MICHELLE SANTOS VIANNA LARA

ATIVIDADE ELETROMIOGRÁFICA DOS MÚSCULOS MASSETER E TEMPORAL EM INDIVÍDUOS COM DIFERENTES TIPOS FACIAIS VERTICAIS

Tese apresentada à Faculdade de Odontologia de Piracicaba, da Universidade Estadual de Campinas, para obtenção do Título de Doutora em Biologia Buco-dental, Área de Concentração em Anatomia.

Orientador: Prof. Dr. Paulo Henrique Ferreira Caria
Co-orientadora: Prof[a]. Dr[a]. Darcy de Oliveira Tosello

PIRACICABA
2007

FICHA CATALOGRÁFICA ELABORADA PELA
BIBLIOTECA DA FACULDADE DE ODONTOLOGIA DE PIRACICABA
Bibliotecário: Marilene Girello – CRB-8ª. / 6159

L32a

Lara, Michelle Santos Vianna.
Atividade eletromiográfica dos músculos masseter e temporal em indivíduos com diferentes tipos faciais verticais. / Michelle Santos Vianna Lara. -- Piracicaba, SP : [s.n.], 2007.

Orientadores: Paulo Henrique Ferreira Caria, Darcy de Oliveira Tosello.
Tese (Doutorado) – Universidade Estadual de Campinas, Faculdade de Odontologia de Piracicaba.

1. Eletromiografia. 2. Cefalometria. 3. Morfologia. I. Caria, Paulo Henrique Ferreira. II. Tosello, Darcy de Oliveira. III. Universidade Estadual de Campinas. Faculdade de Odontologia de Piracicaba. IV. Título.

(mg/fop)

Título em Inglês: Electromyography activity of masseter and temporal muscles in individuals with different vertical facial types
Palavras-chave em Inglês (Keywords): 1. Electromyography. 2. Cephalometry. 3. Morphology
Área de Concentração: Anatomia
Titulação: Doutor em Biologia Buco-Dental
Banca Examinadora: Luciana Reis de Azevedo, Odilon Guariza Filho, Ana Paula de Souza Pardo, Pedro Duarte Novaes, Darcy de Oliveira Tosello
Data da Defesa: 11-12-2007
Programa de Pós-Graduação em 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 11 de Dezembro de 2007, considerou a candidata MICHELLE SANTOS VIANNA LARA aprovada.

PROFa. DRa. DARCY DE OLIVEIRA TOSELLO

PROFa. DRa. LUCIANA REIS DE AZEVEDO

PROF. DR. ODILON GUARIZA FILHO

PROFa. DRa. ANA PAULA DE SOUZA PARDO

PROF. DR. PEDRO DUARTE NOVAES

Dedico este trabalho ao meu marido Flávio, por todo amor, carinho e apoio dedicados durante a realização deste curso, pela compreensão dos momentos ausentes e, por ser meu grande companheiro nos momentos mais difíceis desta caminhada.

Aos meus pais Paulo e Heloiza, pelo amor, carinho e dedicação durante toda a minha formação humana e profissional, e por vezes abrirem mão dos seus sonhos para tornarem os meus e do meu irmão realidades.

Ao meu irmão Alexandre, pela amizade, amor e companheirismo em todos os momentos da minha vida.

AGADECIMENTO ESPECIAL

Ao Professor Paulo Henrique Ferreira Caria toda a minha admiração e respeito pela dedicação, profissionalismo e amor com que exerce suas funções de educador e pesquisador. A exímia orientação nesta pesquisa e a amizade a mim dedicada serão eternamente lembradas.

A Professora Darcy de Oliveira Tosello pela competência, atenção e carinho com que me acolheu nesta orientação.

AGRADECIMENTOS

A Deus pelo dom da vida e suas preciosas oportunidades de crescimento e pela superação de todos os obstáculos.

À Faculdade de Odontologia de Piracicaba – UNICAMP, representada pelo seu Diretor Prof. Dr. Francisco Haiter Neto, pelo acolhimento nesta renomada Instituição de Ensino Superior.

Ao Coordenador do Programa de Pós-Graduação em Biologia Buco-Dental, Prof. Dr. Fausto Bérzin, pela oportunidade de fazer parte deste programa, pelo apoio e incentivo na realização do meu trabalho.

Ao Reitor da Pontifícia Universidade Católica do Paraná, Prof. Clemente Ivo Juliato, ao Decano do Centro de Ciências Biológicas e da Saúde, Prof. Alberto Accioly Veiga, ao Decano Adjunto do Centro de Ciências Biológicas e da Saúde, Prof. Sérgio Vieira, ao Diretor do Curso de Odontologia, Prof. Monir Tacla e a Diretora da Clínica de Odontologia, Prof[a]. Vânia Westphalen, a todos minha gratidão pelo apoio e incentivo a realização deste doutorado.

Aos amigos e professores do Programa de Pós-Graduação em Odontologia da PUCPR, Área de Concentração em Ortodontia, pela dedicação e apoio durante a minha formação.

Aos Amigos de trabalho Luciana Reis de Azevedo Alanis e Paulo Sérgio Batista, por entenderem as minhas dificuldades e por me apoiarem nos momentos em que mais precisei. Serei sempre grata!

Aos meus Amigos Cynthia, Cláudia, Maise e Pedro, pela amizade e convivência, compreensão quanto à minha ausência e companheirismo na realização desse trabalho.

Aos Professores Doutores Pedro Duarte Novaes, Francisco Carlos Groppo e Ana Paula Pardo por participarem da minha banca de qualificação contribuindo de forma considerável no engrandecimento desse trabalho.

Ao Prof. Dr. Sérgio Aparecido Ignácio, estatístico da PUCPR, pela competência e presteza na parte estatística desse trabalho.

Aos amigos do departamento Cris, Juliana, Cristiano, César, Cristina e Felipe pela amizade e convivência durante esses anos.

Às secretárias Joelma, Eli, Suzete, que sempre me ajudaram com a maior boa vontade nos momentos em que necessitei.

Aos alunos e funcionários voluntários da FOP que acreditaram nesse trabalho e permitiram a realização dos exames eletromiográficos.

Aos meus sogros Arlei e Terezinha e cunhado Fausto, pelo amor e carinho e por me acolherem incondicionalmente em sua família.

A todos os meus familiares e amigos que souberam compreender minha ausência durante a realização deste estudo.

RESUMO

A influência dos músculos mastigatórios sobre a morfologia facial é importante para o entendimento do crescimento normal e da manifestação das anomalias morfológicas. O objetivo deste trabalho foi avaliar a atividade eletromiográfica dos músculos masseter e temporal em indivíduos com diferentes tipos faciais verticais. A amostra foi composta de 44 voluntários com idade entre 18 e 35 anos, de ambos os gêneros sem distinção de etnia. Medidas cefalométricas em telerradiografias em norma lateral e análise de agrupamento foram utilizadas para classificá-los em três grupos, de acordo com as dimensões verticais da face em tipos faciais distintos: braquifacial (Grupo 1), mesofacial (Grupo 2) e dolicofacial (Grupo 3). Além da avaliação cefalométrica, os voluntários foram submetidos a um exame eletromiográfico com a finalidade de registrar a atividade dos músculos masseter e da porção anterior do temporal em ambos os lados. Foram aplicados os testes Kolmogorov-Smirnov e de Levene para verificar a normalidade e a homogeneidade de variância. ANOVA e o teste de Kruskal-Wallis identificaram diferenças estatísticas entre grupos para os dados que apresentaram e não apresentaram distribuição normal e homogênea, respectivamente. Todos os testes estatísticos foram realizados com nível de significância de 5% ($p < 0,05$). Para a avaliação repouso apenas os músculos temporal e masseter direitos apresentaram diferença estatisticamente significante entre os grupos. As diferenças foram observadas entre os Grupos 1 e 2 ($p = 0,02$) e 1 e 3 ($p = 0,038$) para o músculo temporal direito; e entre os Grupos 1 e 2 ($p = 0,029$) para o músculo masseter direito, tendo o Grupo 1 apresentado sempre os menores valores eletromiográficos. Para a avaliação da isotonia, nenhum dos músculos apresentou diferença estatisticamente significante entre grupos. Mesmo diante das diferenças observadas no repouso, pôde-se concluir que os diferentes tipos faciais verticais não determinam padrões de atividade eletromiográfica distintos para os músculos masseter e porção anterior do temporal durante o repouso e a mastigação bilateral.

