

Universidade Estadual Paulista “Júlio de Mesquita Filho”

Faculdade de Odontologia de Araraquara

KARLA ORFELINA CARPIO HORTA

**MÉTODO NÃO RADIOGRÁFICO PARA O
DIAGNÓSTICO DO PADRÃO
ESQUELÉTICO CLASSE II
HIPERDIVERGENTE**

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Universidade Estadual Paulista “Júlio de Mesquita Filho”

Faculdade de Odontologia de Araraquara

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**MÉTODO NÃO RADIOGRÁFICO PARA DIAGNÓSTICO
DO PADRÃO ESQUELÉTICO CLASSE II
HIPERDIVERGENTE**

Dissertação apresentada ao Programa de Pós-Graduação em Ciências Odontológicas - Área de Ortodontia, da Faculdade de Odontologia de Araraquara, da Universidade Estadual Paulista, para obtenção do título de Mestre em Ciências Odontológicas.

Orientador: Prof. Dr. João Roberto Gonçalves

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**MÉTODO NÃO RADIOGRÁFICO PARA DIAGNÓSTICO
DO PADRÃO ESQUELÉTICO CLASSE II
HIPERDIVERGENTE**

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DISSERTAÇÃO PARA OBTENÇÃO DO GRAU DE MESTRE

Presidente e Orientador: Prof. Dr. João Roberto Gonçalves

2° Examinador: Profa. Dra. Mirian Aiko Nakane Matsumoto

3° Examinador: Prof. Dr. Ary dos Santos Pinto

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DADOS CURRICULARES

Karla Orfelina Carpio Horta

- Nascimento:** 19/10/1984 – Machupicchu- Cusco/Perú
- Filiação:** Alberto Abad Carpio Delgado
Martha Horta Ccasa
- 2001-2005:** Curso de Graduação em Odontologia na Universidad Católica de Santa Maria- Arequipa/ Perú
- 2006-2008:** Curso de Especialização em Ortodontia na Universidade de São Paulo – Ribeirão Preto/SP
- 2009:** Curso de Extensão Universitária na modalidade de atualização: Ortodontia Preventiva e Interceptadora na Universidade de São Paulo – Ribeirão Preto/SP
- 2010-2012:** Curso de Pós-Graduação em Ciências Odontológicas, Área de Concentração em Ortodontia, nível Mestrado - Faculdade de Odontologia de Araraquara - FOAr/UNESP
- Associações:** International Association of Oral Dental Research.
Associação Brasileira de Ortodontia
Associação dos Ex-Alunos de Ortodontia de Araraquara- AOA
Sociedade Brasileira de Pesquisa Odontológica – SBPqO

DEDICATÓRIA



DEDICATÓRIA

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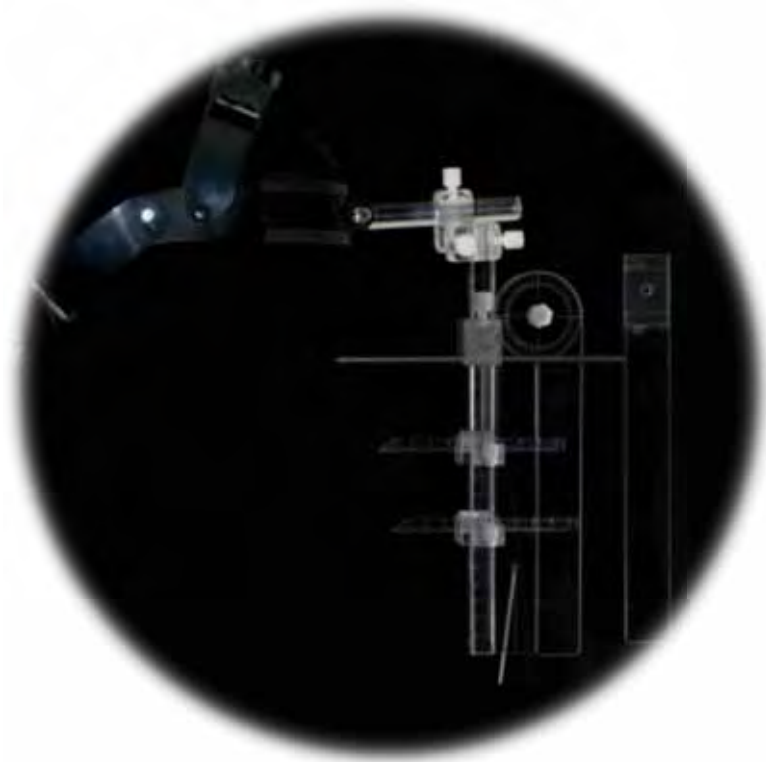
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“Se você é...

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

Se você é honesto e franco,
as pessoas podem enganá-lo
Seja honesto e franco 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 você que, no final de tudo
Será você ... e Deus.

E não você ... e as pessoas!”

(Madre Tereza de Calcutá)

SUMÁRIO



SUMÁRIO

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RESUMO



Horta KOC. Método não radiográfico para diagnóstico do padrão esquelético classe II hiperdivergente [Dissertação de Mestrado]. Araraquara: Faculdade de Odontologia da UNESP; 2012.

RESUMO

Objetivo: Testar a validade do método de uso do paquímetro facial no diagnóstico da classe II esquelética hiperdivergente, assim como possibilitar a análise da postura crânio-cervical.

Materiais e Métodos: Dois artigos científicos foram redigidos e utilizados para a avaliação dos propósitos apresentados.

Resultados: As reprodutibilidades intra e interclasse para quase todas as medidas (Wits (POF)', Wits (HV)', N.Sn.Pg', N.Sn.B', T.Go.Me', AFA', AFP', AFAI', Proporção AFA/AFP', Proporção AFP/AFAI', C7.TN', C7.FH') foram maiores do que 0.90, indicando uma reprodutibilidade excelente. Algumas mensurações (ANB', FMA', Proporção AFAI/AFA', TN.VER', FH.VER') apresentaram resultados que variaram entre excelentes e bons. Somente FNP' apresentou uma reprodutibilidade interclasse fraca (intervalo: <0.65). As características faciais mensuradas com o paquímetro facial mostraram fortes e moderadas correlações estatisticamente significantes ($p < 0.01$ and $p < 0.05$). Correlações fracas foram achadas para a variável FNP' e não foram encontradas correlações significativas para as variáveis que caracterizam a postura da cabeça. A função discriminante canônica, resultado da combinação das medidas Wits (POF)', N.Sn.Pg' e FMA',

classificou corretamente 73,5% dos pacientes de classe II hiperdivergentes na validação interna. Na validação externa, o método mostrou sensibilidade de 81,3% e especificidade de 79,2%.

Conclusões: O paquímetro facial é uma ferramenta válida para realizar o diagnóstico do padrão esquelético de classe II hiperdivergente. Este método não é recomendado para a avaliação da postura da cabeça nem para realizar a medida FNP'. Um cuidado especial deve ser tomado quando forem realizadas medidas angulares agudas e/ou pobremente definidas.

Palavras-chave: Diagnóstico; Antropometria; Crescimento e desenvolvimento; Má oclusão de Angle classe II; Estudos de validação.

ABSTRACT



Horta KOC. Nonradiographic assessment of the hyperdivergent skeletal class II patient [Dissertação de Mestrado]. Araraquara: Faculdade de Odontologia da UNESP; 2012.

ABSTRACT

Objective: To assess the validity of a non-radiographic method in diagnosing skeletal class II hyperdivergent patients, as well as to enable the analysis of cranio-cervical posture.

Materials and Methods: Two research papers were written and analyzed for the evaluation of the aims presented.

Results: The intraclass and interclass reliabilities for almost all measurements (Wits (FOP)', Wits (TV)', N.Sn.Pg', N.Sn.B', T.Go.Me', AFH', PFH', LFH', Proportion AFH/PFH', Proportion PFH/LFH', C7.TN', C7.FH') were greater than 0.90, indicating an excellent reliability. Some variables (ANB', FMA', Prop. LFH/AFH', TN.VER', FH.VER') showed excellent and good results (interval: 0.90-0.99; 0.80-0.89). Only FNP' presented a weak interclass reliability (interval: <0.69). Soft-tissue facial characteristics showed strong to moderate significant correlations ($p < 0.01$ and $p < 0.05$). Weak correlations were found for the FNP' variable and non-significant correlations were found for postural variables. The canonical discriminant function involved combining Wits (FOP)', N.Sn.Pg' and FMA' measurements, correctly classified 73.5% of the hyperdivergent class II

patients in the internal validation. On the external validation, the method showed 81.3% sensitivity and 79.2% specificity.

Conclusions: The facial paquimeter is a valuable diagnostic tool in determining the hyperdivergent skeletal class II pattern. Parameters characterizing hyperdivergent skeletal class II are identifiable through the use of the FP. This method is not recommended to assess the head posture and the FNP' measurement.

Key words: Diagnosis; Anthropometry; Growth and Development; Malocclusion, Angle class II; Validation study.

INTRODUÇÃO



1 INTRODUÇÃO

O diagnóstico dos pacientes associados ao padrão esquelético de classe II hiperdivergente é importante, uma vez que estes pacientes têm sido associados a vários distúrbios, tais como mudanças na postura da cabeça^{25,35,41,43-45} para uma melhor adequação das vias aéreas²⁴ e desordens temporomandibulares (DTM)^{8,19,23,29,31,36,49,52,56}, os quais muitas vezes comprometem a saúde geral destes indivíduos.

Nos campos da Ortodontia e Cirurgia, as discrepâncias maxilares esqueléticas são diagnosticadas através da análise de radiografias cefalométricas. Neste sentido, no início do século XX, grande parte das pesquisas científicas e das condutas clínicas dos ortodontistas e cirurgiões, baseava-se fortemente nos padrões dentários e esqueléticos determinados por diferentes análises cefalométricas¹³. Esse fato tornou a cefalometria fundamental para o planejamento de tratamentos ortodônticos e orto-cirúrgicos.

Apesar de a cefalometria radiográfica ser o método de escolha para avaliação das relações maxilo-mandibulares e da morfologia facial, para a realização de estudos epidemiológicos de larga escala faz-se necessário aplicar métodos mais simplificados e validados com este fim⁵⁹, realizados sem a exposição do paciente à radiação.

Com o intuito de reduzir a exposição à radiação, métodos não invasivos têm sido propostos, uma vez que, não há nenhuma dose abaixo da qual os danos

biológicos não ocorrem³⁷. Além disso, a crescente valorização da estética facial, a grande variabilidade étnica e a popularização da cirurgia ortognática, geraram a necessidade de valorizar as características individuais da face, fazendo com que a análise facial assumisse um papel cada vez mais importante na planificação dos tratamentos^{1,2,6,30}.

Estes métodos alternativos que incluem antropometria^{3,10}, fotogrametria bidimensional^{34,50,59}, fotogrametria tridimensional^{4,57}, e técnicas de imagem tridimensional^{48,51} têm sido realizados diretamente sobre os tecidos moles. Estas pesquisas que relacionaram os tecidos moles com as estruturas ósseas subjacentes foram realizadas em particular na área de morfoanálise²². Na ortodontia esta relação foi encontrada através de métodos e amostras variadas^{5,7,12,33,59}. No entanto, uma amostra com um número representativo de pacientes de classe II esquelética associada ao padrão hiperdivergente não foi investigada até o momento.

A comprovada existência de relações entre os pontos e mensurações nos tecidos moles e seus correspondentes no tecido duro, fornecem um bom sinal sobre a possível capacidade destes métodos na realização do diagnóstico das relações maxilo-mandibulares, mas não verificam este fato. Assim mesmo, métodos subjetivos³², objetivos⁵⁰ e clínicos⁶⁰ tem sido propostos para realizar previsões do crescimento do esqueleto, embora os resultados obtidos fossem limitados.

Ao considerar o método antropométrico, como alternativa para os objetivos propostos, a literatura revela que as principais vantagens são as seguintes: a

natureza não invasiva, a simplicidade tecnológica, de baixo custo, a existência de parâmetros divididos por idade e sexo com as quais os indivíduos podem ser comparados⁵⁴ e satisfatórios níveis de reprodutibilidade⁵⁵. Outro fator importante a destacar é o resultado imediato (evitando tempo de laboratório investido durante o processamento dos achados). Além disso, a antropometria fornece um acesso e resultados objetivos em vez de apenas subjetivos. Todas estas características tornam este método uma ferramenta viável para esta finalidade.

No entanto, o método antropométrico está sujeito a erros inerentes ao tipo de metodologia. Esses erros de medição e precisões foram avaliados em estudos que envolviam a antropometria do corpo inteiro²¹ ou a região craniofacial⁵⁵ utilizando medidas lineares. A precisão de erros de mensurações angulares e lineares para realizar a avaliação da região craniofacial, especificamente as relações maxilo-mandibulares e posição da cabeça, receberam pouca atenção. Assim, torna-se evidente a necessidade de desenvolver um método que permita fazer uma análise simples, confiável e quantitativa deste tipo de mensuração.

Quando da análise da postura crânio-cervical, a literatura relata uma consistente associação entre a morfologia dento-esquelética e a variação individual na postura da cabeça, evidenciando o quanto os princípios biomecânicos da coluna e do pescoço são de especial interesse na Ortodontia e Ortopedia Dentomaxilofacial. Em geral, indivíduos que apresentam uma altura facial anterior inferior aumentada por um padrão de crescimento vertical, assim como aqueles que apresentam retrognatismo mandibular, tendem a desenvolver um posicionamento mais anteriorizado e extensão da cabeça. Por outro lado,

indivíduos face curta e aqueles que apresentam prognatismo mandibular tendem a evidenciar retificação da coluna e posteriorização da cabeça⁴⁰.

