFW	0.75±0.02	0.79±0.03	<0.0001	5.00%
LFH/AFH	0.59±0.03	0.58±0.03	NS	-0.95%

AFH, anterior face height; BFW, bizygomatic facial width; LFH, lower face height.

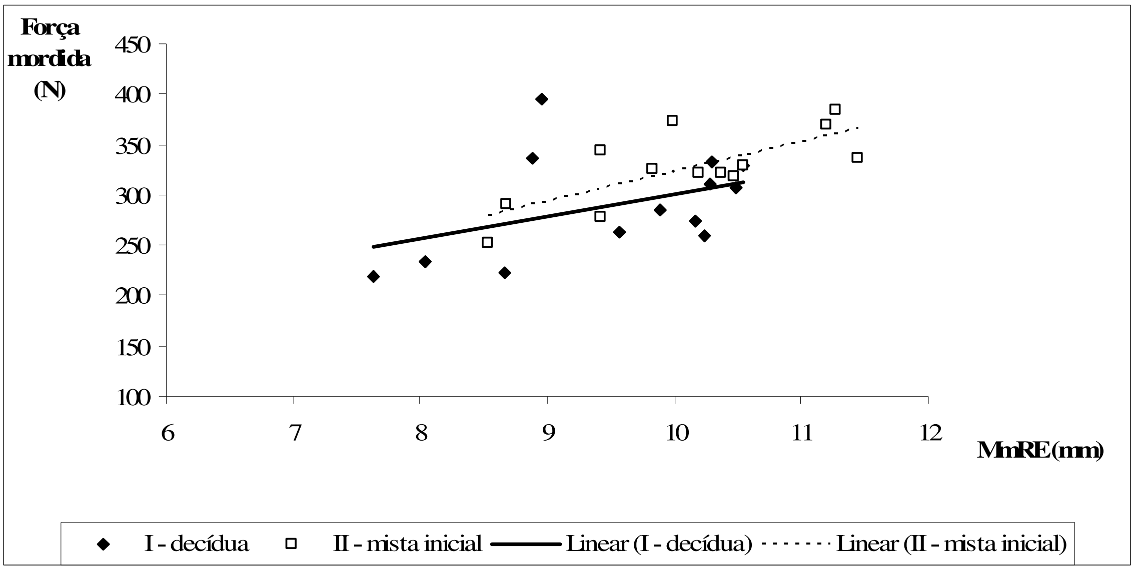

Figure 2. Maximum bite force related to masseter muscle thickness at rest (MmRE).

Table 3. Multiple regression stepwise analysis to test the significance of muscle thickness, age, BMI, and facial dimensions ratios as independent variables on bite force in both stages of dentition. Only statistically significant independent variables are presented.

Stage of dentition	Dependent variable	Independent variable	β	SE	*t* value	*p* value	Significance of the model		
							R	R^2	*p* value
I Deciduous	Bite force	Constant	4.504	0.791	5.692	0.000	0.671	45%	0.029
		MmRE	0.911	0.320	2.853	0.019			
		BMI	-0.540	0.228	-2.366	0.042			
II Early mixed	Bite force	Constant	-6.498	85.108	-0.076	0.941	0.991	83%	0.004
		MmRE	38.183	9.454	4.039	0.004			
		TmRE	-147.323	48.065	-3.065	0.015			

Mm, masseter muscle; Tm, temporalis muscle; RE, resting; BMI, body mass index; β, unstandardized regression coefficient; SE, standard error.

DISCUSSION

Although no agreement exists on the relationship between masticatory muscle size and skeletal craniofacial morphology, past studies have reported significant associations between both in adults (Kubota *et al*., 1998; Benington *et al*., 1999; Kitai *et al*., 2002; Kiliaridis *et al*., 2003) and growing individuals (Kiliaridis *et al*., 1993; Raadsheer *et al*., 1996; Rasheed *et al*., 1996). But a connection between craniofacial form and masticatory function is more evident. This is because elevator muscles have an increased mechanical advantage when the gonial angle is acute and the mandibular plane is flat (Throckmorton *et al*., 1980). Among children in the mixed and permanent dentition, studies have supported this relationship (Ingervall & Minder, 1997; García-Morales *et al*., 2003; Sonnesen & Bakke, 2005), although such relations are less apparent in younger ages. The weak contribution of craniofacial morphology to molar bite force in young subjects as observed in this study has been noticed earlier (Proffit & Fields, 1983; Kiliaridis *et al*., 1993). Gender differences were not taking into consideration, once differences in facial morphology and magnitude of bite force between boys and girls seem to be significant from the age of 8 years (Oueis *et al*., 2002; Šlaj *et al*., 2003; Kamegai *et al*., 2005).

The determination of individual bite force levels has been widely used in researches, mainly in attempts to understand the mechanisms of mastication, and the therapeutic or treatment effects. A relationship between weak jaw muscles, malocclusion and hiperdivergence has been related to poorer mechanical advantage and lower bite force, as well as normal occlusion, number of erupted teeth and teeth in occlusal contact have found to be predictors of muscle efficiency (García-Morales *et al*., 2003; Kamegai *et al*., 2005; Castelo *et al*., 2007). The reduced jaw bone size in the modern population, resulting in the increased prevalence of dental crowding, was a direct consequence of changes in eating behavior (soft diet), what may effect the development and growth of masticatory structures (Beecher & Corruccini, 1981; Ingervall & Bitsanis, 1987; Kitagawa *et al*., 2004).

Among children of this study, the masticatory muscle thicknesses did not vary significantly between the right and left sides. From the stage I to II, they presented significant increase in masseter thickness, anterior face height in relation to the face width, and magnitude of bite force. Transversal studies (Raadsheer *et al*., 1996; Sonnesen *et al*., 2001; Kamegai *et al*., 2005) also observed that the mean bite force increase with age and the various stages of dentition development, stays fairly constant from 20 to 40 years of age, and then declines (Helle *et al.*, 1983). Weight and height increased significantly between the stages evaluated, although BMI did not differ significantly, showing that children grew up proportionally, corroborating with growth studies among boys and girls (CDC, 2000) that has shown a relatively constant period for BMI at the mean age of 6 years.

Moreover, the results showed that the thickness of masseter (RE) and BMI at stage I, and the thicknesses of masseter and temporalis (RE) at stage II, were the most important factors for the magnitude of bite force. That is, the transition between deciduous and mixed dentition presented an increase in bite force magnitude, and this finding was significantly related with the increase in masseter muscle thickness, and lower contribution of temporalis muscle, while BMI remained invariable. At rest, the muscle thickness can be actually determined, since the individual remain at rest during the most time. On contraction, the thickness is increased and a great variability on measures can take place inter- and intra-individually, depending on generated force during the movement. Young children use more the temporalis muscle than the masseter on chewing process (Ogura *et al.*, 1987); on the other hand, in adults, the contribution of the masseter to the variation in bite force magnitude seems to be higher than the craniofacial components (Raadsheer *et al.*, 1999), and past studies demonstrated the connection between measures of masseter muscle and bite force magnitude (Bakke *et al.*, 1992; Tuxen *et al.*, 1999). Rasheed *et al.* (1996) also observed that the masseter ultrasonographic thickness contributed to the higher electromyographic activity in the clenching effort among children aged 8-12 years.

The relation between body variables and bite force magnitude seems controversial in the literature. In children aged 7-9 years, it was not observed significant correlation between bite force and height (Kiliaridis *et al.*, 1993). In younger children, Rentes *et al.* (2002) observed that only 6 and 5% variability in maximum bite force could be explained by the weight and height, respectively. In adults, the concept that persons of larger body built, size and/or weight may exhibit a greater bite force was not confirmed in the study done by Braun *et al.* (1995), once only 16% variability in maximum bite force was predicted by weight. In the present study, children with lower BMI showed higher bite force in the deciduous dentition stage, although it was not related with the increase in bite force magnitude in the transition to the mixed stage.

Despite the increase of bite force observed, the face of the children became proportionally longer in the mixed dentition than it was in the deciduous, and it was not related to an increase in the lower face height. By photographic evaluation, an increase of the total length of the face at a rate about two times that of the width was reported earlier in children from the 4 to 13 years of age (Bishara *et al*., 1995). At birth, the maxilla is vertically short, but by three years it has completed one-third of its eventual growth, while the distance between the eye-balls has achieved adult dimensions, and the remaining growth is related to an increase of the dimension S-Gn (sella turcica-gnathion) (Ranly, 1998). However, typological differences are established as early as 6 years of age, even before the eruption of the permanent dentition (Nanda, 1988), and arch dimensions are well established in the early mixed dentition (Šlaj *et al*., 2003). Past studies (Fields *et al*., 1984; Nanda, 1988; Kiliaridis *et al*., 1993; Sonnesen & Bakke, 2005) showed the influence of lower anterior face height on the formation of vertical facial disproportions and decrease in muscle strength; but in the present study, the variable LFH/AFH did not influence bite force magnitude. Shadows may be a limitation in photographic evaluations, although the present study used printed photographs instead of digitized ones, which have the limitations imposed by the equipment, such as resolution of the monitor (Bishara *et al*., 1995). The use of dimensions ratios was also chosen to reduce errors of camera positioning.