Palavras-chaves: Eletromiografia, Músculo Masseter, Músculo temporal, Cefalometria, Morfologia

ABSTRACT

The influence of masticatory muscles over the facial morphology is important to comprehend the normal growth and the manifest of morphological anomalies. The objective of this study was to evaluate the electromyographic activity of masseter and temporal muscles among individuals with different vertical facial types. The sample was composed by forty-four volunteers of both genders ranging from 18 to 35 years of age. Cephalometrics measures in lateral teleradiographs and multivariate statistical analysis were used to classify the volunteers according with their vertical facial dimensions in three groups: brachyfacial (Group 1), mesofacial (Group 2) and dolicofacial (Group 3). Beside this, the volunteers were submitted to an electromyographic examination to register the activity of masseter and anterior portion of temporal muscles bilaterally. The Kolmogorov-Smirnov and Levene tests were applied to verify variance normality and homogeneity. ANOVA and Kruskal-Wallis test identified statistical differences among the studied groups for data that presented and not normal and homogeny distribution, respectively. All statistical tests were performed with 5% of significance level ($p < 0.05$). For rest evaluation only the right temporal and masseter muscles presented statistically significant differences among the groups. The differences were observed between Groups 1 and 2 ($p = 0.02$) and 1 and 3 ($p = 0.038$) for the right temporal muscle; and between Groups 1 and 2 ($p = 0.029$) for the right masseter muscle. Generally, group 1 presented the lowest electromyographic values for the four muscles evaluated during rest. For isotonic, none of the muscles presented statistically significant difference among the groups. For the analyzed sample, it could be concluded that the different vertical facial types do not determine distinct patterns of electromyographic activity to masseter and anterior portion of temporal muscles during the rest and the bilateral mastication.

Key-words: Electromyography, Masseter muscle, Temporal muscle, Cephalometry, Morphology

LISTA DE ABREVIATURAS E SIGLAS

Ag	-	Prata
ArGoMe	-	Ângulo formado entre as linhas formadas pela união dos pontos articular, gônio e mentual.
Cm	-	Centímetros
CMRR	-	*Commom mode rejection ratio*
dB	-	Decibel
EMG	-	Eletromiográfica
FMA	-	Ângulo formado entre o plano de Frankfurt e o plano mandibular
GΩ	-	Giga Ohms
Hz	-	Hertz
ISEK	-	*International Society of Electromyography and Cinesiology*
MIH	-	Máxima intercuspidação habitual
Mm	-	Milímetros
RMS	-	*Root mean square*
SN.GoGN	-	Ângulo formado entre a linha formada pela união dos pontos sela e násio e o plano formado pela união dos pontos gônio e gnátio.

SUMÁRIO

INTRODUÇÃO

A relação entre a forma e a função do crânio é pouco conhecida (Gerstner *et al.,* 1999). Neste sentido, compreender o efeito da atividade dos músculos faciais e mastigatórios sobre a morfologia facial é importante para o entendimento do crescimento normal e da manifestação das anomalias morfológicas. Se a função muscular apresenta efeito significativo, o seu desequilíbrio pode explicar certas alterações da morfologia facial bem como certas formas de maloclusão (Ingervall & Thilander, 1974).

Alguns pesquisadores (Kiliaridis *et al.,* 1991; Ben-Bassat *et al.*, 1993) tentam esclarecer como esta relação forma-função ocorre e então sugerem que a oclusão e a forma facial contribuem com o padrão funcional. Outros sugerem que os parâmetros funcionais e a atividade eletromiográfica são fatores que contribuem significativamente na determinação dos contatos oclusais (Lowe *et al.,* 1983), forma mandibular (Kiliaridis *et al.,* 1989), morfologia e crescimento condilar (Poikela *et al.*, 1995), crescimento e desenvolvimento de outras estruturas anatômicas maxilo-mandibulares (Kiliaridis *et al.,* 1992, Kiliaridis *et al.,* 1995). É possível também que a morfologia dento-esquelética e anatomia neuromuscular, fisiologia e função poderiam se desenvolver ao mesmo tempo, uma otimizando a outra, de acordo com princípios de organização interna. O desafio é identificar diferenças nos estilos mastigatórios, associados exclusivamente com padrões dento-faciais específicos. Então poderia ser possível prever o desenvolvimento desses estilos mastigatórios, determinar quando eles se manifestam ou se podem ser usados como predição de parâmetros de crescimento e desenvolvimento dento-esquelético (Gerstner *et al.,* 1999).

Uma das formas de se estudar a relação entre forma e função é relacionar a morfologia facial e a atividade eletromiográfica dos músculos mastigatórios. O emprego da eletromiografia (EMG) permite uma avaliação quantitativa e qualitativa da função muscular, superando os exames de palpação e inspeção visual, normalmente empregados pela grande maioria dos profissionais. Assim, trata-se de um exame complementar que contribui não só para o diagnóstico de patologias neuro-musculares, mas também para estabelecer um planejamento individualizado e avaliar os resultados do tratamento executado.

O conhecimento de características eletromiográficas para cada grupo de indivíduos com características morfológicas faciais distintas facilitaria sobremaneira o diagnóstico de alterações musculares. Assim como se faz o reconhecimento de alterações esqueléticas e dentárias por meio das análises cefalométricas e de modelos em gesso, o ortodontista seria capaz de reconhecer distúrbios do comportamento muscular no início do tratamento, ou mesmo predizer o tipo de crescimento e desenvolvimento dento-esquelético, bem como estabelecer metas para o tratamento que objetivassem a correção não só da maloclusão, mas também da função muscular.

EMG e tipos faciais

Tendo em vista a inter-relação forma e função, a função mastigatória tem sido amplamente investigada em indivíduos com diferentes características faciais verticais. A função e a anatomia dos músculos mastigatórios têm sido avaliadas por meio da eletromiografia (Ingervall & Thilander, 1974; Ingervall, 1976; Rasheed *et al*., 1996; Ueda *et al*., 1998; Ueda *et al*., 2000; Farella *et al*., 2003; Serrao *et al*., 2003; Farella *et al*., 2005), da medida da força de mordida (Ingervall & Minder, 1997), da tomografia computadorizada (Gionhaku & Lowe, 1989), da ultra-sonografia (Rasheed *et al*., 1996; Raadsheer *et al*., 1996; Raadsheer *et al*., 1999; Benington *et al*., 1999; Farella *et al*., 2003; Şatıroğlu *et al*., 2005) e da ressonância magnética (Al-Farra *et al*., 2001) além de estudos imuno-histoquímicos das fibras musculares (Rowlerson *et al*., 2005).

Ingervall e Thilander (1974) demonstraram a interdependência entre a morfologia facial e a atividade muscular mastigatória em crianças com oclusão normal. As correlações mais evidentes foram observadas durante a mastigação e o apertamento dentário máximo. Para estas funções as amplitudes dos valores eletromiográficos nos músculos temporal e masseter foram maiores nos indivíduos com face curta. Não observaram diferença da atividade EMG entre músculos contralaterais, e nem correlação entre a idade cronológica e a amplitude do sinal eletromiográfico.

Em 1976, Ingervall também observou que os maiores valores eletromiográficos do músculo temporal, tanto na deglutição, quanto na mastigação, estavam relacionados com medidas verticais faciais características de indivíduos com face curta.

Rasheed *et al*. (1996) avaliaram a espessura, por meio da ultra-sonografia, e a atividade eletromiográfica dos músculos masseter e porção anterior do temporal em jovens com maloclusão Classe I e diferentes relações verticais dos dentes anteriores. Observaram espessura aumentada dos músculos nos indivíduos com mordida profunda anterior seguidos daqueles com mordida aberta. A atividade eletromiográfica também foi maior para estes dois grupos quando comparados com indivíduos com relação anterior vertical normal. O índice de atividade indicou que o masseter contribuiu para atividade mais elevada durante o apertamento dentário.

