UNICAMP

ROSARIO MARTHA DE LA TORRE VERA

"STUDY OF TEMPOROMANDIBULAR DISORDERS AND ELECTROMYOGRAPHIC BEHAVIOR OF MASSETER AND TEMPORAL MUSCLES BEFORE AND FIVE YEARS AFTER ORTOGNATHIC SURGERY IN PATIENTS WITH MANDIBULAR PROGNATHISM."

"ESTUDO DAS DISFUNÇÕES TEMPOROMANDIBULARES E DO COMPORTAMENTO ELETROMIOGRÁFICO DOS MÚSCULOS MASSETER E DO TEMPORAL PRE E CINCO ANOS APÓS TRATAMENTO COM CIRURGIA ORTOGNÁTICA EM PACIENTES COM PROGNATISMO MANDIBULAR."

Piracicaba

2014

UNIVERSIDADE ESTADUAL DE CAMPINAS

FACULDADE DE ODONTOLOGIA DE PIRACICABA

ROSARIO MARTHA DE LA TORRE VERA

Study of temporomandibular disorders and electromyographic behavior of masseter and temporal muscles before and five years after ortognathic surgery in patients with mandibular prognathism.

"Estudo das disfunções temporomandibulares e do comportamento Eletromiográfico dos músculos masseter e do temporal pre e cinco anos após tratamento com cirurgia ortognática em pacientes com prognatismo mandibular."

Orientador: Prof. Dr. Fausto Berzin.

Tese de doutorado apresentada à faculdade de Odontologia de Piracicaba, da Universidade Estadual de Campinas para a obtenção do Título de **Doutora** em Biologia Buco-Dental, area de Anatomia.

Doctorate Thesis Presented to the Piracicaba Dental School to obtain the Ph.D. Grade in Oral and Dental Biology in Anatomy área.

Este exemplar corresponde à versão final da tese defendida pela aluna Rosario Martha De La Torre Vera, e orientada pelo Prof. Dr. Fausto Berzin.

Assinatura do Orientador.

Profº. Dr. Fausto Bérzin

Prof. Dr. Fausto Berzin

Piracicaba, 2014

Ficha catalográfica
Universidade Estadual de Campinas
Biblioteca da Faculdade de Odontologia de Piracicaba
Marilene Girello - CRB 8/6159

V58e

Vera, Rosario Martha de La Torre, 1981-
Estudo das disfunções temporomandibulares e do comportamento eletromiográfico dos músculos masseter e do temporal pré e cinco anos após tratamento com cirurgia ortognática em pacientes com prognatismo mandibular / Rosario Martha de La Torre Vera. – Piracicaba, SP : [s.n.], 2014.

Orientador: Fausto Berzin.
Tese (doutorado) – Universidade Estadual de Campinas, Faculdade de Odontologia de Piracicaba.

1. Eletromiografía. 2. Maxilares - cirurgia. 3. Mastigação. 4. Articulação temporomandibular. 5. Prognatismo. I. Berzin, Fausto,1940-. II. Universidade Estadual de Campinas. Faculdade de Odontologia de Piracicaba. III. Título.

<u>Informações para Biblioteca Digital</u>

Título em outro idioma: Study of temporomandibular disorders and electromyographic behavior of masseter and temporal muscles before and five years after ortognathic surgery in patients with mandibular prognathism
Palavras-chave em inglês:
Electromyography
Maxillary - surgery
Mastication
Temporomandibular joint
Prognathism
Área de concentração: Anatomia
Titulação: Doutora em Biologia Buco-Dental
Banca examinadora:
Fausto Berzin [Orientador]
Simone Cecilio Hallak Regalo
Francisco José de Moraes Macedo
José Ricardo de Albergaria Barbosa
Mirian Hideko Nagae Espinosa
Data de defesa: 14-02-2014
Programa de Pós-Graduação: Biologia Buco-Dental

UNICAMP

UNIVERSIDADE ESTADUAL DE CAMPINAS
Faculdade de Odontologia de Piracicaba

A Comissão Julgadora dos trabalhos de Defesa de Tese de Doutorado, em sessão pública realizada em 14 de Fevereiro de 2014, considerou a candidata ROSARIO MARTHA DE LA TORRE VERA aprovada.

Prof. Dr. FAUSTO BERZIN

Profa. Dra. SIMONE CECILIO HALLAK REGALO

Prof. Dr. FRANCISCO JOSÉ DE MORAES MACEDO

Prof. Dr. JOSE RICARDO DE ALBERGARIA BARBOSA

Profa. Dra. MIRIAN HIDEKO NAGAE ESPINOSA

RESUMO

Objetivos: Avaliar os sinais e sintomas das disfunções temporomandibulares (DTM), a dor crônica, a depressão, assim como também avaliar a função muscular dos masseteres e do temporal na mastigação habitual. Todas estas variáveis foram analisadas pré e após cinco anos da cirurgia ortognática. Materiais: Foi utilizado o questionário RDC (reseach diagnostic Criteria), para avaliar e classificar o tipo de disfunção temporomandibular (DTM), assim como para observar o grau de dor crônica e depressão (eixo II), para a análise dos sinais e sintomas das DTMs foi utilizado o eixo I do RDC. Na análise do ciclo mastigatório foi utilizado o eletromiógráfo Myosystem I e software Myosystem BRI, versão 2.52 (DataHominis Tecnologia Ltda). Os músculos avaliados foram a parte anterior do temporal e a parte superficial do masseter de ambos os lados. O comportamento muscular foi avaliado em cinco períodos: pré-cirurgia 2-3 meses (T0); Pós-cirurgia 6 meses (T1), 12 meses (T2), 24 meses (T3) e 60 meses (T4). Resultados: A dor crônica e a depressão apresentaram melhoras após 5 anos do tratamento cirúrgico. Em relação às outras variáveis analisadas, observamos, que após 12, 24 e 60 meses da cirurgia, existe um aumento do tempo e do instante máximo da atividade do ciclo mastigatório. O RMS apresenta o sinal eletromiográfico mais estável após cinco anos do tratamento cirúrgico. Conclusão: A cirurgia ortognatica não é tratamento para as disfunções temporomandibulares. O ciclo mastigatório mostra melhoras no sinal eletromiográfico para pacientes prognatas que não apresentem nenhum tipo de disfunção temporo mandibular.

ABSTRACT

Objectives: To evaluate the signs and symptoms of temporomandibular disorders, chronic pain, depression, as well as evaluate the muscle function of the masseter and temporal in mastication. All these variables were analyzed before and five years after orthognathic surgery. Materials: RDC (reseach diagnostic Criteria) questionnaire was used to assess and classify the type of temporomandibular disorders (TMD) , as well as to observe the degree of chronic pain and depression (axis II) , for the analysis of the signs and symptoms of the TMD axis I RDC was used . In the analysis of the masticatory cycle Myosystem I electromyography and software Myosystem BRI , version 2.52 (DataHominis Technology Ltd.) was used . The muscles tested were the anterior part of the temporal and superficial part of the masseter muscle on both sides . Muscle performance was evaluated in five periods : pre - surgery 2-3 months (T0), 6 months post- surgery (T1) , 12 months (T2) , 24 months (T3) and 60 months (T4) . Results: Chronic pain and depression showed improvement after 5 years of surgical treatment . Regarding the other variables, we observe that 12, 24 and 60 months after surgery , there is an increase in the time and the maximum moment of the masticatory cycle activity. The RMS has the most stable EMG signal after five years of surgical treatment Conclusion: Orthognathic surgery is no treatment for temporomandibular disorders . The masticatory cycle shows improvement in electromyographic signal for prognathic patients without any type of temporomandibular disorders.

SUMÁRIO:

DEDICATORIAS.....xiii

EPÍGRAFE.....xv

AGRADECIMENTOS xvii

LISTA DE ABREVIATURAS E SIGLAS xix

INTRODUÇÃO 1

Capitulo I 3

Evaluation of Temporomandibular Disorders, Chronic pain and Depression, before and five years after Orthognathic Surgery in Patients with Mandibular Prognathism..

Capitulo II 24

Electromyographic evaluation of masticatory cycle before and five year after Orthognathic Surgery in Patients with Mandibular Prognathism.

CONCLUSÃO 40

REFERÊNCIAS 41

ANEXOS 44

Anexo 1 : Certificado do Comitê de Ética 44

Anexo 2: Carta de submição para revista Cientifica 45

Anexo 3: Resumo em Espanhol do capitulo I 46

Anexo 4: Resumo em Portugues do capitulo I I 47

Anexo 5: Análise do ciclo mastigatório 48

.

DEDICATÓRIAS

Dedico este trabalho:

A Deus, meu criador, pai, amigo e salvador, por tudo que faz por mim cada segundo, cada minuto, cada hora y cada día...
Obrigada Deus por tudo! .... Não tem palavras para descrever a alegría no meu coração, não tem palavras para descrever meu agradecimento a tí Senhor.

A tuda minha família, meus pais, Elio Roger De La Torre Rios e Lourdes Vera Caceres, meus motivadores, pilares de formação e exemplos de vida pelo imenso amor e apoio constante em toda esta caminhada. A minhas irmãs Estefany, Nelani e Andreita....eternas amigas, confidentes, parceiras que me impulsionam a seguir crescendo.

EPÍGRAFE:

Muitas vezes as pessoas são ilógicas, insensatas, egocêntricas. Ama-as assim mesmo.

Se você é gentil, as pessoas podem acusá-lo de egoísta, interesseiro. Seja gentil, assim mesmo.

Se você é um vencedor, terá alguns falsos amigos e alguns inimigos verdadeiros. Vença assim mesmo.

Se você é honesto e franco, as pessoas podem enganá-lo. Seja honesto assim mesmo.

O que você levou anos para construir, alguém pode destruir de uma hora para outra. Construa assim mesmo.

Se você tem paz e é feliz, as pessoas podem sentir inveja. Seja feliz assim mesmo.

Dê ao mundo o melhor de você, mas isso pode nunca ser o bastante.

Dê o melhor de você assim mesmo. Veja que, no final das contas, é entre você e DEUS. Nunca foi entre você e as outras pessoas.

(Madre Teresa)

A veces sentimos que lo que hacemos es tan solo una gota en el mar, pero el mar sería menos si le faltara una gota.

(Madre Teresa)

AGRADECIMIENTOS

A Fundação de Amparo e Pesquisa do Estado de São Paulo (FAPESP)

Pelo apoio econômico para o desenvolvimento deste projeto e pela ajuda na melhora ética e profissional atraves dos cursos financiados.

Muito Obrigada.

Ao Professor Fausto Bérzin,

Obrigada pela oportunidade, pela

Paciência, pelo carinho, por todo este tempo de convivência, agradeço por tê-lo como meu orientador, professor mais que tudo, como um pai que Deus colocou em meu caminho. Obrigada por me receber sempre com um abraço afetuoso, pela compreensão, preocupação e atenção.

Agradeço de coração pelo ensino acadêmico e espero sinceramente ter correspondido a todo o apoio e confiança depositados em mim.

AGRADECIMIENTOS

À universidade Estadual de Campinas, na pessoa de seu Reitor Dr. José Tadeu Jorge, professor titular na Faculdade de Engenharia Agrícola (Feagri) da Unicamp.

A Faculdade de Odontologia de Piracicaba na pessoa do Prof. Dr. Jacks Jorge Júnior, Diretor desta instituição que permitiu a concretizadeste trabalho.

Ao Prof. Renato Mazzonetto que em paz descansa, por me permitir avaliar a seus pacientes e pela confiança depositada em mim.

Ao Prof. Marcelo Correa Alves pela paciência e pela ajuda na elaboração da análise estatística deste trabalho.

A Prof. Célia Marisa Rizzatti Barbosa pela paciência na revisão dos artigos e apoio acadêmico dados neste trabalho.

A Prof. Maria Duarte Gavião pela revisão dos artigos e apoio acadêmico dados neste trabalho.

A Profa. Mirian Hideko Nagae pela amizade e apoio incondicional em todo este tempo de aprendizado.

Aos professores da banca Simone Cecilio Hallak Regalo, Francisco Macedo e José Ricardo de Albergaria Barbosa, pelo tempo dado na revisão da tese e aceitar ser parte desta historia.

A meus amigos Sr. Milton Brunelly e Liliana Brunely por acolher-me e fazer melhor minha estadia no Brasil.

A meus amigos Sr. Geraldo e Selma A. Segalla pelo carinho e ajuda brindada nesta caminhada, muito obrigada.

As meus amigos queridos, sem eles nada seria possível Liege de Biselly, Nataly Veronica Rondinel, Camilia Pinhata, Martha Gama, Driely Furlan, Samira Polisense, Betania Carrillo, sem vocês tudo séria mais difícil, são anjos em minha vida.

Aos meus colegas de curso, Casia M. Grilho, Marilia Ruivo, Marivel Hillasaca, Marthita, Claudia Kroll pelos bons momentos que passamos juntos.

A todos os voluntários pela paciência e solicitude em participar desta pesquisa.

Obrigada muito obrigada!