The findings indicates that the increase in bite force magnitude from the deciduous to the early mixed dentition was related to an increase in masseter muscle thickness, but not with body mass index and facial dimensions, although the face of those children became proportionally longer in this transition. The selection criteria, and the longitudinal characteristic of this study, reduced the sample size; thus, further investigations are needed to determine the relationship between form and function of the craniofacial complex growth in a larger sample.

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CAPÍTULO 3

"Intra-individual evaluation of morphological and functional aspects of the stomatognatic system during early treatment of functional posterior crossbite"

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"Intra-individual evaluation of morphological and functional aspects of the stomatognatic system during early treatment of functional posterior crossbite"

ABSTRACT

Early intervention has been advocated for discrepancies in occlusion in order to achieve normal growth and function of the craniofacial structures. Thus, this study evaluated the effects of treatment of functional posterior crossbite in 19 children, divided in two groups: deciduous dentition (DecG) and early mixed dentition (MixG), which received slow maxillary expansion. Maximum bilateral bite force, ultrasonographic masticatory muscle thickness and facial asymmetry (FAA) were evaluated in three stages: before the start of treatment (s1), after three months of retention (s2), and after three months of observation (s3). The results were analyzed with FM ANOVA and multiple regression analysis. Bite force magnitude showed significant increase from s1 to s2 and s1 to s3 in both groups ($p<0.05$). The temporalis thickness increased significantly from s1 to s3 in DecG, and from s1 to s2 in MixG ($p\leq0.05$). Masseter muscle thickness, FAA, and BMI did not differ among the stages in both groups. BMI contributed significantly for bite force only in DecG (s2), and age did not contributed for its variance in both groups. In the studied sample, the bite force magnitude and anterior portion of temporalis thickness increased significantly after early treatment of functional posterior crossbite.

DESCRIPTORS: Ultrasonography; Bite Force; Face; Malocclusion.

INTRODUCTION

The treatment of posterior crossbite in young children has been advocated for better long-term stability, reduction in overall treatment complexity and time, better functional and/or esthetic end results, and elimination of the lateral forced bite (Thilander *et al.*, 2002; Malandris & Mahoney, 2004; Kecik *et al.*, 2007). Moreover, past studies have reported that the persistency of this malocclusion is associated with decrease in bite force magnitude (Sonnesen *et al.*, 2001; Kamegai *et al.*, 2005; Castelo *et al.*, 2007), asymmetrical masticatory muscle activity (Kecik *et al.*, 2007) and growth of the muscles and hard tissues (Kiliaridis *et al.*, 2000; Allen *et al.*, 2003), and an abnormal chewing pattern (i.e. reverse sequencing) (Brin *et al.*, 1996; Pinto *et al.*, 2001; Saitoh et al., 2002). The adult masticatory pattern is well established by the time a child develops complete deciduous dentition (Ahlgren, 1967; Wickwire *et al.*, 1981); therefore, studies have suggest that patients with discrepancies in occlusion and voluntary mandibular movement require earlier intervention (Allen *et al.*, 2003; Tausche *et al.*, 2004).

The crossbite is characterized by a reduction in width of the maxillary dental arch, which is induced by non-nutritive sucking habits, obstruction of the upper airways, dietary consistency, or hereditary factors (Malandris & Mahoney, 2004; Marinelli *et al.*, 2005; Machado Jr. & Crespo, 2006). Early treatment of posterior crossbite is defined as intervention in deciduous or early mixed dentition, i.e., before the age of 10 years (Petrén *et al.*, 2003). Many studies about the morphological characteristics of crossbite have been published, although longitudinal analysis of form and function of the masticatory system in young children with such malocclusion are rare. Thus, the aim of this study was to investigate intra-individually the changes in bite force magnitude, masticatory muscle thickness, facial asymmetry, and body variables in the deciduous and early mixed dentition, after early correction of functional posterior crossbite.

MATERIAL AND METHODS

The sample comprised 19 healthy children of both genders, with ages ranging from 4 to 7 years old (Table I), who were to start treatment at the Department of Pediatric Dentistry; they were selected after a detailed anamneses and clinical examination, verifying the normality of oral tissues, morphological occlusion (Keski-Nisula *et al.*, 2003), absence of anomalies and/or alterations of teeth dimensions, and the presence of functional unilateral posterior crossbite involving at least three teeth and midline deviation. Children with bilateral/skeletal crossbite, dental caries, sucking habit, severe obstruction of upper airways, history of previous orthodontic treatment, open/deep bite were excluded. The mean ages at the beginning and the end of treatment are presented in Table I. The subjects and their parents consented to participate in the study, which was approved by the Ethics Committee of our institution (n. 147/2001 and 148/2002). The selection was based on the stage of dental development rather than on chronological age, and children were distributed in two groups: complete deciduous dentition (DecG) and early mixed dentition (MixG). The inclusion criterion for early mixed dentition was the eruption of the first molar and/or permanent incisors (Šlaj *et al*., 2003). Weight and height were determined using an anthropological scale, and the body mass index (BMI) was calculated as weight/height^2 (Kg/m^2).

The occlusion at the start of treatment was examined by clinical examination and study casts (Lindner, 1989; Kurol & Berglund, 1992; de Boer & Steenks, 1997), and all children were treated with removable maxillary expansion plates, made with acrylic resin and occlusal surfaces cover, clasps, and passive labial arch of 0.7 mm stainless steel wire. The expander screw was placed transversally to the palate (tooth-mucosa-supported), which was worn 24 hours a day, only removing for eating or brushing the teeth. The children were seen twice a month to activate the screw, and the end of the expansion was established by clinical criteria, when it was confirmed the over-correction of the malocclusion and the absence of lateral deviations during opening and closing of the mouth. Treatment was followed by a retention period of three months (Boysen *et al*., 1992; Bjerklin, 2000) with a removable plate without coverage of the occlusal surfaces. All analyses were done in three stages: before the start of treatment (s1), when crossbite had improved and a Hawley retainer used for three months had been removed (s2), and after three months of observation without any appliance (s3).

No attempts have been made to set up crossbite groups without treatment, since it was known that spontaneous correction of the malocclusion rarely occurs, and it was not justified for ethical reasons to withhold treatment in children with treatment need. The first author (PMC) did all analysis and treatments.

Masticatory muscle thickness measurement

The masseter and anterior portion of the temporalis muscle thicknesses were assessed by means of ultrasonography (Just Vision Toshiba, Japan, 56mm/10MHz, linear transducer), with the muscle at rest (RE) and in maximal clenching (maximal intercuspal position, MI) of both sides (right/left). The measurements were performed twice, while the child was seated upright, with the head in natural position, and it corresponded to the most bulky part of the muscle image. The recording site was determined by palpation, following the orientations: masseter - level halfway between the zygomatic arch and gonial angle, close to the level of the occlusal plane; anterior portion of the temporalis muscle - in front of the anterior border of the hairline. The transducer was moved until they were depicted on the screen as a sharp white line, and the measures were done directly on the screen; the final value was obtained from the mean of both measurements (accuracy of 0.1 mm).

Bilateral bite force determination

Maximal bilateral bite force was measured in the second deciduous molars region with a pressurized and flexible tube (10 mm diameter) connected to a sensor element (MPX5700, Motorola, Texas, USA). Children were seated upright, with their heads in natural position, and they were asked to bite the tube as forcefully as possible. The procedure was made three times, with an interval of 2 minutes, and transferred to a computer in Basic language in pounds per square inch (PSI); later, they were converted into Newton (N), and the final value was determined as the average of the measurements.

Facial asymmetry measurement

Standardized frontal photographs (10x15cm) were taken with the subjects standing up in front of the digital camera with automatic flash (Canon EOS 3000 V), teeth in maximal intercuspal position and the Frankfort plan approximately parallel to the floor. Five images were obtained from each subject, and the best one was chosen. The planes and dimensions (Ferrario *et al*., 1993; Bishara *et al*., 1995; Pompei *et al*., 2005; Martins *et al*., 2006) were hand traced on acetate paper and are presented in Figure 1. In this way, a perpendicular line from the interpupillary line was traced and its divergence with the midsagittal plane was calculated, determining the facial asymmetry angle (FAA).