Contudo, estudos têm mostrado a existência de uma forte relação entre a adequação das vias aéreas e postura da cabeça, onde uma obstrução ou diminuição da adequação das vias aéreas foi associado a maiores ângulos crânio-cervicais e crânio-verticais^{20,38,43,53,58}. Além disso, a adequação das vias aéreas está relacionada ao tamanho e posição da mandíbula, onde uma diminuição dessas vias aéreas está correlacionada a uma mandíbula menor e mais posteriormente posicionada⁴³.

No entanto, a relação causa-efeito entre este padrão de crescimento craniofacial específico e as condições acima mencionadas não está totalmente clara. Métodos simplificados, embora ainda não desenvolvidos e/ou acurados, para a detecção destes indivíduos em larga escala ou em estudos epidemiológicos podem oferecer uma melhor compreensão dessas complexas relações.

PROPOSIÇÃO



2 PROPOSIÇÃO

2.1 Objetivo geral

Testar a validade do método de uso do Paquímetro Facial no diagnóstico de pacientes de classe II esquelética associada ao padrão hiperdivergente e na análise da postura da cabeça.

2.2 Objetivos específicos:

1. Avaliar a confiabilidade de o método de uso do Paquímetro Facial na realização de mensurações faciais
2. Avaliar a correlação existente entre as variáveis faciais realizadas fazendo uso do Paquímetro Facial e suas correspondentes variáveis cefalométricas;
3. Detectar as mensurações faciais realizadas diretamente na face do paciente fazendo uso do Paquímetro Facial, capazes de realizar o diagnóstico da classe II esquelética associada ao padrão hiperdivergente.

Os objetivos específicos serão tratados em dois artigos separadamente:

ARTIGO 1: Reliability of a nonradiographic assessment of maxillo-mandibular relationships.

Artigo a ser enviado para publicação no periódico American Journal of Orthodontics and Dentofacial Orthopedics.

ARTIGO 2: Nonradiographic assessment of the hyperdivergent skeletal class II patient.

Artigo a ser enviado para publicação no periódico American Journal of Orthodontics and Dentofacial Orthopedics.

ARTIGO 1



**Reliability of a nonradiographic assessment of maxillo- mandibular
relationships**

Karla Orfelina Carpio Horta^a; Liliane de Carvalho Rosas Gomes^a; Marcelo Gonçalves^b; Ary dos Santos Pinto^b; João Roberto Gonçalves^b

^a MS student, Faculdade de Odontologia de Araraquara, Univ Estadual Paulista-UNESP, Araraquara, São Paulo, Brazil.

^b Professor, Faculdade de Odontologia de Araraquara, Univ Estadual Paulista-UNESP, Araraquara, São Paulo, Brazil.

Corresponding Author: Karla Orfelina Carpio Horta, Universidade Estadual Paulista, UNESP, Department of Orthodontics, Rua Humaitá 1680, Araraquara, São Paulo 14801-385, Brazil.

e-mail: karlitach@hotmail.com

Reliability of a nonradiographic assessment of maxillo-mandibular relationships

ABSTRACT

Objective: The aim of this study was evaluate the reliability of a non-radiographic assessment of maxillo-mandibular relationships. Furthermore, the reliability of the method assessing the head posture was tested. **Material and methods:** A random sample of 26 healthy children was studied. Two trained operators undertook 8 linear and 10 angular measurements directly on the patient's face by using a new non-radiographic tool also 3 proportions were calculated. Intraclass and interclass reliability were assessed through the Intraclass Correlation Coefficient of reliability that statistically analyzed the data with a confidence interval of 95%. **Results:** The intraclass and interclass reliabilities for almost all measurements (Wits (FOP)', Wits (TV)', N.Sn.Pg', N.Sn.B', T.Go.Me', AFH', PFH', LFH', Proportion AFH/PFH', Proportion PFH/LFH', C7.TN', C7.FH') were within an interval of 0.90-0.99, indicating an excellent reliability. Some variables (ANB', FMA', Prop. LFH/AFH', TN.VER', FH.VER') showed excellent and good (interval: 0.80-89) results. Only FNP' presented a week interclass reliability (interval: <0.69). **Conclusions:** The proposed method has proven to be a reliable diagnostic tool for assessing maxillo- mandibular relationships and head position. This method is not recommended for taking the

FNP' measurement. Special care must be taken when acute angular and/or poorly defined measurements are made.

KEY WORDS: Diagnosis; anthropometry; growth and development, jaw relationships; skeletal pattern; reliability.

INTRODUCTION

A very important factor when planning the orthodontic treatment and the assessment of treatment changes is to evaluate the soft tissue,¹ mainly as regards jaw relationships. The soft tissue evaluation has been carried out by different methods such as anthropometry,^{2,3} two dimensional photogrammetry,⁴⁻⁶ three dimensional photogrammetry^{7,8} and three dimensional imaging techniques.^{9,10} The main advantages of the anthropometric method are its noninvasive nature, technological simplicity, low cost, and the existence of age and sex-matched standards to which subjects can be compared.¹¹

However, the anthropometric method is subject to sources of errors. These measurement errors and precisions were assessed for whole body anthropometry¹² and craniofacial region¹¹ using linear measures. Nevertheless, the precision of angular and linear measurement errors assessing maxillo-mandibular relationships of the craniofacial region and head position received little attention. Thus, the need to develop a method that allows a simple, reliable and quantitative analyses of this important facial feature is evident.

In addition, during the initial clinical examination, patients almost always ask about the diagnosis and the type and duration of the orthodontic treatment. With an objective rather than only a subjective facial assessment, the orthodontist will be more confident and able to satisfy this requirement providing a preliminary or provisional diagnosis and prognostic.

Therefore, the aim of this study is to assess the reliability of a non-radiographic assessment of maxillo-mandibular relationships. Also, the reliability of the method assessing the head position was tested.

Material and methods:

1. The facial meter and its parts:

The development of this tool was inspired in another instrument, the Caliper of the Facial Profile,¹³ which have different objectives than the Facial Paquimeter (FP). The Facial Paquimeter (FP) (Figure 1) is a tool developed to allow vertical and horizontal, linear and angular measurements characterized to determine the craniofacial growth pattern and the head position directly on the patient's face. In this sense, the exposure to radiation resulting from cephalometric radiographs is eliminated and after its validation, the instrument can be used on large-scale studies.

The FP was developed in a joint work with a group of technical professionals specializing in the construction of new technologies.

The FP is essentially made of acrylic, polyethylene, plastic and little parts of metal. It is made up of three areas: head support, measurement and articulation. The head support adjusts the instrument on the patient's head in both vertical and antero-posterior directions. The three rulers make vertical and horizontal linear measurements assisted by clamps. The protractor allows angular measurements.

Some parts are transparent to improve the visualization of the facial landmarks. To hold the apparatus in a fixed position, the FP has polyethylene screws. Finally, the articulation area joint the two areas mentioned above. One clamp holds the acrylic rod and the other holds the rulers still and allows some movement aided by an occlusal device (reference of the occlusal plane, Figure 4) and a metallic pendulum (reference of the true vertical, Figure 5). A protractor device is used to record the Natural Head Position (NHP) angle¹⁴ confirming its constancy when necessary. These two devices are auxiliary instruments and are not part of the FP.

2. The method and its reliability:

Ethics Committee of the Araraquara Dental School, Univ Estadual Paulista (UNESP), Brazil approved the study under the protocol n° 66/10.

Twenty-six children of a sample of 120 children aged between 7 to 12 years were randomly selected for this study. All subjects had facial symmetry and none had a history of facial and/or cervical trauma, facial abnormality and/or cranio-cervical deformities, neurological disorders or congenital abnormality,

absence of any upper front teeth, previous orthodontic or surgical treatment. The children's parents were informed about the procedures, accepted the terms and signed the consent forms.

Two trained operators undertook all measurements and an assistant recorded the data. The measurements were made in profile with the right side of the face toward the investigator, always in maximum intercuspation and with the lips in a relaxed posture. Furthermore, the subjects were instructed to wear headbands to remove hair strands from the face, ear and neck when needed.

In addition, the landmarks^{15,16} used were identified by palpation and/or visualization (Table I). Four adhesive dots and two adhesive mini balls were placed on the children's faces to better identify some landmarks (Figure 2). A total of 5 linear and 10 angular measurements were taken and 3 proportions were calculated (Table II). The facial measurements were chosen to be counterparts of commonly cephalometric measurements used to characterize the assessment of maxillo-mandibular relationships and the head and cervical posture.

Before the procedure the NHP angle was recorded. The subjects were asked to stand up and positioned in "orthoposition",¹⁸ i.e. the intension position from standing to walking. The children were situated in front of a mirror (placed 55 cm away) with their arms and lips relaxed and their teeth in maximum intercuspation. Then, they were asked to look into the mirror image of their own eyes, after tilting their head up and down with decreasing amplitude until they felt that they were relaxed. When the individual's NHP, "mirror position",¹⁷ was

achieved, its angle was recorded using the protractor device (Figure 3).¹⁴

When taking the facial measurements, the patient was sitting in a chair with their spine erect and head centered over the vertebral column,¹⁹ viewing his own eyes in a mirror placed 25 cm away. The occlusal approach was positioned with its inner part being held by the bite of the patient's right occlusal hemi arch. Subsequently, the FP completely armed, was positioned on the patient's head with its anterior part at the height of the middle of the forehead. Then, the head support was adjusted turning its two plastic devices.

By sliding the support clamp on the acrylic rod, the vertical ruler was located 15 mm in front of the tip of the nose, and fixed adjusting its fixative screw. The metallic rod was lowered towards occlusal device by sliding its clamp. Then, by rotating the articable clamp (in a clockwise or counterclockwise direction), the metallic rod was placed parallel to the occlusal device. This first position (Figure 4) was fixed adjusting the screw and the occlusal device was taken out of the patient mouth. Then, the measurement Wits Facial Occlusal Plane (Wits (FOP)) (Table II, Figure 4) was made using the patient's occlusal plane as a reference.

Subsequently, the screw of the articable clamp was unscrewed, the NHP was conferred using the protractor (Fig. 3) and the metallic pendulum was positioned. By rotating the articable clamp (in a clockwise or counterclockwise direction), the long axis of the metallic pendulum was aligned with the laser drawn line of the protractor's principal ruler. This second position was fixed by adjusting the fixative screw (Figure 5). Thus, the measurements, Wits True

Vertical (Wits (TV)'), AFH' and LFH' were made with the true vertical as a reference (Figure 5).

The FM was removed from the patient's head and disassembled (third position) (Figure 6). The rest of the measurements, PFH', ANB', FNP', N.Sn.Pg', N.Sn.B', T.GoMe', and FMA', were made using only the complex ruler-protractor and the metallic pendulum. All these measurements were made using the inner part of the principal and secondary rulers with the hole of the protractor as the intersection point (Figure 6). Finally, the patient had to stand up and being in NHP.¹⁷ The NHP angle was confirmed using the protractor device, and subsequently, the craniocervical measurements, TrN.VER', FH. VER', C7.TrN', C7.FH', were made. Finally, the calculation of the proportions, ALFH/AFH', PFH'/AFH' and PFH'/ALFH', were performed.

Reliability

For accessing the intraclass reliability i.e. repeatability, all measurements were made in each patient by the same investigator at two different times, with an interval of 15 days. Also, for accessing the interclass reliability, all the measurements were made in each patient by two operators the same day.

The Intraclass Correlation Coefficient of reliability (ICC)²⁰ statistically analyzed the data with a confidence interval (CI) of 95%. All the analyses were carried out using the Statistical Package for Social Sciences 16.0 (SPSS Inc., Chicago, Illinois, USA).

Results:

The reliability of the proposed method was satisfactory, almost all measurements had an ICC value above 0.84.

Table III presents the intraclass correlation coefficient of reliability i.e. repeatability. For almost all measurements (Wits (FOP)', Wits (TV)', ANB', N.Sn.Pg', N.Sn.B', T.Go.Me', FMA', AFH', PFH', LFH', Prop. AFH/PFH', Prop. PFH/LFH', C7.TN', C7.FH') the ICC were within an interval of 0.90-0.99. Their inferior limits varied from 0.79 to 0.95 and the superior ones from 0.95 to 0.99. The rest of the variables (FNP', Prop. LFH/AFH', TrN.VER' and FH.VER') presented an ICC within an interval of 0.80-0.89. Their inferior limits varied from 0.68 to 0.73, and the superior limits from 0.93 to 0.94.

Table VI presents the interclass correlation coefficient of reliability for each variable. For almost all measurements (Wits (FOP)', Wits (TV)', N.Sn.Pg', N.Sn.B', T.Go.Me', AFH', PFH', LFH', Prop. LFH/AFH', Prop. AFH/PFH', Prop. PFH/LFH', C7.TN', C7.FH') the ICC were within an interval of 0.90-0.99. Their inferior limits varied from 0.80 to 0.96 and the superior ones from 0.96 to 0.99. Three variables (ANB', FMA', and FH.VER') presented an ICC in an interval of 0.80-0.89 and their limits varied from 0.68 to 0.72 for the inferior limits and from 0.93 to 0.94 for the superior ones. Only FNP' presented the ICC in the interval <0.69 , its inferior limit was 0.34 and its superior limit was 0.82.

Discussion

Although other methods^{21,22} have been described to assessing maxillo-mandibular relationships through the soft tissue, they showed limitations e.g. the inability to adequately quantifying the soft tissue by cephalographic techniques.²¹ Also, the complexity of the analysis, the costly equipment, and the questionable accuracies of other techniques (stereo photogrammetry,²³ mesh grid analysis²⁴ and photocephalometry²⁵) made them impractical for general use.²⁶ Subsequently, they would be useless on large-scale studies. In this sense, the simplicity, speed and low cost of the FP made the proposed method feasible to meet the above-mentioned purposes.

The sample selected represent an age group where the interrelationship between hard and soft-tissue shapes should be particularly close, without the added variability of the aging effects in adults.²⁷ Also, they were selected to be in an ideal age group to have their malocclusions treated. However, since the anthropometric procedure requires collaboration and patience from the evaluated subject, working with child presented difficulties that could have influenced the results. To minimize this factor, the posture of their body (sitting or standing), head (NHP)¹⁷ and lips (relaxed)²⁸ were standardized. In addition, the landmarks were signalized with adhesives dots and mini balls to reduce the time of the complete procedure (maximum 15 minutes).