LISTA DE ABREVIATURAS E SIGLAS.

ATM – Articulação Temporomandibular.

DTM – Disfunção Temporomandibular

ON – Duração do período do ciclo mastigatório

IMAX – Instante Máximo de Atividade

EMG – Eletromiografia.

Hz – Hertz

μ- Microvolts

RDC/TMD – Research Diagnostic Criteria for Temporomandibular Disorders.

RMS – Raiz quadrada da media (Root Mean Square).

TE – Temporal Esquerdo

TD – Temporal direito

ME – Masseter esquerdo

MD – Masseter direito.

INTRODUÇÃO:

O prognatismo é caracterizado pelo desenvolvimento excessivo mandibular e/ou hipoplasia maxilar, cuja deformidade pode ocasionar comprometimentos tanto estéticos quanto funcionais (Duque 2002, Sforza 2008, Takeda 2009). Em geral, as tentativas de correção são realizadas desde a infância por meio de intervenções ortopédicas e/ou ortodônticas. Essas intervenções são longas e, nos casos de insucesso, cirurgias ortognáticas são indicadas para o reposicionamento esquelético da mandíbula em relação à maxila. Os pacientes com prognatismo mandibular submetidos a tratamentos ortodôntico e ou cirúrgicos podem ou não apresentar disfunções temporomandibulares (DTMs). Esta patologia pode ser desencadeada por processos multifatoriais relacionados à combinação de desequilíbrios entre fatores neuromusculares, psicológicos e anatômicos (Steenks & Wijer, 1996). Dentre estes fatores, pode-se citar a disfunção da musculatura mastigatória como fatores etiológicos amplamente discutidos na literatura (Rodrigues et al, 2000; Pedroni et al., 2003; Issa et al., 2005). O sistema mastigatório é um elemento regulador ou perturbador do sistema postural, assim o desequilíbrio induzido por uma disfunção mastigatória pode levar a uma descompensação do sistema estomatognatico (Bricot, 1999). Nos músculos da mastigação, sobretudo no músculo temporal e no músculo masseter, estão presentes numerosos receptores responsáveis pela condução de informações para áreas centrais que interferem no equilíbrio postural do sistema estomatognatico (Ghessa et al., 2002). Através destes conceitos observamos a íntima relação entre músculos, ossos, dentes, artérias, nervos que fazem em conjunto um sistema, como, o sistema estomatognático, que quando desequilibrado pode ocasionar doenças em outros sistemas do corpo, porem é necessário entender e observar os mecanismos e alterações físicas, biomecânicos e até psicológicos que a cirurgia ortognática pode ocasionar neste tipo de pacientes.

Acreditamos que é importante pesquisar as alterações causadas por este tipo de tratamento invasivo ao longo do tempo, já que pesquisas longitudinais são poucas na literatura pelo grau de dificuldade que estas apresentam. Os objetivos deste trabalho serão apresentados na forma de dois capítulos.

Esta tese está baseada na Resolução CCPG UNICAMP/002/06 que regulamenta o formato alternativo para teses de Mestrado e Doutorado e permite à inserção de artigos científicos de autoria ou co-autoria do candidato, já publicados ou submetidos em periódicos científicos ou anais de congressos sujeitos a arbitragem.

Por se tratar de pesquisa envolvendo seres humanos, o projeto de pesquisa deste trabalho foi submetido e aprovado pelo Comitê de Ética em Pesquisa da Faculdade de Odontologia de Piracicaba, tendo sido aprovado (Anexo 1). Sendo assim, esta tese é composta de dois capítulos contendo dois artigos submetidos para publicação.

CAPITULO I

Evaluation of Temporomandibular Disorders, Chronic pain and Depression, before and five years after Orthognathic Surgery in Patients with Mandibular Prognathism.

Vera-DeLaTorre RM[1] , Rocha CP[2], Rizzatti – Barbosa CM[3], Berzin F[5]

[1]DDS, MS, Postgraduate Student, Department of Dental Biology, Dental College of Piracicaba, State University of Campinas – Brazil. rmarthadelatorre@gmail.com
[2]DDS, MS, Postgraduate Student, Department of Dental Biology, Dental College of Piracicaba, State University of Campinas – Brazil. camilapinhata@yahoo.com.br
[3]DDS, MS, PhD, Professor, Department Prosthesis and Periodontology, Dental College of Piracicaba, State University of Campinas – Brazil. rizzatti@fop.unicamp.br
[5]DDS, MS, PhD, Professor, Department of Dental Biology, Dental College of Piracicaba, State University of Campinas – Brazil. fberzin@gmail.com

ABSTRACT

Aims: This five-year study aimed to evaluate changes in the signs and symptoms of temporomandibular joint dysfunction, as well as the presence of chronic pain and depression in subjects with mandibular prognathism treated with orthognathic surgery (OS). **Methods:** Twenty patients with mandibular prognathism aged between 18 and 36 years (23.3 ± 8.2 years) were evaluated using research diagnostic criteria for temporomandibular dysfunction (RDC/TMD). Axis I of the RDC/TMD was applied 2-3 months before surgery (T0) and at the following time points post-surgery: 6 months (T1), 12 months (T2), 24 months (T3), and 60 months (T4). For axis II, only T0, T3, and T4 were applicable. **Results:** Significant changes were observed in joint noise [T1 (p=0.0020) and T4 (p=0.0044)], muscle pain [T2 (p=0.01), T3 (p=0.0022), and T4 (p=0.0433)], deviation in mouth opening [T1 (p=0.0002), T2 (p=0.0009), T3 (p=0.0004), and T4 (p=0.0004)], amplitude of mouth opening [reduced only in T1 (p=0.0001)], chronic pain [T3 (p=0.0138) and T4 (p=0.0045)], and depression [T4 (p=0.0139)]. The changes showed a strong relationship between chronic pain and temporomandibular joint dysfunction (p=0.0030) and between chronic pain and depression (p=0.0230) before orthognathic surgery. After surgery, there was no association between these variables. **Conclusion:** There were reductions in chronic pain and depression post OS, which were evident five years after treatment.

Key-words: Temporomandibular disorders; cronic pain, depression, orthognathic surgery; and mandibular prognathism.

INTRODUCTION

The face and mouth are primary structures necessary for survival; without them, an individual is not able to eat or communicate. When these structures are threatened by pain or dysfunction, quality of life can be greatly decreased.[1] These problems are observed in subjects with mandibular prognathism, who have a dentofacial deformity (asymmetric growth of the maxilla and mandible) and, consequently, a disconformity in their physical appearance (body image). This disproportion growth can cause changes in occlusal biomechanics and in the temporomandibular joint, consequently resulting in other symptoms, such as anxiety, pain, and depression.[2]

Temporomandibular joint dysfunction (TMD) is a term given to a set of clinical problems involving the masticatory muscles, the temporomandibular joint, or both. Psychological problems may also be associated with TMD.[3]

The signs and symptoms of TMD have been investigated in patients with mandibular prognathism submitted to orthognathic surgery (OS), with this pathology reported in 41-88% of such individuals,[4,5] but there have been few studies on the emotional and psychological factors associated with TMD in patients with mandibular prognathism.[6]

Studies have used different types of tools to assess the signs and symptoms of TMD before and after OS, showing different degrees of improvement[7,8] or deterioration[9] or no changes[4,10], as well as positive[11] and negative changes in the emotional and psychological aspects of the disorder. The differences found between the studies may be due to the small sample sizes used, as well as the variability in surgical techniques, time of post-surgical evaluation, and assessment instruments used.

This study used the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) Axis I and II questionnaire, which is considered the gold standard in TMD evaluation.[12] An important aspect of this questionnaire is that it provides information on the biopsychosocial conditions of patients. The biological aspects are evaluated through Axis I of the RDC/TMD, reflecting the nociceptive impulses originating in the somatic tissues. The psychosocial aspects of pain are evaluated on Axis II of the RDC/TMD, reflecting the interaction among the thalamus, cortex, and limbic structures.[1]

The term chronic pain is used to describe any pain that lasts more than six months, regardless of origin. [1, 13, 14] Mladenovic et al. [6] studied subjects with mandibular prognathism and found that some patients suffered chronic pain, regardless of whether they underwent OS, and that more women than men suffer from this disorder.

Depressive disorders are characterized by a sharp decrease in interest or pleasure in things; feelings of sadness or emptiness; and uncontrollable crying, fatigue, tiredness, insomnia, and thoughts of death. These aspects are evaluated quantitatively by Axis II of the RDC/TMD.[12] Some studies[6,15] evaluated patients with mandibular prognathism six months after OS and found high levels of depression; however, studies[11,16] that evaluated patients two or more years after OS found psychological improvements.

Knowing that psychological aspects, such as depression, are associated with pain and TMD[6,17] is important for understanding the development of all these factors in subjects with dentofacial deformities, such as mandibular prognathism, submitted to invasive treatments such as OS. Furthermore, it is believed that these features must be studied longitudinally.

Therefore, this study aimed to evaluate the possible five-year changes in the signs and symptoms of TMD, as well as evaluate the presence of chronic pain and depression in subjects with mandibular prognathism treated with OS.

MATERIALS AND METHODS

Twenty patients with mandibular prognathism (11 males and 9 females) agreed to be part of this study. All sought treatment during 2008 for painful and aesthetic discomfort at Piracicaba Dental School, University of Campinas, Piracicaba, SP, Brazil. These patients were aged between 18 and 36 years (23.3 ± 8.2 years) and underwent OS. Each patient received orthodontic treatment for an average of 19.8 months (± 7.5) pre-OS and for an average of 10.55 months (± 3.8) after OS. This research protocol was approved by the Ethics Committee of Piracicaba Dental School, and all patients signed an informed consent form.

Exclusion criteria were as follows: class I patients, angle class II patients, patients with open bite, patients partially or completely edentulous, patients with a history of facial trauma, and patients who were taking painkillers, anti-inflammatories, muscle relaxants, or antidepressants. All women were evaluated on the eighth day of their menstrual cycle to prevent hormonal changes from altering the results, as hormonal fluctuations may be responsible for the onset of or increase in physical symptoms, as well as for the onset of psychiatric[17,18] and emotional disorders, which can affect the tone of the mastication muscles and occlusal forces.[19]

The diagnosis of mandibular protrusion was made based on cephalometric radiographs, following the guidelines of Arnett & Bergman (Sant'Ana et al, 2009).[20]

The presence of TMD and the biopsychosocial aspects of patients were evaluated by the RDC/TMD (Axis I and Axis II).[12] Axis I was applied at the following times: before surgery, 2-3 months (T0); and post-surgery, 6 months (T1), 12 months (T2), 24 months (T3), and 60 months (T4). Axis II was applied at times T0, T3, and T4 (figure 1). These periods are relevant to psychosocial analysis; therefore, assessments prior to 24 months post-OS, may interfere with the psychological results for the patient.[21,22] All evaluations were performed by a single examiner (dentist) trained following the guidelines of Dworkin & Leresche (1992).[12] The procedure was performed by a single trained evaluator (kappa=0.80).

Application of Axis I

Signs and symptoms of TMD

Briefly, issues related to the pattern of mouth opening, mandibular movements, joint noises, laterality and noises associated with laterality, and muscle and joint pain were evaluated. All these issues were analyzed by physical measurements as well as a palpation exam.[12] These characteristics reveal information that is divided into three diagnostic categories:

I- Masticatory muscle disorders, subclassified based on the limitation of mouth opening as myofascial pain (IA) and myofascial pain with limited opening (IB).

II- Disc displacement (DD), subclassified based on the disc reduction and the limitation of mouth opening as DD with reduction (IIA), DD without reduction and limited mouth opening (IIB), and DD without reduction and without limited mouth opening (IIC).

III- Degenerative diseases, subclassified as arthralgia (IIIA), osteoarthritis (IIIB), and osteoarthritis (IIIC).

These diagnostics are individual to the right and left temporomandibular joint, and they are not mutually exclusive, i.e., the patient can receive diagnoses in more than one category.[23]

Application of Axis II

Psychosocial factors (chronic pain and depression)

Briefly, Axis II of the RDC/TMD was used to assess psychosocial factors. This axis relies on self-reporting of pain and the patient's emotional state. It includes the chronic pain scale[24] and measures of depression and somatization.[12] In this study, somatization was not considered because most of the patients did not feel comfortable answering the related questions.

The degree of chronic pain includes measures that indicate the type of pain, pain intensity, and how the pain interferes with daily life, and it is divided into five categories: 1 - TMD with no pain in the last 6 months (grade 0), 2 – low-intensity pain (grade I), 3 – high-intensity pain (grade II); 4 – high-intensity pain with moderate limitation (grade III), 5 – high-intensity pain with severe limitation (grade IV).

The assessment of depression includes 20 of the 32 questions of Axis II that are related to loss of sexual interest; lack of energy; tearfulness; feelings of guilt; feelings of loneliness; feelings of sadness; worries; thoughts of death, deceit, and guilt; and insomnia.[12, 25, 26, 27]

Surgical procedures

Six patients underwent a mandibular setback, bilateral sagittal ramus osteotomy; a Lefort I osteotomy was performed to advance the maxilla in four patients; and ten patients received a combination of these two treatments.