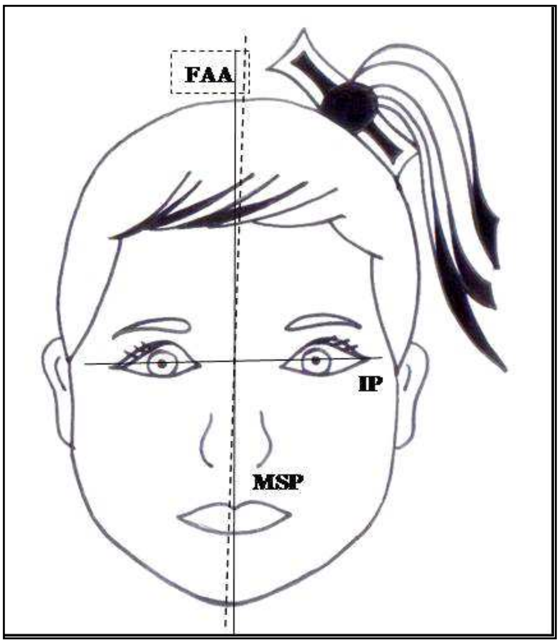

Fig. 1. Facial asymmetry angle (FAA) determination: MSP - midsagittal plane (solid vertical line formed by soft tissue nasion and soft tissue subnasale); IP – interpupillary plane; FAA – facial asymmetry angle (angle formed by the perpendicular line of the interpupillary plane and the midsagittal plane).

Statistics

The statistical analyses were performed using Sigma Stat software (3.1 Sigma Stat Software Inc., Richmond, CA, USA), and the results from the tests were considered to be significant at *P*-values less than 0.05. The data were submitted to the descriptive statistical analysis, and each group was separately analyzed. Normality was assessed using Shapiro-Wilks *W*-test.

Muscle thickness was considered as the mean of the right and left sides. Differences in bite force, muscle thickness, BMI and FAA among the stages were evaluated by means of one way repeated measures analysis of variance (RM ANOVA) and Friedman repeated measures analysis of variance on ranks (FRM ANOVA), when appropriate. Multiple regression analysis determined the relative contribution of age and BMI to variation in bite force magnitude in the stages.

Measurement errors

The reliability of the measurements for muscle thickness (only the left side was chosen) and bite force was determined on 15 randomly selected children not included in this study using the same method as in the present investigation (Castelo *et al*., 2007). Two repeated measurements (x_1, x_2), at interval from 7 to 30 days, were taking and the differences between the two set of measurements were calculated by the Dahlberg's formula: Method Error (ME) = $\sqrt{\Sigma(x_1 - x_2)^2/2n}$ (Table I).

Table I. Error of the method (ME) for masticatory muscle thickness (mm) and bite force (N) assessed on repeated measurements of 15 subjects.

Variable	ME
Left masseter / resting	0.53
Left masseter / maximal intercuspal position	0.36
Left temporalis / resting	0.09
Left temporalis / maximal intercuspal position	0.15
Bite force	16.28

RESULTS

The total mean active treatment and retention time was 18.6 and 23.3 months, for the DecG and MixG, respectively; and only one child, from the DecG, presented relapse after the s2. At the end of the treatment, children of the DecG and MixG have reached the early and the second phase of the mixed dentition, respectively.

Bite force values presented normal distribution. The average of bite force increased significantly from the s1 to s2 and from s1 to s3 in both groups ($p<0.05$) (Figures 2 and 3), but the averages of the s2 and s3 did not differ significantly. Regarding the contribution of age and BMI to the bite force magnitude, multiple regression analysis showed that, only in the DecG (s2), BMI explained 65 per cent of the bite force variance, while age did not contributed significantly to its variance in both groups.

Table I shows the average (±SD) for age, BMI, masticatory muscle thickness, and facial asymmetry angle for both groups in each stage of treatment. The anterior portion of the temporalis thickness (RE) showed significant increasing from s1 to s3 in DecG, and from s1 to s2 in MixG, whereas for masseter thickness there were no significant differences among the evaluations. BMI and FAA showed no significant differences among the stages in both groups.

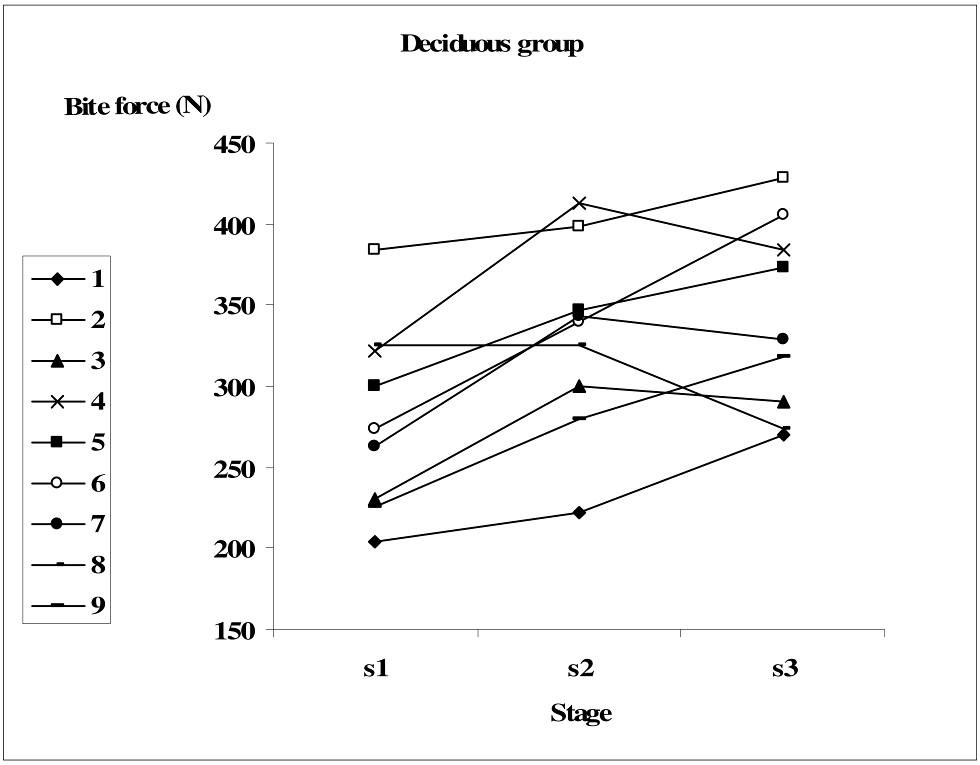

Fig 2. Bite force magnitude changes for each child of the DecG (n=9) during the treatment. Average (±SD) for bite force: s1 = 280.82 N (54.24), s2 = 329.97 N (58.44), s3 = 341.39 N (58.56). There were significant differences between the averages of bite force in s1 and s2 and in s1 and s3 ($p<0.05$, RM ANOVA). The values in s2 and s3 did not differ significantly.

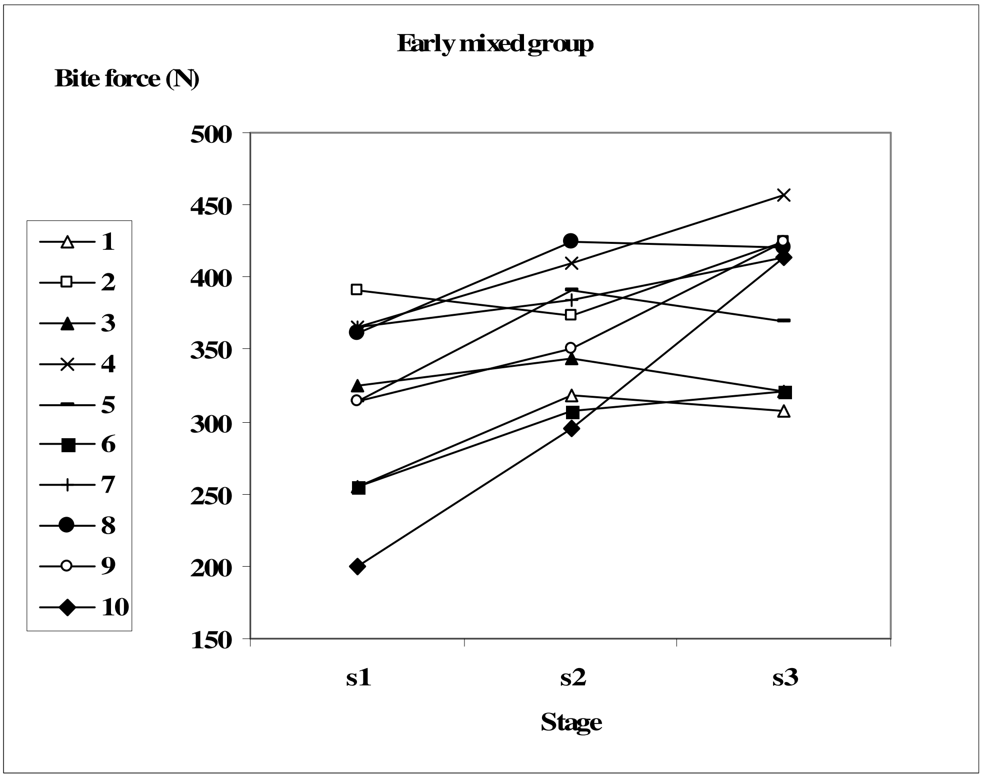

Fig 3. Bite force magnitude changes for each child of the MixG (n=10) during the treatment. Average (±SD) for bite force: s1 = 314.95 N (61.09), s2 = 359.79 N (43.95), s3 = 387.32 N (53.29). There were significant differences between the averages of bite force in s1 and s2 and in s1 and s3 ($p<0.05$, RM ANOVA). The values in s2 and s3 did not differ significantly.

