UNIVERSIDADE ESTADUAL DE CAMPINAS
FACULDADE DE ODONTOLOGIA DE PIRACICABA

ANNICELE DA SILVA ANDRADE

AVALIAÇÃO MORFOLÓGICA E FUNCIONAL DOS MÚSCULOS MASTIGATÓRIOS EM CRIANÇAS COM MORDIDA CRUZADA POSTERIOR

Dissertação apresentada à Faculdade de Odontologia de Piracicaba, da Universidade Estadual de Campinas, para obtenção do título de Mestre em Odontologia, Área de Concentração em Odontopediatria.

Orientadora: Prof[a]. Dr[a]. Maria Beatriz Duarte Gavião

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RESUMO

O objetivo da presente pesquisa foi realizar uma revisão sistemática sobre as principais alterações funcionais associadas à mordida cruzada posterior (MCP), bem como verificar parâmetros morfológicos e funcionais de crianças com MCP, por meio de avaliação do lado preferido da mastigação, espessura muscular e atividade eletromiográfica (EMG) dos músculos mastigatórios. Para a revisão sistemática foram utilizados os descritores "crossbite" and "bite force" or "surface EMG" or "TMD". A pesquisa resultou em 494 artigos, dos quais 8 foram selecionados após passar pelos os critérios de exclusão. A revisão demonstrou que crianças com MCP apresentam menor força de mordida, função muscular assimétrica durante a mastigação e máxima intercuspidação e maior prevalência de sinais e sintomas de disfunção temporomandibular (DTM).

No capítulo 2, a espessura muscular e atividade EMG dos músculos masseter e temporal anterior na posição de repouso e máxima intercuspidação foram avaliadas em crianças, de ambos os gêneros (7-10 anos), divididas nos seguintes grupos: Grupo com MCP (n=20); e Grupo com oclusão normal (ON, n=16). Para avaliação da atividade EMG e espessura muscular foram utilizados eletrodos de superfície e equipamento de ultrasom, respectivamente, nas posições de repouso e máxima intercuspidação. Os dados dos exames foram comparados entre os grupos e entre os lados dentro de cada grupo. A correlação entre espessura muscular e atividade EMG também foi avaliada. Os resultados demonstraram uma maior atividade EMG no masseter do lado cruzado em relação ao lado não-cruzado no grupo com MCP durante a máxima intercuspidação. Na avaliação da espessura muscular, não houve diferença estatística entre os lados e nem entre os grupos. Houve correlação positiva entre a atividade EMG e espessura muscular somente no masseter esquerdo do grupo controle. No capítulo 3, o lado preferido, as características dos ciclos mastigatórios e a atividade EMG durante a mastigação foram avaliados em crianças com MCP (n=20) e com ON (n=14). O lado preferido da mastigação foi avaliado através do método visual "spot-checking" e a atividade EMG dos músculos mastigatórios foi registrada com eletrodos de superfície durante a mastigação habitual por 20s, período em que também foi quantificada a duração e a freqüência do ciclo mastigatório. Os dados foram comparados entre os lados e entre os grupos. A correlação entre a atividade EMG e duração dos ciclos também foi avaliada. Os resultados demonstraram que os 2 grupos, MCP e ON, não apresentaram um lado preferido da mastigação. A atividade EMG dos músculos mastigatórios, a velocidade e duração dos ciclos não diferiram entre os grupos. Houve correlação positiva significativa entre atividade EMG do masseter e a duração dos ciclos no grupo MCP. De acordo com os estudos, conclui-se que crianças com MCP apresentam atividade EMG assimétrica do masseter durante a máxima intercuspidação, porém esta assimetria não resultou em alterações na espessura muscular. Além disso, as características morfológicas e funcionais da mastigação avaliadas na presente pesquisa não diferiram entre crianças com e sem MCP.

Palavras-chave: mordida cruzada posterior, lado preferido da mastigação, músculos mastigatórios, ultrassonografia, eletromiografia.

ABSTRACT

The aim of the present research was to perform a systematic review about the major functional changes associated with posterior crossbite (PCB), as well as to verify morphological and functional parameters of children with PCB, through the evaluation of the preferred chewing side, muscle thickness and electromyographic (EMG) activity of masticatory muscles. For the systematic review the descriptors "crossbite" and "bite force" or "surface EMG" or "TMD" were used. The search resulted in 494 articles, in which 8 met the inclusion criteria. The review showed that children with posterior crossbite presented reduced bite force, asymmetrical muscle function during chewing or clenching, and more prevalence of signs and symptoms of temporomandibular disorders (TMD). In chapter 1, the thickness and EMG activity of the muscles masseter and anterior temporalis in rest position and maximum clenching were evaluated in children, of both sexes (7-10 years), divided into the following groups: Group with posterior crossbite (n=20); and group with normal occlusion (NOccl, n=16). In assessing the EMG activity and muscle thickness surface electrodes and ultrasound equipment were used, respectively, in rest position and maximum clenching. Data were compared between groups and between right and left sides within each group. The correlation between muscle thickness and EMG activity was also evaluated. The results showed a higher EMG activity in the masseter of the crossbite side in relation to the non-crossbite side in the group PCB during maximum clenching. In the evaluation of muscle thickness, there was no statistical difference between sides, nor between groups. There was a positive correlation between the EMG activity and muscle thickness only in the left masseter in the NOccl group. In chapter 2, the preferred chewing side, chewing rate and EMG activity during mastication were evaluated in children with PCB and with normal occlusion (NOccl, n=14). The preferred chewing side was evaluated using a visual spot-checking method and the EMG activity of masticatory muscles was recorded with bipolar surface electrodes during habitual mastication for 20s, period in which the duration and velocity of each masticatory cycle were quantified. Data were compared between sides and between groups. The correlation between EMG activity and cycle duration was also evaluated. The results demonstrated that both groups, PCB and NOccl, did not present a preferred chewing side. The EMG activity of masticatory muscles, the chewing rate and cycle duration did not differ between groups. The correlation between chewing rate and EMG activity of masseter was statistically significant in the PCB group. It was concluded that children with PCB present asymmetric muscle activity of the masseter muscle during maximal clenching, but this asymmetry did not result in alterations in the muscle thickness. Moreover, the morphological and functional characteristics of mastication evaluated in the present research did not differ between children with or without PCB.

Keywords: posterior crossbite, preferred chewing side, mastigatory muscles, ultrassonographic, electromyography.

SUMÁRIO

I. INTRODUÇÃO

A mordida cruzada posterior caracteriza-se por uma alteração na oclusão dos arcos dentários no sentido transversal (Moyers, 1991). De acordo com dados epidemiológicos, a presença da mordida cruzada posterior no inicio da dentição mista situa-se entre 8-23% (Ingervall *et al*., 1972; Magnússon, 1977; Jämsä, 1988).

A discrepância transversal e instabilidade oclusal, características da mordida cruzada podem abranger um dente, um grupo de dentes ou todo o arco dentário. A origem pode estar associada a fatores dento-alveolares, musculares ou esqueléticos, sendo o diagnóstico diferencial de suma importância para a escolha e sucesso do tratamento (Moyers, 1991).

Enlow, em 1993, enfatizou que nenhuma face cresce exatamente igual à outra; a extensão, os locais e os padrões de crescimento são muitos variáveis e individualizados. O crescimento é um processo que trabalha constantemente em busca de um equilíbrio funcional e estrutural do complexo craniofacial, que apesar de constituir-se em uma unidade biológica, o desenvolvimento depende de fatores interrelacionados. Por exemplo, a resposta esquelética do ramo da mandíbula é resultado das ações de crescimento contínuo e remodelamento, reguladas pela função e crescimento dos músculos da mastigação, das vias áreas, mucosa, músculos faríngeos, tecido conjuntivo entre outros.

A mastigação é uma atividade rítmica controlada pelo tronco cerebral (Lund, 1991) que pode ser modificada por informações periféricas (Ottenhoff *et al*., 1992). O processo é iniciado pela mordida, sucedido pela mastigação propriamente dita e finalizado pela deglutição (Hiiemae *et al*., 1996). Durante a mastigação, os músculos elevadores da mandíbula são utilizados para sobrepujar a resistência dos alimentos (van der Bilt, 1995).

O desenvolvimento da função da mastigação dentro de padrões adequados influencia beneficamente a definição das formas e contornos das arcadas dentarias (Agustoni, 1989). Após a irrupção dos dentes decíduos, o arco formado pelas coroas dentárias altera-se pela atividade muscular, embora a atividade inicial deste processo não seja determinada pelos músculos, e sim pela codificação genética (Petrelli,1994).

Atualmente, avanços tecnológicos têm contribuído para aprimorar as técnicas de diagnóstico, permitindo avaliação minuciosa e precisa das estruturas anatômicas do complexo craniofacial. Como exemplos podem ser citados a tomografia e a ressonância magnética. Além destas, podem ser incluídas a ultra-sonografia e a eletromiografia da musculatura buco-facial, que são utilizadas na avaliação morfológica e funcional das estruturas do sistema estomatognático, servindo como auxiliares no diagnóstico de suas alterações, bem como na determinação de fatores etiológicos, permitindo prognosticar e avaliar a evolução de tratamentos instituídos (Pereira, 2006).

A análise da atividade muscular mastigatória em indivíduos com alterações oclusais pode fornecer dados úteis sobre o impacto funcional das discrepâncias morfológicas. Essa análise da atividade muscular pode ser verificada usando a eletromiografia (EMG) de superfície, que permite o acompanhamento dos principais músculos mastigatórios (masseter e temporal anterior) com resultados semelhantes aos obtidos com registro intramuscular (Belser & Hannam, 1986). Já a ultrasonografia, consiste em um recurso efetivo, simples, permitindo acesso fácil e reprodutível aos parâmetros da função muscular e sua interação com o sistema craniofacial (Bakke *et al.*, 1992).

Apesar da análise dos músculos mastigatórios fornecer dados proveitosos do impacto funcional das discrepâncias morfológicas e permitir a avaliação funcional dos tratamentos de problemas oclusais, acreditamos serem necessárias maiores investigações sobre o comportamento da função mastigatória durante o período de crescimento e desenvolvimento.

Assim, os objetivos da presente pesquisa foram:

- Realizar revisão sistemática sobre as principais alterações funcionais observadas em crianças com mordida cruzada posterior.
- Avaliar a espessura e atividade elétrica dos músculos mastigatórios em posição de repouso e máxima intercuspidação em crianças com mordida cruzada posterior, através de comparações entre os lados cruzado e não-cruzado e em relação ao grupo com oclusão normal.
- Verificar se crianças com mordida cruzada posterior possuem lado preferido de mastigação, diferenças na duração e velocidade do ciclo mastigatório ou na atividade elétrica dos músculos em relação ao grupo com oclusão normal.

II. CAPÍTULOS

Capítulo 1: "Posterior Crossbite and functional changes of the masticatory muscles: A Systematic Review

Capítulo 2: "Electromyographic activity and thickness of masticatory muscles in children with posterior crossbite"

Capítulo 3: "Preferred chewing side, cycle characteristics and electromyographic activity of masticatory muscles in children with posterior crossbite".

Capítulo 1

"Posterior Crossbite and functional changes of the masticatory muscles: A Systematic Review"

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ABSTRACT

Objective The aim of this study was to assess the functional changes of masticatory muscles associated with posterior crossbite in primary and mixed dentition, by systematically reviewing the literature. **Materials and Methods:** A literature survey from the Medline database covering the period from January 1965 to February 2008 was performed. Randomized controlled trials, controlled clinical trials and clinical trials evaluating bite force, surface electromyography and signs and symptoms of temporomandibular disorders (TMD) were included. Two reviewers extracted the data independently and also assessed the quality of the studies. **Results** The search strategy resulted in 494 articles, of which 8 met the inclusion criteria. Children with posterior crossbite can have reduced bite force and asymmetrical muscle function during chewing or clenching, in which the anterior temporalis is more active and the masseter less active on the crossbite side than the non-crossbite side. Moreover, there is a significant association between posterior crossbite and TMD symptomatology. **Conclusion:** The consequences of the functional changes for the growth and development of stomatognathic system deserves further investigation.

INTRODUCTION

Posterior crossbite is one of the most prevalent malocclusions in primary and early mixed dentition and is reported to occur in 8% to 22% of cases.[1,2] It is defined as any abnormal buccal–lingual relation between opposing molars, premolars, or both in centric occlusion.[1] The commonest form is a unilateral presentation with a functional shift of the mandible toward the crossbite side, which occurs in 80% to 97% of cases.[3,4] The etiology of posterior crossbite can include any combination of dental, skeletal and neuromuscular functional components, but the most frequent cause is reduction in width of the maxillary dental arch, which can be induced by finger sucking,[3,5-6] certain swallowing habits[5] or obstruction of the upper airways caused by adenoid tissues or nasal allergies.[6,7]

Because spontaneous correction is rare, posterior crossbite is believed to be transferred from primary to permanent dentition with long-term effects on the growth and development of the stomatognathic system.[8,9] The condyles on the crossbite side are positioned relatively more superiorly and posteriorly in the glenoid fossa than those on the non-crossbite side.[10] Since skeletal remodeling of the temporomandibular joint (TMJ) can occur over time, the condyles become more symmetrically positioned in their fossa, and facial asymmetry and mandibular midline deviation toward the crossbite side might persist. Subsequent adaptation of the neuromusculature to the acquired mandibular position can cause asymmetric mandibular growth, facial disharmony, and several functional changes in the masticatory muscles and TMJ.[11-14]

Previous studies have found associations between crossbite and parameters related to the masticatory muscle performance, such as asymmetric electromyographic activity (EMG),[15,16] different thickness of the elevator muscles on each side of the jaw,[17] different bite force magnitude and more TMJ symptomatology in crossbite subjects.[14, 16,18] A considerable variety of diagnostic approaches, study designs, sample sizes, and research approaches have produced disparate outcomes among studies.