The occlusion was obtained using a surgical guide (a thin plate of acrylic). L-shaped titanium plates combined with titanium screws were used for the fixation of the mandible cortical bone. In this study, no patients received wire fixation.

Statistical analysis

The analysis of variance for multiple comparisons with the Tukey-Kramer test was used to evaluate the biopsychosocial factors (TMD signs and symptoms, chronic pain, and depression). To compare the qualitative measures (TMD subtypes), the chi-square test was used. To analyze the association of three variables (TMD, chronic pain, and depression) in different periods, the chi-square test was again used. The analyses were performed using SAS System 9.1 (SAS Institute, Inc., Cary, NC), and a significance level of 5% ($p<0.05$) was used for all the procedures.

RESULTS

Axis I

Signs and symptoms of TMD

The results obtained in this study showed that, before OS, 14 (70%) of the patients had TMJ clicking, and after OS, there was a significant reduction at T1 ($p=0.0020$) and T4 ($p=0.0044$). At T0, 12 patients (60%) had muscle pain on palpation, which was significantly reduced at T2 ($p=0.01$), T3 ($p=0.0022$), and T4 ($p=0.0433$). Although there was a decrease in joint pain at all-time points post-OS, it was not statistically significant. Seventeen (85%) of the 20 patients presented a deviated opening pattern at T0; after surgery, deviation was corrected at all-time points [T1 ($p=0.0002$), and T2 ($p=0.0009$), T3 ($p=0.0004$), and T4 ($p=0.0004$)]. The mouth opening was significantly reduced only at T1 ($p=0.0001$). When quantified, the set of all parameters of the RDC/TMD defining the presence of TMD were observed in 13 patients before OS, and 12 patients showed TMD after OS. However, these findings were not significant (Table 1).

Regarding the TMD classification, the data indicated that before OS, 35% (7 patients) of the patients were not diagnosed with TMD, and 65% (13 patients) were diagnosed with some type of TMD. At T3 and T4, there were changes in the classification of the subtypes of TMD, but they were not significant. The most common type of TMD before and after OS was IIA (35%) (Figure 2).

Axis II

Psychosocial factors (chronic pain and depression)

The results showed that 60% of the patients showed some grade of chronic pain in the initial evaluations. A significant decrease in chronic pain was recorded at T3 and T4 (p=0.0138 and p=0.0045, respectively). Grade I was diagnosed in the most patients (T0=25%, T3=30%, and T4=25%); grade II was observed at T0 (20%), T3 (10%), and T4 (5%); and grade III was observed only at T0 (Table 2).

Regarding the degree of depression according to Axis II of the RDC/TMD, at the initial examinations, 50% (10) of the patients showed some grade of depression; at T4, the patients continued to show moderate (10%) or severe (5%) depression. When T0 was compared with T4, a significant difference in depression was observed (p=0.0139). The most common form of depression at the beginning and end of the evaluations was moderate (Table 3).

The chi-square test revealed that there was a strong correlation between chronic pain and TMD (p=0.0030) and between chronic pain and depression (p=0.0230) before OS. It further revealed that there was no association between TMD and chronic pain or depression after surgery (Table 4).

DISCUSSION

Axis I

Signs and symptoms of TMD

The results showed positive and significant changes in the signs and symptoms of TMD evaluated before and after OS, with a significant decrease in joint noises at T1 (30%) and T4 (20%). The results suggest that the relationship between the condyle and disc can improve after OS without wire fixation, in accordance with the results of previous studies[8]. Other studies[4, 6, 7] evaluated patients undergoing OS with wire fixation and found that these symptoms were maintained or increased; orthognathic surgery with fixation reduces movement; moreover, the decrease in proprioceptive stimuli at the dental surfaces and temporomandibular joint that provide information to the CNS regarding the new intraoral space and new mandibular position, as well as the new muscle biomechanics, causes a slower adaptation, which can increase some of the signs and symptoms of TMD. This study also showed a significant decrease in painful symptoms[6] during the palpation of muscles at T2, T3, and T4. Other studies[7, 8] also found a significant decrease in muscle pain 12 months or more after OS. Onizawa et al.[28] found no decrease in painful symptoms, but this observation probably occurred because the patients were evaluated six months after OS in their study and, according to some studies[29, 30], six months is not enough time to develop stability and improve postural occlusion. Additionally, after OS, patients continue orthodontic treatment for an average of 10 to 13 months, which can also influence the soreness of muscles.

Regarding deviations in the opening and closing of the mandible, there was a significant reduction in all patients after OS, most likely due to the better proportionality between the maxilla and mandible provided by the OS. However, 30% of the patients still showed deviations in the opening and closing of the mouth at the end of the study, suggesting the presence of some muscle or joint imbalance, although the patients had an occlusion within the parameters of normality (class I) after the OS. The occlusal balance is more complex than it seems, as class I patients do not necessarily have occlusal balance[31] and patients with a dentoskeletal deformity do not always have a full imbalance, i.e., the signs and symptoms of TMD appear to be independent of this condition.

A significant decrease in the amplitude of mouth opening was observed at T1, which indicates that the possible tissue trauma caused by OS can remain 6 months after treatment and that the decreased amplitude of mouth opening may be associated with a neuromuscular protection mechanism[32]. The amplitude of mouth opening is recovered over time, as noted in the assessments made at T2, T3, and T4 in the present study, demonstrating positive signs of new musculoskeletal biomechanics, as also observed by Dervis and Tuncer [8].

In this longitudinal study, it was observed that the TMD symptoms present before OS remained present and did not show any significant change over time after OS. These results indicate that OS can relieve some signs and symptoms of TMD [4,6,7,8] but should not be the only treatment for this condition. This condition is complicated and requires better understanding of the anatomy, physiology, and biomechanics of the TMJ in relation to the skull bones, muscles, teeth, and whole-body posture.

According to the RDC/TMD, the most frequent subtype of TMD patients in this study was IIA, followed by IA, IB, and combined TMD. After 60 months, there were no significant changes in the TMD subtype distribution. This lack of change was most likely due to the small number of patients evaluated. It is known that the frequency of disc displacements with reduction in patients with mandibular prognathism is caused by biomechanical factors that generate an occlusal imbalance that can cause asymmetry in opening and closing of the mouth, mastication, and swallowing. Previous findings [4, 6, 33] also demonstrated the presence of different subtypes of TMD in patients with mandibular prognathism who underwent OS.

Axis II

Psychosocial factors (chronic pain and depression)

In this study, a significant decrease in the level of chronic pain 60 months after OS was observed, which can be attributed to two factors. **First,** there is a change in the nociceptive and proprioceptive information, as this information is captured by the new occlusal tooth contact position, which conveys different proprioceptive and nociceptive interpretations[1] to the higher centers (thalamus, cortex, limbic system, and reticular substance), where the changes are interpreted, forming new circuits of afferent and efferent information (Figure 3). The **second** factor is psychological and is associated with the unusual emotional meaning of the face and mouth with respect to concepts of self-image[1]. Distortion in self-image can be expressed as pain[34]. Physical appearance (new facial image) is a factor that positively affects patients; thus, the changes in psychosocial characteristics, image, emotional status, and interpersonal and social relationships provided by OS play an important role in the final results of painful symptoms [35].

Chronic pain is not only caused by tissue injury or functional factors but also by the interaction of cognitive, emotional, motivational, behavioral, and physical components [1, 36]. Thus, it can be understood that patients with dentofacial deformities may present psychological factors that relate to the constant pain that these patients feel, regardless of whether the pain is caused by depressive factors related to their facial image[34], as pain, depression, and learning image are interpreted in common structures that interrelate at the level of the cerebral cortex. Other researchers [37, 38] concluded that the presence of depression and pain suggests an association between depression and some chronic pain conditions.

In the depression evaluation, it was observed that 45% of the patients had moderate depression before OS and that only 10% continued to experience moderate depression after OS. This significant decrease in depression can be attributed to a change in the self-perception of image. The observation and recognition of changes in our image after any surgery initiates changes in neural mechanisms because the new information is carried from the retina by neural mechanisms that provide the information on the new facial image to the thalamus (lateral geniculate nucleus) and transmit it to the primary visual cortex. This new image is stored in the cortex (posterior parietal side), which is interrelated with the amygdala, responsible for integrating sensory information with behavioral and physiological responses[39, 40]. Understanding this interaction, we can assume that the change in self-image perception can influence the neural networks that modulate emotions, which may have occurred in some of the volunteers in this study, whereby the perception of the new image influenced the emotional state of the patient and, consequently, his/her depressive state was improved. Other studies [11, 16, 35, 41] also show positive psychosocial changes generated by the physical appearance of patients after surgical treatments.

OS is usually sought by patients who want to change their physical appearance (facial image) [11, 42]; however, for the treatment to be successful, it is necessary to evaluate all the signs and symptoms presented by these patients. At the end of this study, 30% of the patients continued to suffer from chronic pain, and 15% continued to suffer from depression, which could be because these patients may have atypical pain and other mental symptoms requiring further treatment.

This study possesses some limitations commonly found in longitudinal studies, such as the small number of patients and the disproportionality between genders. We suggest future longitudinal studies of patients with other dentofacial deformities, with the application of validated questionnaires on chronic pain and depression related to the facial image, as well as the study of neurophysiological mechanisms.

CONCLUSIONS

- Patients with some type of TMD before surgery still exhibit this type of dysfunction five years after surgical treatment.
- OS may improve some signs and symptoms of TMD, but it is not a treatment for this disease.
- There was a reduction in chronic pain and depression after OS, which was evident five years after treatment.
- It is necessary to observe the psychological conditions related to pain and depression of a patient before initiating any treatment, especially before OS, which is an invasive treatment that generates physical changes in the patient.

ACKNOWLEDGMENTS

- The authors thank the Foundation of Research Support in the State of São Paulo (FAPESP) for providing financial support for the first author (research project 2010/08185-1).

REFERENCES

1. Okesson JP. Bell´s Orofacial pains. The clinical Management of Orofacial Pain. In: Okesson JP (ed) Psychological factors and orofacial pain axis II. Sao Paulo: Quintessence, 2006:519–541.
2. P. Kafas, R. Leeson: Assessment of pain in temporomandibular disorders: the biopsychosocial complexity. Int. J. Oral Maxillofac. Surg. 2006; 35: 145–149.
3. Adrian U.J, Tan KBC, Chua KE and Tan HH. Depresion and Somatization in patient with temporomandibular disorders. The Jornal of prosthetic dentistry 2002;88:479-84.
4. Farella M, Michelotti A, Bocchino T, Cimino R, Laino A, Steenks MH. Effects of orthognathic surgery for class III malocclusion on signs and symptoms of temporomandibular disorders and on pressure pain thresholds of the jaw muscles. J Oral Maxillofac Surg 2007;36:583-7.
5. Ueki K, Marukawa K, Nakagawa K, Yamamoto E. Condylar and temporomandibular joint disc positions after mandibular osteotomy for prognathism. J Oral Maxillofac Surg 2002;60: 1424-32.
6. Mladenovic I, Jovic N, Cutovic T, Mladenovic G and kozomara R. Temporomandibular disorders after orthognathic surgery in patients with mandibular prognathism with depression as a risk factor. Acta Odontologica Scandinavica, 2013; 71: 57-64.
7. Panula K. Finne K. Oikarinen K. Incidence of complication and problems to orthogntathic surgery a review 665 patient. J. Oral Maxillofac Surg 2000;59:1128-36.

8. Dervis E, Tuncer E. Long-term evaluations of temporomandibular disorders in patients undergoing orthognathic surgery compared with a control group. Oral Surg Oral Med Oral Pathol Oral Radial Endodont 2002;94:554-60.

9. Aoyama S, Kino K, Kobayashi J, Yoshimasu H, Amagasa T. Clinical evaluation of the temporomandibular joint following orthognathic surgery-multiple logistic regression analysis. J Med Dent Sci 2005;52:109-14.

10. Aghabeigi B, Hiranaka D, Keith DA, Kelly JP, Crean SJ. Effect of orthognathic surgery on the temporomandibular joint in patients with anterior open bite. J Adult Orthodon Orthognath Surg 2001;16:153-60.

11. Gerzanic L, Jagsch R, Watzke I. Psychologic implications of orthognathic surgery in patients with skeletal Calss II or Class III malocclusion. J. Orthod Orthognath Surg 2002;17:75-81

12. Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. J Craniomandib Disord 1992; 6: 301-355

13. Carette S. Chronic pain syndromes. Annals of the Rheumatic Diseases 1996; 55: 497-501

14. Dworkin SF, Von Korff M, LeResche L. Epidemiologic studies of chronic pain: a dynamic-ecologic perspective. Ann Behav Med 1992;14:3–11.

15. Cunningham SJ, Hunt NP, Feinmann C. Perceptions of outcome following orthognathic surgery. Br J Oral Maxillofac Surg 1996;34:210-13.