Table II. Average (±SD) for age (months), BMI (Kg/m^2), masseter and temporalis muscle thicknesses (mm), and facial asymmetry angle (°) for both groups in each stage of treatment.

Group	DecG			MixG		
Stage	s1	s2	s3	s1	s2	s3
Age	60.56 (4.67)	79.11 (9.05)	82.11 (9.05)	72.70 (8.11)	96.00 (9.82)	99.10 (10.04)
BMI	15.77 (1.14)	15.57 (1.20)	16.15 (1.64)	16.37 (2.74)	17.06 (2.83)	17.60 (3.07)
MmRE	9.51 (0.84)	9.69 (1.17)	9.57 (1.06)	9.75 (1.21)	10.50 (1.39)	10.40 (1.54)
MmMI	10.87 (1.06)	11.00 (1.24)	10.94 (1.04)	11.44 (1.32)	11.83 (1.48)	11.69 (1.81)
TmRE	2.72^{a} (0.16)	2.92 (0.18)	2.99^{b} (0.27)	2.71^{c} (0.24)	3.13^{d} (0.34)	3.05 (0.30)
TmMI	3.30 (0.17)	3.61 (0.35)	3.66 (0.37)	3.44 (0.39)	3.86 (0.43)	3.83 (0.44)
FAA	0.78 (0.53)	0.61 (0.55)	0.89 (0.60)	1.35 (0.47)	0.95 (0.69)	0.80 (0.63)

BMI, body mass index; Mm: masseter muscle; Tm, temporalis muscle; RE, resting; MI, maximal intercuspation; FAA, facial asymmetry angle.

^{a} # ^{b}, ^{c} # ^{d} ($p \leq 0.05$, FRM ANOVA).

DISCUSSION

Three therapeutic modalities are cited in the literature to managing posterior crossbite in young children: removal any sucking habit related to the malocclusion, selective grinding of tooth interferences, and expansion of a constricted maxillary (Petrén *et al.*, 2003; Malandris & Mahoney, 2004; Turpin, 2004). Despite the limitations of this type of treatment, such broken appliances and lack of cooperation, the slow expansion plate has shown to be the most popular and successful form of upper expansion in early stages (Malandris & Mahoney, 2004), with a rate of success close to 100% (Boysen *et al.*, 1992; Sandikcioglu & Hazar, 1997; Erdinc *et al.*, 1999). The mechanical movements are a result of forces applied over the teeth and transmitted to the bones, aiming at changing growth direction (Machado Jr. & Crespo, 2006). Children from the present study showed a mean active treatment time of 15.6 and 20.3 months for the deciduous and mixed groups, respectively. Previous studies have shown that among young children the treatment time with expansion plates varied from 11 to 20 months (Ranta, 1988; de Boer & Steenks, 1997; Erdinc *et al*., 1999). It has been also showed that maxillary expansion and elimination of mandibular lateral shift lead to improvement of unbalanced masticatory muscle activity, elimination of the asymmetric position of the condyles on glenoid fossa (Pinto *et al*., 2001; Saitoh *et al*., 2002; Kecik *et al*., 2007), and increase in bite force magnitude (Sonnesen & Bakke, 2007). Moreover, cephalometric modifications caused by maxilla expansion could be seen, as increase in widths of the maxilla and nasal cavity (Chung & Font, 2004), allowing for anatomic and nasal respiration improvements.

Reduced jaw muscles strength is a common feature of patients with craniomandibular disorders (Michler *et al*., 1988; Bakke *et al*., 1989) and neuromuscular disease (Kiliaridis *et al*., 1989), so that assessment of bite force has been demonstrated to be relevant for diagnosis and treatment planning. Additionally, bite force increases with teeth in occlusal contact, with the increasing number of erupted teeth, and with the stages of dental eruption (Sonnesen *et al*., 2001; Sonnesen & Bakke, 2005), and decreases with pain, malocclusion, dentition deterioration, and hiperdivergence (Shiau & Wang, 1993; Raadsheer *et al*., 1999). Children of the DecG and MixG showed significant higher bite force in s2 and s3 in relation to the s1, that is, after the treatment, their averages of bite force increased significantly. In the presence of crossbite, a significant decrease in bite force magnitude in the transition between the deciduous and mixed dentition was demonstrated in previous studies (Sonnesen *et al*., 2001; Rentes *et al*., 2002; Kamegai *et al*., 2005; Castelo *et al*., 2007); they showed that subjects in the early mixed dentition presented significant lower bite force than those with normal occlusion, but in the deciduous dentition this difference was not presented. After the improvement of crossbite, children of both groups showed significant increase in the magnitude of bite force. However, some subjects showed a decrease in bite force magnitude after the retention period (s3, Figures 2 and 3), that may be explained by fact that the period after treatment to be characterized by transient changes, such reduced occlusal support on the crossbite-side, pain adaptation, and differences in muscle length resulting from wearing the appliance

(Tabe *et al*., 2005; Sonnesen & Bakke, 2007), until the occlusal support could be acquired with chewing function.

The relative contribution of body variables to the magnitude of bite force remains controversial in the literature. In previous studies, weight explained only 6 and 16 per cent of the bite force magnitude variance among children and adults, respectively (Braun *et al*., 1995; Rentes *et al*., 2002), since weight may be related to adipose tissue, and not necessarily with muscle strength. Linderholm *et al*. (1971) observed that young subjects who have a stronger body musculature system presented a stronger bite force. In the present study, only in the DecG (s2), 65 per cent variability in bite force could be explained by BMI, while age did not contribute significantly to its variance. The study done by Sonnesen & Bakke (2007) did not observe significant differences in bite force regarding age and gender in older children, although body variables were not evaluated.

The decrease in masticatory activity as a consequence of the increased consumption of processed food (soft diet) may be responsible of underdeveloped muscles and jaws and inadequate wear of deciduous teeth, resulting in dental interferences and forced guidance of mandible to an incorrect position (Kiliaridis *et al*., 1995; Marinelli *et al*., 2005). The anterior portion of the temporalis muscle showed morphological development during the orthodontic treatment in both groups studied, while the masseter thickness remained unchanged. Likewise, young children use more the temporalis muscle than the masseter on chewing process (Ogura *et al*., 1987), and the pattern of masticatory muscles activity showed temporalis activity adaptation in the presence of transverse malocclusion (Troelstrup & Møller, 1970). Increase in muscle thickness was shown to be positively correlated with muscle function and age in young subjects (Bakke *et al*., 1992; Kiliaridis *et al*., 2003), as well as patients suffering from neuromuscular disease with a narrow palate presented weaker bite forces and less efficient jaw muscles (Kiliaridis *et al*., 1989). In this way, the new position of the dentition should be compatible with the dynamics of the muscular and occlusal forces, and training of chewing after treatment may contribute to masticatory performance and occlusion balance, preventing relapse.

Significant skeletal asymmetry of the mandibular ramus and condyles related to an asymmetric postural were seen among young subjects with posterior crossbite (Martín *et al*., 2000; Pinto *et al*., 2001; Langberg *et al*., 2005). Otherwise, perfect bilateral body symmetry is largely a theoretical concept, and all subjects, including those who are perceived as normal, have some degree of craniofacial asymmetry (Bishara *et al.*, 1993). Occlusal cant asymmetries, defined as a divergence of the occlusal plane from the horizontal axis, and orbit or globe asymmetries (interpupillary plane), may be related to posterior crossbite, but they are not always easily detected because soft tissues and posture can compensate these imbalances (Padwa *et al.*, 1997). The orbit asymmetries may be related to insufficient growth of the maxilla, malocclusion, or oral breath (Severt & Proffit, 1997). Pompei *et al.* (2005) verified that children with normal occlusion presented stronger correlation between the interpupillary and commisure planes in relation to the middle-line of the face than those with posterior crossbite, but the difference between groups was not statistically significant. The present study showed that the asymmetry of interpupillary plane in relation to the midsagittal plane decreased in the mixed dentition at the evaluated stages, but there were no statistical difference intra-groups, possibly due to the sample size, which could be considered a limitation of this study.

To design a treatment plan, the clinician must understand the growth and development patterns, and the known effects of the chosen treatment modality. The results found showed that early treatment of crossbite allowed development for functional and morphological variables of the stomatognatic system, agreeing with previous studies (de Boer & Steenks, 1997; Saitoh *et al.*, 2002; Yawaka *et al.*, 2003; Kecik *et al.*, 2007; Sonnesen & Bakke, 2007). Although conclusions may be difficult to draw with confidence since the number of subjects was small due to the longitudinal character of the study, the findings suggest that good treatment results can be achieved with early intervention, with a favorable cost-benefits ratio.

CONCLUSIONS

The results found in the studied sample showed that early treatment was effective in the improvement of functional posterior crossbite and the anterior portion of the temporalis muscle thickness and bite force magnitude showed morphological and functional development after the intervention.