Os músculos masseter, temporal e digástrico de indivíduos adultos com padrão esquelético sagital normal, apresentaram sinal eletromiográfico de baixa amplitude quando avaliados por um período contínuo de 3 horas durante o dia. Vale ressaltar que períodos de alimentação, atividade física e sono não foram avaliados. A atividade eletromiográfica dos músculos masseter e digástrico mostraram correlação negativa significante com a morfologia craniofacial vertical, entretanto o músculo temporal apresentou correlação positiva (Ueda *et al*., 1998).

A atividade eletromiográfica dos músculos masseter, temporal e digástrico de crianças e adultos com padrão esquelético sagital normal, com oclusão aceitável e sem qualquer disfunção temporomandibular, consistia principalmente de sinal de baixa amplitude em um período de 3 horas contínuas de coleta. Períodos de alimentação, atividade física e sono não foram avaliados. A duração dos períodos de atividade EMG dos músculos masseter e digástrico apresentou uma correlação significante com a morfologia facial, tanto nas crianças como nos adultos. Entretanto o músculo temporal não mostrou qualquer correlação (Ueda *et al*., 2000).

Farella *et al*. (2003) observaram que indivíduos com face curta apresentaram secção transversal maior do músculo masseter do que aqueles com face normal para longa. Não conseguiram, entretanto, observar diferenças na atividade eletromiográfica, para a contração voluntária máxima, entre indivíduos com face curta e face normal para longa.

Segundo Serrao *et al*. (2003), a morfologia facial e a função muscular estão intimamente relacionadas. Comparando indivíduos com face longa e curta, de acordo com a

inclinação do plano mandibular, observaram valores eletromiográficos sempre maiores para os músculos da mastigação nos indivíduos com face curta.

Quando indivíduos com face curta e face longa foram comparados entre si por um período de 8 horas seguidas em atividades normais, não houve diferença estatisticamente significante entre os grupos quanto ao número de períodos de ativação por hora do músculo masseter, amplitude eletromiográfica média, e média de duração de atividade EMG. Segundo Farella *et al*. (2005), a atividade habitual do músculo masseter em ambiente natural não foi influenciada pela morfologia craniofacial vertical.

Classificação dos tipos faciais

A aplicação de análises cefalométricas para a classificação de indivíduos em grupos distintos é prática comum nos trabalhos científicos. Embora toda análise cefalométrica traga informações relevantes sobre as estruturas avaliadas, há que se lembrar que a maioria apresenta limitações quanto à interpretação de suas grandezas. Os valores cefalométricos normativos provenientes da cada análise representam médias de populações étnicas distintas, geralmente de caucasianos e a aplicação rígida destes valores pode ser imprópria para todas as populações. Segundo Steiner (1953) e Downs (1948), os valores normativos de suas análises deveriam ser usados como guias e não como valores absolutos para todos os indivíduos. Al-Jasser (2005) afirmou que os valores médios das variáveis cefalométricas para um grupo étnico não podem ser considerados normais para outros.

As diferenças étnicas decorrentes da interação de fatores genéticos e ambientais nas características faciais são notórias. Cada um dos grandes grupos (asiáticos, negros e caucasianos) apresenta suas próprias características, que, de maneira geral, servem para distinguir um grupo do outro. Contudo, a literatura tem mostrado que dentro do próprio grupo étnico, cada sub-grupo apresenta o seu padrão cefalométrico (Burstone, 1958; Holdaway, 1983). São vários os trabalhos (Iizuka, Ishikawa, 1957; Kowaliski *et al.*, 1974; Fonseca, Klein, 1978; McNamara, 1984; Hamdam, Rock, 2001; Lew *et al.*, 1992; Miyajima *et al.*, 1996; Cooke, Wei, 1988; Al-Jasser, 2005; Wu *et al.,* 2007) que procuraram mostrar as diferenças, bem como determinar valores normativos específicos para cada população visando o sucesso no diagnóstico, planejamento e tratamento ortodôntico. Em se tratando

do Brasil, há que se considerar que sua população formou-se a partir de três grupos étnicos: indígenas, negros e brancos. A intensa miscigenação confere a esta população características bastante peculiares, e como já foi demonstrado, os seus valores cefalométricos médios também apresentam diferenças quando comparados aos valores normativos de análises cefalométricas distintas (Martins *et al.*, 1998).

Diante da literatura apresentada, o presente trabalho tem o propósito de estudar a atividade EMG dos músculos masseter e temporal de acordo com os diferentes tipos faciais, classificados por meio de técnicas estatísticas.

Portanto, são objetivos do trabalho:

1 – apresentar a aplicação da análise estatística multivariada para divisão de grupos em uma amostra;

2 – comparar a atividade eletromiográfica dos músculos masseter e temporal entre indivíduos com tipos faciais distintos (mesofacial, braquifacial e dolicofacial).

CAPÍTULO 1

APPLICATION OF MULTIVARIATE ANALYSIS TO DIVIDE GROUPS IN A SAMPLE

Michelle Santos Vianna-Lara, DDS, MSc[a]
Paulo Henrique Ferreira Caria, DDS, MSc, PhD[b]
Sérgio Aparecido Ignácio, PhD[c]
Darcy de Oliveira Tosello, DDS, MSc, PhD[b]

[a]Professor, Department of Anatomy, School of Dentistry of Pontifical Catholic University of Paraná, Curitiba, PR, Brazil
[b]Professor, Department of Morphology, Faculty of Dentistry of Piracicaba – State University of Campinas - UNICAMP, Piracicaba, SP, Brazil
[c]Professor, Department of Statistics, School of Dentistry of Pontifical Catholic University of Paraná, Curitiba, PR, Brazil

Reprint requests to:
Michelle Santos Vianna Lara
Rua Francisco Rocha, 62 – conj. 409. Curitiba, Paraná, Brazil.
CEP. 80420-130. Telephone/Fax: 00(55)413014-0947
E-mail: m.vianna@pucpr.br

Abstract

Objectives: The aim of this study was to compare the classification of the volunteers of three vertical facial groups, according to three cephalometric variables in an independent manner, with the results of multivariate statistical analysis, applied from these three variables, for grouping individuals. **Methods:** Forty-four lateral teleradiographs obtained from individuals of both genders ranging from 18 to 35 years of age were evaluated. FMA, SN.GoGn and gonial angles were measured by means of the Cephalometric Program Radiocef 2000® from the cephalometric points demarcated on the computer monitor. The cephalometric values were tabulated and the vertical groups were classified according to each of the variables, and by means of multivariate statistical analysis. **Results:** Classification of the volunteers by means of the normative values of the cephalometric variables was not coincident for the three variables in the majority of the volunteers. Beside that, classification of the volunteers by means of the grouping analysis was coincident with the classification of at least two cephalometric variables in 79.54% of the sample. **Conclusion:** According to the results, multivariate statistical analysis was shown to be a useful tool for dividing a sample into groups, when based on distinct cephalometric variables that present correlation among them.

Key-words: Multivariate Analysis, Cephalometry, Classification

Introduction

The application of cephalometric analyses to classify individuals into distinct groups is a common practice in scientific studies. Although all cephalometric analysis provide relevant information about the assessed structures, one has to remember that the majority of them have limitations regarding the interpretation of their variables. The normative cephalometric values provided by each analysis represent means of populations of different ethnicities, frequently Caucasians, and the strict application of these values may be unsuitable for all populations. According to Steiner[1] and Downs,[2] the normative values of their analyses must be used as guides and not as absolute values for all individuals. Al-Jasser[3] affirmed that the mean values of cephalometric variables for one ethnic group cannot be considered normal for others.

The ethnic differences resulting from the interaction of genetic and environmental factors on facial characteristics are widely known. Each of the large groups (negroid, mongoloid and caucasoid) present their own characteristics, which serve to distinguish one group from another. Nevertheless, the literature has shown that within an ethnic group itself, each subgroup presents its cephalometric pattern.[4,5] Various studies[3,6-14] have endeavored to show the differences, as well as determine specific normative values for each population, with the goal of successful diagnosis, planning and orthodontic treatment. As far as Brazil is concerned, one has to consider that its population was formed from three ethnic groups: the indigenous population, negroes and whites. Intense miscegenation has conferred extremely peculiar characteristics on this population, and as has already been demonstrated, its mean cephalometric values also present differences when compared with the normative value of different cephalometric analyses.[15]

In addition to these considerations with respect to ethnic characteristics, one notes that when more than one cephalometric variable is applied for classifying individuals in a sample, it is very common to observe incompatibilities among the variables. For example, an individual that presents a FMA value (Frankfurt Mandibular Angle) corresponding to the mesofacial type may, as facial height index (FHI), present a value compatible with that of individuals with a short face. Such incompatibilities may be related to threshold cases, or even to the sampling used to compare the normative values of each

cephalometric analysis related in the literature, since the authors that recommend them used distinct samples.[16]

Therefore, a possible solution for the application of cephalometric analysis in the classification of individuals in distinct groups would be to use analysis techniques for group protocols.[16] This analysis would group individuals that present similar cephalometric values, maximizing the differences among different individuals, irrespective of the number of cephalometric criteria adopted and the normative values recommended for each cephalometric variable.