All measurements were taken with the patients in NHP, the ‘‘mirror position’’.¹⁷ The body position varied according to the measurement taken.

Almost all measurements were made in a sitting position and only the craniocervical measures were made with the patient standing as recommended by other authors.¹⁷ The upper and lower movements of their heads were controlled using the protractor device (Fig. 3) (in either standing or sitting positions). However, the extension or flexion of the neck that influences the position of the c7 landmark was not. Therefore, before the craniocervical measurements were taken, the patient was repositioned with his/her body in the *orthoposition*¹⁸ and in the NHP.¹⁷

The relaxed lip posture was always monitored because many children use to force their lips to achieve closure. Straining the lips not only changes the shape of the lips but also affects the chin area,²⁷ compromising the real position of important landmarks (me, pg, b, a, sn).

The criterion for selecting the facial variables was more approximately and corresponding to cephalometric measures (gold standard) commonly used to characterize jaw relationships and head position (Table II).

To clarify and simplify the understanding of the variables, the landmarks were abbreviated with lower case letters¹⁵ (e.g. a, n and b) while facial measures with upper case letters accompanied with the symbol quotes (e.g. ANB'). This procedure also helps to differentiate the facial measures to their cephalometric hard tissue counterparts.

Some landmarks denominations of common measurements used in anthropometric studies were changed to better correspond with their

cephalometric hard tissue counterparts. For example, the AFH' (n-gn) and LFH' (sn-gn) established by Farkas,¹⁵ instead of using 'gn', 'me' was used, i.e. AFH' (n-me) LFH' (sn- me) whose counterparts are AFH (N-Me) and LFH (Sn-Me).

The intraclass and interclass reliabilities for almost all measurements were greater than 0.90, indicating an excellent reliability (interval: 0.90-0.99). The rest of the measurements (ANB', FMA', Prop. LFH/AFH', TN.VER', FH.VER') had excellent and good (interval: 0.80-0.89) reliabilities. Only one variable FNP' presented a weak interclass reliability (interval: <0.69).

The best results were expected for linear measurements because they are easily taken. For example, it was expected that PFH' (0.96- 0.98) presented the best results not only for being a linear measurement, but because its landmarks were signalized by adhesives. Instead, N.Sn.Pg' (0.98- 0.95) presented the highest intraclass reproducibility. This could be explained through the difficulty³⁰ and the consequent variation when signalizing the landmark go, whereas, n, sn, and pg are more easily visualized. The interclass reliability for PFH' (0.98) presented the best result because as it was taken the same day. Therefore, the variation of the go position mentioned above, did not exist.

A factor affecting the reliability was the difficulty in identifying the landmarks. In accordance to Ward and Jamison,¹¹ measurements derived from one or more well-defined bony or anatomical landmarks, had better reliabilities than those derived only from constructed or estimated points. For example, N.Sn.B'

(0.96- 0.97) showed better results than ANB' (0.92- 0.84). Probably because subnasal was an easily identified landmark compared with nasion.

Despite FMA' (0.94- 0.87) being formed by well- defined landmarks, its reliability varied, perhaps by difficult founded on measuring obtuse FMA angles where the support rod had to be used. (Figure 6).

Another factor affecting the reliability of angular measurements is its size. In accordance with other authors,¹¹ acute angles were more difficult to measure than obtuse ones. For example: T.Go.Me' had better inter and intraclass reliabilities than ANB'.

Although, the variables AFH', PFH', and LFH', presented excellent reliabilities. The intraclass reproducibility of LFH' and AFH' presented better results when compared with another author's results (0.88 and 0.85 respectively).¹¹

Between the craniocervical measurements, it was expected that, C7.TN' and C7.FH' presented the worst results. This is because it is difficult to locate the c7 landmark and orthodontists are not used to recognizing it. It is possible that the interdisciplinary collaboration of the physiotherapists in training the operators and the use of a rigid protocol³¹ for identifying this structure, improved the results.

The measurements TN.VER' and FH.VER' presented good reproducibility; except by the interclass reproducibility of TN.VER that was excellent. Perhaps the difficulty in taking the True Vertical (VER') could explain this situation.

The most unreliable measure was FNP'. The intraclass reliability was good, however, its interclass reliability was weak. The difficulty in taking this measure can be justified by the absence of a well- defined center of rotation like other angular measurements such as T.Go.Me', where the center of rotation was at the point go.

CONCLUSION

The proposed method has proven to be a reliable diagnostic tool for assessing maxilo- mandibular relationships and head posture. This method is not recommended for taking the FNP' measurement. Special care must be taken when acute angular and/or poorly defined measurements are made.

REFERENCES

1. Aksu M, Kaya D, Kocadereli I. Reliability of reference distances used in photogrammetry. *Angle Orthod* 2010;80(4):482-9.
2. Farkas LG, Cheung G. Facial asymmetry in healthy North American Caucasians. An anthropometrical study. *Angle Orthod* 1981;51(1):70-7.
3. Arslan SG, Genç C, Odabaş B, Kama JD. Comparison of facial proportions and anthropometric norms among Turkish young adults with different face types. *Aesthetic Plast Surg* 2008;32(2):234-42.

4. Staudt CB, Kiliaridis S. A nonradiographic approach to detect Class III skeletal discrepancies. *Am J Orthod Dentofacial Orthop* 2009;136(1):52-8.
5. Zhang X, Hans MG, Graham G, Kirchner HL, Redline S. Correlations between cephalometric and facial photographic measurements of craniofacial form. *Am J Orthod Dentofacial Orthop* 2007;131(1):67-71.
6. Scavone H, Zahn-Silva W, do Valle-Corotti KM, Nahás AC. Soft tissue profile in white Brazilian adults with normal occlusions and well-balanced faces. *Angle Orthod* 2008;78(1):58-63.
7. Wong JY, Oh AK, Ohta E, et al. Validity and reliability of craniofacial anthropometric measurement of 3D digital photogrammetric images. *Cleft Palate Craniofac J* 2008;45(3):232-9.
8. Aynechi N, Larson BE, Leon-Salazar V, Beiraghi S. Accuracy and precision of a 3D anthropometric facial analysis with and without landmark labeling before image acquisition. *Angle Orthod* 2011;81(2):245-52.
9. Strömmland K, Chen Y, Michael G, Svensson E, Gustavsson T. Assessment of facial features with a range camera. *Scand J Plast Reconstr Surg Hand Surg* 1998;32(1):91-6.
10. Soncul M, Bamber MA. Evaluation of facial soft tissue changes with optical surface scan after surgical correction of Class III deformities. *J Oral Maxillofac Surg* 2004;62(11):1331-40.

11. Ward RE, Jamison PL. Measurement precision and reliability in craniofacial anthropometry: implications and suggestions for clinical applications. *J Craniofac Genet Dev Biol* 1991;11(3):156-64.
12. Jamison PL, Zegura SL. A univariate and multivariate examination of measurement error in anthropometry. *Am J Phys Anthropol* 1974;40(2):197-203.
13. de Farias RL. Interpretation and conceptualization of the types of facial profiles using the Caliper of the Facial Profile and committee evaluators using facial photographs. [Standar thesis]. Araraquara: State University Luis Mesquita Filho; 2006.
14. Moate SJ, Geenty JP, Shen G, Darendeliler MA. A new craniofacial diagnostic technique: the Sydney diagnostic system. *Am J Orthod Dentofacial Orthop* 2007;131(3):334-42.
15. Farkas LG. "Anthropometry of the Head and Face in Medicine". New York: Elsevier Science Ltd 1981.
16. Howells WW. The designation of the principle anthropometric landmarks on the head and skull. *Am J Phys Anthropol* 1937;22:477-94.
17. Solow B, Tallgren A. Natural head position in standing subjects. *Acta Odontol Scand* 1971;29(5):591-607.
18. Molhave A. A biostatic investigation. The standing posture of man theoretically and statometrically illustrated. *Acta Orthop Scand* 1960;29:291-300.

19. Graber TM. Orthodontics- principles and practices. Philadelphia: W. B. Saunders; 1972.
20. Fleiss JL. The Design and Analysis of Clinical Experiments. 1 ed: Wiley-Interscience; 1986.
21. Phillips C, Greer J, Vig P, Matteson S. Photocephalometry: errors of projection and landmark location. Am J Orthod 1984;86(3):233-43.
22. Romero-Maroto M, Nieto-Sanchez I, Miguez-Contreras M, Lopez-de-Andres A. Visual perception of skeletal class and biotype in Spain. Eur J Orthod 2012;34(3):322-6.
23. Beard LFH. The evolution of stereophotogrammetry measurements for the study off facial morphology. Med Biol Illust 1967;17:20-25.
24. Moorrees CFA, Le Bret L. The mesh diagram and cephalometrics. Angle Orthod 1962;32:214-31.
25. Hothi TH, Wolford LM, Epker BN, Fonseca FJ. Craniofacial ostetomies: a photocephalometric technique for the prediction and evaluation of tissue changes. Angle Orthod 1978;48(2):114-25.
26. El-Mangoury NH, Mostafa YA, Rasmy EM, Salah A. Faciometrics: a new syntax for facial feature analysis. Int J Adult Orthodon Orthognath Surg 1996;11(1):71-82.
27. Halazonetis DJ. Morphometric correlation between facial soft-tissue profile shape and skeletal pattern in children and adolescents. Am J Orthod Dentofacial Orthop 2007;132(4):450-7.

28. Fernández-Riveiro P, Smyth-Chamosa E, Suárez-Quintanilla D, Suárez-Cunqueiro M. Angular photogrammetric analysis of the soft tissue facial profile. *Eur J Orthod* 2003;25(4):393-9.
29. Molhave A. A biostatic investigation: the standing posture of man theoretically and statometrically illustrated. Copenhagen: Munksgaard; 1958.
30. Farkas LG, Tompson B, Phillips JH, Katic MJ, Cornfoot ML. Comparison of anthropometric and cephalometric measurements of the adult face. *J Craniofac Surg* 1999;10(1):18-25; discussion 26.
31. Shin S, Yoon DM, Yoon KB. Identification of the correct cervical level by palpation of spinous processes. *Anesth Analg* 2011;112(5):1232-5.

FIGURE LEGENDS

Figure 1: The Facial Paquimeter and its parts.

A) Disassembled facial paquimeter; **a) Head support área** (■): adjustment devices (1), protective foams (2), plastic strips (3), articulable screws (4), protective rubber band (5), complex metal plate- screw (6) and acrylic rod (7); **b) Articulation area** (■): support clamp (8), articulable clamp (9) and fixative screws (10); **c) Measurement area** (■): vertical ruler (11), protractor (12), principal ruler and its laser drawn line (13), secondary ruler (14), metallic

pendulum (15), support rod (16), horizontal rulers (17) clamps (18), metallic rod (19), acrylic rod (20) and clamp (21).

B) Assembled Facial Paquimeter.

Figure 2: Facial landmarks: adhesive dots placed on tracion (t), gonion (go), orbitale (or), nasion (n); adhesive miniballs placed on: menton (me) and C7 (c7).

Figure 3: Protractor device on E-line for assessment of NHP.¹⁴

Figure 4: The Facial Paquimeter taking the measurement Wits (FOP)'. A) First position i.e. the metallic rod parallel to the occlusal device; **B)** Occlusal device; **C)** Measurement Wits (FOP)': b- vr (■)/a-vr (■); (vr // clamp, Table II).

Figure 5: The Facial Paquimeter taking the measurement Wits (TV)'. A) Second position i.e. the metallic pendulum aligned with the laser drawn line of the protractor's principal ruler; **B)** Measurement Wits (TV)': b- vr (■)/a-vr (■); (vr // clamp, Table II).

Figure 6: Third position, the FP disassembled. A) Measurement T.Go.Me'; **B)** Measurement FMA'; a and b lines are parallel.