16. Motegi, EJP, Hatch JD, Rugh H. Yamaguchi. Health-related quality of life and psychosocial function 5 years after orthognathic surgery. Am J Orthod Dentofacial Orthop 2003; 124: 138–143.

17. Sherman JJ, LeResche L, Huggins KH, Mancl LA, Sage JC, Dworkin SF. The relationship of somatization and depression to experimental pain response in women with temporomandibular disorders. Psychosom Med 2004;66:852–860.

18. Janse de Jonge XA, Boot CR, Thom JM, Ruell PA, Thompson MW. The influence of menstrual cycle phase on skeletal muscle contractile characteristics in humans. J Physiol 2001;530: 161-166.

19. Carlsson CR, Okeson JP, Falace DA, Nitz AJ, Curran SL Anderson D. Comparison of psychologic and physiologic functioning between patients with masticatory muscle pain and matched controls. J Orofac Pain 1993;7:15–22.

20. Arnett GW, Bergman R. Facial keys to orthodontic diagnosis and treatment planning. Part I and II. Am. J. Orthod. Dentofacial Orthop 1993; 103: 299-411

21. Flannery C, et al. Impact of orthognathic surgery patients: a 24-month follow-up. J Oral Maxillo- fac Surg 1990;98:313-22.

22. Laziaidou-Terzoudi T, et al. Long-term assessment of psychologic outcomes of orthognathic surgery. J Oral Maxillofac Surg 2003;61(5): 533-4.

23. Biopsychosocial factors associated with the subcategories of acute temporomandibular joint disorders. J Orofac Pain 2012;26(1): 7–16.

24. Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. Arch Gen Psychiatry 1961;4:561-71.

25. Radloff L. The CES-D scale: a self report depression scale for research in the general population. J Appl Psychol Meas 1977;1:3385-401.

26. Carlson CR, Collins FL, Porzelius J, Stewart JF, Nitz AJ, Lind C. The assessment of emotional reactivity. J Psychopathol Behav Assessment 1989;11:313-25.

27. Dworkin SF, Sherman JJ, Mancl L, Ohrbach R, LeResche L, Truelove E. Reliability, validity, and clinical utility of the research diagnostic criteria for temporomandibular disorders axis II scales: depression, non-specific physical symptoms and graded chronic pain. J Orofac Pain 2002;207–20.

28. Onizawa K, Schemelzeisen R, Vogt, O'ryan F. Alteration of temporomandibular joint symptom after orthognathic surgery comparation with healthy volunteers. J Oral Maxillofac. Surg 1995;53:117-21.

29. Busby BR, Bailey LJ, Proffit WR, Phillips C and White RP. Long-Term Stability of surgical Class III treatment: A study of 5-year postsurgical results. J Adult Orthod Orthognath Surg 2002; 17(3):159-170.

30. Proffit WR, Phillips C, Previt JW, Turvey TA. Stability after surgical-orthodontic correction of skeletal Class III malocclusion. II. Maxillary advancement. J Adult Orthod Othognath Surg 1991; 6:71-80

31. Magnusson T, Egermark I, Carlsson GE. A longitudinal epidemiologic study of signs and symptoms of temporomandibular disorders from 15 to 35 years of age. J Orofac Pain 2000;14:310–319.

32. Bianchini EMG. Speech assessment of oral motor: oral myofunctional disorders or adaptative situations. Ver Dent Press Orthodon Ortopedi Facial 2001, 6(3):73-82. (traduzir)

33. Abrahamsson C, Ekberg EC, Henrikson T; Nilner M; Sunzel B; Bondemark L. TMD In Consecutive Patients Referred for Orthognathic Surgery. The Angle Orthodontist 2009; 79:621-627.

34. Pilling LF. Psychosomatic aspects of orofacial pain. In: Alling CC, Mahan PE (eds). Facial Pain. Philadelphia: 1977: 213-226.

35. Ferreira L.M., Rzeszetkowiski B.S.H. Plastic Surgery: An anthroposophic approach Rev. Soc. Bras. Cir. Plást 2004; 19:39–40.

36. Carroll LJ, Cassidy DJ, Côte P. Depression as risk factor for onset of an episode of troublesome neck and low back pain. J Pain. 2003;107:134-139

37. Ferreira L.M., Rzeszetkowiski B.S.H. Plastic Surgery: an anthroposophic approach Rev. Soc. Bras. Cir. Plást., 19 (2004), pp. 39–40.

38. Von Korff MR, LeResche L, Dworkin SF. First onset of common pain symptoms: a prospective study of depression as a risk factor. Pain 1993;55:251-8.

39. Linton SJ, Skevington SM. Psychological factors. In: Crombie IK, Croft PR, Linton SJ, LeResche L, VonKorff M, (eds). Epidemiology of pain. Seattle, WA: IASP Press 1999; 235–55

40. Purves D, Agustine GJ, Fitzpatrick D, Katz LC, LaMantia AS, McNamara JO and Williams MS. Neurosciences. In Purves D et al.(eds). Emotions. Porto Alegre: Artmed 2005:625-629.

41. Rivera SM, Hatch JP, Dolce C, Bays RA, Van Sickels JE, Rugh JD. Patients' own reasons and patient-perceived recommendations for orthognathic surgery. Am J Orthod Dentofacial Orthop. 2000;118:134–141.

42. Lautenbacher S, Spernal J, Schreiber W, Krieg JC. Relationship between clinical pain complaints and pain sensitivity in patients with depression and panic disorder. Psychosom Med 1999;61:822-7.

Figures and Tables:

Figure 1: Experimental Design**.**

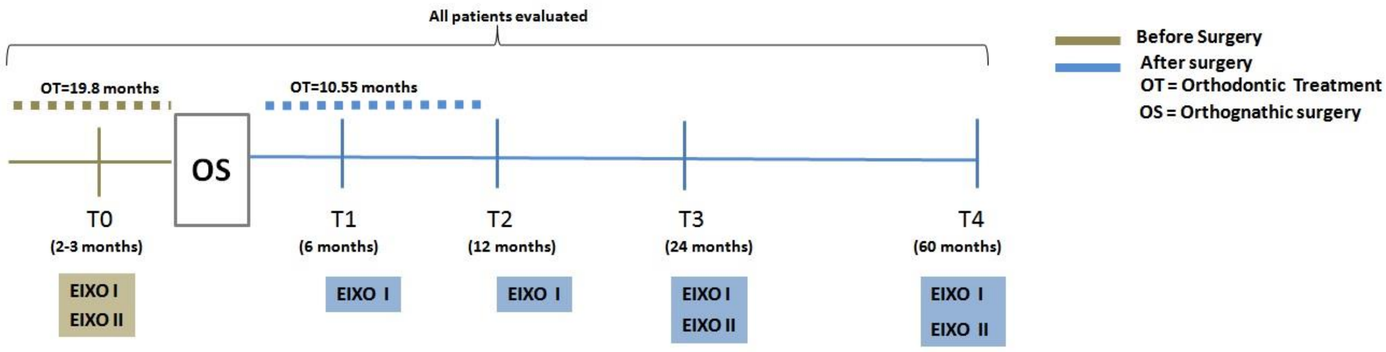
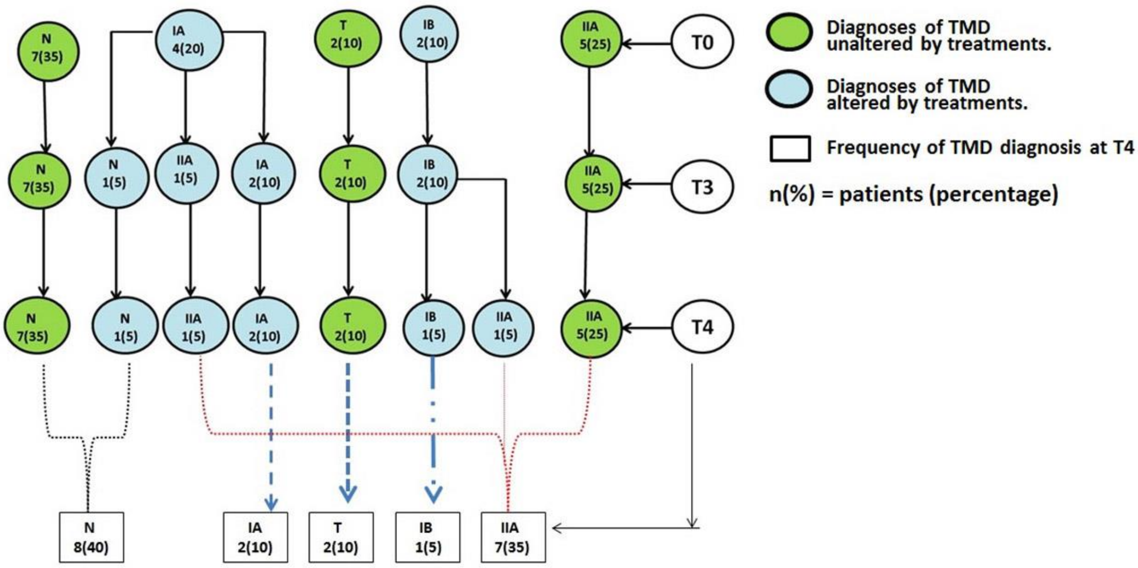


Table 1: Comparison of TMD signs and symptoms (Axis I) between baseline (T0) and each post-surgery time point (T1, T2, T3, and T4).

Signs and symptoms of TMD	T0 n(%)	T1 n (%)	T2 n (%)	T3 n (%)	T4 n (%)
TMJ clicking	14 (70)	6 (30)*	13 (65)	9 (45)	4 (20)*
Muscle pain on palpation	12 (60)	10 (50)	5(25)*	4 (20)*	2 (10)*
TMJ pain on palpation	6 (30)	7 (33)	2(10)	2 (10)	2 (14)
Deviation in mouth opening	17 (85)	7 (35)*	7(35)*	6 (30)*	6(30)*
Measure of mouth opening	50.48 mm	38.6 mm*	50.01 mm	51.04 mm	48 mm
TMD	13 (62)	--------	------	12(57)	12(57)

T0 = 2-3 months before OS, T1 = 6 months after OS, T2 = 12 months after OS, T3 = 24 months after OS, T4 = 60 months after OS. *p<0.05.

Figure 2: Variation and frequency distribution of the sub-types of TMD (Axis I) at different time points (T0, T3, and T4).



N=absence of TMD, IA=myofascial pain, T=two types of TMD [in this study (IA+ IIA)], IB=myofascial pain with limited opening and IIA=DD with reduction

Figure 3. Change in nociceptive and proprioceptive information before and after OS.

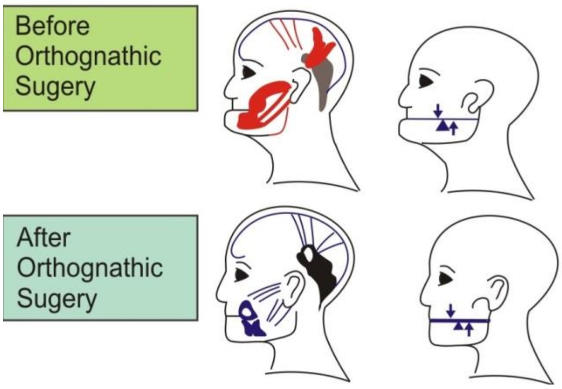


Table 2: Comparison of chronic pain (according to Axis II) in patients with mandibular prognathism before (T0) and after (T3 and T4) orthognathic surgery.

CHRONIC PAIN	T0 n(%)	T3* n(%)	T4 * n(%)
Grade 0	8(40)	12(60)	14(70)
Grade I	5(25)	6(30)	5(25)
Grade II	4(20)	2(10)	1(5)
Grade III	3(15)	0	0
Grade IV	0	0	0

Grade 0 = No TMD pain in the last six months; Grade I = Low disability, low intensity of pain; Grade II = Low disability, high intensity of pain; Grade III = High disability, moderately limiting; Grade IV = High disability, severely limiting.
*p <0.05, when comparing T0 with T3 and T0 with T4.

Table 3: Depression (according to Axis II) in patients with mandibular prognathism before (T0) and after (T3 and T4) orthognathic surgery.

Depression	T0 n(%)	T3 n(%)	T4 * n(%)
Normal	10 (50)	16 (80)	17 (85)
Moderate	9 (45)	3 (15)	2 (10)
Severe	1 (5)	1 (5)	1 (5)

*p <0.05, when comparing T0 with T3 and T0 with T4.

Table 4: Associations between chronic pain, TMD, and depression.

Time Points	Chronic Pain/ TMD	Chronic Pain/ Depression	Depression/TMD
T0	0.0030*	0.0230 *	0.1596
T3	0.306	0.2347	0.0679
T4	0.697	0.2026	0.1250

***p<0.01* based on the c*hi-square test*

CAPITULO II

Electromyographic evaluation of masticatory cycle before and after Orthognathic Surgery in Patients with Mandibular Prognathism.