The aim of this study is to compare the classification of the volunteers of three vertical facial groups, according to three cephalometric variables in an independent manner, with the results of multivariate statistical analysis, applied from these three variables, for grouping individuals.

Material and Methods

This study was conducted with 44 lateral teleradiographs obtained from volunteers of both genders ranging from 18 to 35 years of age. The project was submitted to and approved by the Human Research Ethics Committee of FOP/UNICAMP - Brazil.

The radiographs were analyzed on a viewbox and the anatomic structures were drawn on acetate paper fixed to the radiograph by an orthodontist. According to Miyashita,[17] the following anatomic structures were traced: external acoustic pore, outline of the orbital cavity, mandible, sella turcica and frontonasal suture. Carried through the anatomical structures tracing, the image was digitalized and the FMA[18] (Figure 1), SN.GoGn[1] (Figure 2) and gonial (ArGoMe)[19] angles (Figure 3) were measured by Radiocef 2000® cephalometric program. This combined method (association of manual and computerized methods)[20] was selected because it presented the advantages of being practical to perform, filing, and mainly, precision of the results.

The cephalometric values were tabulated and the vertical groups were classified according to each of the variables, and by means of multivariate statistical analysis.

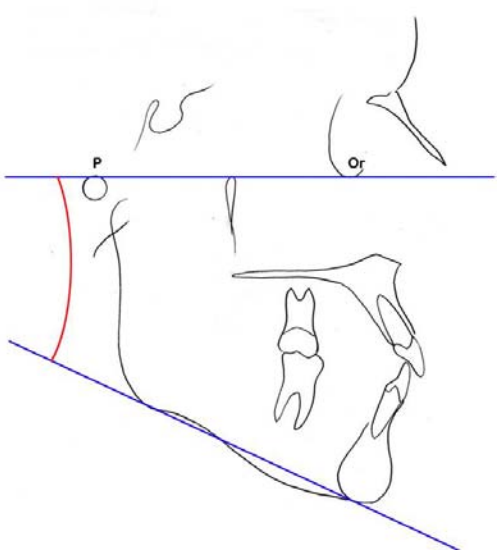

Figure 1 – FMA angle.

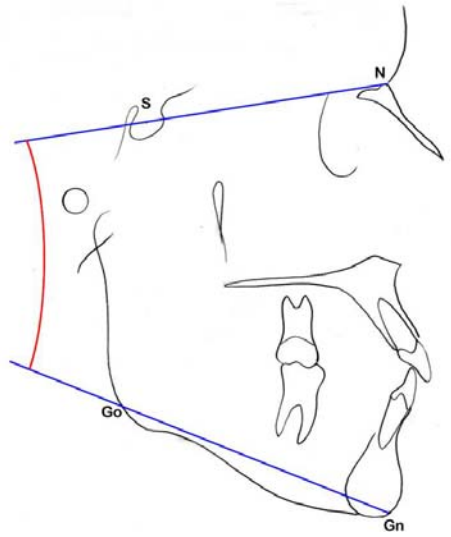

Figure 2 – SN.GoGn angle.

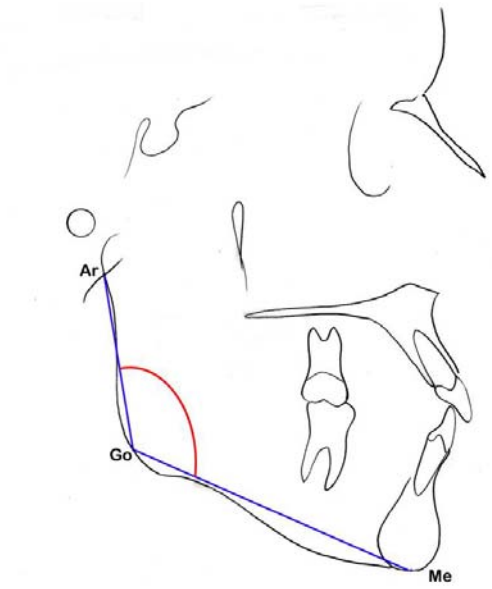

Figure 3 – Gonial angle.

Multivariate Analysis

Grouping the radiographs into three facial groups was obtained from the multivariate statistical techniques (analysis of Pearson's correlation, factorial analysis and grouping analysis). The base for constructing the Pearson's correlation matrix, with a view to application of the factorial analysis, consisted of three cephalometric variables (SN.GoGn, FMA and ArGoMe) obtained from the 44 radiographs of the sample. These variables, which expressed the vertical characteristics of the volunteers, were organized in a matrix form.

From the Pearson's correlation matrix, the multivariate technique denominated factorial analysis was used to summarize the covariance structure in order to provide grouping of the variables involved.

To group the individuals, the k-Means method was used, which is based on two premises: internal cohesion of the observational units and external isolation between the groups, that is to say, minimize the variance within the group and maximize the variance among groups. Calculation of the distances between the volunteers was based on the mean

euclidian distance, measured by the factorial score variable, obtained from reduction of the three original variables into one factor.

Results

The Pearson's correlation test demonstrated a positive correlation between the variables SN.GoGn, FMA and ArGoMe, according to Table I. Application of the factorial analysis technique summarized the three variables into a single factor that explained 85.53% of the total variance of the variables involved in the analysis.

The results of the factorial score obtained by the regression method for each volunteer are shown in Table II. This table also presents the result of grouping the volunteers into three homogeneous groups, based on the ordered factorial score variable for the 44 radiographs of the sample, using the k-Means non hierarchy method.

According to the factorial score, 13 volunteers presented values between –2.563 and –0.526 and were classified as brachyfacial (Group 1). The volunteers that presented values between –0.413 and 0.808 were classified as mesofacial (Group 2), totalizing 24 individuals. In a similar manner, 7 volunteers presented a factorial score between 1.117 and 2.495 and were classified as dolicofacial (Group 3).

The mean and the standard error for each variable, after obtaining the division of the facial groups according to the factorial score, are shown in Table III.

Discussion

The normative cephalometric values adopted for facial type classification represent means of distinct ethnic populations, and the strict application of these values may be unsuitable for this population,[1-3] in view of the innumerable incompatibilities observed. As the ethnic characteristics of the volunteers were not considered in the inclusion criteria in this study, even the mean cephalometric values obtained in the study of Martins et al[15] could not be used, as his work included only young Brazilian leukoderma Mediterranean descendants: Portuguese, Spanish or Italians.

Furthermore, the choice of a single cephalometric criterion for defining the vertical groups would certainly prejudice the classification of borderline volunteers[20]. It

means that, volunteers who in one variable were classified in a certain group could be fitted into another group by a second variable, by only a few hundredths or tenths of degrees. This situation and the difficulty of identifying the cephalometric points demonstrate the difficulty of precisely defining distinct groups when using only one criterion.

The results of comparative studies are dependent on correctly fitting the individuals of a sample into specific groups. If the use of cephalometric measurements in an isolated manner does not allow precise classification, as previously mentioned, the application of a statistical analysis that allows the individuals to be organized into groups according to their facial characteristics, would be a solution.

The multivariate analysis used in the present study consists of a set of statistical techniques that allow simultaneous treatment of innumerable observational units and their corresponding variables.[21] Based on a data matrix of the type "observational units x variables", it is possible to verify, among other evaluations, the similarity among the observational units, and construct groups of similar individuals. The method used is based on two premises: internal cohesion of the observational units and external isolation between the groups, in such a way as to minimize the variance within the group and maximize the variance among groups. This analysis therefore makes it feasible to discriminate the volunteers more accurately, based on the set of variables used without the intrinsic and inherent characteristics of each criterion adopted.