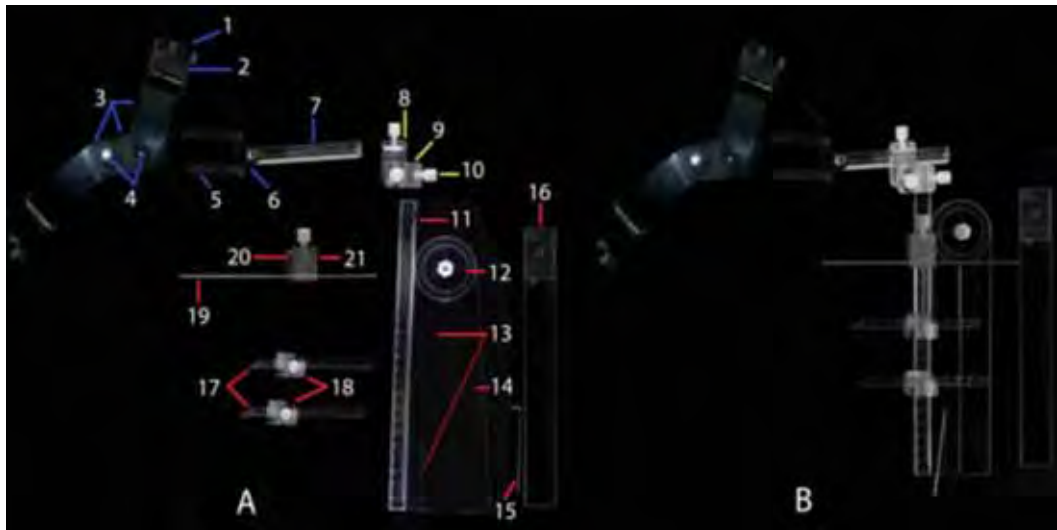


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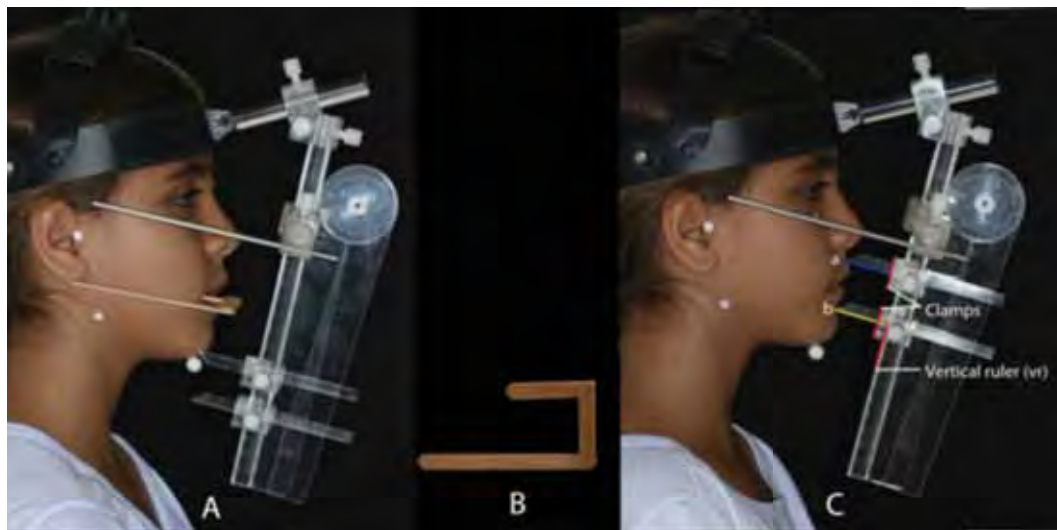


Figure 4: The Facial Paquimeter taking the measurement Wits (FOP)'. A) First position i.e. the metallic rod parallel to the occlusal device; **B)** Occlusal device; **C)** Measurement Wits (FOP)': b- vr (■)/a-vr (■); (vr // clamp, Table II).

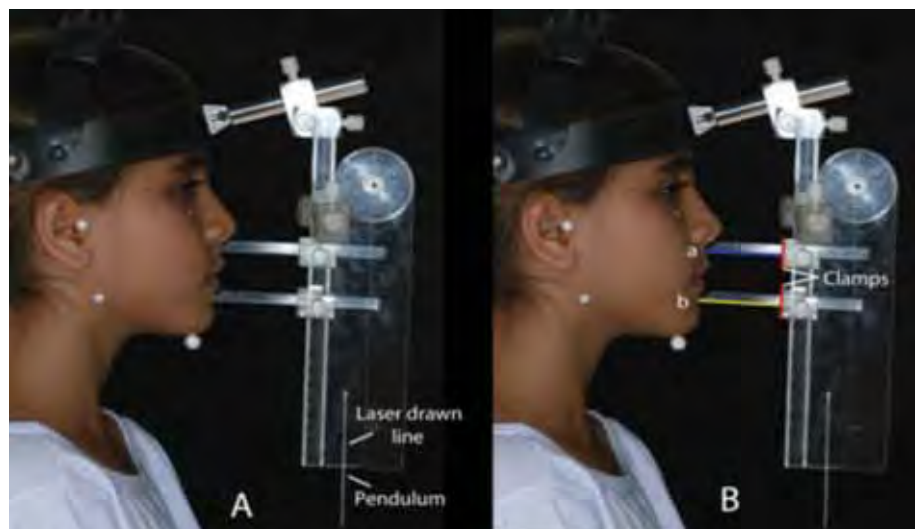


Figure 5: The Facial Paquimeter taking the measurement Wits (TV)'. A) Second position i.e. the metallic pendulum aligned with the laser drawn line of the protractor's principal ruler; **B)** Measurement Wits (TV)': b- vr (■)/a-vr (■); (vr // clamp, Table II).

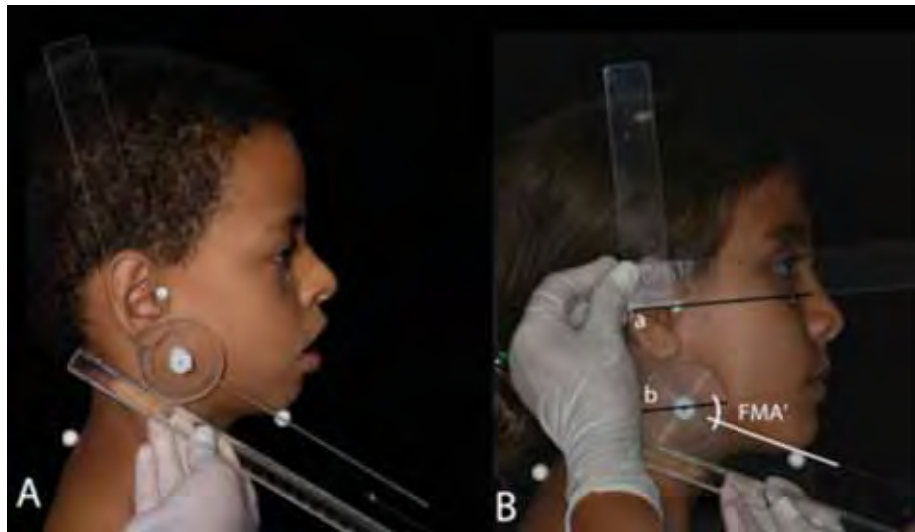


Figure 6: Third position, the FP dissembled. A) Measurement T.Go.Me'; B) Measurement FMA'; a and b lines are parallel.

Table I: Facial landmarks, planes and type of identification.

Landmarks	Description	Identification method
Soft tissue nasion (n)	Most anterior point of frontonasal suture, located in the curvature of the nasal bridge in soft tissue.	Visualization and palpation
Soft tissue orbitale (or)	Lowest point on the lower margin of the right orbit.	Palpation
Soft tissue tragion (t)	The middle point on the center of the tragus of the ear.	Visualization
Soft tissue gonion (go)	Most postero- inferior point of the mandibular angle (gonial angle)	Palpation
Soft tissue menton (me)	The most inferior midline point on the chin.	Visualization
Soft tissue A point (a)	Deepest point of the concavity of the anterior border of the upper lip.	Visualization
Soft tissue B point (b)	Deepest point of the concavity of the anterior border of the lower lip.	Visualization
Soft tissue pogonion (pg)	Outermost point on the soft-tissue chin.	Visualization
Soft tissue subnasal (sn)	Midpoint of the angle at the columella base where the lower border of the nasal septum and the surface of the upper lip meet.	Visualization
Soft tissue C7 (c7)	Most prominent point of the spinous process of C7 vertebra in the soft tissue.	Palpation ¹
Soft tissue Frankfurt horizontal plane (FH')	Line extending between t and or .	
Soft tissue mandibular plane (MP')	Line extending between go and me .	
Soft tissue facial plane (NP')	Line extending between n and pg .	
Soft tissue occlusal plane (OP')	Line defined by the occlusal device when it is positioned on patient's mouth.	
True vertical (VER')	Defined by vertical ruler when the drawn laser line of the principal ruler coincided with the metallic pendulum.	

¹**Protocol to identify c7:** Localize 2 or 3 prominences (sixth cervical vertebra (C6), seventh cervical vertebra (C7) and/or the first thoracic vertebra (T1) respectively) on the area of the seventh cervical vertebra. Ask the patient to extend the head slowly. During this movement, the C6 spinous process moves anteriorly in normal healthy subjects, while C7 and T1 remaining stationary. The c7 is the superior cervical spinous process between the remaining stationary vertebrae.³⁰

Table II: Facial variables description.

Variables/ Assessment	Facial variables*	Method for taking the facial measurement
Sagittal assessment	1. Wits (FOP)' (mm) (b- vr/a-vr ²)	Difference between the horizontal linear distances b point to the vertical ruler and the a point to the vertical ruler, where the edges of the horizontal rulers are positioned on the a and b points. The vr is represented by the horizontal ruler's nuts because they are parallel.
	2. Wits (VER ^b)' (mm) (b- vr/a-vr)	Difference between the horizontal linear distances b point to the vertical ruler and the a point to the vertical ruler. Where the edges of the horizontal rulers are positioned on the a and b points. The posterior surface of the horizontal ruler's, the vertical ruler and the true vertical are parallel. This is because the long axis of the metallic pendulum coincided with the line drawn laser of the principal ruler. Therefore, as the horizontal rulers were perpendicular the vertical ruler this measurement correspond to the distance between points a and b measured along the true horizontal.
	3. ANB' (°) (a.n.b)	Angle between the line a-n , located with the inner part of the principal ruler and the line n-b , located with the inner part of the secondary ruler. The intersection point n was located by the hole in the protractor
	4. FNP' (°) (t.or/n.pg)	Angle between the line t-or located with the inner part of the principal ruler and the line n-pog located with the inner part of the secondary ruler.
	5. N.Sn.Pg' (°) (n.sn.pg)	Angle between the line n- sn located with the inner part of the principal ruler and the line sn-pog located with the inner part of the secondary ruler. The intersection point sn was located by the hole in the protractor.
	6. N.Sn.B' (°) (n.sn.b)	Angle between the line n-sn located with the inner part of the principal ruler and the line sn-b , located with the inner part of the secondary ruler. The intersection point sn was located by the hole in the protractor.
Vertical assessment	7. T.Go.Me' (°) (t.go.me)	Angle between the line t-go located with the inner part of the principal ruler and the line go-me located with the inner part of the secondary ruler. The intersection point go was located by the hole in the protractor.
	8. FMA' (°) (t-or/go-me)	Angle between the line go-me located with the inner part of the principal ruler and the line t-or located with the inner part of the secondary ruler. The intersection point go was located by the hole in the protractor. In cases where the angle was very obtuse, the support rod was used to transfer the t-or plane to the go-me plane.
	9. AFH' (mm) (n-me)	Linear distance between the edges of the horizontal rulers positioned on the n and me points respectively.

*Landmarks abbreviated with lower case letters while facial measures with upper case letters accompanied with the symbol quotes ('). ^avr: vertical ruler;

^bVER': true vertical represented by the vertical ruler when the drawn laser line of the principal ruler coincided with the metallic pendulum..

Table II: Facial variables description.

Variables/ Assessment	Facial variables*	Method for taking the measurement
Vertical assessment	10. LFH' (mm) (sn-me)	Linear distance between the edges of the horizontal rulers positioned on the sn and me points respectively.
	11. PFH' (mm) (t-go)	Linear distance between the t and go measured using the vertical ruler.
	12. Proportion LFH'/AFH' (%) (sn-me/ n-me)	Numeric calculus: proportion LFH'/AFH'
	13. Proportion PFH'/AFH' (%) (t-go/ n-me)	Numeric calculus: proportion PFH'/AFH'
Head and cervical posture assessment	14. Proportion PFH'/LFH' (%) (t-go/ sn-me)	Numeric calculus proportion PFH'/LFH'
	15. TN.VER' (°) (t.n.ver)	Angle between the line t-n located with the inner part of the secondary ruler and the principal ruler parallel to true vertical i.e. the long axis of the metallic pendulum coincided with the line drawn laser of the principal ruler.
	16. FH'.VER' (°) (t.or.ver)	Angle between the line Frankfurt' (t-or), located with the inner part of the secondary ruler and the principal ruler parallel to true vertical.
	17. C7.TN' (°) (c7.t.n)	Angle between the line c7-t located with the inner part of the principal ruler and the line t-n located with the inner part of the secondary ruler. The intersection point t was located by the hole in the protractor.
	18. C7.FH' (c7.t.or)	Angle between the line c7-t located with the inner part of the principal ruler and the line Frankfurt' (t-or) located with the inner part of the secondary ruler. The intersection point t was located by the hole in the protractor.

*Landmarks abbreviated with lower case letters while facial measures with upper case letters accompanied with the symbol quotes (')

Table III. Estimation of intraclass reproducibility (repeatability – one researcher) of the method.

Measurements	ICC	95% CI	
		Lower bound	Upper bound
Wits (FOP)'	0,900	0,789	0,954
Wits (TV)'	0,930	0,850	0,969
FNP'	0,870	0,730	0,940
ANB'	0,922	0,833	0,965
N.Sn.Pg'	0,976	0,947	0,989
N.Sn.B'	0,962	0,916	0,983
TGoMe'	0,948	0,888	0,977
FMA'	0,935	0,860	0,971
AFH'	0,952	0,895	0,978
PFH'	0,955	0,903	0,980
LFH'	0,934	0,857	0,970
Prop. LFH/AFH'	0,853	0,698	0,932
Prop. AFH/PFH'	0,944	0,880	0,975
Prop. PFH/LFH'	0,913	0,815	0,961
C7.TN'	0,951	0,894	0,978
C7.FH'	0,936	0,862	0,971
TrN.VER'	0,842	0,677	0,927
FH.VER'	0,847	0,686	0,929

Table IV. Estimation of interclass reproducibility (reproducibility – two researches) of the method.

Measurements	ICC	95% CI	
		Lower bound	Upper bound
Wits (FOP)'	0,950	0,892	0,978
Wits (TV)'	0,930	0,850	0,968
FNP'	0,640	0,340	0,823
ANB'	0,844	0,681	0,928
N.Sn.Pg'	0,952	0,896	0,979
N.Sn.B'	0,971	0,937	0,987
TGoMe'	0,928	0,846	0,968
FMA'	0,866	0,723	0,938
AFH'	0,968	0,929	0,986
PFH'	0,982	0,960	0,992
LFH'	0,939	0,867	0,972
Prop. LFH/AFH'	0,904	0,796	0,956
Prop. AFH/PFH'	0,973	0,940	0,988
Prop. PFH/LFH'	0,943	0,877	0,975
C7.TN'	0,955	0,903	0,980
C7.FH'	0,952	0,894	0,978
TrN.VER'	0,928	0,845	0,967
FH.VER'	0,847	0,687	0,929

ARTIGO 2



Nonradiographic assessment of the hyperdivergent skeletal class II patient

Karla Orfelina Carpio Horta^a; Liliane de Carvalho Rosas Gomes^a; Marcelo Gonçalves^b; Ary dos Santos Pinto^b; João Roberto Gonçalves^b

^a MS student, Faculdade de Odontologia de Araraquara, Univ Estadual Paulista-UNESP, Araraquara, São Paulo, Brazil.