[a]Rosario Martha De La Torre Vera, [b]Mirian Hideko Nagae, [c]Ferreira LMDB [d]Fausto Berzin.

[a]DDS, MS, Postgraduate Student, Department of Dental Biology, Dental College of Piracicaba, State University of Campinas – Brazil
[b] Speech-language Pathologist, MS,PhD, Faculty of Medical Science Department, University of Campinas, Campinas, SP, Brazil.
[c]MS, Postgraduate Student, Department of Dental Biology, Dental College of Piracicaba, State University of Campinas – Brazil
[d]DDS, MS, PhD, Professor, Department of Dental Biology, Dental College of Piracicaba, State University of Campinas – Brazil

ABSTRACT

The objective of this study was to assess the electromyographic characteristics (EMG) of the masticatory cycle before and five years after orthognathic surgery in volunteers with mandibular prognathism, assessing three variables: duration of masticatory cycle activity (ON), maximum instant of the activity (IMAX) and RMS (Root mean square). Method: a total of 13 male volunteers with prognathism were assessed at 2-3 months before surgery (T0), and again at 6 months (T1), 12 months (T2), 24 months (T3) and 60 months (T4) after surgery. The anterior part of the temporal muscle and superficial portion of the masseter muscles were assessed bilaterally. The Shapiro-Wilk test for normality was applied. Analysis of variance was performed using the Tukey-Kramer test, with a level of significance of 5% $p<0.05$). Results: all the muscles exhibited an increase in duration of activity (ON) after surgery, reaching significance for all muscles at 60 months. A percentage increase in IMAX was noted, reaching significance for all muscles ($p<0.05$) at 12, 24 and 60 months after surgery. RMS increased 24 and 60 months after surgery for the masseter muscles bilaterally and right temporal muscle ($p<0.05$). It was concluded that orthognathic surgery promoted positive changes in the masticatory cycle five years after surgical treatment in individuals with mandibular prognathism and no temporomandibular dysfunction (TMD).

Key-words: Electromyography; Masticatory cycle; Orthognathic surgery; and Mandibular prognathism.

INTRODUCTION:

The morphological alterations resulting from orthognathic surgery can lead to a change in muscle behavior, owing to interdependence with the skeletal structure and occlusion (1). When this change occurs, it is conducive to mandibular stability and surgical success (2) while its absence poses a risk of surgical relapse (3).

After surgery, besides esthetic improvements, the new skeletal and occlusal condition promotes changes in oral functions (4, 5). Thus, surgical success encompasses more than dental and skeletal repositioning where the muscles must also adapt to this new condition.

Of the different oral functions, mastication allows investigation of the patient´s new status, given the broad mandibular excursive movements performed. Studies assessing mastication and the masticatory cycle using a variety of methods are available but results remain conflicting and conclusions disparate (5,7-9). These contradictory data may have stemmed from narrow analyses of muscle activity or from poorly characterized samples. This activity is generally assessed solely by the amplitude of the signal (RMS=Root Mean Square), which reduces the signal to an average (2,7). This reduction however, can be insufficient since it obscures key information which differentiates the electromyographic signal.

Another relevant factor to be considered is the use of normalization (10), whose purpose is to attenuate interindividual differences, rendering the signal more homogenous. Therefore, it follows that assessing alternative variables indicative of muscle profile may help avoid some of the above-cited disparities (8, 11).

In this context, the aim of the present study was to assess the evolution of the masticatory cycle over a five-year period in patients submitted to surgical treatment by electromyographic analysis of the following variables: duration of masticatory cycle activity (ON), maximum instant of the activity (IMAX) and RMS (Root mean square), which may serve as important adjuncts in determining diagnosis after the treatment.

MATERIAL AND METHODS

The sample comprised 37 male volunteers with mandibular prognathism who sought treatment at the Piracicaba School of Dentistry for esthetic and functional discomfort between 2007 and 2008. Of these subjects, 17 were excluded for not meeting the inclusion criteria whereas a further 5 refused to take part in the study. Lastly, 2 were excluded from the sample during data analysis owing to poor electromyographic signal quality, giving a final total of 13 volunteers whose conditions characterized the sample. Classification of the individuals for the assessment of skeletal mandibular prognathism was performed by cephalometric radiographs, according to the guidelines of Arnett and Bergman (12). The Research Diagnostic Criteria RDC / TMD Axis I questionnaire (13) was also applied to check for the presence of temporomandibular disorder (TMD).

The inclusion criteria for the study were: being of male gender, aged between 18 and 36 years, presenting no systemic diseases which might influence the diagnosis of TMD and/or the electromyographic activity, such as: arthritis, arthrosis, diabetes and neurological pathologies, and have no type of temporomandibular disorder (TMD). Volunteers with mandibular retrognathism, biprotrusion, missing teeth (partial or total), history of facial and TMJ traumas, use of analgesics, anti-inflammatory drugs, myorelaxants or antidepressants were also excluded.

Patients received dental treatment for an average of 19.8 months (± 7.5) before surgery and 10.55 months (± 3.8) after surgery. For all volunteers, correction of the skeletal deformity was performed using combined osteotomy (Le fort I for advancement of the maxilla and bilateral sagittal split osteotomy of the mandibular ramus to reduce the lower jaw).

The research project was approved by the Research Ethics Committee of the institution (CEP)(Protocol no. nº 035/2010).

Experiment design:

Muscle behavior was assessed at five different timepoints: 2-3 months before surgery (T0); and at 6 months (T1), 12 months (T2), 24 months (T3) and 60 months (T4) after surgery.

Electromyographic Assessment:

The measurements were acquired on a Myosystem I electromyographic device using Myosystem BRI version 2.52 software (DataHominis Tecnologia Ltda), a 12-bit resolution signal conditioner with Common Mode Rejection (CMRR) of 112dB @ 60 Hz and a Myosystem A/D converter, model PCI-DAS 1200 (Prosecon Ltda).

The electromyographic (EMG) signals from the muscles assessed were acquired using active differential surface electrodes, consisting of two parallel silver/silver chloride rectangular bars (10x2 mm) spaced 10 mm apart, encased in an acrylic resin housing measuring 23 x 21 x 5 mm, manufactured by EMG System do Brasil Ltda.

For electrode placement, function tests for each of the muscles were first carried out. This test entails muscle palpation during simultaneous bilateral mastication and yielded the following positioning criteria: superficial part of the masseter muscle – muscle body, 2cm above the angle of the mandible; and the anterior portion of the temporal muscle body (14,15). A circular stainless steel electrode measuring 3cm in diameter was also used, coated with conductive gel and attached to the sternum bone to serve as a reference.

Mastication Assessment:

In this study, habitual mastication was performed for assessment of the electromyographic signal, in an effort to replicate a clinical situation during mastication as accurately as possible (16). A Parafilm M® (American National Can TM Chicago, IL.60641) paraffin film, folded 5 times, was employed because this material offers the least variability in assessing electromyographic signals (17).

Mastication was performed for five seconds initially, and the volunteer then instructed to place the Parafilm M® onto the tongue and given a verbal prompt to resume normal chewing (18). The analysis of the bilateral masticatory cycle was done using the Matlab math routine (MathWorks®, Inc. Matlab: The Language of Technical Computing, R13, version 6.5. MathWorks®). The masseter muscle is considered the main mastication muscle and used as a reference for defining masticatory cycles, with the start of the cycle marked by commencement of masseter muscle activity and the end the start of the next cycle. This procedure was performed by the same trained evaluator and had a Kappa value of 0.80.

Masticatory cycle analysis:

1. A sequence of 6 (±1) masticatory cycles was found for all 5-second periods performed. These electromyographic signals from habitual mastication were windowed, filtered (10-500 Hz band pass filter), rectified and processed on the Myosystem I electromyographic device using Myosystem BRI software version 2.52.

2. During this collection, the initial cycles were rejected for containing high intensity activity and likewise the final cycles were rejected owing to the decline in intensities characteristic of these phases (19). Thus, a sequence of 4 masticatory cycles was selected per individual for all periods.

3. After determination of the cycles, the signals were submitted to normalization using the Matlab program, based on the criteria of maximum and mean electromyographic peak during dynamic activity (20,21), in order to obtain the lowest coefficient of variability of the signals among the subjects. Normalization by the mean yielded the

lowest coefficient of variability for this study. In conjunction with this analysis, the variables ON, IMAX and RMS were also assessed.

ON (ms): This defines the time in which the masseter and temporal muscles are active during the masticatory cycle (8). Muscle was considered active when its activity was greater than or equal to 20% of its maximum amplitude value (14). (Fig 2a)

IMAX (%): This is defined as the instant of maximum activity of the masticatory cycle. (Fig. 2b)

RMS (µv): This represents the square root of the mean of the squares of the current or voltage during the cycle, where the parameter reflects the degree of muscle activation (22).

STATISTICS:

The sample exhibited a normal distribution, according to the Shapiro-Wilk test for normality. Comparison of the mean scores of the groups was performed by analysis of variance using the Tukey-Kramer test. The analysis was carried out using the BioEstat 5.0 program and the level of significance used for this procedure was 5% $p<0.05$).

RESULTS:

ON exhibited a significant difference ($p<0.01$) for the left and right temporal muscles when comparing pre-surgical (T0) with post-surgical (T2, T3 and T4) timepoints. The left masseter showed a significant difference for timepoints T2 and T4 while the right masseter was statistically significant for all timepoints ($p<0.01$). All the muscles assessed exhibited an increase in duration (ON) after surgery.

Results revealed, 6 months after surgical treatment, no significant difference in the IMAX variable for any of the muscles assessed. At 12, 24 and 60 months after surgery, a percentage increase in IMAX was observed that attained significance for all muscles assessed ($p<0.05$).

The results showed a significant increase in RMS for the masseter muscle bilaterally when comparing T0 against T3 and T4 ($p<0.05$). This difference was also observed for the same timepoints for the right temporal muscle ($p<0.05$), whereas the left temporal muscle showed no significant difference for any of the timepoints ($p>0.05$).

DISCUSSION:

Duration of masticatory cycle (ON):

Values for the ON variable were lower before surgery, showing a significant increase after surgery across all muscles assessed. These results are similar to the findings of Nakaya et al. (23) and of Throckmorton (1), who assessed masticatory cycle duration and reported a significant increase in the length of the cycle time. Similarly, Proschel et al.(24) reported an increase of 0.2 seconds while Youssef et al. (11) described a rise of 0.01 seconds in the length of the cycle after orthognathic surgery, minimal differences which did not reach significance in either of the studies. This result most likely occurred because the respective samples included different types of occlusion, where each tends to differ in terms of muscle biomechanics, perhaps masking the true findings. Studies by Ingervall et al. (25) and Kobayashi et al. (8) using electromyography reported a reduction in masticatory time two years after surgical intervention, contradicting our results. This disparity may be because the sample used by these authors failed to determine the presence or absence of temporomandibular disorders among the volunteers, leading to variations in electromyographic recordings (16) and also included both men and women with different malocclusions, important criteria differentiating muscle assessment (26). Another discrepant factor in the study by Ingervall et al. (25)

was the prolonged intermaxillary fixation after surgery, a determinant for recovery of muscle function in lifting and lowering the jaw.

In the present study, it is noteworthy that prior to surgery, the verticalized masticatory patterns characteristic of malocclusions (27,28) were evident, exhibiting reduced horizontal vector and predominant verticality, compensating the interference in the anterior zone of the arches. The muscle pattern was found to alter after surgery, showing a more symmetrical cycle in which the horizontal vector increased and verticality decreased. The increase in the horizontal vector was measured as a function of time, showing that the increase in the length of the cycle after surgery approached normal levels, where a typical cycle in normal occlusion ranges from 0.6 to 1 second (11, 27). Another important factor is the presence of the incisal guide and canine which directs the mandible, rendering the masticatory movement more coordinated. This factor, together with the elevating muscles of the mandible, allows improved meshing of the teeth (molars, pre-molars, canines and finally incisors) lengthening the duration of this movement.

Instant of maximum activity of the masticatory cycle (IMAX).

Values of less than half the length of the cycle were observed prior to surgery, with IMAX values increasing to almost half the length of the masticatory cycle after surgery, showing a cycle with symmetric elevation and decrease, suggestive of improvement in mastication post surgically. Di palma et al. (6) showed improvement in muscle asymmetry after orthognathic surgery, explained by occlusal stability as opposed to improved biomechanics of the muscle action resulting from orthognathic surgery. However, there is a dearth of specific studies on the assessment of the IMAX variable in the related literature. It can be concluded that improvements in both biomechanical and occlusal conditions lead to enhanced distribution of the mechanical stimuli signalling the periodontal mechanoreceptors, conveying information to the CNS to regulate muscle activity and establish equilibrium of the stomatognathic system over time.

RMS (Root Mean Square).

The RMS analysis revealed a general significant reduction in masseter and temporal muscle activity at T1 compared with values before surgery. These findings suggest that after orthognathic surgery, possible traumas in the tissue remain, and that this reduction in activity might be associated to a neuromuscular protective mechanism (29). Electromyographic activity increased for all muscles over time, reaching significance for the right temporal muscle five years after surgery and for the masseters twelve months after surgery. This same behavior was also seen in the studies by Shiratsuchi et al. (7); Ellis et al. (30), who concluded that the increase in activity of the muscles in the masticatory cycle is a parameter of improvement in function.