When assuming the normative values for facial type classification according to authors that recommend the cephalometric variables adopted in this study (SN.GoGn[1] – 32º ± 2º; FMA[18] – 25º ± 3º; ArGoMe[19] – 130º ± 7º), it was observed that of the 44 volunteers, 16 presented classification compatible with the three variables. Of the others, 27 presented compatibility with two of the three variables and only 1 volunteer presented a different classification for each of the measurements.

As regards comparison of the classificatory result between the analysis of group and the cephalometric variables, it could be perceived that 35 (79.54%) of the volunteers presented classification compatibility with the result of the statistical analysis and at least two of the three variables. Thus the criteria used presented good compatibility among them

and inferred that application of the multivariate statistical analysis for dividing groups must be based on cephalometric variables that present a strong correlation among them.

For 8 volunteers (18.18%), classification according to two of the three variables did not coincide with the classification according to the grouping analysis. When analyzing the cephalometric values for each of the variables, it could be observed that for 3 of them, this incompatibility was due to threshold cases which, by less than 0.6º of FMA were classified into a group other than the one of the grouping analysis. For the other 5 individuals, the classification of the grouping analysis was coincident only with the variable gonial angle for 4 of them, and with FMA for only 1. The only volunteer classified in a distinct manner for each of the cephalometric variables was also among the borderline cases. This volunteer presented a SN.GoGn value of 34.96º, coming very close to the top limit value for the mesofacial group. If the volunteer was classified as such, compatibility of classification for two of the three variables would be presented, and it would be coincident with the classification according to the grouping analysis.

Conclusions

According to the results:

a) Classification of the volunteers by means of the normative values of the variables SN.GoGn, FMA and ArGoMe, was coincident for the three in only 16 volunteers.

b) Classification of the volunteers by means of the grouping analysis was coincident with the classification of at least two cephalometric variables in 79.54% of the sample.

c) Multivariate statistical analysis was shown to be a useful tool for dividing a sample into groups, when based on distinct cephalometric variables that present correlation among them.

REFERENCES

1. Steiner CC. Cephalometric for you and me. Am J Orthod 1953;39:729-54.
2. Downs WB. Variations in facial relationship. Their significance in treatment and prognosis. Am J Orthod 1948;34:812-40.
3. Al-Jasser NM. Cephalometric evaluation for Saudi population using the Downs and Steiner analysis. J Contemp Dent Pract 2005;6:52-63.
4. Burstone CJ. The integumental profile. Am J Orthod 1958;44:1-25.
5. Holdaway RA. A soft tissue cephalometric analysis and its use in orthodontic treatment planning. Am J Orthod 1983;84:1-28.
6. Iizuka T, Ishikawa F. Normal standards for various cephalometric analyses in Japanese adults. J Jpn Orthod 1957;16:4-12.
7. Kowaliski CJ, Nasjleti C, Walker GF. Differential diagnosis of American adult male black and white populations using Steiner analysis. Angle Orthod 1974;44:346-50.
8. Fonseca RJ, Klein WD. A cephalometric evaluation of American Negro women. Am J Orthod 1978;73:152–60.
9. McNamara JA. A method of cephalometric evaluation. Am J Orthod 1984;86:449-69.
10. Hamdan AM, Rock WP. Cephalometric norms in an Arabic population. J Orthod 2001;28:297-300.
11. Lew KK, Ho KK, Keng SB, et al. Soft-tissue cephalometric norms in Chinese adults with esthetic facial profiles. J Oral Maxillofac Surg 1992;50:1184-9.
12. Miyajima K, McNamara JA, Kimura T, et al. Craniofacial structure of Japanese and European-American adults with normal occlusions and well-balanced faces. Am J Orthod Dentofac Orthop 1996;110:431-8.
13. Cooke MS, Wei SHY. Cephalometric standards for the Southern Chinese. Eur J Orthod 1988;10:264-72.
14. Wu J; Hägg U; Rabie AB. Chinese norms of McNamara's cephalometric analysis. Angle Orthod 2007;77:12-20.
15. Martins DR, Janson GRP, Almeida RR, Pinzan A, Henriques JFC, Freitas MR. Atlas of craniofacial growth. 1 ed. São Paulo: Santos Livraria Editora, 1998.

16. Saga AY, Maruo H, Tanaka O, Ignácio SA. The application of multivariate analysis in the division of groups inside of samples or populations. J Bras Ortodon Ortop Facial 2006;11:22-32.

17. Miyashita K. Contemporary Cephalometric Radiography. Tokyo: Quintessence Publishing Co, 1996.

18. Tweed CH. The diagnostic facial triangle in the control of treatment objectives. Am J Orthod 1969;55:651-7.

19. Björk A. Prediction of mandibular growth rotation. Am J Orthod 1969;55:585-99.

20. Saga AY, Maruo H, Guariza Filho O, Ignácio SA. Comparative study between the conventional (manual) and combined (manual and computadorized) methods applied to Tweed-Merrifield cephalometric analysis. J Bras Ortodon Ortop Facial 2005;10:359-69.

21. Johnson RA, Wichern DW. Applied multivariate statistical analysis. 2 ed. New Jersey: Prentice Hall International, 1988.

TABLE I – PEARSON'S CORRELATION BETWEEN THE VARIABLES SN.GoGn, FMA AND ArGoMe

	SN.GoGn	FMA	ArGoMe
SN.GoGn	1	0.910	0.679
FMA	0.910	1	0.754
ArGoMe	0.679	0.754	1

SOURCE: Research data.

TABLE II – FACTORIAL SCORE OBTAINED ACCORDING TO THE VARIABLES SN.GoGn, FAM AND ArGoMe AND THE RESULT OF GROUPING

RADIOGRAPHY	SN.GoGn	FMA	ArGoMe	FACTORIAL SCORE	FACIAL GROUP
1	16.44	6.37	115.91	-2.563	1
43	16.67	13.36	119.30	-1.967	1
2	27.63	19.52	115.73	-1.201	1
39	21.15	20.37	121.93	-1.186	1
13	23.30	19.98	122.11	-1.090	1
22	28.81	20.79	117.87	-0.961	1
20	26.24	20.28	123.27	-0.864	1
35	28.53	21.86	119.89	-0.813	1
33	25.02	22.83	122.81	-0.796	1
38	26.57	22.01	122.34	-0.788	1
9	32.88	22.55	118.61	-0.609	1
42	25.13	25.15	125.17	-0.537	1
27	29.18	22.57	124.27	-0.526	1
40	28.68	22.29	127.50	-0.413	2
3	27.99	24.82	125.20	-0.407	2
36	26.68	25.17	126.94	-0.370	2
7	28.37	27.04	123.44	-0.339	2
19	31.84	23.30	125.53	-0.284	2
21	25.12	23.06	133.07	-0.283	2
5	28.59	24.41	128.51	-0.242	2
8	34.96	24.22	122.37	-0.219	2
37	30.58	27.67	124.15	-0.152	2
30	28.51	25.44	131.20	-0.054	2
24	35.09	26.28	124.53	0.015	2
17	27.26	26.47	132.89	0.025	2
6	35.06	28.31	123.43	0.083	2
14	33.29	25.93	128.43	0.089	2
34	32.10	29.29	126.04	0.115	2
44	33.69	27.88	129.68	0.287	2
4	31.98	26.54	136.14	0.429	2
31	33.50	28.10	133.57	0.478	2
32	33.60	27.37	135.48	0.531	2
25	36.93	31.34	127.50	0.558	2
12	38.15	29.91	129.25	0.619	2
28	36.03	31.64	129.71	0.636	2
15	36.73	33.15	127.61	0.662	2
29	33.79	31.91	135.35	0.808	2
26	40.67	31.08	135.42	1.117	3
10	36.87	32.96	138.15	1.166	3
41	40.47	32.17	136.61	1.230	3
18	44.55	36.50	130.76	1.420	3

RADIOGRAPHY	SN.GoGn	FMA	ArGoMe	FACTORIAL SCORE	FACIAL GROUP
11	43.50	34.64	138.97	1.649	3
23	49.55	41.5	136.32	2.247	3
16	46.12	37.17	150.57	2.495	3

SOURCE: Research data

LEGENDS: Facial Group: 1 – Brachyfacial; 2 – Mesofacial; 3 – Dolicofacial.