Therefore, a systematic review was warranted, focusing on the functional changes associated with posterior crossbite in children, based on the evaluation of EMG activity of masticatory muscles, bite force and signs and symptoms of TMD. Furthermore, a quality analysis of the methodological soundness of the studies in the review was performed.

MATERIALS AND METHODS

Search strategy

The strategy for this systematic review was based on the National Health Service Center for Reviews and Dissemination.[19] A literature survey was done by applying the Medline database (www.ncbi.nim.nih.gov) in the period from January 1965 to February 2008, using "crossbite" and "bite force" or "surface EMG and or "TMD" as descriptors.

Selection criteria

The inclusion and exclusion criteria are given in detail in Table 1.

Table 1. Initial Inclusion and Exclusion Criteria for the Retrieved Studies

Inclusion Criteria	Exclusion Criteria
• Human studies • Primary and early mixed dentition with posterior crossbite • Randomized controlled trials, controlled clinical trials, and prospective studies • Articles written in English	• Case reports and case series • Review articles and abstracts • Permanent dentition, adults • Angle Class III • Cleft lip and/or palate or other craniofacial syndrome diagnosis

Data collection and analysis

Data were collected on the following items: author, year of publication, study design, study groups, methods/measurements and outcome measurements. In addition, to document the methodological soundness of each article, a quality evaluation was performed with respect to pre-established characteristics.[20,21] evaluating eight variables: (1) study design [Randomized clinical trials (RCT), Prospective (P) or Controlled Clinical trials (CCT) = 3 points; Clinical trials (CT) = 1 point]; (2) adequate sample size = 1 point; (3) adequate selection description = 1 point; (4) valid measurement methods = 1 point; (5) use of method error analysis = 1 point; (6) blinding in measurement = 1 point; (7) adequate statistics provided = 1 point; (8) confounders included in analysis = 1 point. A study was categorized as low (0–5 points), medium (6–8 points), or high (9 or 10 points).

The data extraction and quality scoring from each article were assessed independently by two researchers, who selected the articles by reading the title and abstracts. All of them appeared to meet the inclusion criteria were selected. A hundred percent of agreement was obtained in this phase between the two researchers. The reference lists of the selected articles were also searched manually for additional relevant publications that might have been missed in the database searches.

RESULTS

The search strategy resulted in 494 articles. After selection according to the inclusion/exclusion criteria, eight articles qualified for the final analysis.

Quality of the studies

The research quality and methodological soundness were high in one study, medium in six, and low in one (Tables 2 and 3). The most serious shortcomings were the CT design with small sample size and inadequate description of selection. Problems of confounding variables, lack of method error analysis, and the absence of blinding in measurements were other examples of shortcomings. Furthermore, the choice of statistical methods was not explained. Considering the confounding variable facial pattern, only one study selected subjects with a Class I malocclusion and mesofacial growth pattern in order to avoid the influence of sagittal and vertical anomalies in the neuromuscular systems.[15] The others seven studies did not comment or consider this matter at all.

Table 2. Summarized data of the 8 studies included in the review

Author (Year)	Study design	Study Groups			Sample		Age (Years)		Methods/ Measurements	Outcome measurements	
										Statistically difference between Groups	Statistically significant difference between sides
		I	II		I	II	I	II			
Alarcón[15] (2000)	CCT	Unilateral posterior crossbite	Control Normocclusive		n=30 17 girls 13 boys	n=30 16 girls 14 boys	10-14	10-14	EMG	↑ EMG on ipsilateral AT and on both sides of AD during swallowing ↑ EMG on ipsilateral AD and ↓ EMG on ipsilateral MM during chewing	↑ EMG on contralateral PT than ipsilateral PT during rest and swallowing.
Kecik[16] (2007)	P, CCT, L	Unilateral function-nal crossbite	Control		n=35 20 girls 15 boys	n=31 18 girls 13 boys	Mean 10.6	Mean 9.8	EMG and joint vibration analysis	↑ EMG on ipsilateral AT and MM than contralateral ones during rest. ↑ EMG on ipsilateral AT and ↓ EMG on ipsilateral MM than contralateral ones during clenching	↑ EMG on ipsilateral AT and MM than contralateral ones during rest. ↑ EMG on ipsilateral AT and ↓ EMG on ipsilateral MM than contralateral ones during clenching.
Sonnesen[25] (2001)	CCT	Unilateral posterior crossbite	Control		n=26 13 girls 13 boys	n=26 13 girls 13 boys	9.35	9.35	Bite force determination and evaluation of TMD signs and symptoms	Crossbite group showed lower bite force than control group MM and AT had more sensibility in crossbite group	No significant differences in bite force between sides
Rentes[22] (2002)	CCT	I Normocclusion (10)	II Crossbite (10)	III Openbite (10)	n=30		3 - 5.5		Bite force determination	No differences	Not evaluated

Table 2 continued

Sonnesen [23] (2007)	P, L	Unilateral posterior crossbite	n=19 7 girls 12 boys	7-11	Bite force determination	Immediately after treatment↓ bite force on ipsilateral than on contralateral side	No differences
Castelo[24] (2007)	CCT	PNO PCB MNO MCB	n=49 26 boys 23 girls	PNO=58.67 PCB=60.50 MNO=72.85 MCB=71.91	Bite force, Thickeness muscular and occlusal contacs	MCB↓ bite force than in the MNO groups. PNO no differences between PCB	No differences
Vanderas [18] (2002)	RCT	-	n=314 153girls 161 boys	6-8	Clinical examination and evaluation of TMD signs and Symptoms	Posterior crossbite had a significant impact on TMJ tenderness	
Sonnesen [14] (1998)	CT	-	n=104 56 girls 48 boys	7-13	Bite force determination, Clinical examination and evaluation of TMD signs and Symptoms	Crossbite group showed lower bite force than control group and the malocclusion was significantly associated with signs and symptoms of TMD	

CCT: Controlled clinical trials; RCT: Randomized clinical trials; CT: Clinical trials; L: Longitudinal; P: Prospective
MM: Masseter; AT: Anterior temporalis; PT: posterior temporalis; AD: anterior digastric;
EMG: Surface electromyography; TMJ: Temporomandibular joint; TMD: Temporomandibular disorders;
(↑ EMG): higher electromiographic activity; (↓ EMG): Lower electromiographic activity;
PNO: primary normal- occlusion
PCB: primary-crossbite occlusion
MNO: mixed-normal occlusion
MCB: mixed-crossbite occlusion

Table 3. Quality evaluation of the retrieved studies

Author Year	Study Design	Sample size	Selection Description	Valid measurement methods	Method Error Analysis	Blinding in Measurements	Adequate Statistics Provided	Confounding factors	Judged Quality Standard
Alarcón[15] (2000)	CCT	Adequate	Adequate	Yes	Yes	No	Yes	Yes, facial pattern considered	High
Kecik[16] (2007)	CCT	Adequate	Adequate	Yes	Yes	No	Yes	ND	Medium
Sonnesen[25] (2001)	CCT	Adequate	Adequate	Yes	Yes	No	Yes	ND	Medium
Rentes[22] (2002)	CCT	Inadequate	Adequate	Yes	No	No	Yes	ND	Medium
Sonnesen[23] (2007)	P,L	Adequate	Adequate	Yes	Yes	No	Yes	ND	Medium
Castelo[24] (2007)	CCT	Inadequate	Adequate	Yes	Yes	No	Yes	ND	Medium
Vanderas[18] (2002)	RCT	Adequate	Adequate	Yes	Yes	No	Yes	ND	Medium
Sonnesen[14] (1998)	CT	Adequate	Inadequate	Yes	Yes	No	Yes	ND	Low

CCT:Controlled clinical trial; RCT: Randomized clinical trial; CT: Clinical trial; L: Longitudinal; P: Prospective; ND: Not declared

DISCUSSION

This systematic review aimed to select all RCTs, CCTs and all P and retrospective observational studies with concurrent controls as well as observational studies verifying the functional changes in masticatory muscles associated with posterior crossbite in children. No retrospective study could be found. Eight studies were retrieved due to some consistent results.

From a methodological point of view, it was notable that all the studies used examination methods without blinding design. However, this could be explained by the difficulty for the observer to be blind to the presence of posterior crossbite. In all studies, the methods used to detect and analyze the functional changes associated with posterior crossbite were valid and well known. However, different experimental designs and sample selection were used, which caused difficulties for comparing the results.

Crossbite and Bite Force

Five articles evaluated the bite force in children with unilateral posterior crossbite.[14, 22-25] Maximum bite force and number of teeth in contact were significantly lower in children with unilateral crossbite, in comparison with control groups with a similar number of teeth. In addition, there were no significant differences in maximum values between sides of the jaw in the groups with and without posterior crossbite. These finding implying that children with unilateral crossbite can have altered muscular activity and asymmetrical muscle function, when compared with children with neutral occlusion and more tooth contacts.[14,25]

In a prospective, longitudinal study,[23] bite force in children with unilateral posterior crossbite before orthodontic treatment did not differ significantly between sides, but immediately after orthodontic treatment, it was significantly lower on the ipsilateral side (crossbite side) than on the contralateral one.[23] The reason could be due to transient changes in occlusal support, periodontal mechanoreceptors and jaw elevator muscle reflexes, but the bite force increased again after retention, and approached the mean level in children with neutral occlusion.[23]

Nevertheless, in primary dentition, no significant differences in bite force values were found between children with normal occlusion and posterior unilateral crossbite,[22,24] whereas in early mixed dentition, the level of maximum bite force was significantly lower for children with this malocclusion than controls.[24]

Bite force can be influenced by the size of the bite gauge, and in a young age group, the size might be beyond their optimal vertical jaw separation, which in turn might reduce the bite force. [26] Therefore, the reduced bite force associated with crossbite seems to become apparent from the time that mixed dentition starts.

Muscular activity at rest position

Two studies reported EMG differences due to posterior crossbite in children, after evaluating muscular activity at rest position, during swallowing and during mastication,[15] and maximum clench.[16] Alarcon et al[15] found no significant differences in any of the tested muscles (anterior and posterior temporalis, masseter and anterior digastric) at rest position, on comparing the normocclusive and right posterior crossbite subjects. Moreover, the right anterior temporal demonstrated higher EMG activity than the left anterior temporal in the normocclusive group, and they suggested that some degree of muscular asymmetry could be considered as physiological and compatible with a normal function. In the right posterior crossbite subjects, the left posterior temporal showed higher EMG activity than the right posterior temporal, suggesting that this asymmetry could be due to the functional mandibular shift, which could act as a mechanism for reaching a certain degree of occlusal stability.[15] Kecik et al[16] showed that the anterior temporal and masseter muscle activity at rest position differed significantly between the crossbite and control groups, and higher muscle activity was found on the crossbite side, but the respective differences were eliminated after maxillary expansion.

Muscular activity during swallowing

EMG activity of left anterior temporal and both left and right anterior digastric muscles was higher in the right posterior crossbite group than in the normocclusive group, whereas the left posterior temporal showed a higher peak of EMG activity than the right.[15] The increased activity of the anterior digastric muscles in the crossbite subjects could be the result of the higher frequency of atypical deglutition found in this group.[15] In contrast, Kecik et al[16] did not find significant differences in masticatory muscle activities between the right and left sides and crossbite and normocclusive groups. The differences could be attributed to a different sample selection and experimental design (Table 2).

Muscular activity during chewing and clenching

Subjects with posterior crossbite could have a masticatory pattern that is unique and different from normocclusive subjects.[15,16] The anterior temporalis muscles were the most active in crossbite subjects during chewing,[15] and demonstrated significantly higher activity on the crossbite side than non-crossbite side, and also between crossbite and control subjects.[15,16] Conversely, the right masseter (ipsilateral to the crossbite) was less active in the crossbite group than in the normocclusive group.[16] These findings could indicate that the sequence of the neuromuscular system priorities during mastication is different in the crossbite subjects; the most important role is to position the mandible correctly in order to reach higher occlusal stability, and once this is attained, to generate the necessary power to chew.[15,16] This could be the reason why the anterior temporal is the most active muscle. On the other hand, the lower EMG activity of masseter muscles in the crossbite group than in the normocclusive group could be due to an inhibitory-protective reflex to avoid injury or pain in the structures of the stomatognathic system, thus the capacity of the masseter muscles to generate contraction could be diminished.