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CONCLUSÕES

Os resultados encontrados na amostra estudada mostraram que:

1. Os hábitos de sucção desempenharam um papel importante na presença ou ausência da mordida cruzada posterior funcional em crianças de pouca idade, sobretudo a sucção não-nutritiva;

2. A mordida cruzada relacionou-se à menor amplitude de força de mordida e à tendência à face longa;

3. O incremento da força de mordida, observado da fase de dentição decídua completa ao início da mista na oclusão normal, relacionou-se ao aumento da espessura do músculo masseter; já o índice de massa corporal manteve-se constante de uma fase à outra;

4. A máxima força de mordida e a espessura do músculo temporal aumentaram significativamente após a correção da mordida cruzada posterior funcional; o índice de massa corporal apresentou influência significativa na variância da força de mordida apenas na fase de tratamento ativo do grupo de dentição decídua e a idade não apresentou influência significativa em sua variância em ambos os grupos, demonstrando a importância da atenção precoce às alterações dentofaciais.

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APÊNDICE 1

UNIVERSIDADE ESTADUAL DE CAMPINAS
FACULDADE DE ODONTOLOGIA DE PIRACICABA
DEPARTAMENTO DE ODONTOLOGIA INFANTIL

INFORMAÇÃO E CONSENTIMENTO PÓS-INFORMAÇÃO PARA PESQUISA CLÍNICA

Menor:____

As informações contidas neste documento visam firmar acordo por escrito, mediante o qual o responsável pelo menor, objeto de pesquisa, autoriza sua participação, com pleno conhecimento da natureza dos procedimentos e riscos a que se submeterá o paciente, com capacidade de livre arbítrio e sem qualquer coação.

I - TÍTULO DO TRABALHO EXPERIMENTAL: "Variáveis morfológicas e funcionais do sistema estomatognático em crianças com oclusão normal e mordida cruzada posterior: estudo longitudinal".

Responsáveis: Profa. Maria Beatriz Duarte Gavião e Dra. Paula Midori Castelo

II – OBJETIVOS - O objetivo deste estudo será a avaliação da função mastigatória em crianças, através de ultra-sonografia dos músculos da mastigação (masseter e temporal), máxima força de mordida e morfologia facial em crianças na faixa etária de 3,5 a 7 anos, com arcos dentários decíduos ou mistos, com oclusão normal ou mordida cruzada posterior. O acompanhamento da criança, bem como as avaliações experimentais, serão realizados antes e após o tratamento ortodôntico (se a criança possuir mordida cruzada) ou até que os primeiros dentes permanentes irrompam (se ela possuir oclusão normal).

III – JUSTIFICATIVA - Este trabalho justifica-se considerando que a mastigação adequada contribui para o desenvolvimento adequado dos arcos dentários e dos ossos da face. A fase em que os dentes decíduos (de leite) estão na boca é muito importante por influenciar o desenvolvimento dos dentes permanentes, tanto no formato dos maxilares e ossos da face, como no desenvolvimento da função mastigatória.

IV - PROCEDIMENTOS DO EXPERIMENTO

Amostra - será constituída de crianças de ambos os sexos, na faixa etária de 3,5 a 7 anos, portadoras de arcos dentários decíduos ou mistos, as quais serão selecionadas (após a devida a concordância da criança em participar da pesquisa e autorizada pelo seu responsável), de acordo com os seguintes procedimentos:

Anamnese - através de entrevista com o responsável, verificando-se: histórias pré-natal, natal e pós-natal; histórico dental; hábitos - sucção dos dedos, sucção de chupeta, ranger dos dentes, respiração bucal, deglutição atípica e uso de medicamento.

Exame Clínico Intrabucal e Extrabucal - o instrumental utilizado será os de uso rotineiro na clínica (pinça, sonda exploradora e espelho bucal), além do refletor e seringa tríplice; verificar-se-á as condições dos lábios, gengiva, língua, palato, freios labial e lingual, número de dentes. Além disso, serão feitas as medidas de peso e altura.

V - RISCOS ESPERADOS - Os procedimentos realizados não oferecem riscos, pois os exames clínicos intra-bucal e extra-bucal seguem os passos da rotina clínica, utilizando-se instrumental e materiais adequados. Na análise da espessura dos músculos masseter e temporal, o exame de ultra-sonografia utilizado não oferece riscos uma vez que é uma técnica indolor e rotineiramente utilizada no acompanhamento de grávidas, para observação do desenvolvimento fetal. Para a determinação dos contatos dentários, serão utilizados materiais atóxicos e sob supervisão; o mesmo aplica-se para o transmissor de força de mordida. A morfologia facial será avaliada através de fotografias, método este seguro que não expõe a criança à radiação. Todos os cuidados com relação à condução do tratamento, limpeza e assepsia dos instrumentais e equipamentos e procedimentos a serem realizados serão assegurados de acordo com as regras preconizadas na Faculdade de Odontologia de Piracicaba/UNICAMP.

VI – INFORMAÇÕES - O responsável pelo menor tem a garantia de que receberá respostas a qualquer pergunta ou esclarecimento sobre qualquer dúvida à cerca dos ***procedimentos,*** riscos, benefícios, empregados neste documento e outros assuntos relacionados à pesquisa. Também serão dadas informações sobre o diagnóstico das alterações detectadas, o prognóstico e o plano de tratamento que deverá ser instituído, de acordo com os critérios adotados pela disciplina de Odontopediatria do Departamento de Odontologia Infantil da FOP-UNICAMP.

VII - RETIRADA DO CONSENTIMENTO - O responsável pelo menor tem a liberdade de retirar seu consentimento a qualquer momento e deixar de participar do estudo, sem qualquer prejuízo ao atendimento odontológico a que a criança esta sendo ou será submetida na Clínica de Odontologia Infantil da Faculdade de Odontologia de Piracicaba - UNICAMP.

VIII - CONSENTIMENTO PÓS-INFORMAÇÃO

Eu____,

responsável pelo menor ____, certifico que, tendo lido as informações acima e suficientemente esclarecido (a) de todos os itens, estou plenamente de acordo com a realização do experimento. Assim, eu autorizo a execução do trabalho de pesquisa exposto acima.

Piracicaba, _____ de __________________ de 200___.

NOME (legível)____RG_________________

ASSINATURA____

ATENÇÃO: A sua participação em qualquer tipo de pesquisa é voluntária. Em caso de dúvida quanto aos seus direitos, escreva para o Comitê de Ética em Pesquisa da FOP-UNICAMP.

Endereço: Av. Limeira, 901 - CEP/FOP - 13414-900 - Piracicaba - SP.

Dúvidas, ligar para 019 – 3412-5287; falar com Paula Midori Castelo.

APÊNDICE 2

UNIVERSIDADE ESTADUAL DE CAMPINAS
FACULDADE DE ODONTOLOGIA DE PIRACICABA
DEPARTAMENTO DE ODONTOLOGIA INFANTIL
ÁREA DE ODONTOPEDIATRIA

UNICAMP

MENTE · MANV · CORDE

AUTORIZAÇÃO PARA DIAGNÓSTICO E EXECUÇÃO DE PLANO DE TRATAMENTO

MENOR: ____

Por este instrumento de autorização por mim assinado, dou pleno consentimento à Faculdade de Odontologia de Piracicaba, Departamento de Odontologia Infantil, para por meio de seus professores e alunos devidamente autorizados, a fazer diagnóstico, planejamento e tratamento de meu (minha) filho (a), de acordo com os conhecimentos enquadrados no campo da Especialidade em Odontopediatria.

Tenho pleno conhecimento que esta clínica e laboratórios, aos quais meu (minha) filho (a) se submete para fins de diagnóstico e/ou tratamento, tem como principal objetivo a instrução e demonstração destinados a profissionais da área de saúde. Concordo, pois, com toda orientação seguida, quer para fins didáticos, se diagnóstico e/ou tratamento.

Concordo plenamente, também, que todas as radiografias, fotografias, modelos dos arcos dentários, históricos de antecedentes familiares, resultados de exames clínicos e de laboratório e quaisquer outras informações concernentes ao diagnóstico, planejamento e/ou tratamento, constituem propriedade exclusiva desta Faculdade, a qual dou pleno direito de retenção, uso para quaisquer fins de ensino e pesquisa, além de sua divulgação em jornais e revistas científicas do país e do exterior.

Piracicaba, ________ de ___________________ de _________ .