TABLE III – DESCRIPTIVE STATISTICS OF THE VARIABLES SN.GoGn, FMA AND ArGoMe, ACCORDING TO GROUPS

VARIABLE	1 (n=13)		2 (n=24)		3 (n=7)	
	MEAN	SE	MEAN	SE	MEAN	SE
SN.GoGn	25.196	1.333	32.022	0.744	43.104	1.578
FMA	19.818	1.353	27.148	0.599	35.146	1.352
ArGoMe	120.708	0.850	128.647	0.835	138.114	2.303

SOURCE: Research data
LEGENDS: 1 – Brachyfacial; 2 – Mesofacial; 3 – Dolicofacial.

CAPÍTULO 2

ELECTROMYOGRAPHIC ACTIVITY OF MASSETER AND TEMPORAL MUSCLES IN INDIVIDUALS WITH DIFFERENT VERTICAL FACIAL TYPES

Michelle Santos Vianna-Lara, DDS, MSc[a]
Paulo Henrique Ferreira Caria, DDS, MSc, PhD[b]
Darcy de Oliveira Tosello, DDS, MSc, PhD[b]

[a]Professor, Department of Anatomy, School of Dentistry of Pontifical Catholic University of Paraná, Curitiba, PR, Brazil
[b]Professor, Department of Morphology, Faculty of Dentistry of Piracicaba – State University of Campinas - UNICAMP, Piracicaba, SP, Brazil

Reprint requests to:
Michelle Santos Vianna Lara
Rua Francisco Rocha, 62 – conj. 409. Curitiba, Paraná, Brazil.
CEP. 80420-130. Telephone/Fax: 00(55)413014-0947
E-mail: m.vianna@pucpr.br

Abstract

Objectives: The aim of this study was to compare the EMG activity of the masseter and anterior portion of temporal muscles in individuals with different vertical facial types. **Methods:** Clinical examination, cephalometric analysis and electromyographic examination were performed in 44 volunteers (15 males and 29 females) ranging from 18 and 35 years old. The volunteers were classified in accordance with their vertical facial characteristics in three groups: brachyfacial, mesofacial and dolicofacial by the grouping analysis. The electromyographic registers were obtained with 3 repetitions during the mandibular rest, the maximum voluntary contraction in intercuspidation (isometry) and simultaneous bilateral isotonic contraction. The Kolmogorov-Smirnov and Levene tests were applied to verify variance normality and homogeneity. ANOVA and Kruskal-Wallis test identified statistical differences among the studied groups for data that presented and not normal and homogeny distribution, respectively. All statistical tests were performed with 5% of significance level ($p < 0.05$). **Results:** For rest evaluation only the right temporal and masseter muscles presented statistically significant differences among the groups. The differences were observed between Groups 1 and 2 ($p = 0.02$) and 1 and 3 ($p = 0.038$) for the right temporal muscle; and between Groups 1 and 2 ($p = 0.029$) for the right masseter muscle. Generally, group 1 presented the lowest electromyographic values for the four muscles evaluated during rest. For isotonic, none of the muscles presented statistically significant difference among the groups. **Conclusion:** The different vertical facial types do not determine distinct patterns of electromyographic activity to masseter and anterior portion of temporal muscles during the rest and the bilateral mastication.

Key-words: Electromyography, Masseter Muscle, Temporal Muscle, Morphology

INTRODUCTION

Considering the possibility of interrelation between form and function, the masticatory muscles have been widely investigated in individuals with different vertical face characteristics. Their function and anatomy have been evaluated by electromyographic exams,[1-9] by the measure of bite force,[10] computed tomography of muscles thickness,[11] ultrasonography[5,12-15] and by magnetic resonance[16] beyond immunohistochemistry evaluations of muscular fibers.[17]

Concerning the electromyographic (EMG) evaluation of masticatory muscles, divergences are observed when individuals with different vertical facial growth are compared. There are some authors that observe the amplitude of electromyographic values in temporal[1,2,6] and masseter muscles[1,3,6] always greater in individuals with short face. Some papers showed that longer is the face of the individual, greater is EMG activity of the temporal muscle,[3,8] or yet, that this muscle activity does not present any correlation with the vertical face morphology.[4] On the other hand, there are studies that do not show differences in EMG activity of masseter muscle, between individuals with short face and balanced to long face[5] or between normo and hyperdivergents individuals.[8] According to Farella et al[7] and Cha et al,[8] the habitual activity of masseter does not seem to be influenced by the vertical craniofacial morphology.

Regarding the divergent disposals and the relevance of muscles function in orthodontic treatment stability, the present research aims to study EMG activity of masseter and anterior portion of temporal muscles in individuals with different vertical facial types.

Material and Methods

Clinical examination, cephalometric analysis and EMG examination were performed in 44 volunteers (15 males and 29 females) aging between 18 and 35 years old. The examinations were conduct in accordance with the protocol (186/2006) approved by the Ethical Committee Research of the FOP-UNICAMP, Brazil.

The inclusion criteria into the sample were: complete permanent dentition with at least 28 teeth, absence of premature tooth lost, absence of anterior open bite, anterior and/or posterior cross bite, absence of orthodontic treatment of any nature, and absence of temporomandibular disorder parafunctional habit.

The volunteers were evaluated for the presence or not of signals and symptoms of temporomandibular dysfunction, by palpation of the joint area during opening and closing mouth movements beyond the laterality movements and palpation of muscles related to this joint (masseter, temporal and lateral pterygoid).

Volunteers Classification in Facial Groups

For volunteers classification the teleradiographies in lateral norm were used. The radiographs were evaluated in viewbox located in a viewing room with reduced ligth. The cephalometric tracing, in acetate paper settled to the radiograph, was conducted by an orthodontist. The following anatomical structures were traced: external acoustic pore (pore point), orbit contour (orbital point), jaw (traced the mandibular plane and identification of Gonion, Gnatio and Mentual points, sella turcica (S point) and frontonasal suture (nasal point). Carried through the anatomical structures tracing, the image was digitalized[18] and FMA, SN.GoGn and gonial (ArGoMe) angles were measured by Radiocef 2000® cephalometric program.

The volunteers were classified in accordance with its vertical face characteristics in three groups: brachyfacial (Group 1, n=13), mesofacial (Group 2, n=24) and dolicofacial (Group 3, n=7) by the grouping analysis. The grouping of the volunteers in these groups was gotten from multivariate statistical techniques, based in three cephalometrics variables (SN.GoGn, FMA and ArGoMe) gotten from the 44 volunteers. The Pearson correlation test demonstrated positive correlation among these variables. The factorial analysis technique summarized the three variables in only one factor that explained 85.53% of the total variance of the analyzed variables. The grouping method resulted in three homogeneous groups based on an ordinate factorial score for the 44 volunteers.

Electromyographic Exam

The EMG examination was performed without the knowledge of the grouping analysis result and with the purpose to register the EMG activity amplitude of masseter and temporal muscles, bilaterally.

For the register of the EMG signal the equipment Myosystem I® from Prossecon Ltda (Uberlândia, Brazil) of 12 channels was used, being 8 channels to

electromyography and 4 to support. The EMG signals were conditionated through programmable instrumentation amplifiers by software and analogical filters highpass of 20Hz and lowpass of 1000Hz. The signals were digitalized with frequency of sampling of 4000Hz, with 12 bits of resolution and simultaneous sampling of signals. The signal visualization and processing were performed by Myosystem I® version 2.12 software.

The EMG examinations were conducted at the electromyography laboratory at FOP-UNICAMP following the protocol described by Pedroni et al.[19] To acquired the muscles action potential, were used simple distinguishing active electrodes (Lynx Electronic Technology Ltda – São Paulo, Brazil), formed by two parallel rectangular bars (10 x 2mm) made of pure silver (Ag), spaced by 10mm and fixed in an 23 x 21 x 5 mm acrylic resin encapsulated. The electrodes possess entrance impedance of 10 GΩ, CMRR of 130dB and gain of 20 times.

Previously to the EMG registers, the cleanness of the place to set the electrodes was carried through, with alcohol 70% to remove the excess of oiliness skin on the region of interest, facilitating adhesion, acquisition and transmission of electric potentials proceeding from muscular contraction.