We believe that the increase in EMG activity of the masseter muscle was swifter than for the temporal muscle, a phenomenon which may be explained by the change in occlusal biomechanics, whereby alterations in occlusion can affect equilibrium and consequently impact muscle function (31). In the new occlusal biomechanics after surgery, new contact at incisal level was noted which, upon mechanical stimulation during mastication evoke neural excitation reflexes directly in the same motor unit of the masseter (26,28), augmenting and stabilizing the electromyographic signal. The temporal muscle however, is a postural muscle associated with control of mandibular movements (32,33), showing more stable results only five years after surgical treatment. Therefore, further equilibrium in masticatory function may have occurred beyond this period, given the temporal and masseter muscles have a direct relationship with the morphofunctional structure of the stomatognathic system..

Several limitations inherent to this study should be pointed out, such as the small number of volunteers assessed. Notwithstanding, there is currently a lack of studies involving more specific electromyographic variables of the masticatory cycle and further studies investigating larger samples and other dentoskeletal classifications are warranted.

CONCLUSION:

Based on these results, it can be concluded that orthognathic surgery promoted positive changes in the masticatory cycle five years after surgical treatment in individuals with mandibular prognathism and no temporomandibular disorder (TMD).

ACKNOWLEDGMENTS

- The authors thank the Foundation of Research Support in the State of São Paulo (FAPESP) for providing financial support for the first author (research project 2010/08185-1).

.REFERENCES

1. Throckmorton GS, Ellis E 3rd (2001) The relationship between surgical changes in dentofacial morphology and changes in maximum bite force. J Oral Maxillofac Surg 59, 620-7.

2. Duque FLS, Jaramillo PMV, Farbiarz JF, Alvarez DLM, Pelaez AV, Otálvo GJC (2002) Cambios Electromiográficos Después de Cirurgia Ortognática: Reporte de Cuatro Casos. Revista Facultad de Odontología Universidad de Antioquia. 13, 35-50

3. Eckardt L, Harzer W, Schneevoigt R (1997) Comparative study of excitation patterns in the masseter muscles before and after orthognathic surgery. J of Cranio-Maxillofacial surg 25, 344-352.

4. Raustia AM, Oikarinen KS (1994) Changes in electrical activity of masseter and temporal muscles after mandibular sagittal split osteotomy. J Oral Maxillofacial Surg. 23, 180-4.

5. Sforza C, Peretta R, Grandi G, Ferronato G, Ferrario VF (2008) Soft Tissue Facial Planes and Masticatory Muscle Function in Skeletal Class III Patients Before and After Orthognathic Surgery Treatment. J Oral Maxillofac Surg 66, 691-698.

6. Di Palma E, Gasparini G, Pelo S, Tartaglia GM, Chimenti C (2009) Activities of masticatory muscles in patients after orthognathic surgery. J of Cranio-Maxillofacial surg 37, 417-420.

7.Shiratsuchi Y, Kouno K, Tashiro H. Evaluation of Masticatory function following Orthognathic Surgical Correction of mandibular Prognathism. Journal of Cranio-Maxillofacial Surgery. 1991; 19:299-303.

8. Kobayashi T, Honma K, Nakajima T, Hanada K (1993) Masticatory Function in Patients With Mandibular Prognathism Before and After Orthognathic Surgery. J of Cranio-Maxillofacial Surgery 51, 997-1001.

9. Kobayashi, T; Honma, K; Shingaki, S; Nakajima, T (2001) Changes in Masticatory Function After Orthognathic Treatment in Patients with Mandibular Prognathism. J of Cranio-Maxillofacial Surgery 39, 260-265.

10. Lehman GJ, Mcgill SM (1999) The importance of normalization of surface electromyography: a proof of principle. J Manipul Physiol Therap 22, 444-6.

11. Youssef RE, Throckmorton G.S, Ellis E, Sinn DP (1997) Comparison of habitual masticatory cycles and muscle activity before and after orthognathic surgery. J Oral Maxillofacial Surg 55, 699-707,

12. Arnett GW, Bergman R (1993) Facial keys to orthodontic diagnosis and treatment planning. Part I and II. Am J Orthod Dentofacial Orthop 103: 299-411.

13. Dworkin SF, LeResche L (1992) Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. J Craniomandib Disor 6, 301-355.

14. De Luca CJ (1984) The use surface eletromyographic amplitude normalization methods improving their sensitivity as diagnostic tools in gait analysis. Arch Phys Med Rehabil 65, 517-521

15. Cram JR, Kassman GS, (1998) Holtz J. Introduction to surface eletromyography. Gaithesburg, Maryland: Aspen publication,.

16. Duarte Kroll C, Bérzin F, Alves MC (2010) Clinical evaluation of masticatory muscles activity during habitual mastication study about normalization of electromyographic data. Rev Odontol UNESP 39, 157-162.

17. Biasotto DA (1999) Estudo eletromiográfico dos músculos do sistema estomatognático durante a mastigação de diferentes materiais [dissertação mestrado]. Piracicaba: Faculdade de Odontologia da UNICAMP.

18. Mongini F, Tempia-Valenta G, Conserva E (1989) Habitual mastication in dysfunction a computer-based analysis. J Prosthet Dent 61, 484-94.

19. Hanawa S, Tsuboi A, Watanabe M, Sasaki K. EMG (2008) Study for perioral facial muscles function during mastication. J Oral Rehabil. 35,159-70.

20. Soderberg GL, Knutson, LM (2000) A guide for use and interpretation of kinesiologic electromyographic data. Phys Ther 80, 485-98.

21. Lin HT, Hsu AT, Chang JH, Chien CS, Chang GL. (2008) Comparison of EMG activity between maximal manual muscle testing and cyber maximal isometric testing. J Formos Med Assoc 107, 175-80.

22. Basmajian JV, DeLuca CJ (1985) Muscle alive: their functions revealed by electromyography. Baltimore: Williams & Wilkins.

23. Nakaya Y, Nakamura T, Ishikawa H (1997) Chewing rhythm in skeletalbclass III patients. The Journal of Japan Ortodontic Society 56, 170-179

24. Pröschel PA, Hümmer H, Hofmann M, Spitzer W (1990) Reaction of mastication to oclusal change induced by correction of mandibular prognathism. J Prosthet Dent. 64, 211-8.

25. Ingervall B, Rindell A. Thilander B (1979) Changes in activity of the temporal and masseter and lip muscle after surgical correction of mandibular prognathism. J Oral Surg 8, 290-300.

26. Yamamura C, Taguchi Y, Shimada K (1995). Reflex controls of masseter motor unit activity with incisal stimulation in humans. Brain and Oral Function 375-79

27. Ahlgren, J. Masticatory movements in mam (1976) In DJ. Anderson, B Matthews- Mastication. Great Britain, J. Wright and Sons 119-130.

28. Yamamura C, Shimada K (1993) Differential controls of small and large motor unit activity in the masseter muscle with incisal stimulation in humans. Brain Res 632, 339-41.

29. Bianchini EMG (2001) Avaliação fonoaudiológica da motricidade oral: Distúrbios miofuncionais orais o situações adaptativas. Ver Dent Press Orthodon Ortopedi Facial 6, 73-82.

30. Ellis E 3rd, Throckmorton G, Sinn DP (1996) Functional characteristics of patients with anterior open bite before and after surgical correction. Int J Adult Orthodon Orthognath Surg 11, 211-23.

31. Amorim MM, Borini CB, Lopes SL, Haiter-Neto F, Bérzin F, Caria PH (2008) Relationship between the inclination of the coronoid process of the mandible and the electromyographic activity of the temporal muscle in skeletal Class I and II individuals. J Oral Sci. 50, 293-9.

32. Ahlgren J. (1986) Emg pattern of temporalis in normal occlusion. Eur J Orthod. 8, 185-91.

33. Kerstein RB (2004) Combining technologies: a computerized occlusal analysis system synchronized with a computerized electromyography system. Cranio. 22, 96-109.

TABLES

Table 1: Evaluating ON: Mean (M), Standard desvaition (SD), between baseline (T0) and each post-surgery period (T1, T2, T3 and T4).

DURATION OF MASTICATORY CYCLE ACTIVITY (ON) ms								
	LT		RT		LM		RM	
	M	SD	M	SD	M	SD	M	SD
T0	419.80	±6	394.06	±6	485.81	±9	409.90	±6
T1	426.10 ^{ns}	±6	397.06 ^{ns}	±6	475.20 ^{ns}	±10	520.80*	±6
T2	726.07*	±11	688.45*	±14	703.60*	±23	686.47*	±13
T3	584.82*	±6	551.16*	±8	551.16 ^{ns}	±4	603.30*	±6
T4	640.92*	±6	563.70*	±6	661.95*	±3	645.54*	±8

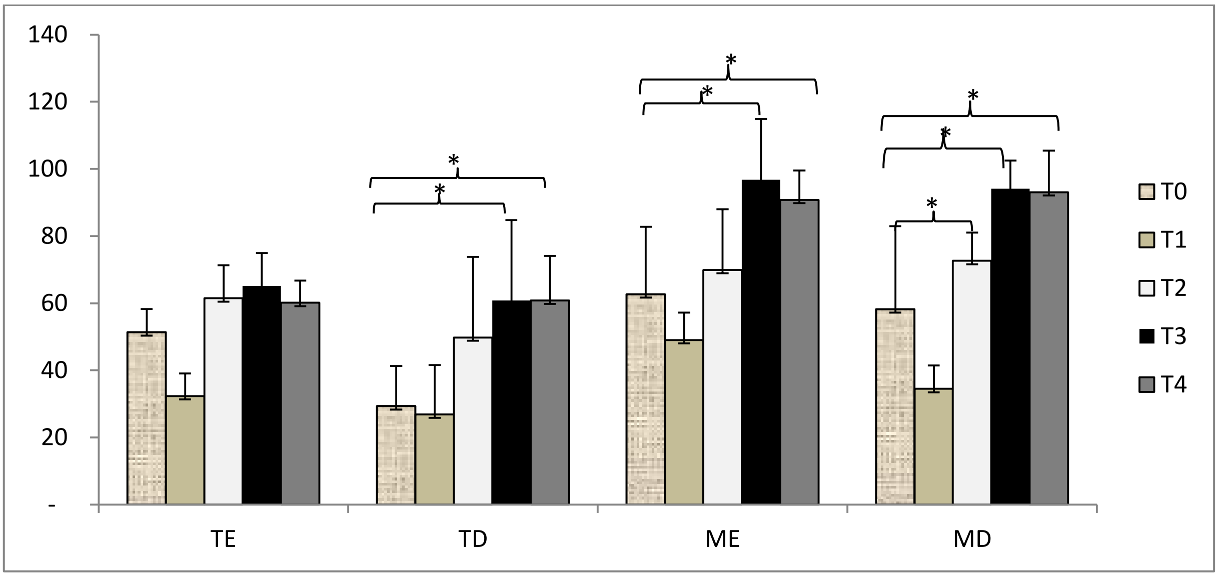
LT=Left temporal, RT=Right Temporal, LM=Left maseter, RM=Right maseter, ms= milliseconds (1000 ms = 1s), M = mean, SD = standard deviation. T0 = 2-3 months before OS, T1 = 6 months after OS, T2 = 12 months after OS, T3 = 24 months after OS, T4 = 60 months after OS. *significant to p<0.05, ** Significant to p <0.01

TABLE 2: Evaluating IMAX: Mean (M), Standard desvaition (SD), between baseline (T0) and each post-surgery period (T1, T2, T3 and T4).

MAXIMUM INSTANT OF THE ACTIVITY (IMAX) %								
	TE		TD		ME		MD	
	M	DP	M	DP	M	DP	M	DP
T0	37,95	±6	37,76	±8	39,27	±8	37,76	±8
T1	42,21^ns	±13	40,34^ns	±14	38,35^ns	±7	47,65^ns	±13
T2	58,42*	±12	56,04*	±9	56,55*	±14	56,04*	±9
T3	63,43*	±8	63,23*	±10	55,97*	±7	63,23*	±10
T4	54,79*	±4	53,86*	±7	53,61*	±10	53,86*	±7

*p<0.05, quando comparado T0 com T1, T2, T3 e T4.

GRAPHIC 1: Analysis of RMS. LT = Left Temporal, RT = right temporal, LM = left masseter, RM = Right Masseter.



* p <0,05, When comparing T0 with T1, T2, T3 and T4.