NOME (legível) ____ RG _____________

____

(assinatura do pai, tutor ou responsável)

APÊNDICE 3

UNIVERSIDADE ESTADUAL DE CAMPINAS
FACULDADE DE ODONTOLOGIA DE PIRACICABA
DEPARTAMENTO DE ODONTOLOGIA INFANTIL

"Variáveis morfológicas e funcionais do sistema estomatognático em crianças com oclusão normal e mordida cruzada posterior: estudo longitudinal"

Responsável: Dra. Paula Midori Castelo

FICHA CLÍNICA DATA___/___/____ GRUPO ____________________

IDENTIFICAÇÃO

Nome____

Data de nascimento _____/_____/______Sexo __________ Raça__________________

Endereço____Bairro_________________

Cidade______________________ CEP_____________ Telefone_____________________

Pai _______________________________________

Mãe _______________________________________

HISTÓRIA PRÉ-NATAL

a. GRAVIDEZ - Normal ❑ Anormal ❑

b. MANIFESTAÇÕES DURANTE A GRAVIDEZ

DOENÇAS ____

MEDICAMENTOS____

HISTÓRIA NATAL

PARTO - Normal ❑ Fórceps ❑ Cesariana ❑

Complicações durante o parto _______________________________________

NASCIMENTO - a termo ❑ prematuro ❑_____meses

HISTÓRIA NEO-NATAL

PROBLEMAS DURANTE O 1º MÊS DE VIDA

❑ Icterícia ❑ Dificuldades respiratórias

❑ Febre alta ❑ Dificuldades de alimentação

❑ Doenças graves ❑ Dentes do nascimento ao 1º mês

HISTÓRIA PÓS-NATAL

DOENÇAS SISTÊMICAS

Presentes/Histórico:____

DOENÇAS DA INFÂNCIA ____

MEDICAMENTOS em uso:____

ALIMENTAÇÃO

AMAMENTAÇÃO NATURAL- até quantos meses?_____________________

AMAMENTAÇÃO ARTIFICIAL: partir de e até quantos anos? _______________

Peso:______ Kg Altura:_______ m

HÁBITOS

TIPO	***SIM /NÃO período***	***FREQUÊNCIA***		
		ESPORÁDICO	***NOITE***	***CONTÍNUO***
SUCÇÃO DE CHUPETA				
SUCÇÃO DIGITAL				
SUCÇÃO DOS LÁBIOS				
ONICOFAGIA				
BRUXISMO				
RESPIRAÇÃO BUCAL				
DEGLUTIÇÃO ATÍPICA				
FONAÇÃO ANORMAL				

AVALIAÇÃO PREVENTIVA

Higiene dental ❑ escova ❑ fio dental ❑ outros frequência ___________

Informação sobre higiene bucal ❑ sim ❑ não por ____________________________

EXAME CLÍNICO

Diagnóstico de DTM ❑ positivo ❑ negativo

Está em tratamento ortodôntico? SIM❑ NÃO ❑

EXAME INTRA-BUCAL

Anormalidade de tecidos moles?

____

EXAME DA OCLUSÃO MORFOLÓGICA - DENTIÇÃO DECÍDUA/MISTA

Arcos decíduos:

Superior: ❑ Espaçado ❑ Não espaçado

Inferior: ❑ Espaçado ❑ Não espaçado

Espaço primata:

Superior: dir ❑ esq ❑

Inferior: dir ❑ esq ❑

Relação terminal dos segundos molares:

Degrau mesial: dir ❑ esq ❑

Plano vertical: dir ❑ esq ❑

Degrau distal: dir ❑ esq ❑

Relação antero-posterior dos caninos:

Classe 1: dir ❑ esq ❑

Classe 2: dir ❑ esq ❑

Classe 3: dir ❑ esq ❑

Relação vestíbulo-lingual dos molares:

Normal : dir ❑ esq❑

Cruzada : dir ❑ esq❑

Relação vestíbulo-lingual dos caninos:

Normal : dir ❑ esq❑

Cruzada : dir ❑ esq❑

Desvio de linha média?_______________________________________

Relação dos incisivos:

Normal ❑ Mordida aberta ❑

Cruzada ❑ Sobremordida ❑

Cruzamentos isolados____

Apinhamento anterior: Superior ❑ Inferior ❑

Distância intercaninos: Superior _________ Inferior__________

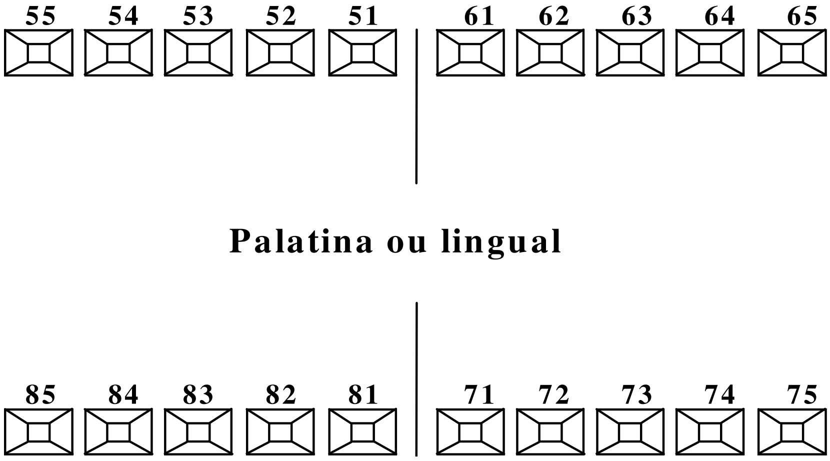
Situação de desgaste oclusal fisiológico:

51.............61...............71.............81.............
52.............62........... ..72..............82.............
53.............63.............73..............83............
54..............64..............74..............84.............
55.............65.............75..............85.............

nenhum desgaste -***1***
dentina exposta - ***2***
severo (+de 1/3 de dentina) - ***3***

DENTIÇÃO MISTA- elementos em irrupção:

____



EXAME DA OCLUSÃO FUNCIONAL

DESVIO DA MANDÍBULA DURANTE A ABERTURA
lado direito.........................
lado esquerdo....................

INTERFERÊNCIAS OCLUSAIS EM RC..

LIMITAÇÃO DE ABERTURA DE BOCA? ❑ NÃO ❑ SIM

LIMITAÇÃO DE MOVIMENTOS MANDIBULARES: ❑ NÃO ❑ SIM

ATIVIDADES

Data (dia, mês, ano)	*Atividade executada*

APÊNDICE 4 - FOTOGRAFIAS INTRABUCAIS – OCLUSÃO NORMAL

Figura 1. Dentição decidua completa com oclusão normal – vista frontal.

Figura 2. Dentição decidua completa com oclusão normal – vista lateral direita.

Figura 3. Dentição decidua completa com oclusão normal – vista lateral esquerda.

Figura 4. Normoclusão na dentição mista inicial (incisivos e primeiros molares permanentes em irrupção) – vista lateral esquerda.

Figura 5. Arco inferior - dentição mista inicial (incisivos e primeiros molares permanentes em irrupção).

APÊNDICE 5 - CASOS CLÍNICOS – MORDIDA CRUZADA POSTERIOR

Figura 1. Caso clínico 1: dentição decídua foto intrabucal frontal inicial (fase 1).

Figura 2. Caso clínico 1: foto intrabucal oclusal superior (fase 1).

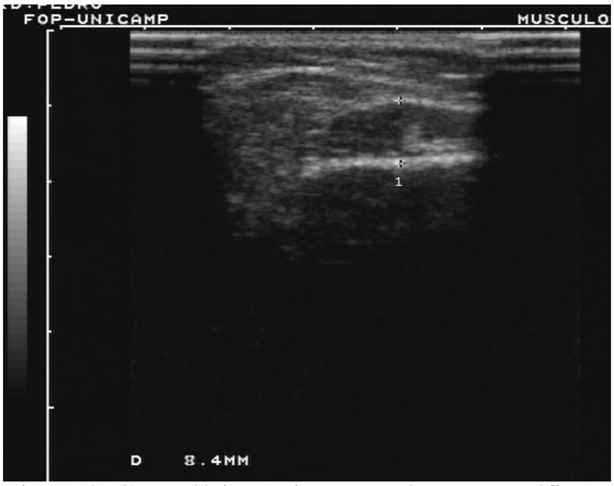


Figura 3. Caso clínico 1: imagem ultra-sonográfica do músculo masseter (lado direito) em repouso (fase 1).

Figura 4. Caso clínico 1: imagem ultra-sonográfica do músculo masseter (lado direito) em máxima intercuspidação (fase 1).

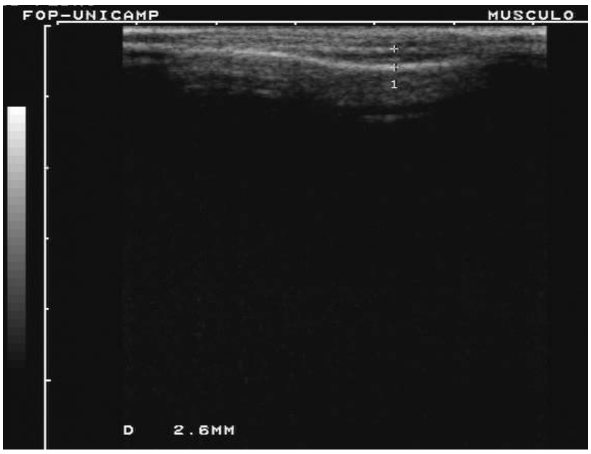


Figura 5. Caso clínico 1: imagem ultra-sonográfica da porção anterior do músculo temporal (lado direito) em repouso (fase 1).