To place electrodes the function test was executed for each one of the muscles. This test consists in muscular palpation during the simultaneous bilateral isotonic contraction and the following positioning criteria were followed: superficial part of masseter - at muscular belly 2 cm above of jaw angle, and anterior portion of temporal muscle at the muscular belly. A reference electrode (land), made up of stainless steel, soaked in its interface with gel water based, was used to eliminate acquisition interferences.

At the moment of EMG examinations, the individuals were kept seated, locating with the guided head as the Frankfurt Horizontal Plan, without being able to visualize the registers on the computer monitor.

The EMG registers were obtained with 3 repetitions during the mandibular rest, the maximum voluntary contraction in intercuspidation (isometry) and simultaneous bilateral isotonic contraction, according to the following protocol:

- Rest during 5 seconds: the volunteer was oriented to relax facial muscles.

- Isometry during 5 seconds: jaw in position of maximum habitual intercuspidation (MHI) and maximum occlusion force with Parafilm M® (American National Can TM Chicago, IL.60641), with dimensions of 15 mm x 8 mm x 3 mm, interposed to the occlusal surfaces of posterior teeth during 5 seconds. This gotten maximum potential served as reference value to normalize the EMG signal of masseter and temporal muscles in the other evaluations.

- Simultaneous bilateral isotonic contraction during 10 seconds with Parafilm M®: This acquisition was rhythmic by a calibrated metronome in 60 cycles.

By the equipment software, EMG signals were processed in the time domain by the Root Mean Square (RMS) calculation and expressed in μV.

Statistics Analysis

The statistics analysis was performed from the data of rest and bilateral isotonic evaluations, which were normalized in function of the isometric average values (reference value of each individual). The Kolmogorov-Smirnov and Levene tests were applied to verify variance normality and homogeneity. Aiming to identify statistical differences between the studied groups, it was used the variance analysis (ANOVA) for the data that presented normal and homogeny distribution and the non-parametric test of Kruskal-Wallis for those that did not attempt to the normality and homogeneity estimated. All statistical tests were done with 5% of significance level ($p < 0.05$).

Results

1. Rest

Generally, group 1 (brachyfacial) presented the lowest EMG values for the four muscles evaluated during rest when compared with groups 2 and 3. The right temporal and masseter muscles presented statistically significant difference among groups (Table I).

For groups definition that are differing among them it was necessary to apply the multiple comparisons of Kruskal-Wallis. The differences were observed between Groups 1 and 2 ($p = 0.02$) and 1 and 3 ($p = 0.038$) for right temporal muscle; and between Groups 1 and 2 ($p = 0.029$) for right masseter muscle.

2. Isotonic contraction

For this evaluation, none of the muscles presented statistically significant difference among the groups (Table II).

Discussion

EMG studies aiming to determine the relationship of masticatory function and face morphology are still inconclusives. The criteria to define vertical craniofacial morphology can be a possible explanation to the divergences.[7] Generally, facial types are defined by an only one criterion: reason between the inferior anterior facial height and the superior anterior facial height,[7] angle formed between the mandibular plan and the skull base,[4] or goniac angle.[1] In the present study, the groups' definition is based on three cephalometrics variables that present positive correlation. When assuming normative values to each of these variables for facial types' classification, incompatibilities of classification were observed. By this way, the use of statistical criterion brought greater security to the classification.[20] By the grouping analysis, the volunteers were classified in a way to minimize the variance inside the group and to maximize the variance among groups.

Another possible explanation for these contradictions involves essential factors in EMG register, in the signals treatment, as well as in their interpretation. Although the normalization of EMG signals for comparisons between individuals is a recommendation of the International Society of Electromyography and Kinesiology (ISEK), the majority of similar studies[1,8,9] used the raw data for such comparisons. This study normalized the values of rest and bilateral mastication, placing them in accordance to a reference value of the proper individual (isometric contraction). Thus, the comparison between volunteers became trustworthy, therefore inter-individuals variations caused by differences in the thickness and electric properties of tissues present between electrodes and the evaluated muscle, as well as the muscle size and the electrodes positioning were brightened up.[2 1-23]

Rest

The volunteers with short face (Group 1) presented the lowest percentile EMG values for rest evaluation, with statistic differences compared with other groups only for muscles on the right side. These results are in accordance with those of Cha et al,[8] which observed that as lower is the mandibular plan, lower is the EMG activity of temporal muscle. On the other hand, they disagree from the ones of Ueda et al[3] and Cha et al[8] for

masseter, Ingervall and Thilander[1] for temporal and Tecco et al[9] for both muscles, which the lowest EMG values are related to the highest values of facial vertical dimensions.

Even with all these appointments, the percentile values for all muscles in the three groups were lower than 5% of maximum isotonic contraction during rest, not representing muscular hyperactivity.[24] If it does not have hyperactivity, EMG values can be considered clinically normal for all groups. Moreover, if the mandibular rest is guaranteed by the muscles viscoelastics properties,[25] the obtained signals could be decurrent of interferences of the acquisition equipment or its installations.[26]

Isotonic contraction

For isotonic evaluation, no differences were observed for all the muscles among the groups. These results agree with those of Farella et al[5] and Farella et al[7], who studied only the masseter, and with those of Cha et al[8] and Tecco et al[9] for masseter and the anterior portion of temporal. However, Serrao et al[6] reported significantly lower EMG values for temporal and masseter muscles for individuals with long face compared to the ones with short face. Moreover, some studies observed negative correlation between EMG activity of temporal[1,2] and masseter muscles[1] and the vertical facial characteristics during mastication.

The lowest EMG activity observed in individuals with long face[1,2,6] might be a consequence of occlusal instability and the presence of anterior open bite more than of the craniofacial characteristics.[7] This because some studies[7,27,28] reported a positive correlation between the activity of masticatory muscles and the number of occlusal contacts. In this research, however, the characteristics of the dental occlusion were not considered and nor the number of occlusal contacts.

Conclusion

For the analyzed sample, it could be concluded that the different vertical facial types did not determine distinct patterns of electromyographic activity to masseter and anterior portion of temporal muscles during the rest and the bilateral mastication.

References

1. Ingervall B, Thilander B. Relation between facial morphology and activity of the masticatory muscles. J Oral Rehabil 1974;1: 131-47.
2. Ingervall B. Facial morphology and activity of temporal and lip muscles during swallowing and chewing. Angle Orthod 1976;46: 372-80.
3. Ueda HM, Ishizuka Y, Miyamoto K, Morimoto N, Tanne K. Relationship between masticatory muscle activity and vertical craniofacial morphology. Angle Orthod 1998;68: 233-8.
4. Ueda HM, Miyamoto K, Saifuddin MD, Ishizuka Y, Tanne K. Masticatory muscle activity in children and adults with different facial types. Am J Orthod Dentofac Orthop 2000;118: 63-8.
5. Farella M, Bakke M, Michelotti A, Rapuano A, Martina R. Masseter thickness, endurance and exercise-induced pain in subjects with different vertical craniofacial morphology. Eur J Oral Sci 2003;111:183-8.
6. Serrao G, Sforza C, Dellavia C, Antinori M, Ferrario VF. Relation between vertical facial morphology and jaw muscle activity in healthy young men. Prog Orthod 2003;4:45-51.
7. Farella M, Michelotti A, Carbone G, Gallo LM, Palla S, Martina R. Habitual daily masseter activity of subjects with different vertical craniofacial morphology. Eur J Oral Sci 2005;113:380-38.
8. Cha BK, Kim CH, Baek SH. Skeletal sagittal and vertical facial types and electromyographic activity of masticatory muscle. Angle Orthod 2007;77:463-70.
9. Tecco S, Caputi S, Tete S, Orsini G, Festa F. Electromyographic activity of masticatory, neck and trunk muscles of subjects with different mandibular divergence. Angle Orthod 2007;77:260-5.
10. Ingervall B, Minder C. Correlation between maximum bite force and facial morphology in children. Angle Orthod 1997;67:415-22.
11. Gionhaku N, Lowe AA. Relationship between jaw muscle volume and craniofacial form. J Dent Res 1989;68:805-9.