FIGURE 1: Masticatory cycle assessment (cutting the last and first cycle chewing)

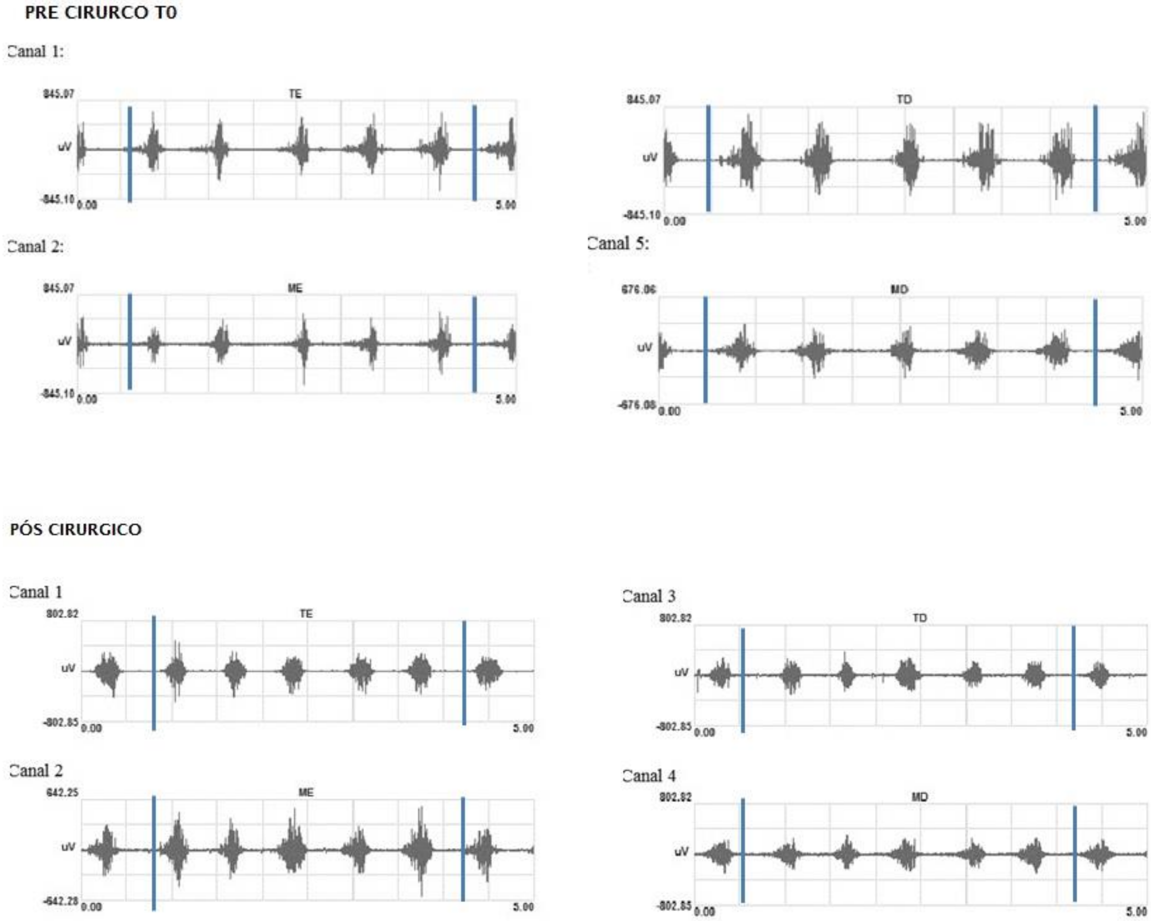
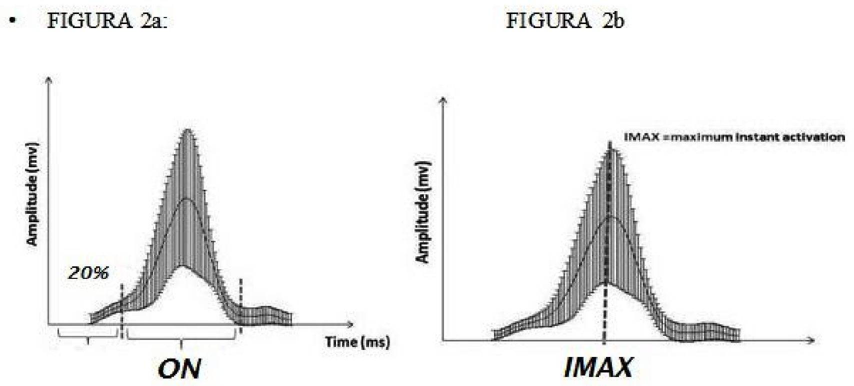


Figure 2: Duration of masticatory cycle activity, analysis function of time (2a) and maximum instant of the activity, analysis in percentage (2b).



CONCLUSÃO:

Concluímos que cirurgia ortognática é um tratamento que ajuda a melhorar alguns sinais e sintomas das disfunções temporomandibulares. Não obstante, é de especial importância realizar uma boa avaliação aos pacientes que apresentem qualquer tipo de disfunção temporomandibular (DTM), sugere-se que antes de qualquer tratamento cirúrgico, seja avaliada e tratada esta condição.

Pacientes com deformidade dentofacial, como prognatismo mandibular apresemtam um fator de risco para depressão e para a dor crônica, porém se sugerimos suporte psicológico pré e após intervenção cirúrgica. Neste estudo observamos que a depressão e a dor crônica diminuíram após cinco anos da cirurgia ortognática.

Em relação à estrutura muscular de voluntários sem disfunção temporomandibular observamos que o tempo ativo, o instante máximo e a atividade eletromiográfica do ciclo mastigatório foram incrementados após a cirurgia ortognática, ou seja, o paciente apresentou os ciclos de sua mastigação mais simétricos.

REFERÊNCIAS:

Alvarez DLM, Pelaez AV e Otálvo GJC. Cambios Electromiográficos Después de Cirurgia Ortognática: Reporte de Cuatro Casos. Revista Facultad de Odontología Universidad de Antioquia. 2002;13(2):35-50

Bricot, B. Posturologia. São Paulo: Ed. Ícone, 1999.

Ghessa G, Capobianco S, Lai V. Stabilometria e disturbi cranio-cervico-mandibolari. Minerva Stomatol. 2002; 51(5):167-171.Duque FLS, Jaramillo PMV, Farbiarz JF, Issa JPM, Silva AMBR, Beebe NT, Silva MAMR. Posturologia associada à disfunção da ATM. Rev. DOR 2005; 6(1):454-459.

Pedroni CR, Oliveira AS, Guaratini MI. Prevalence study of signs and symptoms of temporomandibular disorders in university students. J Oral Rehabil. 2003; 30(3): 283-9.

Rodrigues D, Semeghini TA, Monteiro-Pedro V, Bérzin F. Alterações posturais e desordem craniomandibular. [resumo] Rev Fisioter Univ São Paulo 1999; 6(Supl):41.

Sforza C, Peretta R, Grandi G, Ferronato G, Ferrario VF. Soft Tissue Facial Planes and Masticatory Muscle Function in Skeletal Class III Patients Before and After Orthognatic Surgery Treatment. J Oral Maxillofac Surg 2008;66(4):691-698.

Steenks MH, DeWijer A. Disfunção da articulação temporomandibular do ponto de vista da fisioterapia e da odontologia. 1ª ed. São Paulo: Santos, 1996.

Takeda, H et al. Examination of Masticatory Movement and Rhythm Before and After Surgical Orthodontics in Skeletal Class III Patients With Unilateral Posterior Cross-Bite. Journal of Oral and Maxillofacial Surgery. 2009;67:1844-1849.

ANEXOS

ANEXO 1

Certificado do Comitê de Ética em Pesquisa da Fop/UNICAMP.

(protocolo Nro 035/2010) e TCLE.

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 **"Avaliação cefalométrica, eletromiográfica, da simetria muscular e da dor dos músculos da mastigação em pacientes classe III esquelética submetidos a tratamento ortodôntico-cirúrgico"**, protocolo nº 035/2010, dos pesquisadores Fausto Bérzin, Maria Beatriz Duarte Gavião e Rosario Martha de La Torre Vera, satisfaz as exigências do Conselho Nacional de Saúde - Ministério da Saúde para as pesquisas em seres humanos e foi aprovado por este comitê em 10/05/2010.

The Ethics Committee in Research of the School of Dentistry of Piracicaba - State University of Campinas, certify that the project **"Electromyographic, cephalometric, muscular symmetry and pain evaluation of masticatory muscles in skeletal Class III patients undergoing orthodontic-surgical treatment"**, register number 035/2010, of Fausto Bérzin, Maria Beatriz Duarte Gavião and Rosario Martha de La Torre Vera, 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 05/10/2010.

Prof. Dr. Pablo Agustin Vargas
Secretário
CEP/FOP/UNICAMP

Prof. Dr. Jacks Jorge Junior
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.

ANEXO 2

Carta de submição para revista Cientifica, do capitulo I.

Journal of Oral and Facial Pain and Headache

Dear Dr DE LA TORRE VERA,

Thank you very much for submitting the above article to the Journal of Oral and Facial Pain and Headache. The manuscript is being evaluated and we will contact you as soon as a decision has been made. The standard review process is conducted by an Associate Editor and independent reviewers who are selected for their expertise in that topic. Each article is treated as a confidential document. Dr. Ilana Eli (Email: elilana@post.tau.ac.il) is the Associate Editor handling the review of the article. Please contact her if you have any questions about your paper. Please inform us by return of email if this version does not correspond with the version that was submitted.

The progress of your manuscript can be followed from the progress report accessed from your user account.

Yours sincerely,

Barry J. Sessle

Editor-in-Chief

Journal of Oral and Facial Pain and Headache

Faculty of Dentistry

University of Toronto

124 Edward Street

Toronto

Ontario M5G 1G6

CANADA

Fax +1 416 979 4936

ANEXO 3

ARTIGO I

RESUMO EM ESPANHOL

Evaluación de los disfunciones temporomandibulares, del dolor crónico y la depresión pre y post cinco años de cirugía ortognatica en pacientes con prognatismo mandibular.

Objetivo: Evaluar durante cinco años las posibles mudanzas en las señales y síntomas de las disfunciones temporomandibulares (DTMs), así como también evaluar la presencia del dolor y de la depresión, en individuos con prognatismo mandibular sometidos a tratamiento ortodontico (O) y con cirugía ortognatica (COR).

Metodologia: Fueron evaluados 20 pacientes con prognatismo mandibular con edades entre 18 y 36 años (23.3 ± 8.2) en los períodos: pré-operatórios (2 a 3 meses antes da cirurgia = T0) y pós-operatório (6 meses = T1, 12 meses = T2, 24 meses = T3 y 60 meses =T4). Las señales y sintomas de las DTMs, así como también la presencia de dolor crônico y la depresion fueron evaluadas a través del RDC/TMD eje I y eje II respectivamente.

Resultados: Se observó mudanzas significativas para las señales y síntomas de las DTMs, en ruidos articulares para T1 (p=0.0020) y T4 (p=0.0044), el dolor muscular también disminuyó significativamente en T2 (p=0.01), T3 (p=0.0022) y T4 (p=0.0433). En relación a la desviación en la apertura bucal se muestra una corrección significativa en T1 (p=0.0002), T2 (p=0.0009), T3 (p=0.0004) y T4 (0.0004). La amplitud de la apertura bucal fue reducida solo en T1 (p=0.0001), pero no en T2, T3 y T4. El dolor crónico fue reducido [T3 (p=0.013) y T4 (p=0.0045)] y la depreción [T4 (p=0.0139)]. Hay asociación entre dolor crónico y DTM (p=0.0030) y entre dolor crónico y depresión (p=0.0230) esto observado pre tratamiento quirúrgico. No existe diferencia significativa en relación a la presencia ou ausencia de las DTMs pre y post tratamiento.

Conclusão: La cirugía ayudo a mejorar la auto-percepción del dolor crónico, así como también, mejoraron los niveles de depresión en este tipo de pacientes post cinco años del tramiento con cirurgia ortognática.

Palabras Claves: Disfunciones temporomandibulares; dolor crónico, depresión, cirugía ortognática y prognatismo mandibular.