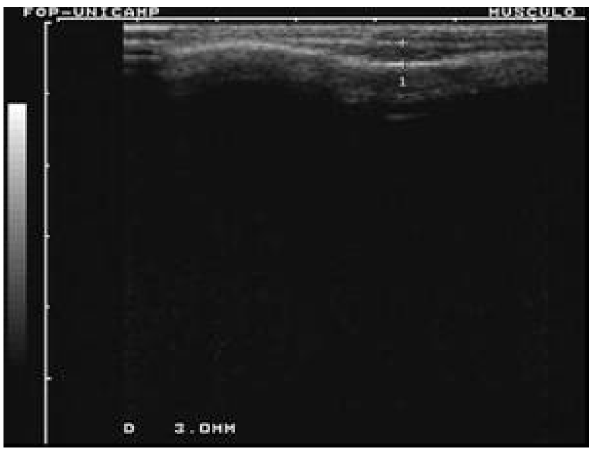


Figura 6. Caso clínico 1: imagem ultra-sonográfica da porção anterior do músculo temporal (lado direito) em maxima intercuspidação (fase 1).

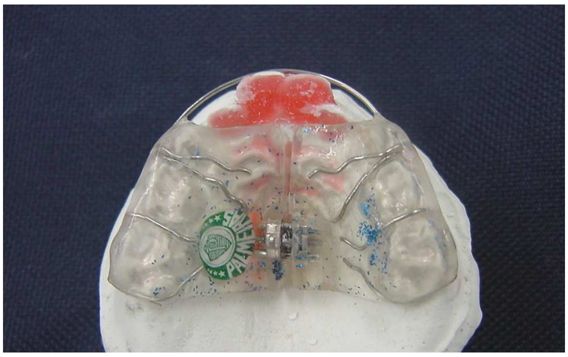


Figura 7. Caso clínico 1: aparelho expansor removível superior com recobrimento oclusal em resina no modelo de gesso de trabalho.

Figura 8. Caso clínico 1: foto intrabucal frontal com o aparelho instalado.

Figura 9. Caso clínico 1: foto intrabucal frontal após término da expansão com sobrecorreção (fase 2).

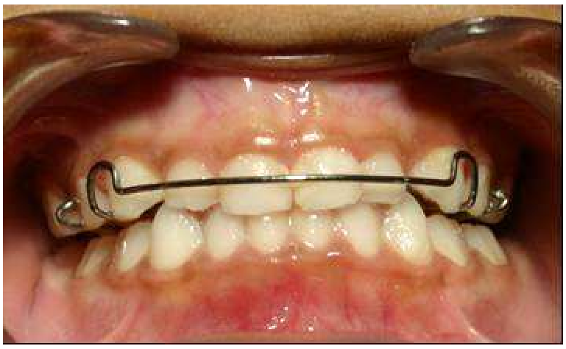


Figura 10. Caso clínico 1: foto intrabucal frontal com contenção instalada (fase 2).

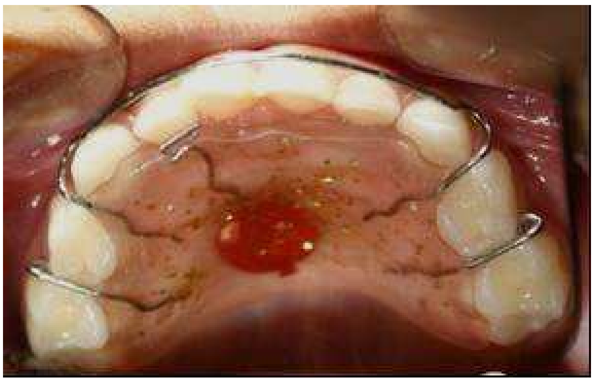


Figura 11. Caso clínico 1: foto intrabucal oclusal com contenção instalada (fase 2).

Figura 12. Caso clínico 1: foto intrabucal frontal final (fase 3).

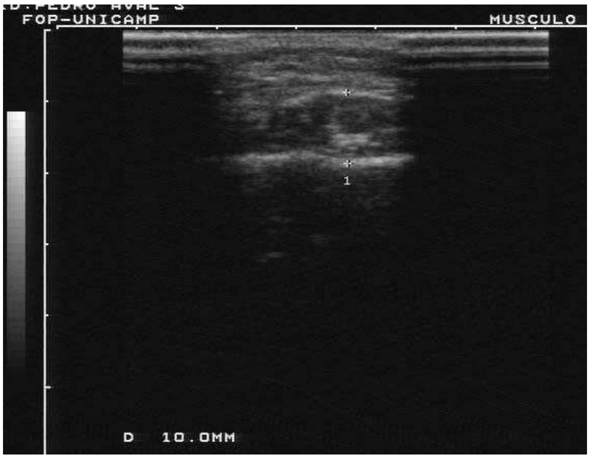


Figura 13. Caso clínico 1: imagem ultra-sonográfica do músculo masseter (lado direito) em repouso (fase 3).

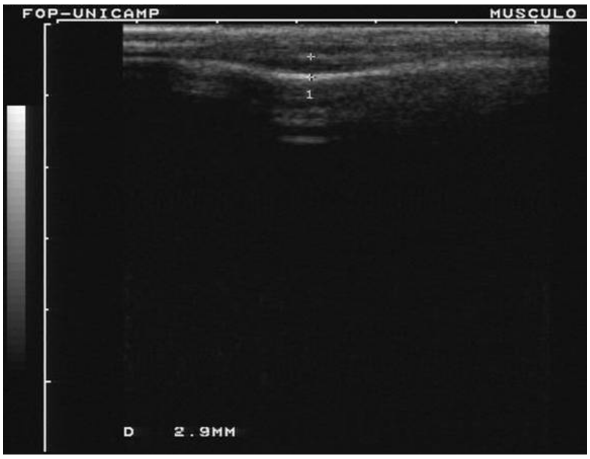


Figura 14. Caso clínico 1: imagem ultra-sonográfica da porção anterior do músculo temporal (lado direito) em repouso (fase 3).


Figura 15. Caso clínico 2: dentição mista inicial foto intrabucal frontal inicial (fase 1).


Figura 16. Caso clínico 2: foto intrabucal com expansor instalado.

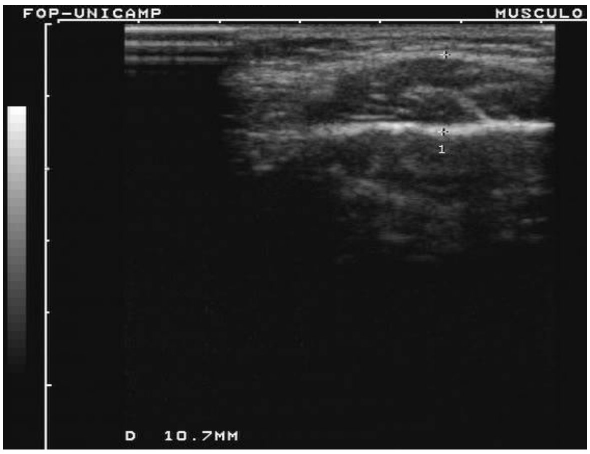


Figura 17. Caso clínico 2: imagem ultra-sonográfica do músculo masseter (lado direito) em repouso (fase 1).

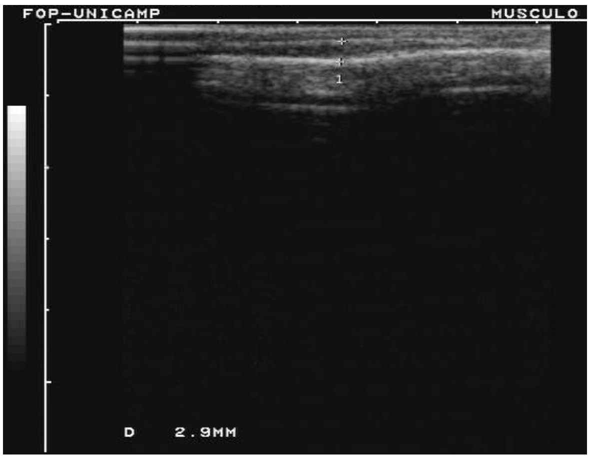


Figura 18. Caso clínico 2: imagem ultra-sonográfica da porção anterior do músculo temporal (lado direito) em repouso (fase 1).

Figura 19. Caso clínico 2: foto intrabucal frontal durante o tratamento.

Figura 20. Caso clínico 2: foto intrabucal lateral durante o tratamento.

Figura 21. Caso clínico 2: foto intrabucal frontal final (fase 3).

Figura 22. Caso clínico 2: foto intrabucal lateral final (fase 3).

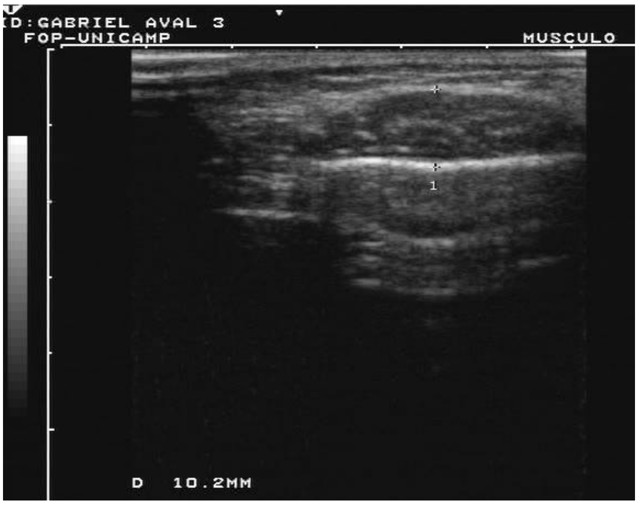


Figura 23. Caso clínico 2: imagem ultra-sonográfica do músculo masseter (lado direito) em repouso (fase 3).