Crossbite and TMD signs and symptoms

Four studies evaluated the TMD signs and symptoms associated with posterior crossbite in children.[14,16,18,25] Headache several times a week occurred more frequently in children with unilateral crossbite.[14] Moreover, headache at least once a week and tenderness of the anterior temporal and superficial masseter muscles were the most prevalent signs and symptoms of TMD.[25] Furthermore, tenderness of the anterior temporal and superficial masseter muscles occurred more frequently in the crossbite group than in the control group.[25]

In a multifactorial analysis of TMD signs and symptoms, Vanderas et al[18] reported that posterior crossbite with lateral shift significantly affected the probability of children developing deviation of the mandible on opening, which would have significant impact on TMJ tenderness. They also found a significant correlation between epinephrine levels and TMJ tenderness, suggesting that emotional stress should not be neglected even in the presence of malocclusion traits.

The surface vibrations of the bilateral TMJs have been studied with electrovibratography in children with and without posterior crossbite.[16] It was found that TMJ vibration was significantly higher on the crossbite side compared with the non-crossbite side before treatment and the differences between the crossbite and the control groups were also significant. After maxillary expansion, both sides had similar values, and there was no significant difference between the treatment and control groups.

CONCLUSIONS

- Altered muscle function associated with posterior crossbite can reduce the bite force in mixed dentition.
- According to EMG analysis, children with posterior crossbite have asymmetrical muscle function during chewing or clenching, in which the anterior temporalis is more active and the masseter less active on the crossbite than on the non-crossbite side. The EMG data of muscular activity during rest and swallowing were not conclusive.
- Posterior crossbite may increase the probability of children developing signs and symptoms of TMD.
- The consequences of these functional changes for the growth and development of stomatognathic system deserves further investigation.

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REFERENCES

1. Kutin G, Hawes RR. Posterior cross-bites in the deciduous and mixed dentitions. *Am J Orthod*. 1969;56:491-504.

2. Egermark-Eriksson I, Carlsson GE, Magnusson T, Thilander B. A longitudinal study on malocclusion in relation to signs and symptoms of cranio-mandibular disorders in children and adolescents. *Eur J Orthod*. 1990;12:399–407.

3. Thilander B, Wahlund S, Lennartsson B. The effect of early interceptive treatment in children with posterior crossbite. *Eur J Orthod*. 1984;6:25–34.

4. Schroder U, Schroder I. Early treatment of unilateral posterior crossbite in children with bilaterally contracted maxillae. *Eur J Orthod*. 1984;6:65-69.

5. Melsen B, Stensgaard K, Pedersen J. Sucking habits and their influence on swallowing pattern and prevalence of malocclusion. *Europ J Orthod*. 1979;1:271-80.

6. Linder-Aronson S. Adenoids. Their effect on mode of breathing and nasal airflow and their relationship to characteristics of the facial skeleton and the dentition. *Acta Otolaryngol.* 1970;265:1-132.

7. Hannuksela A, Vaananen A. Predisposing factors for malocclusion in 7-year-old children with special reference to atopic diseases. *Am J Orthod Dentofacial Orthop.* 1987;92:299–303.

8. Proffit WR Treatment of orthodontic problems in preadolescent children (section VI). In: Proffit WR, ed. *Contemporary Orthodontics*. 3rd ed. Mosby, St Louis; 2000pp.435–439.

9. McNamara JA. Early intervention in the transverse dimension: is it worth the effort? *Am J Orthod Dentofacial Orthop*. 2002;12:572-574.

10. Hesse KL, Årtun J, Joondeph DR, Kennedy DB. Changes in condylar position and occlusion associated with maxillary expansion for correction of functional unilateral posterior crossbite. *Am J Orthod Dentofacial Orthop*. 1997;111:410–418.

11. Bishara SE, Burkey PS, Kharouf JG. Dental and facial asymmetries: a review. *Angle Orthod*. 1994;64: 89–98.

12. O'Bryn BL, Sadowsky C, Schneider B, Be Gole EA. An evaluation of mandibular asymmetry in adults with unilateral posterior crossbite. *Am J Orthod Dentofacial Orthoped*. 1995;107: 394–400.

13. Egermark I, Carlsson GE, Magnusson T. A prospective long-term study of signs and symptoms of temporomandibular disorders in patients who received orthodontic treatment in childhood. *Angle Orthod*. 2005;75:645–650.

14. Sonnesen L, Bakke M, Solow B. Malocclusion traits and symptoms and signs of temporomandibular disorders in children with severe malocclusion. *Eur J Orthod*.1998;20:543-559.

15. Alarcon JA, Martin C, Palma JC. Effect of unilateral posterior crossbite on the electromyographic activity of human masticatory muscles. *Am J of Orthod Dentofacial Orthop*. 2000;118: 32–34.

16. Kecik D, Kocadereli I, Saatci I. Evaluation of the treatment changes of functional posterior crossbite in the mixed dentition. *Am J Orthod Dentofacial Orthop*. 2007;13:202-215.

17. Kiliaridis S. Katsanos C, Raadsher MC, Mahboubi PH. Bilateral masseter muscle thickness in growing individuals with unilateral crossbite. *J Dent Res*. 2000;79:497 (Abstract).

18. Vanderas AP, Papagiannoulis L. Multifactorial analysis of the aetiology of craniomandibular dysfunction in children. *Int J Paediatr Dent*. 2002;12: 336-346.

19. National Health Service (NHS) Centre for Reviews and Dissemination Report. *Undertaking Systematic Reviews of Research on Effectiveness*. University of York: York Publishing Services; 2001. Available at: www.york.ac.uk/inst/crd/ crdrep.htm.

20. Antczak AA, Tang J, Chalmers TC. Quality assessment of randomized control trials in dental research I. Methods. *J Period Res*. 1986;21:305–314.

21. Jadad AR, Moore RA, Carroll D, Jenkinson C, Reynolds DJ, Gavaghan DJ, McQuay HJ. Assessing the quality of reports of randomized clinical trials: is blinding necessary? *Control Clin Trials*. 1996;17:1-12.

22. Rentes AM, Gaviao MB, Amaral JR. Bite force determination in children with primary dentition. *J Oral Rehabil*. 2002;29:1174-1180.

23. Sonnesen L, Bakke M. Bite force in children with unilateral crossbite before and after orthodontic treatment. A prospective longitudinal study. *Eur J Orthod*. 2007;29:310-313.

24. Castelo PM, Gaviao MB, Pereira LJ, Bonjardim LR. Masticatory muscle thickness, bite force, and occlusal contacts in young children with unilateral posterior crossbite. Eur *J Orthod*. 2007;29:149-56.

25. Sonnesen L, Bakke M, Solow B. Bite force in pre-orthodontic children with unilateral crossbite. *Eur J Orthod*. 2001;23: 741-749.

26. Proffitt WR, Fields HW. Occlusal forces in normal and long face children. *J Dent Res*. 1983; 62:571.

Capítulo 2

"Electromyographic activity and thickness of masticatory muscles in children with posterior crossbite"

Running title: posterior crossbite and masticatory muscles

Keys word: posterior crossbite, ultrasonography, electromyography, masseter muscle, anterior temporal muscle

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ABSTRACT

The aim of this study was to assess the thickness and electromyographic (EMG) activity of the masseter and anterior temporal muscles in children with posterior crossbite (PCB). Thirty-six children (22 boys, 14 girls) with a mean age of 8.8 ± 1.1 years were divided into the following groups: The experimental groups consisted of twenty PCB patients (ten on the left side, ten on the right side); the control group consisted of sixteen normal occlusion (NOccl) subjects. EMG activity was recorded with bipolar surface electrodes at rest and during maximal clenching. The thickness of the muscles was measured with a real-time ultrasound equipment. Data were compared between groups and between right and left sides within each group. The correlation between EMG activity and muscle thickness was also evaluated. The results revealed that the masseter of the crossbite side was more active than that of the non-crossbite side in subjects with PCB during maximal clenching. The comparisons of EMG activity between PCB patients and NOccl subjects revealed some variability in the results, depending if the crossbite side was on the left or right side. The ultrasonographic evaluation did not show statistically significant differences neither between groups, nor between sides in the PCB and NOccl groups. Significant correlation between EMG activity and muscle thickness was observed only in the left masseter in the NOccl group. In conclusion, these findings suggest that asymmetric muscle activity of the masticatory muscles may not result in differences in the thickness of these muscles in children with PCB.

INTRODUCTION

According to epidemiological data, the prevalence of unilateral posterior crossbite in the early mixed dentition varies between 8% and 23% (1, 2). When the intercuspal position of the mandibular dentition is forced laterally to the retruded contact position, this condition is described as a functional posterior crossbite (FPCB) (3). FPCB is generally accompanied by deviation of the mandibular arch midline to the crossibite side (4 - 6).

Skeletally, crossbites with lateral shift influence the normal growth of the mandible (7 -9). Another consequence of an untreated FPCB is the likely asymmetry in the condylar position and trajectories, with a displacement of the ipsilateral condyle toward the crossbite side (10 - 13) and an increased growth of the contralateral condyle (13). The intimate mechanism that links the lateral shift of the mandible with the condylar growth remains unclear, but it seems that the main cause could be abnormall muscular activity (10). Subsequent adaptation of the neuromusculature to the acquired mandibular position can cause asymmetric mandibular growth, facial disharmony, and severe skeletal crossbite in the permanent distortion (14).

The evaluation of functional symmetry of the craniofacial complex usually involves the patterns of jaw movements and the activities of masticatory muscles (15, 16). Surface electromyography is a widely used method of monitoring jaw closing muscle activity (17) despite some method problems in recording surface electromiographic (EMG) activity (18). Ultrasound scanning enables dynamic visualization of the muscles of the head and neck (19, 20), and it is an accurate and rapid method for measuring the thickness of superficial muscles, such as the masseter and temporalis, without known adverse effects (21). A significant positive correlation was found between the masseter muscle thickness measured by ultrasonography and its maximal EMG activity in individuals with normal occlusion (22). However, to our knowledge, no attempt was performed to correlate EMG activity and muscle thickness of masticatory muscles in the presence of malocclusions associated with functional deviations, such as functional posterior crossbites.

On this background, the aim of this study was to evaluate the electrical activity and muscle thickness of the masseter and anterior temporalis muscles in children with PCB, compared with those having normal occlusion, all in the mixed dentition. The possibility of an association between EMG activity and muscle thickness was also evaluated.

MATERIALS AND METHODS

The study comprised 36 children aged 7-10 years, who were to start dental treatment at Department of Pediatric Dentistry, Piracicaba Dental School, State University of Campinas. The Research Ethical Committee of the Dental School approved the project (protocol 020/2006 and 023/2006). The children and their parents or guardians received an oral and written explanation about our aims and research methodology. After reaching agreement, we conducted an anamnesis to verify their medical and dental history and oral habits. Complete orthodontic documentation (lateral and posteroanterior cephalometric radiographs, study models, extraoral front and profile photographs, and intraoral photographs) was obtained. The children were divided into 2 groups: pre-orthodontic children with posterior crossbite (n=20) – PCB group, composed by 12 boys and 8 girls (mean age 8.80 ± 1.07 year); children with normocclusion - NOccl group, composed by 10 boys and 6 girls (mean age 8.88 ± 1.15 years). Subjects were excluded if they had clinical signs or symptoms of temporomandibular joint dysfunction, previous or current orthodontic treatment, extensive restorations, cast restorations or cuspal coverage, pathologic periodontal condition, or missing teeth. Only subjects with unilateral presentation of the posterior crossbite with a functional shift of the mandible toward the crossbite side were selected. Children with crossbite resulting from dental inclination were not considered. All children had maxillary transverse discrepancy with indication of rapid maxillary expansion.

Ultrassound imaging (USI)

The masseter and anterior temporalis evaluation was conducted using the Just-Vision 200 digital ultrasonography system (Toshiba Corporation, Japan) and the images were obtained with a high-resolution real-time 56mm/10-MHz linear-array transducer), and the image was measured directly on screen with an accuracy of 0.1 mm. For each side (left and right/ nomal and crossbite side) the recordings were performed twice with the muscles at rest (RE) and in maximal clenching (MC) with an interval of ay least 2 minutes between measurements. The locations for USI were 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 temporal muscle - in front of the anterior border of the hairline

Measurement error for ultrasound

The errors of measurement (Se) for the thickness of masticatory muscles were assessed from repeated measurements on two separate occasions (m1, m2) of 20 randomly selected subjects (n), using the Dahlberg's formula: Se =√Σ (m1 – m2)2 / 2n. The error was 0.47 mm for the contracted and 0.26 mm for the relaxed masseter and 0.32 mm for the contracted and 0.29 mm for the relaxed anterior temporal.

Electromyography evaluation

Muscle activities were measured with the EMG system (Sao Paulo/Brazil) MCS-V2 Electromyograph. Myoelectric signals were captured by various active electrodes with two contacts of 10.0 x 1.0 mm with a distance of 10.0 mm between them, impedance upwards of 10GΩ and a common rejection value of 130dB to 60Hz, crafted in silver and fixed in a resin capsule of 40x20x5 mm. During the experiment, the child sat comfortably, with a straight back and head orientated with the Frankfort plane parallel to the floor. Both the skin and the electrodes were cleaned with 70 percent GL ethyl alcohol.