12. Raadsheer MC, Kiliaridis S, Van Eijden TM, Van Ginkel FC, Prahl-Andersen B. Masseter muscle thickness in growing individuals and its relation to facial morphology. Arch Oral Biol 1996;41:323-32.
13. Raadsheer MC, Van Eijden TMGJ, Van Ginkel FC, Prahl-Andersen B. Contribution of jaw muscle size and craniofacial morphology to human bite force magnitude. J Dent Res 1999;78:31-42.
14. Benington PC, Gardener JE, Hunt NP. Masseter muscle volume measured using ultrasonography and its relationship with facial morphology. Eur J Orthod 1999;21:659-70.
15. Şatıroğlu F, Arun T, Işık F. Comparative data on facial morphology and muscle thickness using ultrasonography. Eur J Orthod 2005;27:562-7.
16. Al-Farra ET, Vandenborne K, Swift A, Ghafari J. Magnetic resonance spectroscopy of the masseter muscle in different facial morphological patterns. Am J Orthod Dentofac Orthop 2001;120:427-34.
17. Rowlerson A, Raoul G, Daniel Y, Close J, Maurage CA, Ferri J *et al.* Fiber-type differences in masseter muscle associated with different facial morphologies. Am J Orthod Dentofacial Orthop 2005;127:37-46.
18. Saga AY, Maruo H, Guariza Filho O, Ignácio SA. Comparative study between the conventional (manual) and combined (manual and computadorized) methods applied to Tweed-Merrifield cephalometric analysis. J Bras Ortodon Ortop Facial 2005;10:359-69.
19. Pedroni CR, Borini CB, Bérzin F. Electromyographic examination in temporomandibular disorders – evaluation protocol. Braz J Oral Sci 2004;3:526-29.
20. Saga AY, Maruo H, Tanaka O, Ignácio SA. The application of the multivariate statistic analysis in the division of groups inside of samples or populations. J Bras Ortodon Ortop Facial 2006;11:22-32.
21. Soderberg GL, Cook TM. Electromyography in biomechanics. Phys Ther 1984;64:1813-20.
22. Mirka GA. The quantification of EMG normalization error. Ergonomics 1991;34:343-52.

23. De Luca CJ. The use of surface electromyography in biomechanics. J Appl Biomech 1997;13:135-63.
24. Finsterer J. EMG-interference pattern analysis. J Electromyogr Kinesiol 2001;11:231-46.
25. Sgobbi de Faria CR, Bérzin F. Electromyographic study of the temporal, masseter and suprahyoid muscles in the mandibular rest position. J Oral Rehabil 1998;25:776-80.
26. Bérzin F; Sakai E. Fundamentals of Electromyography (EMG) – From teory to Practice. *In*: Sakai E; Fiuza SC; Martins NS; Dominguez-Rodrigues GC; Grimberg J; Pereira CB *et al.*, organizadores. New vision on Orthodontics and Dentofacial Orthopedics. São Paulo: Editora Santos; 2004;1:311-30.
27. Bakke M, Michler L, Moller E. Occlusal control of mandibular elevator muscles. Scand J Dent Res 1992;100:284-91.
28. Ferrario VF, Serrao G, Dellavia C, Caruso E, Sforza C. Relationship between the number of occlusal contacts and masticatory muscle activity in healthy young adults. Cranio 2002;20:91-98.

TABLE I – DESCRIPTIVE ANALYSIS AND KRUSKAL-WALLIS TEST VALUE TO REST VARIABLE FOR MUSCLE, FOR EACH GROUP

MUSCLE	1 (n=13)		2 (n=24)		3 (n=7)		P
	MEAN	SE	MEAN	SE	MEAN	SE	
LEFT TEMP	0.022	0.003	0.031	0.003	0.031	0.008	0.296
LEFT MASS	0.016	0.002	0.035	0.009	0.036	0.012	0.078
RIGHT TEMP	0.014	0.002	0.033	0.006	0.028	0.004	0.007*
RIGHT MASS	0.015	0.002	0.032	0.006	0.028	0.005	0.021*

SOURCE: research data
LEGEND: LEFT TEMP – left temporal muscle; LEFT MASS – left masseter muscle; RIGHT TEMP – right temporal muscle; RIGHT MASS – right masseter muscle.
NOTE: values in the table body lower than 0,05 indicate differences statistically significant among treatment means.

TABLE II – DESCIPTIVE ANALYSIS AND P VALUE TO ISOTONIC CONTRACTION VARIABLE FOR MUSCLE, FOR EACH GROUP

MUSCLE	1 (n=13)		2 (n=24)		3 (n=7)		P
	MEAN	SE	MEAN	SE	MEAN	SE	
LEFT TEMP	0.843	0.234	0.685	0.140	0.735	0.278	0.151
LEFT MASS	0.749	0.208	0.708	0.144	0.739	0.279	0.848
RIGHT TEMP	0.725	0.201	0.699	0.143	0.739	0.279	0.857
RIGHT MASS	0.784	0.217	0.712	0.145	0.750	0.283	0.634

SOURCE: research data

LEGEND: LEFT TEMP – left temporal muscle; LEFT MASS – left masseter muscle; RIGHT TEMP – right temporal muscle; RIGHT MASS – right masseter muscle.

CONCLUSÃO

A aplicação da análise estatística multivariada para a divisão de uma amostra em grupos, com características faciais verticais distintas, mostrou ser uma ferramenta útil desde que baseada em variáveis cefalométricas que apresentem correlação entre si.

A morfologia facial vertical dos voluntários analisados parece não ter influência sobre a atividade eletromiográfica dos músculos masseter e temporal durante o repouso e a mastigação bilateral.

REFERÊNCIAS[1]

1. 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 Othod. 1993;15(1): 57-63.
2. Gerstner GE, Marchi F, Haerian H. Relationship between anteroposterior maxillomandibular morphology and masticatory jaw movement patterns. Am J Orthod Dentofacial Orthop. 1999;115(3): 258-66.
3. Kiliaridis S, Engstrom C, Chavez LM. Influence of masticatory muscle function craniofacial growth in hypocalcemic rats. Scand J Dent Res. 1992; 110(6):330-6.
4. Kiliaridis S, Johansson A, Haraldson T, Omar R, Carlsson GE. Craniofacial morphology, occlusal traits, and bite force in persons with advanced occlusal tooth wear. Am J Orthod Dentofacial Orthop. 1995;107(3): 286-92.
5. Kiliaridis S, Karlsson S, Kjellberg H. Characteristics of masticatory mandibular movements and velocity in growing individuals and young adults. J Dent Res. 1991;70(10): 1367-70.
6. Kiliaridis S. Muscle function as a determinant of mandibular growth in normal and hypocalcemic rat. Eur J Orthod. 1989; 11(3):298-308.
7. Lowe AA, Takada K, Taylor LM. Muscle activity during function and its correlation with craniofacial morphology in a sample with Class II, Division 2 malocclusions. Am J Orthod Dentofacial Orthop. 1983;83(3): 204-11.
8. Poikela A, Kantomaa T, Tuominten M, Pirttiniemi P. Effect of unilateral masticatory function on craniofacial growth in the rabbit. Eur J Oral Sci. 1995; 103(2): 106-11.

[1] De acordo com a norma da UNICAMP/FOP, baseada na norma do International Commitee of Medical Journals Editors – Grupo Vancouver. Abreviatura dos periódicos em conformidade com o Medline.

ANEXO – Termo de aprovação do Comitê de Ética

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

CERTIFICADO-2ª VIA

O Comitê de Ética em Pesquisa da FOP-UNICAMP certifica que o projeto de pesquisa "**Comportamento dos músculos mastigatórios em indivíduos de diferentes classes esqueléticas e tipos faciais**", protocolo nº **186/2006**, dos pesquisadores **PAULO HENRIQUE FERREIRA CARIA** e **MICHELLE SANTOS VIANNA LARA**, satisfaz as exigências do Conselho Nacional de Saúde – Ministério da Saúde para as pesquisas em seres humanos e foi aprovado por este comitê em 13/12/2006.

Piracicaba, 09 agosto de 2007

The Ethics Committee in Research of the School of Dentistry of Piracicaba - State University of Campinas, certify that the project "**Masticatory muscles behavior in individuals with different skeletal classes and facial types**", register number **186/2006**, of **PAULO HENRIQUE FERREIRA CARIA** and **MICHELLE SANTOS VIANNA LARA**, 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 13/12/2006.

Piracicaba, SP, Brazil, augustl 09 2007

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.