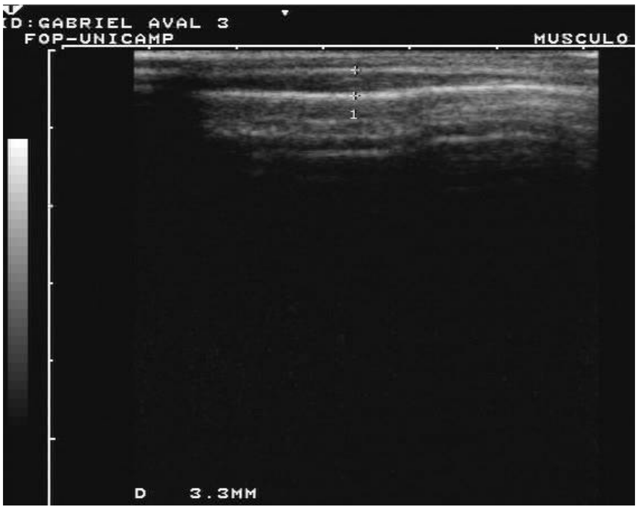


Figura 24. Caso clínico 2: imagem ultra-sonográfica da porção anterior do músculo temporal (lado direito) em repouso (fase 3).

APÊNDICE 6 - MORFOMETRIA FACIAL

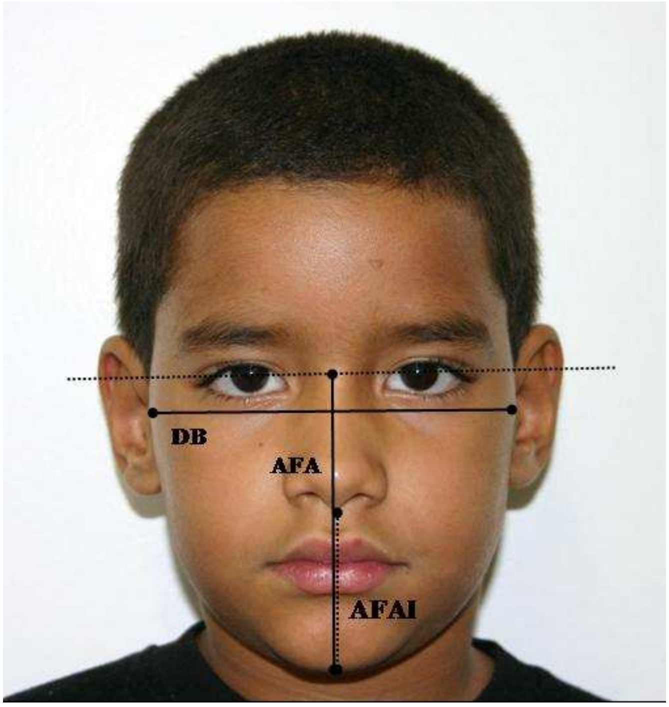


Figura 1. Dimensões faciais: AFA, altura facial anterior; DB, distância bizigomática; AFAI, altura facial anterior inferior.

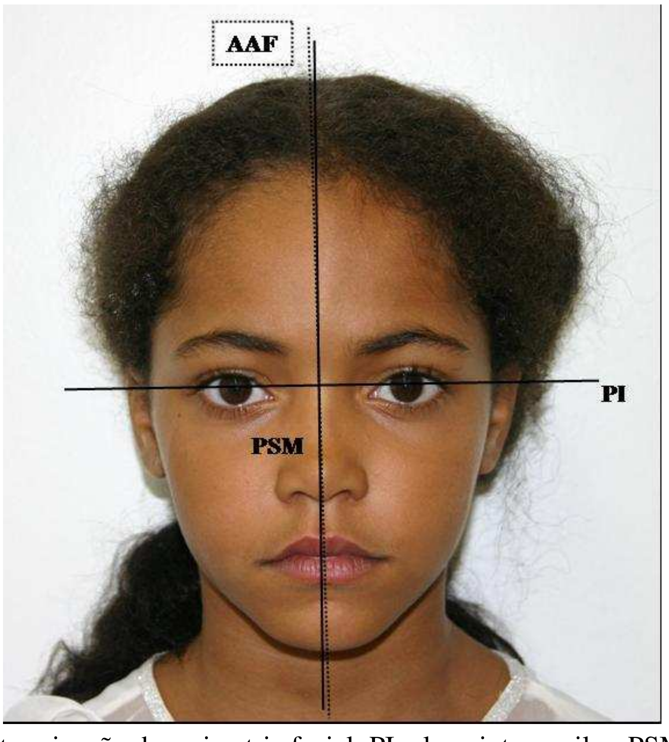


Figura 2. Determinação da assimetria facial: PI, plano interpupilar; PSM, plano sagittal mediano; AAF, ângulo da assimetria facial.

ANEXO 1

COMITÊ DE ÉTICA EM PESQUISA

UNIVERSIDADE ESTADUAL DE CAMPINAS

FACULDADE DE ODONTOLOGIA DE PIRACICABA

UNICAMP

MENTE·MANV·CORDE

CERTIFICADO

Certificamos que o Projeto de pesquisa intitulado "Eletromiografia e ultra-sonografia dos músculos mastigatórios relacionadas à força de mordida, movimentos e contatos oclusais na dentição decídua", sob o protocolo nº **147/2001**, da Pesquisadora ***PAULA MIDORI CASTELO*** e ***NADIA LUNARDI***, sob a responsabilidade da Prof. Dra. **Maria Beatriz Duarte Gavião**, está de acordo com a Resolução 196/96 do Conselho Nacional de Saúde/MS, de 10/10/96, tendo sido aprovado pelo Comitê de Ética em Pesquisa – FOP, em 30 de outubro de 2002.

Piracicaba, 18 de dezembro de 2003

We certify that the research project with title "Electromyografic and ultrasonography evaluation of masticatory muscles related to bite force, movements and occlusal contacts in primary dentition", protocol nº **147/2001,** by Researcher ***PAULA MIDORI CASTELO*** and ***NADIA LUNARDI***, responsibility by Prof. Dr. **Maria Beatriz Duarte Gavião**, is in agreement with the Resolution 196/96 from National Committee of Health/Health Department (BR) and was approved by the Ethical Committee in Resarch at the Piracicaba Dentistry School/UNICAMP (State University of Campinas), in October 30 2003.

Piracicaba, SP, Brazil, December 18 2003

Prof. Dr. Antonio Bento Alves de Moraes

Coordenador

CEP/FOP/UNICAMP

ANEXO 2

UNICAMP

COMITÊ DE ÉTICA EM PESQUISA

UNIVERSIDADE ESTADUAL DE CAMPINAS

FACULDADE DE ODONTOLOGIA DE PIRACICABA

MENTE·MANV·CORDE

CERTIFICADO

Certificamos que o Projeto de pesquisa intitulado "Avaliação cefalométrica do tratamento da mordida cruzada posterior com o uso da placa expansora removível", sob o protocolo nº **148/2002**, da Pesquisadora ***Nadia Lunardi*** e ***Paula Midori Castelo***, sob a responsabilidade do Prof. Dr. **João Sarmento Pereira Neto**, está de acordo com a Resolução 196/96 do Conselho Nacional de Saúde/MS, de 10/10/96, tendo sido aprovado pelo Comitê de Ética em Pesquisa – FOP, em 21 de fevereiro de 2003.

Piracicaba, 18 de dezembro de 2003

We certify that the research project with title "Cephalometric avaliation of the posterior crossbite treatment with expansor plate", protocol nº **148/2002**, by Researcher ***Nadia Lunardi*** and ***Paula Midori Castelo***, responsibility by Prof. Dr. **João Sarmento Pereira Neto**, is in agreement with the Resolution 196/96 from National Committee of Health/Health Department (BR) and was approved by the Ethical Committee in Research at the Piracicaba Dentistry School/UNICAMP (State University of Campinas), in February 21 2003.

Piracicaba, SP, Brazil, December 18 2003

Prof. Dr. Antonio Bento Alves de Moraes

Coordenador

CEP/FOP/UNICAMP

ANEXO 3

Journal of Dentistry for Children

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Manuscript ID:	JDCHILD-2007-05-0225
Title:	Bite force, facial morphology and the prevalence of nutritive and nonnutritive sucking habits in young children with functional crossbite
Authors:	Castelo, Paula Gavião, Maria Beatriz Pereira, Luciano José Bonjardim, Leonardo Rigoldi
Date Submitted:	20-May-2007

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