The electrodes were placed at the same sites as for the masseter and anterior temporalis ultrasonography recordings. The reference electrode was placed on the right first. The muscle activity was recorded twice when the subjects clenched their teeth (maximum voluntary clench) and rest position. The means of Root Mean Square (RMS) in both trials were used. The methodology for signal treatment was in accordance with Merletti *et al.* (23)

EMG signals were recorded at rest position for ten seconds; dental clenching at maximum habitual intercuspation for four seconds . To capture the signals at rest, patients remained relaxed without occlusal contact and during dental clenching patients maintained the force of continuous contractions.

Statistical analysis

Intra-group comparisons of the thickness and electrical activity of the masseter and anterior temporal muscle were carried out considering the right and left sides for NOccl group and the normal and crossbite sides for PCB group. Paired t-test was used for these comparisons, at $p<0.05$.

Inter-group comparisons were carried out considering the right and left crossbite sides in PCB group with the respective sides in NOccl group, using unpaired test-t. Data that did not meet criteria for parametric analysis were assessed by Mann-Whitney test. The relationship between muscle thickness and electrical activity was evaluated by Spearman rank correlation or Pearson's coefficient analysis, as appropriate. The significance level was set at $P<0.05$.

RESULTS

Table 1 shows the means, standard deviations and p-value of EMG activity (µv) and USI measurements (mm) for PCB group. Comparing the crossbite side and normal side, there were no significant statistical differences for the masseter and anterior temporalis during rest position ($P>0.05$). However, in maximum clenching the masseter muscle was significantly more active in the crossbite side than on the normal one ($P<0.01$).

Table 1 - Mean and standard deviation of the eletromyographic data (µv) and masticatory thickness (mm) at rest position and maximum clenching - comparisons between sides in the posterior crossbite group

	Crossbite group	
	Crossbite side	*Normal side*
EMG at rest		
Masseter	9.4 ± 4.2	9.1 ± 4.8
Anterior temporalis	11.4 ± 4.0	10.3± 3.0
EMG during clenching		
Masseter	158.2± 72.8*	121.5± 49.3*
Anterior temporalis	166.8± 69.2	167.8± 83.3
USI at rest		
Masseter	10.7±1.5	10.6±1.5
Anterior temporalis	2.60±0.5	2.5±0.5
USI during clenching		
Masseter	12.2±1.4	11.8±1.4
Anterior temporalis	3.3±0.8	3.3±0.8

(*p<0.05, paired t-test between sides in each group)

In normocclusive subjects, significant differences were found when the EMG activity of right anterior temporal was compared to the left anterior temporal during rest position (P >0.05). This muscle showed a higher electrical activity in the right side than in the left side. No significant differences were found between the sides in maximum clenching recording (P >0.05) (Table 2).

The EMG evaluation at rest position showed that children with right crossbite presented higher EMG activity of the anterior temporal in this side than in the normal one. At clenching, the masseter in the crossbite side presented also higher EMG values in right crossbite side than in normal side (Table 2).

Inter-group comparisons showed no significant differences in masseter and anterior temporalis muscles at rest position, but in maximum clenching the anterior temporal in the right PCB group presented higher EMG activity than anterior temporal in the NOccl group. However, this difference was not observed when the left PCB group was compared to the NOccl group. The thickness of the masticatory muscles did not show statistically significant differences between groups, neither for the masseter, nor for the anterior temporalis (P>0.05) (Table2).

Table 2: Mean and standard deviation (SD) of the eletromyographic data (µv) and ultrasonography (mm) at rest position and maximum clenching compared normoclusive group between right posterior crossbite group and left posterior crossbite group.

	Normoclusive N=16		*Right posterior crossbite group N=10*		*Left posterior crossbite group N=10*	
	Right Mean / SD	*Left Mean/ SD*	*Crossbite side Mean / SD*	*Normal side Mean/ SD*	*Crossbite side Mean / SD*	*Normal side Mean / SD*
EMG at rest						
Masseter	8.0± 4.54	7.8± 4.4	8.2±4.2	7.7±5.2	10.7±4.1	10.5±4.2
Anterior temporalis	10.3±3.2*	8.3± 3.0*	12.6±3.92*	9.9±3.15*	10.2±4.0	10.8±3.0
EMG during clenching						
Masseter	125.0±43.0	113.7±37.1	147.3±64.8*	110.4±51.5*	169.2±81.9	132.8±47.0
Anterior temporalis	113.9±63.6†	127.9±64.1	183.6±76.5†	169.8±96.8	149.6±60.3	165.5±72.6
USI at rest						
Masseter	10.3±1.9	10.3±1.7	10.9±1.7	10.6±1.2	10.6±1.4	10.7±1.8
Anterior temporalis	2.5±0.5	2.7±0.5	2.5±0.6	2.7±0.4	2.7±0.4	2.5±0.6
USI during clenching						
Masseter	12.4±1.6	12.2±1.5	12.4±1.5	11.8±1.3	12.1±1.5	11.9±1.5
Anterior temporalis	3.4±0.7	3.6±0.8	3.4±0.98	3.4±0.8	3.3±0.78	3.3±0.9

*p<0.01 paired test-t – intra-group comparisons

† p<0.05 unpaired test-t – inter-group comparison

Table 3 shows the correlation between EMG activity and muscle thickness in the PCB group and in the control group. A significant positive correlation was observed only in the left masseter in the control group.

Table 3 - Correlation coefficients (r*)* of masseter and anterior portion of the temporalis muscle thickness with EMG activity during rest (RE) and at maximal clenching (MC) in the posterior crossbite groups and normoclusive group

	Masseter				*Temporal*			
	Normal side/Left side		*Crossbite side/Right side*		*Normal side/Left side*		*Crossbite side/Right side*	
	RE	MC	RE	MC	RE	MC	RE	MC
Crossbite group	0.353	-0.029	-0.230	-0.356	-0.230	-0.190	-0.129	-0.339
Normocclusive	0.051	0.555*	0.071	0.171	-0.368	0.339	-0.345	0.325

*P<0.05 (Pearson's Correlation)

DISCUSSION

Posterior crossbite is one of the most common malocclusions observed in growing subjects and involves complex alterations in the stomatognathic system. The present study investigated the bilateral differences in the EMG activity and muscle thickness by ultrasonography in children with PCB, as well in those with normocclusion, and the respective correlations.

The anatomy and function of the human masticatory muscles have already been examined by ultrasonography (USI) and EMG (24 - 26) which makes their application useful for evaluating the masseter and anterior temporal in PCB subjects, as performed in this study. The USI technique is considered to be uncomplicated, and represents a considerable improvement compared to conventional methods for assessing masticatory muscles thickness (27). Computed tomography (CT) and magnetic resonance imaging (MRI) are also used for evaluating cross-sectional areas and volumes of human jaw muscles. However, CT has the disadvantage of showing cumulative biological effects and MRI poses a problem in terms of clinical availability and cost, which made USI a good choice for measuring local linear cross-sectional dimensions of the head and neck muscles (19, 28)

During maximal clenching, the masseter on the crossbite side was more active than that of the non-crossbite side in subjects with PCB, showing an asymmetric muscular activity in this malocclusion (Table 1), being the crossbite on the right side determinant of the respective imbalance (Table 2). This finding could be due to the functional mandibular shift that occurred during maximal voluntary clenching, which could act as a mechanism to reach a certain degree of occlusal stability. The children had severe transverse discrepancy and unilateral posterior crossbites at maximum intercuspal position, which can be associated with a longer mandibular shift. Kecik *et al.* (29) also observed a muscular imbalance in children with functional posterior crossbite at rest, demonstrated by higher EMG activity of anterior temporal and masseter muscles on the crossbite side than on the control one. In the present study, only the anterior temporal on right crossbite side has determined higher EMG values at rest. Contrary to us, at clenching, Kecik *et al.* (29) did not found significant differences, which could be attributed to less severity of the crossbite in their sample. Alarcón *et al*. (30) pointed out a question about EMG asymmetry at rest, since in this position there are no occlusal interferences producing a functional shift of the mandible. We agree with these authors that the functional shift found in maximal intercuspation could persist also at rest. However, when the right and left muscles were compared in the NOccl group, the right anterior temporal demonstrated a higher EMG activity than the left at rest, as verified in normocclusive subjects by Alarcon *et al.* (30). In accordance with Ferrario *et al.* (31) “normal” population can present a certain degree of muscular asymmetry, considered as physiologic and compatible with a normal function. On comparing the EMG activity between sides for Noccl group during maximal clenching, we did not find significant differences, indicating a symmetric function of masticatory muscles in this group (Table 2).

The present study showed that although PCB was associated with asymmetrical muscular activity, this was not reflected to the muscle thickness, since no differences were found, neither between groups, nor between sides in both groups (Table 2). Our results are in agreement with Castelo *et al.* (32) in relation to the muscles during clenching, but these authors found that anterior temporalis at rest was statistically thicker for the crossbite side than the normal one in children with PCB. Kiliaridis *et al.* (33) observed that among children with a unilateral crossbite, the masseter muscle was significantly thinner on the crossbite side, and after treatment of the malocclusion, the difference was not statistically significant. The discrepancies among the results in different studies may be due to differences between the samples, the location of the measuring points, and the use of different imaging techniques (34). Taken together, these findings indicate that it is too early to draw any firm conclusions regarding the muscle thickness alterations in patients with PCB.

It is important to point out that we found large standard deviations relative to the mean values of EMG activity in both groups. This finding agrees with other studies (29 - 31), probably due to the great biological variability found among subjects, which could also explain why the differences between groups were found only in the right PCB group. In this group, the anterior temporalis muscle showed a significantly higher EMG activity in relation to the control group. However, this difference was not observed when the left crossbite group was compared to the control group. Moreover, the inter-individual variability was greater on crossbite subjects than one control ones (Table 3).

There was no correlation between the USI and EMG data in the PCB group. Similarly, previous studies have not found any strong correlation between the masseter muscle thickness measured by ultrasonography and its EMG activity in maximum voluntary contraction (35 - 37). It is possible that this position does not always coincide with maximum muscle activation, and therefore, in some cases, the muscle thickness measurements might not be indicative of the true contraction potential of the muscles. Nevertheless, a significant positive correlation between EMG and USI was found only in the left masseter in the NOccl group (Table 2). This result is similar to that reported by with Georgiakaki *et al.* (22). Positive correlation between the masticatory muscle thickness and the muscle EMG activity could be expected in subjects with healthy normal occlusion, but this is not the case in subjects with PCB, as observed in the present study.

The present investigation showed that although the masseter muscle had asymmetrical activity during maximal clenching, this activity did not result in an increased thickness of this muscle. Further studies are, however, needed to validate the findings of the present investigation, considering the effects of the appropriate interventions and also their implications in a larger sample. In conclusion, our results indicate that children with PCB can present an asymmetrical muscular activity due to mandibular shift performed to reach the maximal intercuspation position. However, EMG activity and muscle thickness of masticatory muscles are not correlated in the studied children presenting this malocclusion.

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REFERENCES

1. Magnusson TE. An epidemiologic study of dental space anomalies in Icelandic schoolchildren. Community Dent Oral Epidemiol. 1977; 6:292-300.

2. Jämsä T, Kirveskari P, Alanen P. Malocclusion and its association with clinical signs of craniomandibular disorder in 5-, 10- and 15-year old children in Finland. Proc Finn Dent Soc. 1988; 84:235-40.

3. Bjork A, Krebs A, Solow B. A method for epidemiologic registration of malocclusion. Acta Odontol Scand 1964;22:27-41.

4. Thilander B, Wahlund S, Lennartsson B. The effect of early interceptive treatment in children with posterior cross-bite. Eur J Orthod. 1984;6:25-34.

5. Myers DR, Barenie JT, Bell RA, Williamson EH. Condylar position in children with functional posterior crossbites: before and after crossbite correction. Pediatr Dent. 1980;2:190-4.

6. Ben-Bassat Y, Yaffe A, Brin I, Freeman J, Ehrlich Y. Functional and morphological-occlusal aspects in children treated for unilateral posterior cross-bite. Eur J Orthod. 1993;15:57-63.

7. Fushima K, Akimoto S, Takamoto K, Sato S, Suzuki Y. Morphological feature and incidence of TMJ disorders in mandibular lateral displacement cases. Nippon Kyosei Shika Gakkai Zasshi. 1989;48:322-8.

8. Pirttiniemi P, Kantomaa T, Lahtela P. Relationship between craniofacial and condyle path asymmetry in unilateral cross-bite patients. Eur J Orthod. 1990;12:408-13.

9. Mew J. Comment on mandibular and facial asymmetries. Am J Orthod Dentofacial Orthop. 1995;108:17A-18A.

10. Vadiakas GP, Roberts MW. Primary posterior crossbite: diagnosis and treatment. J Clin Pediatr Dent. 1991;16:1-4.

11.Pirttiniemi P, Raustia A, Kantomaa T, Pyhtinen J. Relationships of bicondylar position to occlusal asymmetry. Eur J Orthod. 1991;13:441-5.

12. Kantomaa T. The shape of the glenoid fossa affects the growth of the mandible. Eur J Orthod. 1988;10:249-54.

13. Solberg WK, Bibb CA, Nordström BB, Hansson TL.Malocclusion associated with temporomandibular joint changes in young adults at autopsy. Am J Orthod. 1986;89:326-30.