^b Professor, Faculdade de Odontologia de Araraquara, Univ Estadual Paulista UNESP, Araraquara, São Paulo, Brazil.

Corresponding Author: Karla Orfelina Carpio Horta, Universidade Estadual Paulista, UNESP, Department of Orthodontics, Rua Humaitá 1680, Araraquara, São Paulo 14801-385, Brazil.

e-mail: karlitach@hotmail.com

Nonradiographic assessment of the hyperdivergent skeletal class II patient

ABSTRACT

Introduction: Hyperdivergent skeletal class II patients have often been associated with several disturbances such as postural changes by airway adequacy and temporomandibular disorders. Simplified and objective non-radiographic assessment, of these patients is crucial for the development of epidemiological studies in order to better understand the mentioned associations. **Objectives:** To assess the validity of a non-radiographic method in diagnosing skeletal class II hyperdivergent patients. **Methods:** Direct facial measurements were taken in 120 pre-orthodontic children using a specially developed facial caliper and correlated with indirect measurements made in standardized lateral cephalograms. Discriminant analysis calculated a mathematical model used to diagnose the hyperdivergent class II patient through facial assessment. Intraclass correlation coefficients (ICC) were calculated from repeated facial measurements in order to evaluate the intra and inter-rater reliability. **Results:** Soft-tissue facial characteristics showed strong to moderate significant correlations ($p < 0.01$ and $p < 0.05$). Non-significant correlations were found for postural variables. The canonical discriminant function involved combining Wits (FOP)', N.Sn.Pg' and FMA' measurements, correctly classified 73.5% of the hyperdivergent class II patients in the internal validation. On the external validation, the method showed 81.3% sensitivity and 79.2% specificity. **Conclusion:** The facial paquimeter is a valuable diagnostic tool in determining the hyperdivergent skeletal class II pattern. Parameters characterizing hyperdivergent skeletal class II are identifiable through the use of the FP. This method is not recommended for the head posture assessment.

KEY WORDS: Diagnosis; anthropometry; growth and development, jaw relationships; skeletal pattern; validity.

INTRODUCTION

In orthodontics, the skeletal discrepancies are shown through cephalometric radiographs. In order to reduce radiation exposure, non-invasive methods have been proposed since there is no onset dose below which biologic damage does not occur.¹ These alternatives methods including anthropometry,^{2,3} two dimensional photogrammetry,⁴⁻⁶ three dimensional photogrammetry^{7,8} and three dimensional imaging techniques^{9,10} have been performed over the soft tissues.

Researches relating soft tissues to the underlying bony structures have been undertaken particularly in the area of morphanalyses.¹¹ Because of the soft tissue variation in thickness, the relationship between soft tissue profile and skeletal pattern might not be linear.¹² However, dealings between specific soft-tissue and skeletal variables have been found.^{5,13-15}

Also, subjective¹⁶ and clinical¹⁷ methods have been proposed to perform skeletal predictions, but their results were limited. It was indicated that lateral photographs were not sufficient in determining neither skeletal class nor facial biotype of patients,¹⁶ while overjet was considered a good predictor of sagittal relationship only in subjects with a Class II division 1 malocclusion.¹⁷

When considering the anthropometric method, the main advantages are the following: a noninvasive nature, technological simplicity, low cost, the existence of age and sex-matched standards to which subjects can be compared,¹⁸ satisfactory levels of reliability¹⁹ and more importantly, immediate results (avoiding the

processing time results in the laboratory). Furthermore, the anthropometry provides an objective rather than only a subjective facial assessment. These characteristics make this method a feasible tool for this purpose by providing objective scientific data.

Several investigations were executed on Class I, Class II¹³ and Class III⁴ patients, however, a sample with a representative number of hyperdivergent class II patients has not been investigated until now. For these patients, evidence on correlation between soft-tissue and skeletal features would be valuable. This is because the hyperdivergent class II patients have been related to several disturbances such as postural changes²⁰⁻²⁵ by airway adequacy²⁶ and temporomandibular disorders (TMD).²⁷ Nevertheless, the cause-effect relationship between this specific craniofacial pattern and those conditions is still unclear. Simplified methods, while still undeveloped, for detecting these individuals in large scale epidemiological studies may offer an improvement in understanding this complex relationship.

Therefore, the aim of this study was to assess the validity of a non-radiographic method in diagnosing skeletal class II hyperdivergent patients. It was hypothesized that parameters characterizing those patients are identifiable by such method.

MATERIAL AND METHODS

The direct measurements were made up using an instrument specially developed for this investigation; the Facial Paquimeter (FP) (Figure 1) and two

auxiliary devices (Figures 3 and 5). The FP and its entire method of use was described in a previous article (Reference paper 1).

The measurements were made in profile with the right side of the face toward the investigator, in maximum intercuspation, in natural head position (“mirror position”) and with the lips in a relaxed posture. Furthermore, the subjects were instructed to wear headbands to remove hair strands from the face, ear and neck when needed.

The landmarks^{28,29} used were identified by palpation and/or visualization (Table II). Four adhesive dots and two adhesive mini balls were placed on the children’s faces to better identify some landmarks (Figure 2).

Before the procedure the NHP³⁰ angle was recorded. The subjects were asked to stand up using the “*orthoposition*”.^{31,32} i.e. the intension position from standing to walking. The children were positioned in front of a mirror (placed 55 cm away), with the arms and lips relaxed and the teeth in contact in maximum intercuspation. Then, they were asked to look into a mirror image of their own eyes, after tilting their head up and down with decreasing amplitude until they felt they were relaxed. When the individual’s NHP, “mirror position”, was achieved, its angle was recorded using the protractor device³³ (Figures 3 and 4).

Almost all facial measurements were taken with the patient sitting in a chair with the spine erect, the head centered over his/her vertebral column³⁴ and viewing his/her own eyes in a mirror placed 25 cm away (Figures 5, 6 and 7). Only the cranio-cervical and cranio-vertical measurements were taken with the patient standing and in NHP^{30,15,16} (Figure 3).

The same operator (K.O.C.H) undertook five linear and ten angular measurements and calculated three proportions while an assistant recorded the data (Table III).

Indirect measurements:

The lateral cephalometric radiographs were obtained for all the subjects. Aimed at standardization, the procedure for taking the NHP described above was repeated. Three important factors were confirmed in the patients before the cephalogram was taken: NHP angle (same angle as recorded in the facial assessment confirmed using the protractor device), occlusion (maximum intercuspation) and lip posture (relaxed and in a natural position).³⁵

Radiograph images were acquired using the Kodak 8000 C (Kodak Dental Systems, Carestream Health, Atlanta, USA). The exposure data was 78 kV, 10 mA and 0.6 s. The film was fixed at a focus plane distance of 152 cm and a midsagittal focus plane distance of 20 cm with a final enlargement of 15 per cent. In addition, a pendulum with a chain was suspended on the X-ray device in front of the patient's midsagittal plane and functioned as a true-vertical locator device (Figure 5). To allow the recording of the NHP,³⁰ a mirror of 82 x 22 cm was placed 60 cm in front of the ear rods. The images were saved in a JPEG format.

The cephalometric analysis was performed using Radiocef Studio 2 software (Radio Memory Ltda., Belo Horizonte, MG, Brazil), in accordance with the manufacturer's recommendations. Before performing the measurements, the cephalograms were calibrated for magnification by the length of the true-vertical locator device (the pendulum with a chain suspended) (Figure 5).

To obtain linear and angular measurements (Table III), cephalometric points were marked on the digital images by a single examiner (Table IV).

The same operator made direct and indirect measurements in a blind design.

Statistics

Interclass and interclass correlation coefficients (ICC) were estimated to measure the reliability of the repeated facial measurements of 26 randomly selected subjects. Descriptive statistics including means, standard deviations, and minimum/maximum values were given for each facial/cephalometric variables for the entire sample and subgroups (class II hyperdivergent patients/others). Equal variances of the two groups were compared using the Levene test. Depending on the results, the means of groups were compared using the Student *t* test for independent samples from populations with equal variances or unequal variances. The Pearson correlation coefficient was calculated to estimate correlation between the facial and cephalometric variables.

The discriminant analysis (DA) performed a variable selection to obtain a model (group of measurements) with the smallest set of facial variables capable to diagnose class II hyperdivergent patients by using the proposed method. Therefore, through the method stepwise, a canonical discriminant function was calculated by using 80 random selected patients (Calibration set) of the entire sample (120 patients). To validate the model, the classifying power of the selected facial variables was tested on the remaining 40 patients (Test set). This model was adjusted involving subjects with complete data measurements. As the FMA' was not measured in some individuals, measurements missing were replaced by the

average value of FMA' according to the group and gender.

All the analyses were carried out using the Statistical Package for Social Sciences 16.0 (SPSS Inc., Chicago, Illinois, USA). Statistical significance was accepted at $p<0.05$.

RESULTS

The final sample included 120 patients divided into two subgroups: the hyperdivergent class II (70 patients) and the other skeletal pattern group (50 patients).

The intraclass and interclass reliabilities for almost all direct measurements was excellent (ICC in an interval 0.90-0.99) and a few presented good (interval: $0.75<0.90$) results. Only one variable (FNP') presented a weak interclass reliability (interval: <0.65) (Table V).

Means, standard deviations, and the ranges for all cephalometric and facial measurements are shown in Tables VI and VII. The cephalometric measurements showed significant differences ($p<0.01$ and $p<0.05$) between the subgroups for the sagittal and vertical assessment, except for measurements PFH, LPFH and LFH/AFH. The facial measurements showed significant differences ($p<0.01$) for almost all the variables on the sagittal assessment, except for FNP'. Only FMA', AFH', LFH/AFH', PFH'/AFH' of the vertical assessment showed significant differences ($p<0.01$ and $p<0.05$) between the groups. Measurements for head and cervical posture assessment showed no significant differences between the subgroups for neither facial nor cephalometric assessments.

Considering the entire sample, significant correlations ($p<0.01$ and

$p < 0.05$) were found between cephalometric and facial measurements for almost all variables, except for the FH.OPT/C7.FH' correlation. For the sagittal assessment the coefficients were higher than 0.4. On the vertical assessment, the correlations ranged from 0.3 to 0.7. The lowest results were presented for the head and cervical posture assessment (range from 0.2 to 0.4).

The subgroups also presented significant correlations ($p < 0.01$ and $p < 0.05$) for most of the variables. The best results were presented by the sagittal and vertical assessment variables (range from 0.4 to 0.7), with the exception of the proportions of both groups and FNP (0.3) and PFH (S-Go) (0.3) variables of the other skeletal patterns group. There is no evidence of correlation between C7.FH' and FH.OPT measurements. Only significant correlations are showed in Table VIII.

The DA performed through the stepwise method, showed the highest discriminating power given by the following canonical discriminant function (D):

$$D = 17.074 + 0.212 \cdot \text{Wits (FOP)'} - 0.144 \cdot \text{N.Sn.Pg}' + 0.198 \cdot \text{FMA}'$$

Between the 80 selected patients (Calibration set), the adjusted model classified correctly 73.5% of the class II hyperdivergent subjects and 69.6% of individuals of the other skeletal pattern group (Table IX). By applying this model in the 40 remaining patients (Test set), the method showed a total accuracy of 80,0%, sensitivity of 81,3%, specificity of 79.2%, positive predictive value of 72.2% and negative predictive value of 86.4% (Table IX).

DISCUSION

The sample included 120 children (64 females and 56 males) with an age range of 7 to 12 years with different types of vertical and sagittal skeletal discrepancies. The sample selected represent an age group where the interrelationship between hard and soft-tissue shapes should be particularly close, without the added variability of the aging effects.³⁶ However, since the anthropometric procedure requires collaboration and patience from the evaluated subject, working with child presented difficulties that could have influenced the results. To minimize this factor, the posture of their body (sitting or standing), head (NHP)³⁷ and lips (relaxed)³⁵ were standardized. In addition, the landmarks were signalized by adhesives dots and mini balls to reduce the time of the complete procedure (maximum 15 minutes).

With the objective of identifying the hyperdivergent class II patients in the population, the sample was divided into two subgroups (Table I). The first group consisted of patients with class II skeletal hyperdivergent pattern ($ANB > 4^\circ$ and $SN.Go.Me > 36^\circ$) while the second group included those with different antero-posterior and vertical relationships. The descriptive analyses showed significant differences between the subgroups for most cephalometric and facial variables on the sagittal and vertical assessments, except for some linear measurements. FNP' showed no significant differences between the groups, perhaps because it was the most difficult measurement to take due to a lack of a clear reference for the n-pg plane.

The absence of significant differences between the groups on the Tr.Go.Me' variable, could be explained by the presence of more extreme vertical

patients ($\text{Tr.Go.Me}'=150.00$) in the second group (table VII). Despite these problems, the proposed method possibilities distinguish the hyperdivergent class II patients from the other skeletal types by several variables.

The cephalometric and facial assessments of the head and cervical variables did not-corroborate the ‘soft-tissue stretching’ hypothesis,³⁸ in which an extended head posture and/or forward inclination of the cervical column were related to subjects with high mandibular plane angle, long-face morphology and retrognathic profile.^{22, 39}

The reproducibility of the method was satisfactory. Only FNP' presented a weak reproducibility.