ANEXO 4

ARTIGO II

RESUMO EM PORTUGUES:

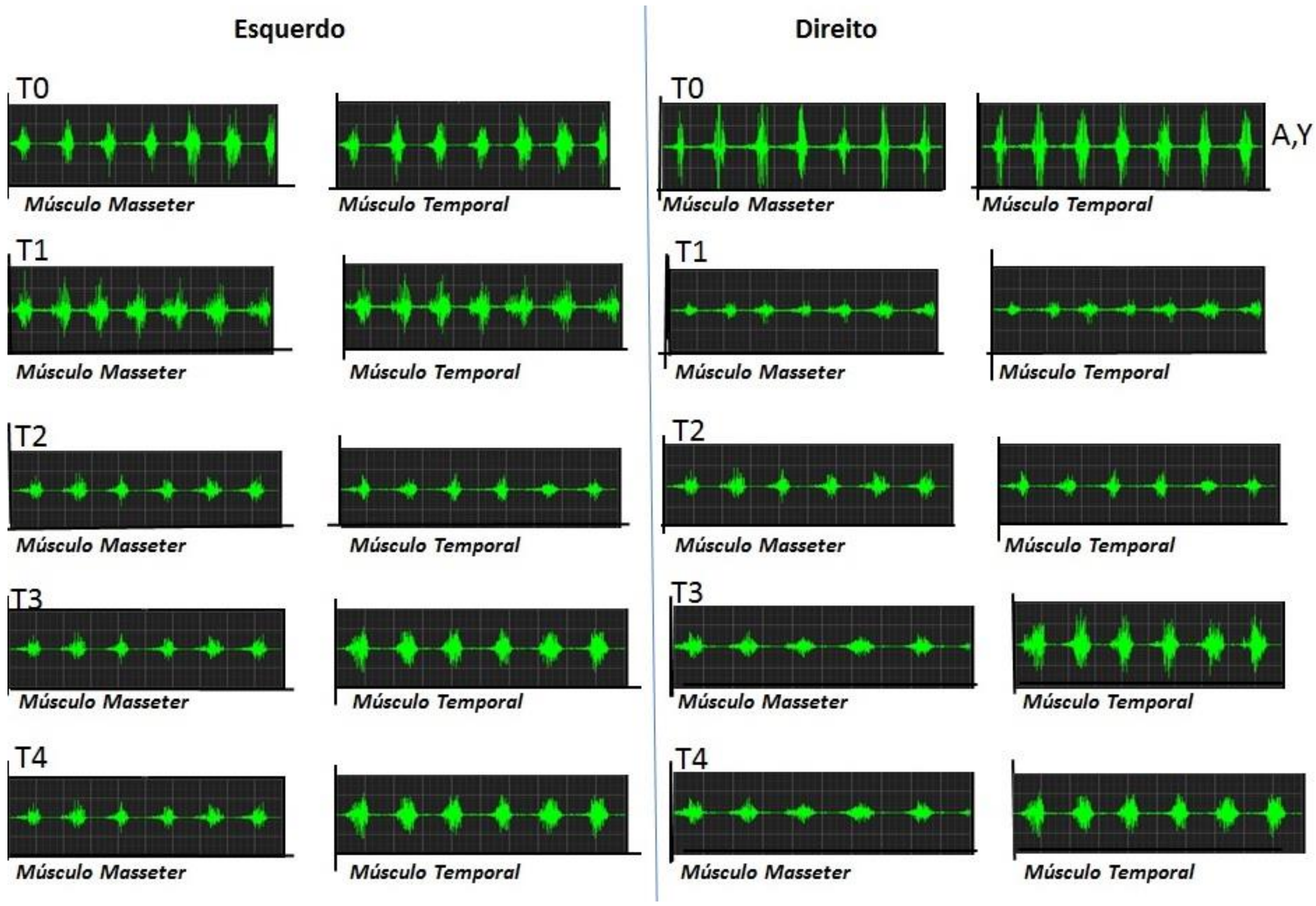
Avaliação eletromiografica do ciclo mastigatorio pre e após cinco anos da cirurgia ortognatica, em pacientes com prognatismo mandibular.

Objetivo foi avaliar as características eletromiográficas (EMG) do ciclo mastigatório pré e pós cinco anos de cirurgia ortognatica em voluntários com prognatismo mandibular, avaliando três variáveis: tempo ativo do ciclo mastigatório (ON), instante máximo da atividade (IMAX) e RMS (Root means square). Metodologia: foram avaliados 13 voluntários prognatas do gênero masculino, nos períodos Pré-cirurgia 2-3 meses (T0); Pós-cirurgia 6 meses (T1), 12 meses (T2), 24 meses (T3) e 60 meses (T4). Os músculos avaliados foram à parte anterior do temporal bilateralmente e a parte superficial dos masseteres bilateralmente. Foi utilizado o Teste de normalidade de Shapiro-Wilk; e a análise de variância usando o teste de Tukey-Kramer, com nível de significância de 5% ($p<0.05$). Resultados: Após a cirurgia todos os músculos apresentaram um incremento do tempo (ON), sendo este significativo para todos os músculos pós 60 meses. Existe um aumento do IMAX expressado em porcentagem sendo este significativo para todos os músculos ($p<0,05$), após 12, 24 e 60 meses. O RMS aumenta após 24 e 60 meses para o músculo, masseter bilateralmente e para o temporal direito ($p<0.05$). Conclui-se que a cirurgia ortognática gera mudanças positivas no ciclo mastigatório após cinco anos do tratamento cirúrgico, em indivíduos com prognatismo mandibular sem disfunção temporomandibular (DTM).

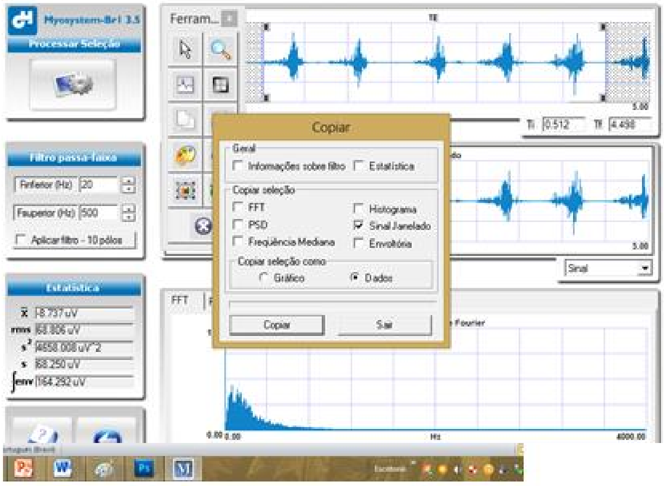
Palavras Chaves: Electromyogrfia; Ciclo mastigatório; Cirurgia ortognatica e Prognatismo mandibular.

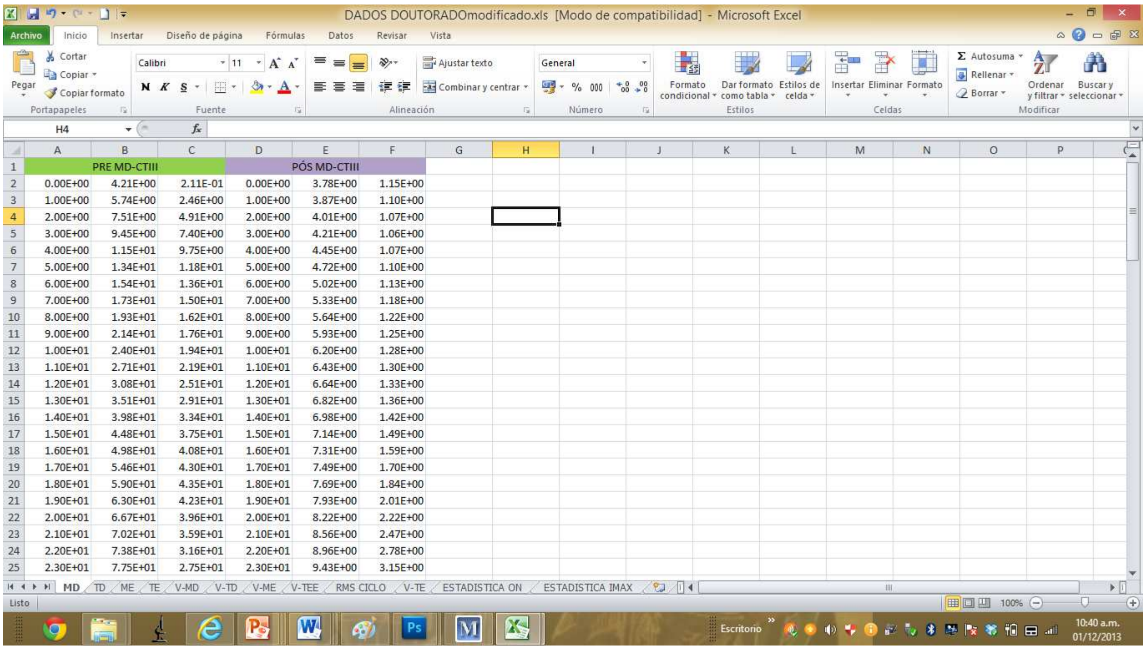
ANEXO 5

ANÁLISE DO CICLO MASTIGATORIO NO PRPGRAMA DO ELETROMIOGRAFO MYOSISTEM



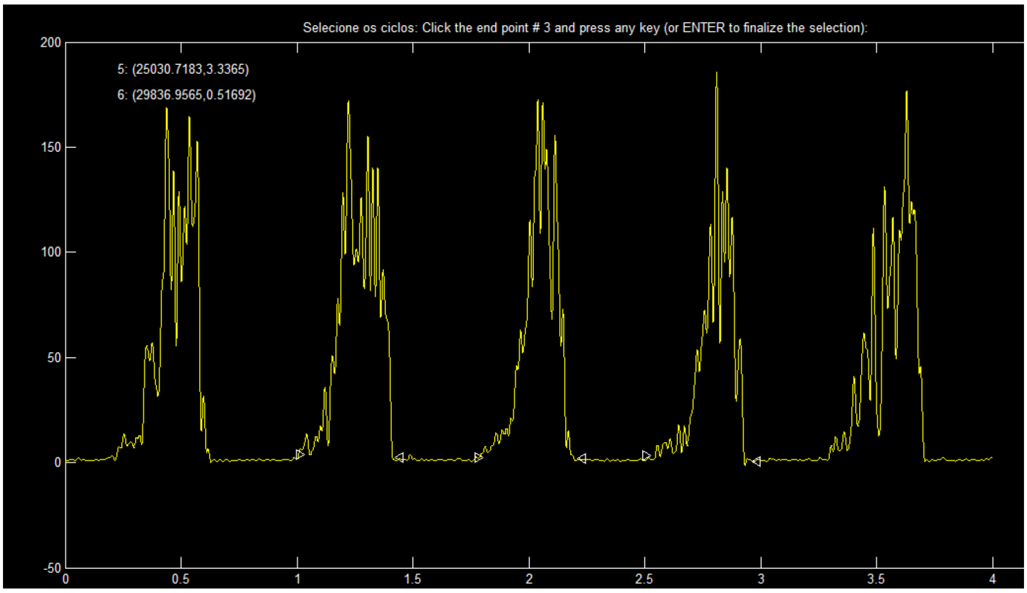
Dados do myosistem analisados no Exel y posteriormente no MATLAB





	B	C	D	E	F
PRE MD-CTIII			PÓS MD-CTIII		
0.00E+00	4.21E+00	2.11E-01	0.00E+00	3.78E+00	1.15E+00
1.00E+00	5.74E+00	2.46E+00	1.00E+00	3.87E+00	1.10E+00
2.00E+00	7.51E+00	4.91E+00	2.00E+00	4.01E+00	1.07E+00
3.00E+00	9.45E+00	7.40E+00	3.00E+00	4.21E+00	1.06E+00
4.00E+00	1.15E+01	9.75E+00	4.00E+00	4.45E+00	1.07E+00
5.00E+00	1.34E+01	1.18E+01	5.00E+00	4.72E+00	1.10E+00
6.00E+00	1.54E+01	1.36E+01	6.00E+00	5.02E+00	1.13E+00
7.00E+00	1.73E+01	1.50E+01	7.00E+00	5.33E+00	1.18E+00
8.00E+00	1.93E+01	1.62E+01	8.00E+00	5.64E+00	1.22E+00
9.00E+00	2.14E+01	1.76E+01	9.00E+00	5.93E+00	1.25E+00
1.00E+01	2.40E+01	1.94E+01	1.00E+01	6.20E+00	1.28E+00
1.10E+01	2.71E+01	2.19E+01	1.10E+01	6.43E+00	1.30E+00
1.20E+01	3.08E+01	2.51E+01	1.20E+01	6.64E+00	1.33E+00
1.30E+01	3.51E+01	2.91E+01	1.30E+01	6.82E+00	1.36E+00
1.40E+01	3.98E+01	3.34E+01	1.40E+01	6.98E+00	1.42E+00
1.50E+01	4.48E+01	3.75E+01	1.50E+01	7.14E+00	1.49E+00
1.60E+01	4.98E+01	4.08E+01	1.60E+01	7.31E+00	1.59E+00
1.70E+01	5.46E+01	4.30E+01	1.70E+01	7.49E+00	1.70E+00
1.80E+01	5.90E+01	4.35E+01	1.80E+01	7.69E+00	1.84E+00
1.90E+01	6.30E+01	4.23E+01	1.90E+01	7.93E+00	2.01E+00
2.00E+01	6.67E+01	3.96E+01	2.00E+01	8.22E+00	2.22E+00
2.10E+01	7.02E+01	3.59E+01	2.10E+01	8.56E+00	2.47E+00
2.20E+01	7.38E+01	3.16E+01	2.20E+01	8.96E+00	2.78E+00
2.30E+01	7.75E+01	2.75E+01	2.30E+01	9.43E+00	3.15E+00

Recorte dos 05 ciclos mastigatórios mais centrais e homogêneos no período T0



Média do sinal EMG, convertido em um único ciclo e normalizado na base do tempo, referente ao m. temporal direito. Pode-se visualizar o Período Ativo (ON) e o Instante Máximo (IMAX).