14. O'Byrn BL, Sadowsky C, Schneider B, BeGole EA. An evaluation of mandibular asymmetry in adults with unilateral posterior crossbite. Am J Orthod Dentofacial Orthop. 1995;107:394-400.

15. Abekura H, Kotani H, Tokuyama H, Hamada T. Asymmetry of masticatory muscle activity during intercuspal maximal clenching in healthy subjects and subjects with stomatognathic dysfunction syndrome. J Oral Rehabil. 1995;22:699-704.

16. Ferrario VF, Sforza C, Colombo A, Ciusa V. An electromyographic investigation of masticatory muscles symmetry in normo-occlusion subjects. J Oral Rehabil. 2000;27:33-40.

17. Dahlström L. Electromyographic studies of craniomandibular disorders: a review of the literature. J Oral Rehabil. 1989;16:1-20.

18. Ferrario VF, Sforza C, D'Addona A, Miani A Jr. Reproducibility of electromyographic measures: a statistical analysis. J Oral Rehabil. 1991;18:513-21.

19. Emshoff R, Bertram S, Strobl H. Ultrasonographic cross-sectional characteristics of muscles of the head and neck. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1999;87:93-106.

20. Kiliaridis S, Georgiakaki I, Katsaros C. Masseter muscle thickness and maxillary dental arch width. Eur J Orthod. 2003;25:259-63.

21. Emshoff R, Bertram S, Brandlmaier I, Scheiderbauer G, Rudisch A et al. Ultrasonographic assessment of local cross-sectional dimensions of masseter muscle sites: a reproducible technique? J Oral Rehabil. 2002;29:1059-62.

22. Georgiakaki I, Tortopidis D, Garefis P, Kiliaridis S. Ultrasonographic thickness and electromyographic activity of masseter muscle of human females. J Oral Rehabil. 2007;34:121-8.

23. Merletti R. Standards for reporting EMG data. J Electromyogr Kinesiol 1999; 9:3-4.

24. Ariji Y, Sakuma S, Izumi M, Sasaki J, Kurita K, Ogi N et al. Ultrasonographic features of the masseter muscle in female patients with temporomandibular disorder associated with myofascial pain. Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics 2004; 98:337-41.

25. Emshoff, R., Bertram, S, Strobl, H. Cross-sectional characteristics of mucles of the head and neck. Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics 1997;87: 93.

26. Landulpho AB, E Silva WA, E Silva FA, Vitti M. Electromyographic evaluation of masseter and anterior temporalis muscles in patients with temporomandibular disorders following interocclusal appliance treatment. Journal of Oral Rehabilitation 2004; 31:95-8.

27. Emshoff R, Emshoff I, Rudisch A, Bertram S. Reliability and temporal variation of masseter muscle thickness measurements utilizing ultrasonography. Journal of Oral Rehabilitation 2003; 30:1168-72.

28. Bertram S, Brandlmaier I, Rudisch A, Bodner G, Emshoff R. Cross-sectional characteristics of the masseter muscle: an ultrasonographic study. International Journal of Oral Maxillofacial Surgery 2003; 32:64-8.

29. Kecik D, Kocadereli I, Saatci I. Evaluation of the treatment changes of functional posterior crossbite in the mixed dentition. Am J Orthod Dentofacial Orthop. 2007;131:202-15.

30. Alarcón JA, Martín C, Palma JC. Effect of unilateral posterior crossbite on the electromyographic activity of human masticatory muscles. Am J Orthod Dentofacial Orthop. 2000;118:328-34.

31. Ferrario VF, Sforza C, Miani A, D'Adonna A, Barbini E. Electromyographic activity of human masticatory muscles in normal young people—statistical evaluation of reference values for clinical applications. J Oral Rehabil 1993;20:271-80.

32. Castelo PM, Gavião MB, Pereira LJ, Bonjardim LR. Masticatory muscle thickness, bite force, and occlusal contacts in young children with unilateral posterior crossbite. Eur J Orthod. 2007;29:149-56.

33. Kiliaridis S, Mahboubi PH, Raadsheer MC, Katsaros C. Ultrasonographic thickness of the masseter muscle in growing individuals with unilateral crossbite. Angle Orthod. 2007;77:607-11.

34. Benington P C , Gardener J E , Hunt N P Masseter muscle volume measured using ultrasonography and its relationship with facial morphology . Eur J Orthod. 1999;21: 659 – 670

35. Bakke M, Tuxen A, Vilmann P, Jensen BR, Vilmann A, Toft M. Ultrasound image of human masseter muscle related to bite force, electromyography, facial morphology, and occlusal factors. Scand J Dent Res. 1992;100:164–171.

36. Ruf S, Pancherz H, Kirschbaum M. Facial morphology and the size and activity of the masseter muscle. Fortschr Kieferorthop. 1994;55:219–227.

37. Rasheed SA, Prabhu NT, Munshi AK. Electromyographic and ultrasonographic observations of masseter and anterior temporalis muscles in children. J Clin Pediatr Dent. 1996;20:127–132.

Capítulo 3

“Preferred chewing side, cycle characteristics and electromyographic activity of masticatory muscles in children with posterior crossbite”

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SUMMARY

Background: The posterior crossbite is frequently seen in the deciduous or mixed dentition. Understanding the changes in chewing patterns during growth may help in assessing the effects of this malocclusion. **Hypothesis**: During mastication children with posterior crossbite differ from children with normal occlusion in relation to a preferred chewing side, cycle characteristics and electromyographic activity (EMG) of the masseter and anterior temporalis muscles. **Design**: Thirty-four children were divided into two groups: posterior crossbite (PCB group, n=20), mean age 8.65±1.15, and normal occlusion (NOccl group, n=14), mean age 8.64±1.23. The preferred chewing side was determined using a visual spot-checking method. The EMG activity was recorded with bipolar surface electrodes during mastication, and two chewing sequence of 20 s were evaluated to establish each subject's chewing rate (cycles/sec) and cycle duration. Data were compared within and between groups and the association of chewing rate with EMG activity was also evaluated. **Results**: PCB and NOccl groups did not have a preferred chewing side. The EMG activity and the cycle characteristics did not differ between groups. The correlation between cycle duration and EMG activity was statistically significant for the masseter muscle in the PCB group. **Conclusions**: Children with PCB did not differ from those with NOccl regarding the presence of a preferred chewing side, chewing rate, cycle duration and EMG activity of masseter and anterior temporalis during mastication.

INTRODUCTION

Posterior crossbite is defined as a malocclusion in the canine, molar and/or premolar regions, characterized by the buccal cusps of the maxillary teeth occluding lingually to the buccal cusps of the corresponding mandibular teeth [1]. It may develop during eruption of the primary dentition and can involve the permanent dentition at a later stage of development. It may originate from a skeletal or dental malrelationship, or both, and may lead to a mandibular displacement [2]. When the intercuspal position of the mandibular dentition is forced laterally to the retruded contact position, this condition is described as a functional posterior crossbite (FPCB) [1].

Some studies have shown that FPCB has been associated with asymmetrical function of the masticatory muscles [3], signs and symptoms of temporomandibular disorders (TMD), such as pain, headache, and muscle tenderness [4,5] which may relate to activity of masticatory muscle performance [6,7]. Mastication is of course a very complex behavior, with patterns of mandibular movement being highly variable, reflecting the different functions and types of occlusions [8]. Various techniques have been used to monitor mastication [9]. Among these techniques, electromyography (EMG), the measurement of the electrical activity of muscles, has found wide application [10]. EMG has been used to identify differences in chewing patterns between individuals, and to classify them into groups according to their chewing efficiency [11, 12].

According to Planas [13], the crossbite side presents a greater number of occlusal contacts in function, being the preferred chewing side. However, these characteristics were not confirmed by other studies [14, 9]. The chewing side preference was defined by Christensen and Radue [15] as “when mastication is performed consistently or predominantly on the right or left side of the dentition”. Considering that masticatory function during growth has a biological impact on the growing structures, a unilateral mastication may lead to asymmetric anatomical structures (bones, temporomandibular joint, muscles, and teeth) on completion of growth [13]. Thus, understanding whether and how posterior crossbite malocclusion influences the preferred chewing side and EMG activity of masticatory muscles would be particularly appropriate.

This study was designed to detect whether there is any difference in the EMG activity, chewing rate, cycle duration and preferred chewing side between children with and without FPCB.

MATERIAL AND METHODS

The posterior crossbite group (PCB group) was comprised by 20 subjects (10 males and 10 females) aged between 7-10 years (8.65±1.23). Eight subjects had unilateral crossbite on the left side, five on the right side and seven subjects presented bilateral crossbite. The control group comprised 14 children with normal occlusion (Nocl group) (9 males and 5 females), aged between 7-10 years (8.64±1.15). The children were selected from the clinic of the Department of Pediatric Dentistry, Piracicaba Dental School, State University of Campinas, SP, Brazil. The Research Ethical Committee of the Dental School approved the project (protocol n° 020/2006 and 023/2006). The children and their parents or guardians received an oral and written explanation about our aims and research methodology. After reaching agreement, we conducted an anamnesis to verify their medical and dental history and oral habits. The exclusion criteria for both groups were the presence of symptoms of craniomandibular dysfunction, major dental reconstructions, prior or current orthodontic treatment, caries, and/or severe periodontal pathology or missing of teeth. Children with crossbite resulting from dental inclination were not considered. All children had maxillary transverse discrepancy with indication of rapid maxillary expansion.

Preferred chewing side

The preferred chewing side was determined using a modification of the visual spot-checking method described by Christensen and Radue [16]. Subjects were given a 1.7 g piece of chewing gum Trident *Free Sugar and instructed to chew as normal on their posterior teeth. They were not told the aim of the experiment. After 15 s, they were asked to stop chewing, clench the gum between their teeth and grin broadly so that the position of the chewing gum could be observed and recorded as right or left. This procedure was carried out seven times consecutively. The term “observed preferred chewing side” (OPCS) was used when the child chewed 5/7, 6/7 or 7/7 times on the same side.

Chewing characteristics

Two chewing sequences of 20 seconds were recorded, as explicated above. The average of the number of cycles in these two sequences was then divided by 20 s to establish each subject's automatic habitual chewing rate (cycle/s). Furthermore, the mean duration of each cycle during the 20 seconds was calculated.

Electromyography evaluation

Muscle activities were measured with the EMG system (Sao Paulo/Brazil) MCS-V2 Electromyograph. Myoelectric signals were captured by various active electrodes with two contacts of 10.0 x 1.0 mm with a distance of 10.0 mm between them, impedance upwards of 10GΩ and a common rejection value of 130dB to 60Hz, crafted in silver and fixed in a resin capsule of 40x20x5 mm. During the experiment, the child remained sat comfortably, with a straight back and head orientated with the Frankfort plane parallel to the floor. Both the skin and the electrodes were cleaned with 70 percent GL ethyl alcohol.

The electrodes were placed at the masseter and anterior temporalis 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 reference electrode was placed on the right first. The muscle activity was recorded during two chewing sequences (chewing gum) of 20 seconds and the means of RMS were used. The methodology for signal treatment was in accordance with Merletti *et al.* [17].

Statistical analysis

Comparisons between sides (crossbite side vs. non-crossbite side/PCB group or right side vs. left side/NOccl group) were performed by paired t-test. The chewing rate and EMG activity were compared between groups using the unpaired t-test. Fisher´s exact test was used to compare the preferred chewing side between groups. The relationship between chewing characteristics and EMG activity was evaluated by Pearson's coefficient. The significance level was set at $p<0.05$.

RESULTS

Table 1 shows the sample distribution (%) of crossbite side (left crossbite, right crossbite and bilateral crossbite) in relation and preferred chewing side.

Table 1: Sample distribution in relation crossbite side and preferred chewing side

	Mastication Preference Side		
	Left crossbite n= 8 (40%)	Right crossbite n= 5 (25%)	Bilateral crossbite n= 7 (35%)
Left	1 (12, 5%)	0 (0%)	1 (14%)
Right	1 (12, 5%)	1 (20%)	0 (0%)
Bilateral	6 (75%)	4 (80%)	6 (86%)

Table 2 shows the sample distribution the total crossbite group and control group in relation to preferred chewing side. There was no statistical difference between groups (Fischer´s exact test).

Table 2: Sample distribution in relation to preferred chewing side

	PCB group	NOccl group
Left	2	3
Right	2	3
Bilateral	16	8
Total	20	14

Fisher´s exact test

Figure 1 shows the values of EMG activity of the masseter and anterior temporalis muscles. There were no significant differences between groups (p>0.05).