On the sagittal and vertical assessment, the soft tissue measurements Wits (FOP)', ANB', N.Sn.Pog', N.Sn.B' Tr.Go.Me' and AFH' were the variables best associated with skeletal parameters describing the sagittal and vertical jaw relationship. Their correlations were considered strong ($r \geq 0.65$).¹⁵ FMA' and LFH' measurements showed moderate correlations ($0.5 < r < 0.65$).¹⁵ The rest of the measurements presented weak correlations ($r \leq 0.50$)¹⁵. This could be explained by the difficulty¹⁵ and the consequent variation when signalizing the landmark go. Better correlations were found by another method¹⁵ for AFH' and PFH' measurements (0.93 and 0.87 respectively), when a sample of adults were analyzed.

Despite their excellent and good reliabilities the head and cervical measurements showed weak correlations. In accordance to other authors,⁴ the

head position can differ from the cephalogram, and rotation in the horizontal plane and tilting of the head affects angular measurements. In this sense, these measurements completely depended on the patient whose cooperation could have affected the results, since many of them tended to rest the head⁴⁰ during the procedure. Consequently, the assessment of the head and cervical posture by this method is not recommended.

Our findings corroborate the hypothesis that measurements characterizing hyperdivergent skeletal class II are identifiable by using the proposed method. The DA attempted to find the best set of predictors in distinguishing the hyperdivergent class II from the other skeletal patterns. The combination of Wits (FOP)', N.Sn.Pg' and FMA' variables presented the highest discriminative power. A satisfactory result was found on the internal validation where the adjusted model classified correctly 73.5% of the hyperdivergent class II subjects. Even better results were found on the external validation where the method showed a total accuracy of 80,0% and correctly classified 81.3% of the hyperdivergent class II subjects and 79.2% of the others skeletal class patients. Furthermore, satisfactory results of positive predictive value (72.2%) and negative predictive value (86.4%) were recorded.

CONCLUSION

The facial paquimeter is a valuable diagnostic tool in determining the hyperdivergent skeletal class II pattern. Parameters characterizing hyperdivergent skeletal class II are identifiable through the use of the FM.

Although cephalometry remains the method of choice for clinical patient care, the method proposed can be useful for initial consultations and large-scale epidemiological studies where the use of a noninvasive method is crucial.

REFERENCES

1. Smith NJ. Risk assessment: the philosophy underlying radiation protection. *Int Dent J* 1987;37(1):43-51.
2. Farkas LG, Cheung G. Facial asymmetry in healthy North American Caucasians. An anthropometrical study. *Angle Orthod* 1981;51(1):70-7.
3. Arslan SG, Genç C, Odabaş B, Kama JD. Comparison of facial proportions and anthropometric norms among Turkish young adults with different face types. *Aesthetic Plast Surg* 2008;32(2):234-42.
4. Staudt CB, Kiliaridis S. A nonradiographic approach to detect Class III skeletal discrepancies. *Am J Orthod Dentofacial Orthop* 2009;136(1):52-8.
5. Zhang X, Hans MG, Graham G, Kirchner HL, Redline S. Correlations between cephalometric and facial photographic measurements of craniofacial form. *Am J Orthod Dentofacial Orthop* 2007;131(1):67-71.
6. Scavone H, Zahn-Silva W, do Valle-Corotti KM, Nahás AC. Soft tissue profile in white Brazilian adults with normal occlusions and well-balanced faces. *Angle Orthod* 2008;78(1):58-63.

7. Wong JY, Oh AK, Ohta E, et al. Validity and reliability of craniofacial anthropometric measurement of 3D digital photogrammetric images. *Cleft Palate Craniofac J* 2008;45(3):232-9.
8. Aynechi N, Larson BE, Leon-Salazar V, Beiraghi S. Accuracy and precision of a 3D anthropometric facial analysis with and without landmark labeling before image acquisition. *Angle Orthod* 2011;81(2):245-52.
9. Strömmland K, Chen Y, Michael G, Svensson E, Gustavsson T. Assessment of facial features with a range camera. *Scand J Plast Reconstr Surg Hand Surg* 1998;32(1):91-6.
10. Soncul M, Bamber MA. Evaluation of facial soft tissue changes with optical surface scan after surgical correction of Class III deformities. *J Oral Maxillofac Surg* 2004;62(11):1331-40.
11. Jayaprakash PT, Srinivasan GJ, Amravanewaran MG. Cranio-facial morphanalysis: a new method for enhancing reliability while identifying skulls by photo superimposition. *Forensic Sci Int* 2001;117(1-2):121-43.
12. Burstone CJ. The integumental profile. *Am J Orthod* 1958;44:1-25.
13. Saxby PJ, Freer TJ. Dentoskeletal determinants of soft tissue morphology. *Angle Orthod* 1985;55(2):147-54.
14. Barnett DP. Variations in the soft tissue profile and their relevance to the clinical assessment of skeletal pattern. *Br J Orthod* 1975;2(4):235-8.

15. Farkas LG, Tompson B, Phillips JH, Katic MJ, Cornfoot ML. Comparison of anthropometric and cephalometric measurements of the adult face. *J Craniofac Surg* 1999;10(1):18-25; discussion 26.
16. Romero-Maroto M, Nieto-Sanchez I, Miguez-Contreras M, Lopez-de-Andres A. Visual perception of skeletal class and biotype in Spain. *Eur J Orthod* 2012;34(3):322-6.
17. Zupancic S, Pohar M, Farcnik F, Ovsenik M. Overjet as a predictor of sagittal skeletal relationships. *Eur J Orthod* 2008;30(3):269-73.
18. Ward RE. Facial morphology as determined by anthropometry: keeping it simple. *J Craniofac Genet Dev Biol* 1989;9(1):45-60.
19. Ward RE, Jamison PL. Measurement precision and reliability in craniofacial anthropometry: implications and suggestions for clinical applications. *J Craniofac Genet Dev Biol* 1991;11(3):156-64.
20. Marcotte MR. Head posture and dentofacial proportions. *Angle Orthod* 1981;51(3):208-13.
21. Solow B, Siersbaek-Nielsen S. Cervical and craniocervical posture as predictors of craniofacial growth. *Am J Orthod Dentofacial Orthop* 1992;101(5):449-58.
22. Solow B, Tallgren A. Head posture and craniofacial morphology. *Am J Phys Anthropol* 1976;44(3):417-35.
23. Solow B, Tallgren A. Dentoalveolar morphology in relation to craniocervical posture. *Angle Orthod* 1977;47(3):157-64.

24. Solow B, Siersbaek-Nielsen S, Greve E. Airway adequacy, head posture, and craniofacial morphology. *Am J Orthod* 1984;86(3):214-23.
25. Schwartz AM. Positions of the head and malrelations of the jaws. *Int J Orthod* 1928;14:56-8.
26. Lowe AA, Santamaria JD, Fleetham JA, Price C. Facial morphology and obstructive sleep apnea. *Am J Orthod Dentofacial Orthop* 1986;90(6):484-91.
27. Nebbe B, Major PW, Prasad NG, Grace M, Kamelchuk LS. TMJ internal derangement and adolescent craniofacial morphology: a pilot study. *Angle Orthod* 1997;67(6):407-14.
28. Farkas LG. "Anthropometry of the Head and Face in Medicine". New York: Elsevier Science Ltd 1981.
29. Howells WW. The designation of the principle anthropometric landmarks on the head and skull. *Am J Phys Anthropol* 1937;22:477-94.
30. Solow B, Tallgren A. Natural head position in standing subjects. *Acta Odontol Scand* 1971;29(5):591-607.
31. Molhave A. A biostatic investigation: the standing posture of man theoretically and statometrically illustrated. Copenhagen: Munksgaard; 1958.
32. Molhave A. A biostatic investigation. The standing posture of man theoretically and statometrically illustrated. *Acta Orthop Scand* 1960;29:291-300.

33. Moate SJ, Geenty JP, Shen G, Darendeliler MA. A new craniofacial diagnostic technique: the Sydney diagnostic system. *Am J Orthod Dentofacial Orthop* 2007;131(3):334-42.
34. Graber TM. *Orthodontics- principles and practices*. Philadelphia: W. B. Saunders; 1972.
35. Fernández-Riveiro P, Smyth-Chamosa E, Suárez-Quintanilla D, Suárez-Cunqueiro M. Angular photogrammetric analysis of the soft tissue facial profile. *Eur J Orthod* 2003;25(4):393-9.
36. Halazonetis DJ. Morphometric correlation between facial soft-tissue profile shape and skeletal pattern in children and adolescents. *Am J Orthod Dentofacial Orthop* 2007;132(4):450-7.
37. Solow B, Tallgren A. Natural head position in standing subjects. *Acta Odontol Scand* 1971;29(5):591-607.
38. Solow B, Kreiborg S. Soft-tissue stretching: a possible control factor in craniofacial morphogenesis. *Scand J Dent Res* 1977;85(6):505-7.
39. Solow B, Sandham A. Cranio-cervical posture: a factor in the development and function of the dentofacial structures. *Eur J Orthod* 2002;24(5):447-56.
40. Han K, Kwon HJ, Choi TH, Kim JH, Son D. Comparison of anthropometry with photogrammetry based on a standardized clinical photographic technique using a cephalostat and chair. *J Craniomaxillofac Surg* 2010;38(2):96-107.

41. Hellsing E, McWilliam J, Reigo T, Spangfort E. The relationship between craniofacial morphology, head posture and spinal curvature in 8, 11 and 15-year-old children. *Eur J Orthod* 1987;9(4):254-64.
42. Jacobson A. The "Wits" appraisal of jaw disharmony. *Am J Orthod* 1975;67(2):125-38.
43. Shin S, Yoon DM, Yoon KB. Identification of the correct cervical level by palpation of spinous processes. *Anesth Analg* 2011;112(5):1232-5.

FIGURE LEGENDS

Figure 1: The Facial Paquimeter and its parts.

A) Disassembled facial paquimeter; **a) Head support área** (■): adjustment devices (1), protective foams (2), plastic strips (3), articulable screws (4), protective rubber band (5), complex metal plate- screw (6) and acrylic rod (7); **b) Articulation area** (■): support clamp (8), articulable clamp (9) and fixative screws (10); **c) Measurement area** (■): vertical ruler (11), protractor (12), principal ruler and its laser drawn line (13), secondary ruler (14), metallic pendulum (15), support rod (16), horizontal rulers (17) clamps (18), metallic rod (19), acrylic rod (20) and clamp (21).

B) Assembled Facial Paquimeter.

Figure 2: Facial landmarks: adhesive dots placed on tracion (t), gonion (go), orbitale (or), nasion (n); adhesive miniballs placed on: menton (me) and C7 (c7).

Figure 3: Patient standing and in natural head position.

Figure 4: Protractor device on E-line for assessment of NHP.³¹

Figure 5: The Facial Paquimeter taking the measurement Wits (FOP)'. A)

First position i.e. the metallic rod parallel to the occlusal device; **B)** Occlusal device; **C)** Measurement Wits (FOP)': b- vr (■)/a-vr (■); (vr // clamp, Table II).

Figure 6: The Facial Paquimeter taking the measurement Wits (TV)'. A)

Second position i.e. the metallic pendulum aligned with the laser drawn line of the protractor's principal ruler; **B)** Measurement Wits (TV)': b- vr (■)/a-vr (■); (vr // clamp, Table II).

Figure 7: Third position, the FP dissembled. A) Measurement T.Go.Me', B)

Measurement FMA'; a and b lines are parallel.

Figure 8: Cephalometric radiograph with the patient in NHP.

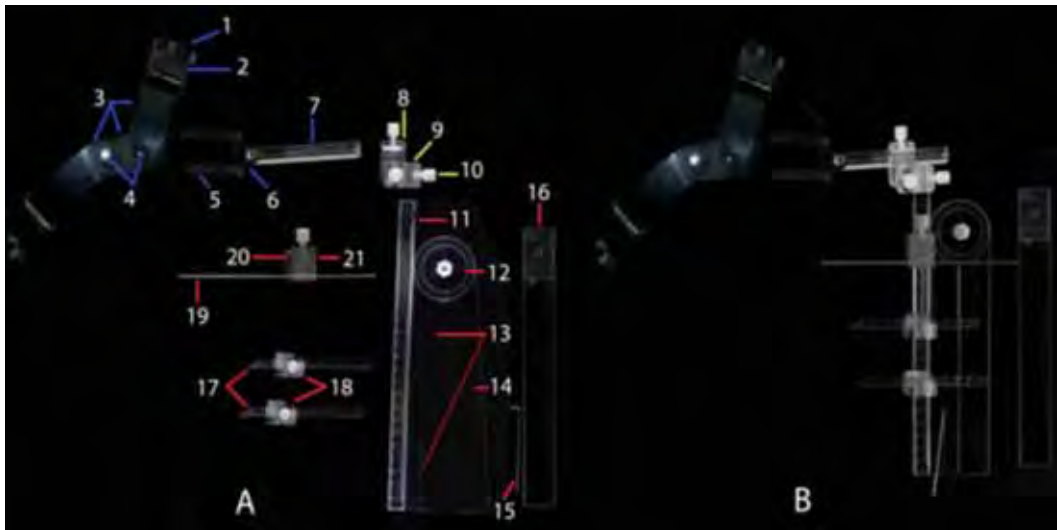


Figure 1: The Facial Paquimeter and its parts.

A) Disassembled facial paquimeter; **a) Head support area** (■): adjustment devices (1), protective foams (2), plastic strips (3), articulable screws (4), protective rubber band (5), complex metal plate- screw (6) and acrylic rod (7); **b) Articulation area** (■): support clamp (8), articulable clamp (9) and fixative screws (10); **c) Measurement area** (■): vertical ruler (11), protractor (12), principal ruler and its laser drawn line (13), secondary ruler (14), metallic pendulum (15), support rod (16), horizontal rulers (17) clamps (18), metallic rod (19), acrylic rod (20) and clamp (21).

B) Assembled Facial Paquimeter.



Figure 2: Facial landmarks. Adhesive dots placed on trasion (t), gonion (go), orbitale (or), nasion (n). Adhesive miniballs placed on: menton (me) and C7 (c7).



Figure 3: Patient standing and in natural head position.