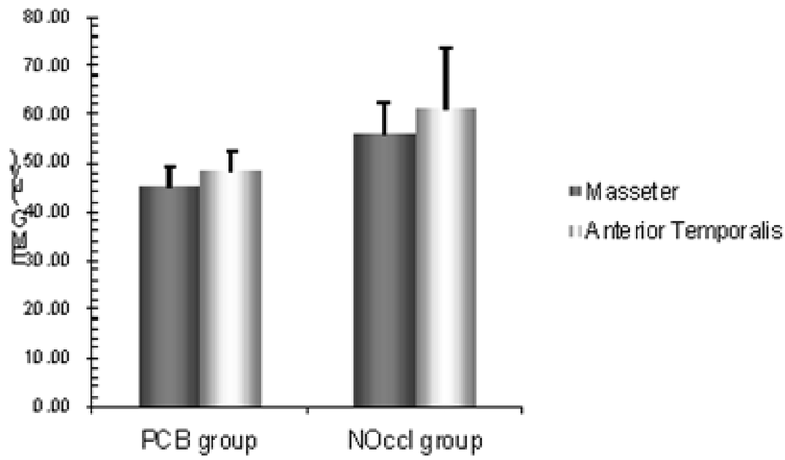

Figure 1 – Eletromyographic data (μv) of chewing during 20 s. Data are plotted as mean ± SEM (p>0.05, unpaired *t*-tests for inter-group comparisons in each muscle).

Figure 2 shows the values of chewing cycle characteristics for PCB and Noccl. There were no significant differences between groups (p>0.05)

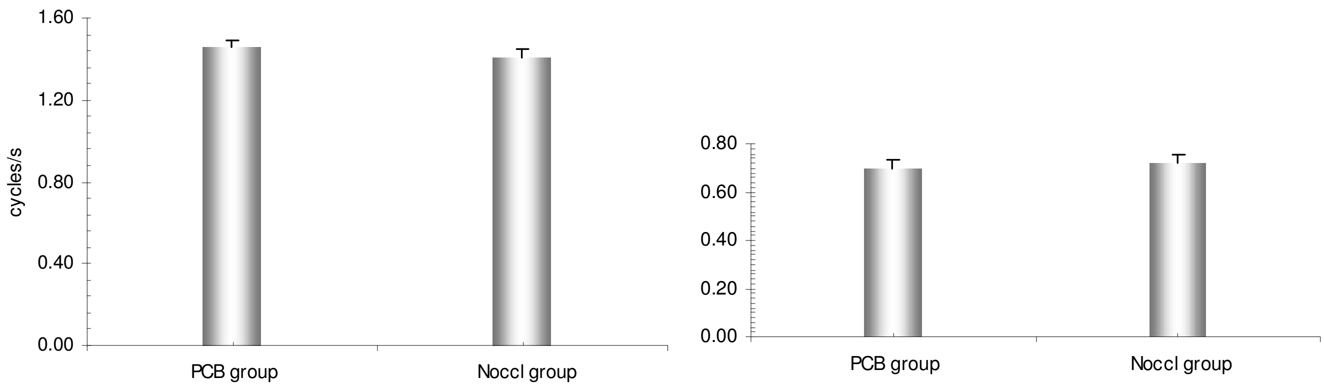

Figure 2 – Chewing cycle characteristics for PCB and NOccl groups. **A** – Chewing rate (cycles/s) **B**– cycle duration (s). Data are plotted as mean ± S.E.M (p>0.05, unpaired *t*-tests for inter-group comparisons)

Table 3 reports the correlation between chewing characteristics and EMG activity during chewing in the PCB group and in the NOccl group. It was observed a significant correlation between chewing rate and cycle duration, as expected. For masseter the correlation between cycle duration and electrical activity in PCB group was moderate and significant. Conversely, in NOccl group the correlation was negatively moderate, but did not reach statistical significance. Moreover, for chewing rate these respective correlations were in the reverse way, without statistical significance. Electrical activity of the anterior temporalis showed weak and no significant correlations with chewing characteristics, but in the NOccl group the correlations with the electrical activity of masseter was strong and significant.

Table 3 – Matrix of Pearson correlations between electrical activity of masseter and temporalis during chewing and chewing characteristics (chewing rate and cycle duration) obtained in PCB and NOccl groups

	Chewing rate		Cycle duration		Masseter	
Group	PCB	NOccl	PCB	NOccl	PCB	NOccl
Cycle duration	-0.986**	-0.991**	-	-	-	-
Masseter	-0.422	0.455	0.534*	-0.447	-	-
Anterior temporalis	-0.082	0.347	0.152	-0.331	0.265	0.747†

*p<0.05 (p = 0.0152) **p< 0.001 †p<0.01

DISCUSSION

In the present study, it was observed by visual spot-checking method that most of the children with posterior crossbite showed a bilateral pattern of mastication, without a preferred side, agreeing with previous findings [9, 14, 18, 19]. There were no significant differences regarding the preferred chewing side between PCB and NOccl groups (Table 2). These findings could be justified by the fact that chewing is considered an event determined at two levels, an individual central chewing pattern generator and peripheral events inducing chewing adaptations [20, 21]. The individual central chewing pattern starts to be established with tooth eruption and is well established in a child with a complete deciduous dentition [20, 22]. Once the central chewing pattern has been established, it appears to be relatively resistant to change [21]. In this way, as the children have been evaluated during the mixed dentition, perhaps they could persist with their chewing pattern acquired early. The present outcomes suggest that, despite the presence of malocclusion, children with PCB could have achieved a certain degree of occlusal stability, allowing a bilateral chewing pattern.

The comments above can be supported by the absence of significant differences observed between sides on electrical activity of masseter and anterior temporalis in both groups, as well as in inter-groups comparisons (Figure 1). These results are in agreement with those obtained by Alarcón *et al*. [14], in which no significant differences were found between sides in both crossbite and normocclusive subjects. This could mean that during chewing there is a symmetric function of the masticatory muscles, and therefore chewing can be predominantly bilateral, despite the presence of PCB, as considered also by Ingervall and Thilander [18], Alarcón *et al*. [14] and Salioni *et al*.[9]. Conversely, Egermark-Eriksson *et al.* [4] found that crossbite subjects preferred to chew unilaterally, whereas Ingervall and Thilander [18] showed that patients with lateral shift had a lower activity of the anterior and posterior temporalis muscles than normocclusive subjects, but the activity of the masseter muscles was similar in both groups. The discrepancies among the results in different studies may be due to differences between the samples, the location of the measuring points, and the use of different EMG techniques.

The comparisons between the chewing characteristics in children with and without PCB showed a similar rhythm and cycle duration during mastication (Figure 2), showing that the ones with PCB probably have generated adaptive responses to the morphologic alterations, allowing similar masticatory function. Besides, there was a significant correlation between masseter and cycle duration in PCB group, but no correlation between the evaluated muscles, showing an effective participation of the masseter during chewing, independent of the temporalis, which is considered a postural muscle [20, 23]. Conversely, in NOccl group, the electrical activities of masseter and anterior temporalis muscles were strongly correlated, but no correlations with their chewing characteristics were found (Table 3). Throckmorton et al. [21] reported that patients with unilateral posterior crossbite chewed more slowly than did the controls, and after treatment their cycle duration were shortened to equal control values. This controversial finding could be due to different methodologies, since they recorded the chewing using an intraoral splint attached to each subject's lower teeth, and we recorded the mean EMG activity during chewing without any intraoral appliance. It is well known that the masticatory rhythm is sensitive to sensory input. This peripheral level responds to interferences by slowing or even stopping the chewing cycle and by lowering the amount of occlusal force used during mastication [24 - 26]. However, the chewing cycle duration is much more sensitive to the central pattern generator located in the brain stem [27], and the chewing rate is relatively resistant to change. Therefore, our results suggest that the occlusal interferences associated with crossbite are not enough to alter the output of the central pattern generator in relation to the chewing rate.

Some studies showed that children with a unilateral posterior crossbite exhibit unusual chewing patterns when chewing on the affected side and this is characterized by an increased frequency of reverse sequencing [3, 21]. Ben-Bassat *et al.* [3] Throckmorton *et al.* [21] reported that successful treatment of a unilateral crossbite with palatal expansion did not eliminate the reverse-sequencing chewing cycles. However, there is evidence that the treatment of posterior crossbite with orthodontic functional appliance (Function Generating Bite) was able to reduce the prevalence of reverse sequencing chewing cycles in children with this malocclusion [28].

In conclusion, the present investigation demonstrated that both groups, with and without PCB did not present a preferred chewing side. The results obtained by EMG evaluation during chewing indicate a bilateral masticatory pattern in both groups, in which the chewing rate and cycle duration were also similar. These findings suggest that other stomathognathic functions, such as deglutition or postural activity could be important variables in the development of the musculoskeletal problems associated with posterior crossbite, and so, these functions should be further evaluated.

Bullet Points should include two headings:

***What this paper adds**

The present study provides scientific data about the neuromuscular adaptation of masticatory system to the posterior crossbite.

Despite the presence of the malocclusion, children with posterior crossbite did not present a preferred chewing side.

***Why this paper is important to paediatric dentists.**

This research provides a better understanding about the dynamic of masticatory function in children with and without posterior crossbite.

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REFERENCES

1. Bjork A, Krebs A, Solow B. A method for epidemiologic registration of malocclusion. Acta Odontol Scand 1964; 22: 27-41.

2. Daskalogiannakis J. Glossary of orthodontic terms. Quintessence Publishing Group, Berlin 2002

3. Ben-Bassat Y, Yaffe A, Brin I, Freeman J, Ehrlich Y. Functional and morphological-occlusal aspects in children treated for unilateral posterior cross-bite. Eur J Orthod 1993; 15: 57-63.

4. Egermark-Eriksson I, Carlsson GE, Magnusson T, Thilander B.. A longitudinal study of malocclusion in relation to signs and symp toms of craniomandibular disorders in children and adolescents. Eur J Orthod 1990; 12: 399–407.

5. Vanderas AP, Papagiannoulis L. Multifactorial analysis of the aetiology of craniomandibular dysfunction in children. Int J Paediatr Dent. 2002; 12: 336-346.

6. Sonnesen L, Bakke M, Solow B. Malocclusion traits and symptoms and signs of temporomandibular disorders in children with severe malocclusion. Eur J Orthod 1998; 20: 543–559.

7. Sonnesen L, Bakke M, Solow B. Bite force in pre-orthodontic children with unilateral crossbite. Eur J Orthod 2001; 23: 741– 749.

8. Yamashita S, Hatch JP, Rugh JD. Does chewing performance depend upon a specific masticatory pattern? J Oral Rehabil 1999; 26: 547-553.

9. Salioni MA, Pellizoni SE, Guimarães AS, Juliano Y, Alonso LG. Functional unilateral posterior crossbite effects on mastication movements using axiography. Angle Orthod 2005; 75: 362-367.

10. Brown WE. Method to investigate differences in chewing behaviour in humans: I. Use of electromyography in measuring chewing. J Text Stud 1994; 25: 1–16.

11. Braxton D, Dauchel C, Brown WE. Association between chewing efficiency and mastication patterns for meat, and influence on tenderness perception. Food Qual Pref 1996; 7: 217–23.

12. Brown WE, Braxton D. Dynamics of food breakdown during eating in relation to perceptions of texture and preference: a study on biscuits. Food Qual. Pref. 2000; 11: 259–267.

13. Planas P. Reabilitação Neuroclusal, 2nd edn. Meds , Rio de Janeiro, 1997

14. Alarcón JA, Martín C, Palma JC. Effect of unilateral posterior crossbite on the electromyographic activity of human masticatory muscles. Am J Orthod Dentofacial Orthop. 2000; 118: 328-341.

15. Christensen LV, Radue JT. Lateral preference in mastication. A feasibility study. J Oral Rehabil. 1985; 12: 421–427.

16. Christensen LV, Radue JT. Lateral preference in mastication: an electromyographic study. J Oral Rehabil. 1985; 12 :429–34.

17. Merletti R. Standards for reporting EMG data. J Electromyogr Kinesiol 1999; 9 :3-4.

18. Ingervall B, Thilander B. Activity of temporal and masseter muscles in children with a lateral forced bite. Angle Orthod. 1975; 45 :249–58.

19. Martin C, Alarcón JA, Palma JC. Kinesiographic study of the mandible in young patients with unilateral posterior crossbite. Am J Orthod Dentofacial Orthop. 2000; 118 :5541–48.

20. Ahlgren J. Mechanisms of mastication, Acta Odontol Scand 24 (1966) (suppl. 44), pp. 9–36.

21. Throckmorton GS, Buschang PH, Hayasaki H, Pinto AS. Changes in the masticatory cycle following treatment of posterior unilateral crossbite in children. Am J Orthod Dentofacial Orthop. 2001; 120: 5521–29.

22. Wickwire NA, Gibbs CH, Jacobson P, Lundeen HC. Chewing patterns in normal children. Angle Orthod. 1981; 51: 148–160

23. Ingervall B, Thilander B. Relation between facial morphology and activity of the masticatory muscles. J Oral Rehabil. 1974; 1: 131-47.

24. Ingervall B, Carlsson GE. Masticatory muscle activity before and after elimination of balancing side occlusal interference. J Oral Rehab 1982; 9: 183-192.

25. Riise C, Sheikholeslam A. Influence of experimental interfering occlusal contacts on the activity of the anterior temporal and masseter muscles during mastication. J Oral Rehab 1984; 11: 325-33.

26. Bakke M, Michler L, Moller E. Occlusal control of mandibular elevator muscles. Scand J Dent Res 1992; 100: 284-291.

27. Thexton AJ. Mastication and swallowing: an overview. Br Dent J 1992; 10; 173: 197-206. Review.

28. Piancino MG, Talpone F, Dalmasso P, Debernardi C, Lewin A, Bracco P.Reverse-sequencing chewing patterns before and after treatment of children with a unilateral posterior crossbite. Eur J Orthod. 2006; 28: 480-484

III. CONCLUSÕES

De acordo com os resultados do presente trabalho, concluiu-se que:

- Crianças com mordida cruzada posterior apresentaram assimetria da atividade muscular durante o registro EMG em posição de máxima intercuspidação. No entanto, esta assimetria não se refletiu em alterações na espessura dos músculos avaliados.

- Crianças com e sem mordida cruzada posterior não apresentaram lado preferido de mastigação. Os resultados obtidos pela avaliação EMG durante a mastigação indicaram atividade muscular simétrica, bem como freqüência e duração dos ciclos semelhantes em ambos os grupos.

IV. REFERÊNCIAS BIBLIOGRÁFICAS

Kutin G, Hawes RR. Posterior crossbite in decíduous and mixed dentitions. Am J Orthod 1969 Nov; 56: 491-504.

Moyers RE. Ortodontia. 4ª ed. Rio de Janeiro: Guanabara Koogan; 1991

Wood AWS. Anterior and posterior crossbite. J Dent Child 1962; 29: 280-5.

Ingervall B, Seeman L, Thilander B. Frequency of malocclusion and need of orthodontic treatment in 10-year old children in Gothenburg. Sven Tandlak Tidskr. 1972 Jan;65(1):7-21

Jämsä T, Kirveskari P, Alanen P.Malocclusion and its association with clinical signs of craniomandibular disorder in 5-, 10- and 15-year old children in Finland. Proc Finn Dent Soc. 1988;84(4):235-40.

Magnússon TE. An epidemiologic study of dental space anomalies in Icelandic schoolchildren. Community Dent Oral Epidemiol. 1977 Nov;5(6):292-300.

Enlow, DH. Crescimento facial. São Paulo, artes Médicas, 1993. 553p

Lund JP. Mastication and its control by the brain stem. Crypt Rev Oral Biol Med. 1991;2:33-64.

Ottenhoff FA, van der Bilt A, van der Glas HW, Bosman F. Control of elevator muscle activity during simulated chewing with varying food resistance in humans. J Neurophysiol. 1992;68:933-44.

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* De acordo com a norma da UNICAMP/FOP, baseada no modelo Vancouver.
Abreviatura dos periódicos em conformidade com o Medline.

Hiiemae K, Heath MR, Heath G, Kazazoglu E, Murray J, Sapper D, Hamblett K. Natural bites, food consistency and feeding behaviour in man. Arch Oral Biol. 1996;41:175-89.

van der Bilt A, Weijnen FG, Ottenhoff FA, van der Glas HW, Bosman F. The role of sensory information in the control of rhythmic open-close movements in humans. J Dent Res. 1995;74:1658-64.

Petrelli, E. Ortodontia para fonoaudiologia. São Paulo, Lovise Científica, 1994.

Pereira LJ. Avaliação morfológica, funcional e sensorial do sistema mastigatório [tese]. Piracicaba: Unicamp / FOP; 2006.

Agustoni, CH. Deglutição atípica – manula prático de exercícios para sua reeducação. Rio de Janeiro, Enelivros, 1989. 122p

Belser UC, Hannam AG. The contribution of the deep fibers of the masseter muscle to selected tooth-clenching and chewing tasks. J Prosthet Dent. 1986 Nov;56(5):629-35

Bakke, M., Tuxen, A., Vilmann, P., Jensen, B.R., Vilmann, A., Toft, M. Ultrasound image of human masseter relates to bite force, electromyography, facial morphology, and oclusal factors. Scand J Dent Res 100: 164-71. 1992

Apêndice 1

Figura 1: Sistema de aquisição de sinais EMG SYSTEM DO BRASIL Ltda.

Figura 2: Eletrodos de barras paralela

Figura 3: Palpação do músculo temporal anterior para a fixação dos eletrodos

Figura 4: Palpação do músculo masseter para a fixação dos eletrodos

Figura 5: Eletrodos já posicionados nos músculos temporal anterior e masseter

Figura 6: Registro da atividade muscular na posição de repouso

Figura 7: Registro da atividade muscular na posição de máxima intercuspidação

Figura 8: Equipamento de ultra-som digital Just Vision 200, da Toshiba Corporation, Japão

Figura 9: Posição do transdutor no músculo temporal anterior

Figura 10: Posição do transdutor no músculo masseter

Apêndice 2 (Ficha Clínica)

Universidade Estadual de Campinas - UNICAMP

Faculdade de Odontologia de Piracicaba - FOP

Programa de Pós-Graduação em Odontologia - Odontopediatria

Nº

Data:

IDENTIFICAÇÃO

Nome: ______________________ **Apelido:** ______________

Idade: ____ **anos e** ____ **meses** **Data de nascimento:** / /

Sexo: ( ) masculino ( ) feminino **Raça:** ( ) branco ( ) negro ( ) mulato

Naturalidade: ______________________ **Nacionalidade:** ______________

Pai: ____

Mãe: ____

Irmãos: ____

Endereço: ____

____

Bairro: ______________________ **CEP:** - ______________

Cidade: ______________________ **Estado:** ______________

Fones: **Casa (** **)** ______________

Celular (**)** ______________

Trabalho (**)** ______________

Outro (**)** ______________

Motivo da consulta: ____

____

Informações adicionais: ____

Período disponível: ______________

HISTÓRIA MÉDICA

I) HISTÓRIA PRÉ-NATAL

A) Gravidez: ( ) Normal ( ) Anormal: ______________________________

B) Manifestações durante a gravidez

Doenças: ______________________________

Medicamentos: ______________________________

II) HISTÓRIA NATAL

Parto: ( ) Normal ( ) Fórceps ( ) Cesariana

Complicações durante o parto: ______________________________

Nascimento: ( ) A termo ( ) Prematuro: _______ meses

III) HISTÓRIA PÓS- NATAL

Doenças sistêmicas ( ) Não ( ) Sim

( ) Alergia: ______________ ( ) Diabete: ______________

( ) Rinite alérgica: ______________ ( ) Problemas renais: ______________

( ) Resfriados frequentes: ______________ ( ) Discrasias sanguíneas: ______________

( ) Sinusite: ______________ ( ) Febre reumática: ______________

( ) Amigdalite: ______________ ( ) Problemas cardíacos: ______________

( ) Verminose: ______________ ( ) Hepatite: ______________

( ) Anemia: ______________ ( ) Asma: ______________

( ) HIV: ______________ ( ) Outras: ______________

Doenças da infância

( ) Catapora ( ) Rubéola ( ) Sarampo ( ) Caxumba

( ) Coqueluxe ( ) Outras: ______________________________

Está sendo submetido a algum tipo de tratamento ? ( ) Não ( ) Sim

( ) Psicológico: ______________________________

( ) Otorrinolaringológico: ______________________________

( ) Fonoaudiológico: ______________________________

( ) Homeopático: ______________________________

( ) Outros**:** ______________________________

Está tomando algum tipo de medicamento ? ( ) Não ( ) Sim

( ) Antibióticos ( ) Antinflamatórios ( ) Analgésicos

( ) Anticonvulsivo ( ) Antialérgico ( ) Descongestionante

( ) Vitaminas ( ) Outros: ________________________________

Doenças na família

( ) Diabetes: ____________________ ( ) Problemas cardíacos: ____________

( ) Problemas respiratórios: ________ ( ) Problemas hematológicos: __________

( ) Outros: ____

Já ficou hospitalizado: ( ) Não ( ) Sim

Motivo: ____

Cirurgia: ____

Declaro que as informações acima são verdadeiras e comprometo-me a informar a cirurgiã dentista sobre qualquer alteração na saúde do menor sobre minha responsabilidade enquanto o mesmo estiver sob tratamento odontológico.

Data / /

____

Assinatura do pai, mãe ou responsável

Nº

HISTÓRIA DENTAL

I) INFORMAÇÕES GERAIS

( ) Nunca recebeu nenhum tratamento odontológico

( ) Recebe ou recebeu tratamento na escola

( ) Recebe ou recebeu tratamento no posto de saúde

( ) Recebe ou recebeu tratamento em clínica particular

Já tomou anestesia? ( ) Não ( ) Sim Teve algum tipo de problema? ( ) Não ( ) Sim

( ) Outros: ____

Problemas manifestados:

( ) Prevenção ( ) Cárie ( ) Tratamento de canal ( ) Traumatismo
( ) Sangramento gengival ( ) Não sabe ( ) Outros: ________________________

Já recebeu tratamento ortodôntico? ( ) Não ( ) Sim: ____________________________
Comportamento no dentista: ( ) Bom ( ) Regular ( ) Ruim
Observações: ____

Características comportamentais:
( ) Normal ( ) Alegre ( ) Extrovertido ( ) Agitado ( ) Atento
( ) Desanimado ( ) Irritado ( ) Desatento ( ) Triste ( ) Calmo
( ) Tímido ( ) Medroso ( ) Ansioso ( ) Outros: _________________

II) INFORMAÇÕES PREVENTIVAS

Higiene Dental: ( ) Escova ( ) Fio dental ( ) Outros Frequência: __________
Informação sobre higiene bucal: ( ) Não ( ) Sim, por: _________________________
Responsável pela escovação: ( ) Pais ( ) Criança ( ) Ambos
ÁGUA FLUORETADA: ( ) NÃO ( ) SIM
Soluções para bochecho: ( ) Não ( ) Sim: __________________________________

III) QUESTIONÁRIO PARA DIAGNÓSTICO DE DTM

Seu (sua) filho (a) tem ou teve:

Dor de cabeça?	( ) Não	( ) Sim	Quando ?
Dor de ouvido?	( ) Não	( ) Sim	Quando?
Apito no ouvido?	( ) Não	( ) Sim	Quando?
Dor nos olhos?	( ) Não	( ) Sim	Quando?
DOR NO PESCOÇO?	( ) NÃO	( ) SIM	**QUANDO?**
Dor nos ombros?	( ) Não	( ) Sim	Quando?
Dor na mandíbula?	( ) Não	( ) Sim	Quando?

Sente dor quando mastiga ou abre a boca? ( ) Não ( ) Sim: ____________________
____

Tem dificuldade para engolir? ( ) Não ( ) Sim: ________________________________

____

Tem algum problema para abrir a boca? ( ) Não ( ) Sim

Quando:

( ) Conversa ( ) Boceja ( ) Grita

Quando abre a boca percebe algum barulho no ouvido? ( ) Não ( ) Sim:

____

Aperta ou range os dentes? ( ) Não ( ) Sim Quando? ( ) Noite ( ) Dia

Sente a mandíbula cansada? ( ) Não ( ) Sim Quando?

EXAME CLÍNICO

I) EXAME FACIAL (VISUAL)

Simetria Facial: simétrica ( ) assimétrica ( )

Perfil Facial: reto ( ) convexo ( ) côncavo ( )

Tipo Morfológico: mesofacial ( ) braquiofacial ( ) dolicofacial ( )

Observações extra-bucais: ____

II) EXAME BUCAL E FUNCIONAL

Saúde Bucal: boa ( ) regular ( ) má ( )

Higiene Bucal: boa ( ) regular ( ) má ( )

Lado da Mordida Cruzada Posterior ( ) direita ( ) esquerda ( ) bilateral

Em R.C: ( ) direita ( ) esquerda ( ) bilateral

Maloclusões ( ) mordida aberta ( ) mordida profunda ( ) mordida cruzada anterior

( ) outras: ____

Desvio da linha média ( ) Ausente ( ) Superior ( ) direita ( ) esquerda

( ) Inferior ( ) direita ( ) esquerda

Desvio Mandibular ( ) Ausente ( ) abertura ( ) direita ( ) esquerda

( ) fechamento ( ) direita ( ) esquerda

Interferências Dentais ( ) OC:

6 V IV III 2 1	1 2 III IV V 6
6 V IV III 2 1	1 2 III IV V 6

( )Ausente

( ) RC:

6 V IV III 2 1	1 2 III IV V 6
6 V IV III 2 1	1 2 III IV V 6

( )Ausente

Lateralidade direita:

6 V IV III 2 1	1 2 III IV V 6
6 V IV III 2 1	1 2 III IV V 6

Lateralidade esquerda:

6 V IV III 2 1	1 2 III IV V 6
6 V IV III 2 1	1 2 III IV V 6

Protrusão

6 V IV III 2 1	1 2 III IV V 6
6 V IV III 2 1	1 2 III IV V 6

Hábitos Bucais: Não ( ) Sim ( )

Sucção de dedo	( )	Esporádico	( )	Noite	( )	Contínuo	( )
Sucção de chupeta	( )	Esporádico	( )	Noite	( )	Contínuo	( )
Sucção de lábios	( )	Esporádico	( )	Noite	( )	Contínuo	( )
Mordedura de lábios	( )	Esporádico	( )	Noite	( )	Contínuo	( )
Onicofagia	( )	Esporádico	( )	Noite	( )	Contínuo	( )
Bruxismo	( )	Esporádico	( )	Noite	( )	Contínuo	( )

Outros ( ):