Figure 4: Protractor device on E-line for assessment of NHP.³¹

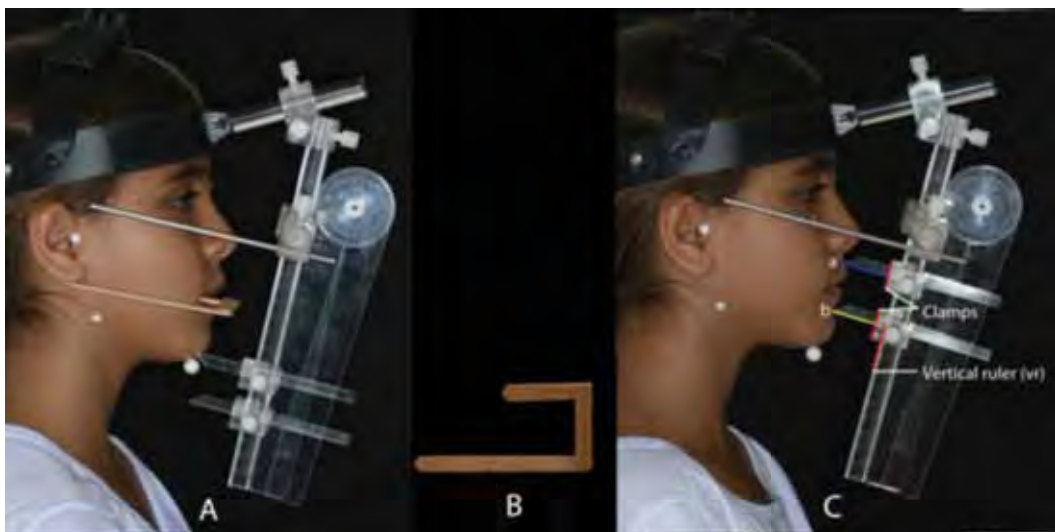


Figure 5: The Facial Paquimeter taking the measurement Wits (FOP)'. A) First position i.e. the metallic rod parallel to the occlusal device; **B)** Occlusal device; **C)** Measurement Wits (FOP)': $b - vr$ (■ $a - vr$ (■ $(vr // \text{clamp}$, Table II).

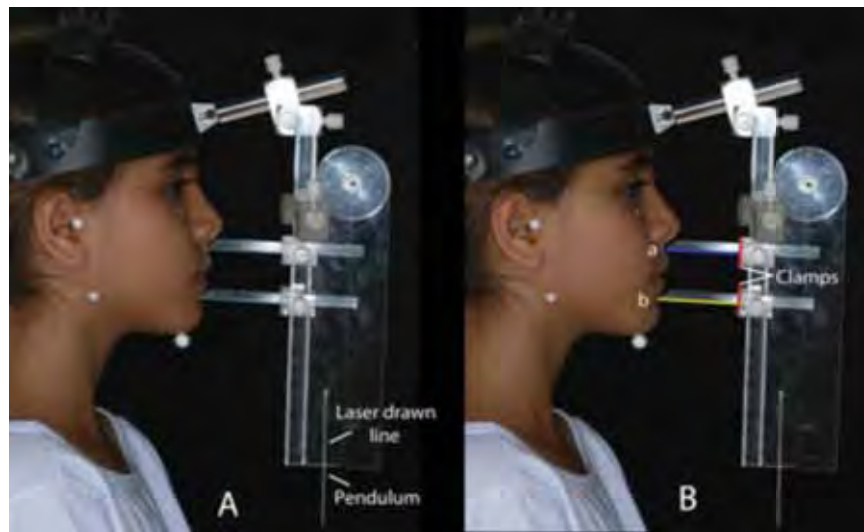


Figure 6: The Facial Paquimeter taking the measurement Wits (TV)'. A) Second position i.e. the metallic pendulum aligned with the laser drawn line of the protractor's principal ruler; **B)** Measurement Wits (TV)': b- vr (■)/a-vr (□); (vr // clamp, Table II).

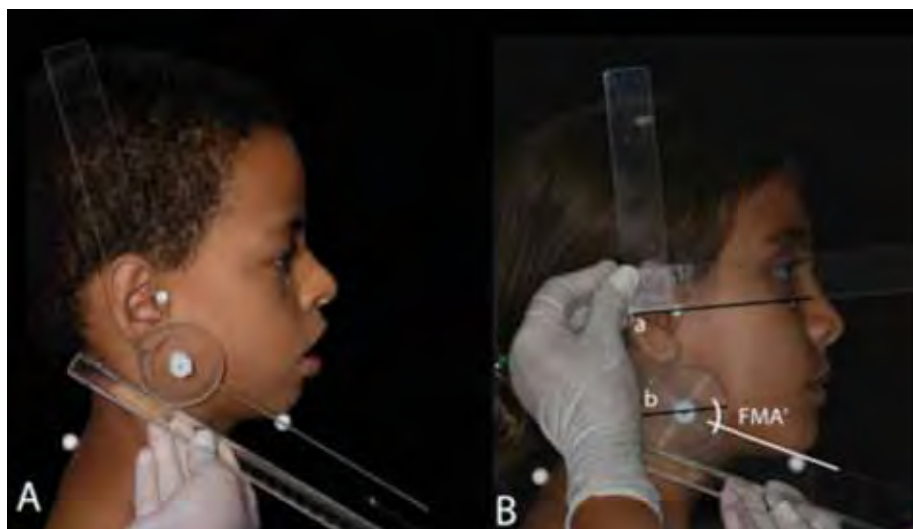


Figure 7: Third position, the FP disassembled. A) Measurement T.Go.Me', **B)** Measurement FMA'; a and b lines are parallel.



Figure 8: Cephalometric radiograph with the patient in NHP.

Table I: Sample characterization.

120 PATIENTS	
Cephalometric diagnosis (Gold standard)	
HYPERDIVERGENT CLASS II	OTHERS SKELETAL PATTERNS
(ANB>4,5°, SN.GoMe>36°)	(ANB≤4,5°, SN.GoMe≤36°)
50 patients	70 patients

Table II: Facial landmarks, planes and type of identification.

Landmarks	Description	Identification method
Soft tissue nasion (n)	Most anterior point of frontonasal suture, located in the curvature of the nasal bridge in soft tissue.	Visualization and palpation
Soft tissue orbitale (or)	Lowest point on the lower margin of the right orbit.	Palpation
Soft tissue tragon (t)	The middle point on the center of the tragus of the ear.	Visualization
Soft tissue gonion (go)	Posterior and inferior point of the mandibular angle (gonial angle)	Palpation
Soft tissue menton (me)	The most inferior midline point on the chin.	Visualization
Soft tissue A point (a)	Deepest point of the concavity of the anterior border of the upper lip.	Visualization
Soft tissue B point (b)	Deepest point of the concavity of the anterior border of the lower lip.	Visualization
Soft tissue pogonion (pg)	Outermost point on the soft-tissue chin.	Visualization
Soft tissue subnasal (sn)	Midpoint of the angle at the columella base where the lower border of the nasal septum and the surface of the upper lip meet.	Visualization
Soft tissue C7 (c7)	Most prominent point of the spinous process of C7 vertebra in the soft tissue.	Palpation ¹
Soft tissue Frankfurt horizontal plane (FH')	Line extending between t and or .	
Soft tissue mandibular plane (MP')	Line extending between go and me .	
Soft tissue facial plane (NP')	Line extending between n and pg .	
Soft tissue occlusal plane (OP')	Line defined by the occlusal device when it is positioned on patient's mouth.	
True vertical (VER')	Defined by vertical ruler when the drawn laser line of the principal ruler coincided with the metallic pendulum.	

¹**Protocol to identify c7:** Localize 2 or 3 prominences (sixth cervical vertebra (C6), seventh cervical vertebra (C7) and/or the first thoracic vertebra (T1) respectively) on the area of the seventh cervical vertebra. Ask the patient to extend the head slowly. During this movement, the C6 spinous process moves anteriorly in normal healthy subjects, while C7 and T1 remaining stationary. The c7 is the superior cervical spinous process between the remaining stationary vertebrae.⁴³

Table III: Cephalometrics and their corresponding facial measurements.

Variables/ Assessments	Cephalometric variables	Facial variables*
Sagittal Assessment	1. Wits	1. Wits (FOP) ¹ : b-vr/a-vr ² (mm)
	2. ANB	2. Wits (VER) ³ : b-vr/a-vr (mm)
	3. FNP	3. ANB': a.n.b (°)
	4. N.ANS.Pog	4. FNP': t.or/n.pg (°)
	5. N.ANS.B	5. N.Sn.Pg': n.sn.pg (°)
Vertical Assessment	6. Ar.Go.Me	6. N.Sn.B': n.sn.b (°)
	7. FMA	7. T.Go.Me': t.MP' (°)
	8. SNGoMe	8. FMA': FH'/MP' (°)
	9. AFH	-
	10. LFH	9. AFH': n-me (mm)
	11. PFH (S- Go)	10. LFH': sn-me: (mm)
	12. LPFH (Ar- Go)	11. PFH': t-go (mm)
	13. LFH/AFH	12. Proportion LFH/AFH': sn-me/ n-me (%)
	14. PFH/AFH	13. Proportion PFH'/AFH': t-go/ n-me (%)
	15. LPFH/AFH	14. Proportion PFH'/LFH': t-go/ sn-me (%)
Head and cervical posture assessment	16. PFH/LFH	
	17. LPFH/LFH	
	18. NSL.VER	15. TN.VER': t.n.VER' (°)
	19. FH.VER	16. FH.VER' (°)
	20. NSL.CVT	
	21. NSL.OPT	17. C7.TN': c7.t.n (°)
	22. NSL.EVT	
	23. FH.CVT	
24. FH.OPT	18. C7.FH' (°)	
25. FH.EVT		

*Landmarks abbreviated with lower case letters while facial measures with upper case letters accompanied with the symbol quotes (').

¹ Wits (FOP)': Wits Facial Occlusal Plane; ² vr: vertical ruler; ³ Wits (VER)': Wits True Vertical.

Table IV: Cephalometric landmarks and planes.

Anatomical landmarks	Definition
Nasion (N)	The anterior point of the suture at the junction of the frontal and nasal bones in the mid-sagittal plane.
Articulare (Ar)	The projection of the posterior outline of the condylar process onto the inferior outline of the cranial base.
Porion (Po)	The midpoint on the upper edge of the externals acoustic meatus.
Orbitale (Or)	The lowest point on the lower margin of the bony orbit.
Subspinale (A)	The deepest point on the distance between anterior nasal spine and the alveolar crest.
Supramentale (B)	The deepest point on the distance between the pogonion and the alveolar crest.
Gonion (Go)	The junction between the lower border of the mandibular body and the posterior border of the mandibular ramus located at the point where the angle of the mandible meets the bisector of tangents of these borders.
Pogonion (Pog)	The most anteriorly located point on the mandibular symphesal outline.
Menton (Me)	The most inferior point on the mandibular symphesal outline.
Anterior Nasal Spine (ANS)	Tip of the bony anterior nasal spine in the median plane.
Sella turcica (S)	The center of the pituitary fossa of the sphenoid bones.
Second cervical vertebra body (Cv2ip)	The most inferior and posterior point on the body of the second cervical vertebra. ²⁹
Odontoid process tangent (Cv2tg)	The tangent point at the superior and posterior extremity of the odontoid process of the second cervical vertebra. ²⁹
Fourth cervical vertebra body (Cv4ip)	The most inferior and posterior point on the body of the fourth cervical vertebra. ²⁹
Sixth cervical vertebra body (Cv6ip)	The most inferior and posterior point on the body of the sixth cervical vertebra. ⁴¹
Frankfurt horizontal plane (FH)	Horizontal plane running through Porion and Orbitale.
Mandibular plane (MP)	Line extending between Gonion and Menton.
Occlusal plane (OP)	Line that joins the midpoint of the overlap of the mesio-buccal cusp of the first molar and the buccal cusp of the first premolar. ⁴²
Facial plane (NP)	Line extending between Nasion and Pogonion.
True vertical line (VER)	Defined by a plumb line.
Cranial base line (NSL)	Line extending between Sella turcica and Nasion.
Cervical vertebra tangent (CVT)	Posterior tangent to the odontoid process through Cv4ip. ²⁹
Odontoid process tangent (OPT)	Posterior tangent to the odontoid process through Cv2ip. ²⁹
Lower cervical spine segment (EVT)	Line through Cv4ip and Cv6ip (Hellsing) ⁴³

Table V. Reproducibility of the method.

Measurements	ICC	
	Intraclass	Interclass
Wits (FOP)'	0,900	0,950
Wits (TV)'	0,930	0,930
FNP'	0,870	0,640
ANB'	0,922	0,844
NSnPg'	0,976	0,952
NSnB'	0,962	0,971
TGoMe'	0,948	0,928
FMA'	0,935	0,866
AFH'	0,952	0,968
PFH'	0,955	0,982
LFH'	0,934	0,939
Prop. LFH/AFH'	0,853	0,904
Prop. AFH/PFH'	0,944	0,973
Prop. PFH/LFH'	0,913	0,943
C7TN'	0,951	0,955
C7.FH'	0,936	0,952
TrN.VER'	0,842	0,928
FH.VER'	0,847	0,847

Table VI. Descriptive analyses for the cephalometric measurements.