Deglutição:	( ) típica	( ) atípica	
Fonação:	( ) normal	( ) anormal	
Amígdalas:	( ) normais	( ) hipertróficas	( ) operadas
Adenóides:	( ) normais	( ) hipertróficas	( ) operadas
Respiração:	( ) nasal	( ) bucal	( ) ambas

Freio Labial Superior: ( ) inserção normal ( ) baixa ( ) alta

Freio Labial Inferior: ( ) inserção normal ( ) baixa ( ) alta

Freio lingual: ( ) inserção normal ( ) inserção anormal

Lábio Superior: ( ) normal ( ) hipotônico ( ) hipertônico

Lábio Inferior: ( ) normal ( ) hipotônico ( ) hipertônico

Outras informações: ______________________________

Ruídos articulares: Não ( ) Sim ( )

Estalido ( ) Direito ( ) Esquerdo ( )

Crepitação( ) Direito ( ) Esquerdo ( )

Dor durante palpação:

ATM: Não ( ) Sim ( ) Direita ( ) Esquerda ( )

Masseter : Não ( ) Sim ( ) Direito ( ) Esquerdo ( )

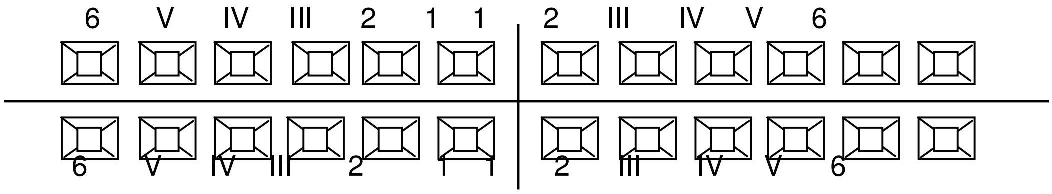
Temporal : Não ( ) Sim ( ) Direito ( ) Esquerdo ( )

Trapézio: Não ( ) Sim ( ) Direito ( ) Esquerdo ( )

Esternocleidomastóideo: Não ( ) Sim ( ) Direito ( ) Esquerdo ( )

III) EXAME DENTAL

Odontograma



(/) Dente Ausente (azul) Restauração insatisfatória

(vermelho) Cárie (verde) Restauração satisfatória

( ) número
Anomalias Dentais: ( ) forma
( ) tamanho
( ) estrutura

Alterações de cor: ____

ANÁLISE DOS MODELOS

DATA:

Forma dos arcos dentais: Superior: ______________ Inferior: ________________

Classificação de Angle: ____

Lado Direito: ______________ Lado Esquerdo: ___________

Observação: ____

____

Relação ântero-posterior dos molares decíduos: Lado Direito: Lado Esquerdo:

Relação ântero-posterior dos caninos decíduos: Lado Direito: Lado Esquerdo:

Sobremordida: _____ mm normal ( ) moderado ( ) profundo ( )

Sobressaliencia: _____ mm **Mordida aberta:** ____ mm

Desvio da linha mediana: ausente ( ) presente ( ) : ______________________

Anormalidades na posição individual dos dentes: ____________________________

Apêndice 3

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Nome da criança: ____

Por este instrumento de autorização, na qualidade de __________________ autorizo que o (a) menor ____________________________________ participe da pesquisa *"Correção da mordida cruzada posterior na fase de dentição mista: avaliação longitudinal eletromiográfica, cefalométrica e ultra-sonográfica"*, conduzida pelas alunas Annicele da Silva Andrade e Moara De Rossi, aluna da pós-graduação da Faculdade Odontologia de Piracicaba - Universidade Estadual de Campinas, sob a orientação da Profa. Dra. Maria Beatriz Duarte Gavião.

- Tenho conhecimento que a pesquisa tem o objetivo de: 1) Corrigir a mordida cruzada posterior (dentes fora da posição adequada), através de um aparelho que ficará fixo nos dentes e que será ativado pelo responsável para aumentar o tamanho da maxila, de modo que o cruzamento dos dentes seja corrigido. 2) Avaliar, através de radiografias, o padrão facial (forma do rosto) e as possíveis alterações esqueléticas antes do tratamento e as possíveis correções após a o tratamento da mordida cruzada posterior. 2) Avaliar, a atividade elétrica e a espessura dos músculos da mastigação através de aparelhos especiais (eletromiógrafo e ultra-som), antes e após a correção da mordida cruzada posterior, para verificar o efeito do tratamento na forma e função dos músculos da mastigação. Estes aparelhos são inócuos, não causam desconforto e efeitos prejudiciais.
- Estou ciente de que esta pesquisa é científica e os dados poderão ser publicados em jornais, revistas e/ou congressos científicos no país e no exterior, mantendo-se o sigilo e respeita o código de Defesa do Menor e do Adolescente.

Declaro que fui devidamente esclarecido (de forma oral e por escrito) que:

- Serão feitos:

- anamnese, através de preenchimento das fichas para obtenção de dados pessoais
- exame clínico, com instrumentos utilizados normalmente no exame odontológico

- documentação ortodôntica, consistindo de exame radiográfico, onde todas as normas se segurança em relação à radiação serão observadas; moldagem para obtenção e análise dos modelos de estudo e obtenção de modelos de trabalho, durante as fases do tratamento. Estou ciente de que a moldagem pode provocar certo incômodo, mas que serão contornados através de técnicas preconizadas para tal e que o material utilizado para a moldagem é inócuo. Serão também realizadas fotografias da face, de frente e de perfil, sendo que os pesquisadores garantem o sigilo em relação à identificação.
- o voluntário receberá o tratamento para a correção da mordida cruzada posterior, através expansão rápida da maxila, uma terapia amplamente aceita e recomendada para a correção da mordida cruzada posterior esquelética. A criança utilizará um aparelho fixado aos dentes superiores, sendo que as ativações do aparelho deverão ser feitas, de 12 em 12 horas, pelos responsáveis pelo menor. O paciente deverá retornar semanalmente à Faculdade de Odontologia para que os pesquisadores acompanhem o tratamento e determinem o momento em que as ativações não serão mais necessárias.
- Após a correção da mordida cruzada, a criança deverá permanecer com o aparelho, sem ativá-lo, por mais 4 meses para que não ocorra recidiva. Durante os quatro meses, a criança deverá retornar quinzenalmente à Faculdade de Odontologia para que os pesquisadores acompanhem o tratamento. Após esse período o aparelho será removido e a criança deverá utilizar, por 6 meses, um aparelho removível para contenção. Durante o uso da contenção removível os retornos à Faculdade de Odontologia deverão ser mensais.
- Todos os cuidados sobre os desconfortos iniciais com o uso do aparelho serão devidamente informados, bem como a orientação e monitoração da higiene adequada, de modo que não ocorram problemas gengivais.
- As avaliações da musculatura serão feitas, com o auxílio da eletromiografia e ultra-sonografia, antes do tratamento, após a remoção do aparelho disjuntor e seis meses após o uso da contenção removível. Os exames permitem avaliar a espessura e a atividade da musculatura, sendo dados importantes para o diagnóstico e prognóstico do tratamento. Os exames serão realizados na própria Faculdade de Odontologia. Serão demonstrados aos voluntários e seu responsáveis os materiais e as técnicas de todo o tratamento e também de todos os exames, fazendo-se simulações e

treinamentos.

- Todo o tratamento e monitoração serão realizados pelos responsáveis pela pesquisa.
- O voluntário deverá apresentar características que indiquem o tratamento a ser instituído, portanto haverá apenas um grupo, constituído por voluntários com o mesmo tipo de alteração do menor sob minha responsabilidade.
- Todos os dados confidenciais serão mantidos em sigilo, sendo que os resultados e as imagens não revelarão a identidade do voluntário, de modo a não causar constrangimento ou prejuízo ao mesmo e aos responsáveis.
- Não haverá nenhum custo financeiro ao voluntário, quer no tratamento em si como nos exames que serão realizados.
- Não há riscos previsíveis
- Tenho plena liberdade de recusar e tenho liberdade que o menor sob minha responsabilidade participe desta pesquisa, ou o próprio voluntário, podendo de retirá-lo desta pesquisa a qualquer momento, sem nenhuma penalização ou prejuízo.
- Não é previsto o ressarcimento de despesas ou indenização, uma vez que não há riscos previsíveis, e a participação na pesquisa não causa despesas ao voluntário.
- O voluntário terá como benéfico a correção da posição inadequada dos dentes, receberá tratamento educativo e preventivo da cárie dentária e de problemas na gengiva, tratamento curativo, quando houver presença de cárie.

Assino este documento de livre e espontânea vontade, estando ciente do seu conteúdo e recebendo uma cópia.

Piracicaba, ______ de ________________ de 200.....

____

ASSINATURA DO PAI/MÃE/RESPONSÁVEL

____

Profª Drª Maria Beatriz Duarte Gavião

____

Annicele Andrade/Moara De Rossi

- <u>Informações para contato com as pesquisadoras:</u>

  Profa. Dra. Maria Beatriz Duarte Gavião – (19) 3412 5368 mbgaviao@fop.unicamp.br

  Annicele Andrade/ Moara de Rossi – (19) 3412 5287 annicele@fop.unicamp.br

  moderossi@yahoo.com.br
- Em caso de dúvida quanto a questões éticas, entrar em contato com o Comitê de Ética em Pesquisa (CEP) da Faculdade de Odontologia de Piracicaba (FOP) UNICAMP, Av. Limeira, 901, Vila Areião, CEP: 13414-900, Piracicaba - SP. Telefone: 3412 5349 / cep@fop.unicamp.br

Anexo 1

COMITÊ DE ÉTICA EM PESQUISA

FACULDADE DE ODONTOLOGIA DE PIRACICABA
UNIVERSIDADE ESTADUAL DE CAMPINAS

CERTIFICADO

O Comitê de Ética em Pesquisa da FOP-UNICAMP certifica que o projeto de pesquisa "**A relação entre o padrão mastigatório e a maloclusão do tipo classe II, subdivisão de Angle**", protocolo nº **020/2006**, dos pesquisadores **MARIA BEATRIZ DUARTE GAVIÃO, ANNICELE DA SILVA ANDRADE e PAULA MIDORI CASTELO**, satisfaz as exigências do Conselho Nacional de Saúde – Ministério da Saúde para as pesquisas em seres humanos e foi aprovado por este comitê em 10/12/2007.

The Ethics Committee in Research of the School of Dentistry of Piracicaba - State University of Campinas, certify that the project "**The relationship between masticatory pattern and Angle class II subdivision malocclusion**", register number **020/2006**, of **MARIA BEATRIZ DUARTE GAVIÃO, ANNICELE DA SILVA ANDRADE and PAULA MIDORI CASTELO**, comply with the recommendations of the National Health Council – Ministry of Health of Brazil for research in human subjects and therefore was approved by this committee at 10/12/2007.

Cínthia Pereira Machado Tabchoury

Profa. Cínthia Pereira Machado Tabchoury
Secretária
CEP/FOP/UNICAMP

Prof. Jacks Jorge Júnior
Coordenador
CEP/FOP/UNICAMP

Nota: O título do protocolo aparece como fornecido pelos pesquisadores, sem qualquer edição.
Notice: The title of the project appears as provided by the authors, without editing.

COMITÊ DE ÉTICA EM PESQUISA
FACULDADE DE ODONTOLOGIA DE PIRACICABA
UNIVERSIDADE ESTADUAL DE CAMPINAS

CERTIFICADO

O Comitê de Ética em Pesquisa da FOP-UNICAMP certifica que o projeto de pesquisa "**Correção da mordida cruzada posterior na fase de dentição mista: avaliação longitudinal**", protocolo nº **023/2006**, dos pesquisadores **MARIA BEATRIZ DUARTE GAVIÃO, BRUNA ANTUNES GONÇALVES, MARIA CAROLINA SALOMé MARQUEZIN e MOARA DE ROSSI**, satisfaz as exigências do Conselho Nacional de Saúde – Ministério da Saúde para as pesquisas em seres humanos e foi aprovado por este comitê em 10/12/2007.

The Ethics Committee in Research of the School of Dentistry of Piracicaba - State University of Campinas, certify that the project "**Treatment of posterior crossbite in the mixed dentition: electromyographic, cephalometric and ultrasonographic longitudinal evaluation**", register number **023/2006**, of **MARIA BEATRIZ DUARTE GAVIÃO, BRUNA ANTUNES GONÇALVES, MARIA CAROLINA SALOMé MARQUEZIN and MOARA DE ROSSI**, comply with the recommendations of the National Health Council – Ministry of Health of Brazil for research in human subjects and therefore was approved by this committee at 10/12/2007.

Cínthia Pereira Machado Tabchoury

Profa. Cínthia Pereira Machado Tabchoury
Secretária
CEP/FOP/UNICAMP

Prof. Jacks Jorge Júnior
Coordenador
CEP/FOP/UNICAMP

Nota: O título do protocolo aparece como fornecido pelos pesquisadores, sem qualquer edição.
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Anexo 2

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Submission Confirmation

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Title:	Electromyographic activity and thickness of masticatory muscles in children with posterior crossbite
Authors:	Andrade, Annicele Gameiro, Gustavo DeRossi, Moara Gavião, Maria Beatriz
Date Submitted:	23-Jan-2008

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