Measurements	Hyperdivergent class II (n=50)				Other skeletal pattern (n=70)				Teste t
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Sagittal assessment:									
1. Wits ²	0,79	2,49	-4,82	4,97	-1,56	3,06	-7,81	4,67	**
2. ANB	6,63	1,81	4,51	10,09	4,34	2,18	-1,55	8,71	**
3. FNP	86,41	2,36	81,77	91,21	88,54	2,27	82,99	95,15	**
4. N.ANB.Pog	160,33	4,35	152,34	169,83	164,92	4,44	155,57	177,55	**
5. N.ANB.B	157,35	4,24	150,20	165,41	162,28	4,77	152,29	175,61	**
Vertical assessment:									
6. ArGoMe2 ²	130,99	4,23	119,49	138,26	128,71	5,32	118,61	141,03	*
7. FMA	28,45	3,56	22,33	37,68	24,42	3,65	13,69	32,63	**
8. SN.GoMe	39,81	3,08	36,16	50,36	34,22	3,98	24,35	43,63	**
9. AFH	101,27	5,57	90,09	113,67	98,63	4,92	85,62	110,36	**
10. LFH	56,06	3,85	47,71	65,48	54,61	3,72	45,54	63,82	*
11. PFH (S- Go)	59,62	3,45	50,95	66,75	61,05	4,21	51,05	73,82	ns
12. LPFH (Ar-Go)	33,23	3,01	26,59	38,78	34,25	3,21	26,79	41,69	ns
13. LFH/AFH	0,55	0,02	0,51	0,60	0,55	0,02	0,51	0,60	ns
14. PFH/AFH	0,59	0,03	0,52	0,64	0,62	0,03	0,54	0,71	**
15. LPFH/AFH	0,33	0,03	0,27	0,39	0,35	0,03	0,28	0,40	**
16. PFH/LAFH	1,07	0,07	0,90	1,21	1,12	0,07	0,98	1,27	**
17. LPFH/LAFH	0,59	0,05	0,47	0,72	0,63	0,06	0,50	0,74	**
Head and cervical posture assessment:									
18. NSL_VER	81,07	3,98	73,57	92,34	82,48	4,19	74,09	93,81	ns
19. FH_VER	91,66	3,30	83,69	99,43	92,05	3,59	85,35	101,81	ns
20. NSL_CVT	99,91	8,21	85,89	116,92	97,74	7,69	78,11	118,01	ns
21. NSL_OPT	97,24	9,11	81,06	115,42	94,91	8,12	75,12	111,70	ns
22. NSL_EVT ¹²	111,63	6,65	100,16	131,08	109,28	9,38	86,60	128,34	ns
23. FH_CVT	88,95	8,10	72,76	106,25	87,60	7,66	65,28	109,95	ns
24. FH_OPT	86,31	9,27	64,52	105,28	84,43	8,38	59,76	105,70	ns
25. FH_EVT ¹²	100,83	6,39	87,33	117,39	99,32	9,21	75,21	117,88	ns

¹ n<120² testes de Levene para a igualdade das variâncias significante – o teste t de Student foi corrigido para a heterocedasticidade das populações .

t Test: ** = p<0,01 * = p<0,05 ns = not significant

Table VII. Descriptive analyses for the facial measurements.

Measurements	Hyperdivergent class II (n=50)				Others skeletal patters (n=70)				Teste t
	Mean	SD	Min	Max	Mean	SD	Min	Max	
Saggital assessment:									
1. Wits (FOP)'	5,25	2,74	0,50	10,50	2,73	2,76	-3,00	10,00	**
2. Wits (TV)'	10,39	3,30	3,00	17,00	8,11	3,12	0,50	15,50	**
3. FNP'	82,21	4,11	74,00	94,00	83,40	3,36	78,00	93,00	ns
4. ANB'	10,69	2,00	7,00	16,00	8,39	2,46	4,00	14,00	**
5. N.Sn.Pog'	157,39	3,67	151,00	164,00	161,59	4,05	153,00	173,00	**
6. N.Sn.B'	154,33	3,81	147,00	164,00	158,93	4,38	150,00	170,00	**
Vertical assessment:									
7. Tr.Go.Me'	129,05	5,79	117,00	140,00	126,81	7,87	106,00	150,00	ns
8. FMA' ¹	27,28	3,02	20,00	34,00	24,38	3,67	14,00	36,00	**
9. AFH'	105,56	6,28	91,00	117,50	102,86	5,84	90,00	115,00	*
10. LFH'	59,30	3,79	50,50	67,50	59,39	4,21	50,00	71,00	ns
11. PFH'	54,43	4,25	46,00	62,00	55,49	4,35	45,00	64,00	ns
12. LFH'/AFH'	0,56	0,03	0,49	0,61	0,58	0,03	0,49	0,65	**
13. PFH'/AFH'	0,52	0,04	0,44	0,61	0,54	0,04	0,46	0,64	**
14. PFH'/LFH'	0,92	0,08	0,73	1,12	0,94	0,09	0,78	1,17	ns
Head and cervical posture assessment:									
15. C7.TrN	140,26	5,99	128,00	155,00	141,16	5,80	129,00	152,00	ns
16. C7.FH'	129,58	6,16	118,00	146,00	130,58	5,63	120,00	140,00	ns
17. TrN.VER	72,24	3,51	64,00	79,00	71,96	2,99	66,00	78,00	ns
18. FH.VER	82,32	3,51	74,00	88,00	82,06	3,29	76,00	89,00	ns
¹ n<120									
t Test: ** = p<0,01 * = p<0,05 ns = not significant									

Table VIII. Correlation between cephalometric and facial measurements.

Measurements		Correlation Coefficients		
Cephalometric variables	Facial variables	Entire sample (n=120)	Hyperdivergent class II (n=50)	Others skeletal patterns (n=70)
Sagittal assessment:				
Wits	Wits (FOP)'	0,65 **	0,49 **	0,65 **
Wits	Wits (TV)'	0,49 **	0,37 **	0,46 **
ANB	ANB'	0,73 **	0,72 **	0,61 **
FNP	FNP'	0,46 **	0,56 **	0,33 **
N.ANB.Pog	N.Sn.Pog'	0,75 **	0,65 **	0,70 **
N.ANB.B	N.Sn.B'	0,76 **	0,68 **	0,70 **
Vertical assessment:				
ArGoMe2 ²	TrGoMe'	0,66 **	0,52 **	0,71 **
FMA	FMA' ¹	0,63 **	0,48 **	0,59 **
AFH	AFH'	0,65**	0,70**	0,57**
LFH	LFH'	0,59**	0,67**	0,56**
PFH (S- Go)	PFH'	0,37**	0,44**	0,31**
LPFH (Ar- Go)	PFH'	0,38**	0,39**	0,35**
LFH/AFH	LFH'/AFH'	0,31 **	-	0,38 **
PFH/AFH	PFH'/AFH'	0,25 **	-	-
LPFH/AFH	PFH'/AFH'	0,28 **	-	-
PFH/LAFH	PFH'/LFH'	0,32 **	0,29 *	0,32 **
LPFH/LAFH	PFH'/LFH'	0,31 **	0,28 *	0,30 *
Head and cervical posture assessment:				
NSL.VER	TrN.VER	0,34 **	0,29 *	0,40 **
FH.VER	FH.VER	0,43 **	0,44 **	0,43 **
NSL.CVT	C7.TrN	0,25 **	-	0,27 *
NSL.OPT	C7.TrN	0,19 *	-	-
NSL.EVT	C7.TrN	0,25 *	-	0,37 **
FH_CVT	C7.FH'	0,25 **	0,30 *	-
FH_OPT	C7.FH'	-	-	-
FH_EVT	C7.FH'	0,32 **	-	0,43 **

** = p<0,01 * = p<0,05 ns = not significant

Table IX. Classification of individuals by a canonical discriminant function to fit the model (Calibration set: n = 80 patients) by means of radiographic examination and measurements with the facial caliper.

Canonical discriminant function (D)			
Calibration set; diagnosis (D\geq0)			
Cephalometric diagnosis (Gold standard)	Hyperdivergent Class II	Other skeletal patterns	Total
Hyperdivergent Class II	25 (73.5%)	9 (26.5%)	34 (100%)
Other skeletal patterns	14 (30.4%)	32 (69.6%)	46 (100%)
Total	39 (48.8%)	41 (51.3%)	80 (100%)

Obs.: Total accuracy 71.3%, sensitivity 73.5%, specificity 69.6%, positive predictive value 64.1%, negative predictive value 78%.

Table X. Classification of individuals by a canonical discriminant function for model validation (Test set: n = 40 patients) by means of radiographic examination and measurements with the facial caliper.

Cephalometric diagnosis (Gold standard)	Canonical discriminant function (D) Test set; diagnosis ($D \geq 0$)		Total
	Hyperdivergent Class II	Other skeletal patterns	
Hyperdivergent Class II	13 (81.3%)	3 (18.8%)	16 (100%)
Other skeletal patterns	5 (20.8%)	19 (79.2%)	24 (100%)
Total	18 (45%)	22 (55%)	40 (100%)

Obs.: Total accuracy 80.0%, sensitivity 81.3%, specificity 79.2%, positive predictive value: 72.2%, negative predictive value 86.4%.

CONSIDERAÇÕES

FINAIS



3 CONSIDERAÇÕES FINAIS

Baseado nos resultados e conclusões apresentados nos artigos pode-se afirmar que:

1. Considerando os excelentes níveis de reprodutibilidade, o método de uso do paquímetro facial demonstrou ser confiável para realizar o diagnóstico das relações maxilo-mandibulares.
2. Os níveis satisfatórios de correlação entre as variáveis usadas no diagnóstico das relações maxilo-mandibulares acessadas direta e indiretamente mostram que o método proposto pode ser considerado útil para realizar o procedimento mencionado.
3. Parâmetros que caracterizam os pacientes de classe II esquelética hiperdivergentes são identificáveis através da utilização do método do PF. Sendo assim, embora o método de escolha para a realização do diagnóstico preciso destes pacientes seja a análise cefalométrica, o método proposto pode ser útil para a identificação destes pacientes em estudos de grande escala e/ou epidemiológicos, onde a utilização de um método não invasivo é crucial.

- Um cuidado especial deve ser tomado na realização de mensurações faciais angulares agudas e/ ou mal definidas.

4. O método proposto não é recomendado para a avaliação da postura da cabeça nem para a mensuração da medida FNP'.

REFERÊNCIAS



4 REFERÊNCIAS*

1. Arnett GW, Bergman RT. Facial keys to orthodontic diagnosis and treatment planning--Part II. Am J Orthod Dentofacial Orthop. 1993; 103 : 395-411.
2. Arnett GW, Bergman RT. Facial keys to orthodontic diagnosis and treatment planning. Part I. Am J Orthod Dentofacial Orthop. 1993; 103 : 299-312.
3. Arslan SG, Genç C, Odabaş B, Kama JD. Comparison of facial proportions and anthropometric norms among Turkish young adults with different face types. Aesthetic Plast Surg. 2008; 32 : 234-42.
4. Aynechi N, Larson BE, Leon-Salazar V, Beiraghi S. Accuracy and precision of a 3D anthropometric facial analysis with and without landmark labeling before image acquisition. Angle Orthod. 2011; 81 : 245-52.
5. Barnett DP. Variations in the soft tissue profile and their relevance to the clinical assessment of skeletal pattern. Br J Orthod. 1975; 2 : 235-8.
6. Burstone CJ. Integumental contour and extension patterns. Angle Orthod. 1959; 29 : 93-104.
7. Burstone CJ. The integumental profile. Am J Orthod. 1958; 44: 1-25.
8. De Clercq CA, Abeloos JS, Mommaerts MY, Neyt LF. Temporomandibular joint symptoms in an orthognathic surgery population. J Craniomaxillofac Surg. 1995; 23 : 195-9.

9. Farkas LG. "Anthropometry of the Head and Face in Medicine". New York: Elsevier Science Ltd 1981.
10. Farkas LG, Cheung G. Facial asymmetry in healthy North American Caucasians. An anthropometrical study. *Angle Orthod.* 1981; 51 : 70-7.
11. Farkas LG, Cheung G. Facial asymmetry in healthy North American Caucasians. An anthropometrical study. *Angle Orthod.* 1981; 51 : 70-7.
12. Farkas LG, Tompson B, Phillips JH, Katic MJ, Cornfoot ML. Comparison of anthropometric and cephalometric measurements of the adult face. *J Craniofac Surg.* 1999; 10 : 18-25; discussion 6.
13. Feres R, Vasconcelos MHF. Estudo comparativo entre a análise facial subjetiva e a análise cefalométrica de tecidos moles no diagnóstico ortodôntico. *R Dental Press Ortodon Ortop Facial.* 2009; 14 : 81-8.
14. Fernández-Riveiro P, Smyth-Chamosa E, Suárez-Quintanilla D, Suárez-Cunqueiro M. Angular photogrammetric analysis of the soft tissue facial profile. *Eur J Orthod.* 2003; 25 : 393-9.
15. Graber TM. *Orthodontics- principles and practices.* Philadelphia: W. B. Saunders; 1972.
16. Halazonetis DJ. Morphometric correlation between facial soft-tissue profile shape and skeletal pattern in children and adolescents. *Am J Orthod Dentofacial Orthop.* 2007; 132 : 450-7.

17. Han K, Kwon HJ, Choi TH, Kim JH, Son D. Comparison of anthropometry with photogrammetry based on a standardized clinical photographic technique using a cephalostat and chair. *J Craniomaxillofac Surg.* 2010; 38 : 96-107.
18. Howells WW. The designation of the principle anthropometric landmarks on the head and skull. *Am J Phys Anthropol.* 1937; 22: 477-94.
19. Huang GJ, LeResche L, Critchlow CW, Martin MD, Drangsholt MT. Risk factors for diagnostic subgroups of painful temporomandibular disorders (TMD). *J Dent Res.* 2002; 81 : 284-8.
20. Huggare JA, Laine-Alava MT. Nasorespiratory function and head posture. *Am J Orthod Dentofacial Orthop.* 1997; 112 : 507-11.
21. Jamison PL, Zegura SL. A univariate and multivariate examination of measurement error in anthropometry. *Am J Phys Anthropol.* 1974; 40 : 197-203.
22. Jayaprakash PT, Srinivasan GJ, Amravanewaran MG. Cranio-facial morphanalysis: a new method for enhancing reliability while identifying skulls by photo superimposition. *Forensic Sci Int.* 2001; 117 : 121-43.
23. Kahn J, Tallents RH, Katzberg RW, Ross ME, Murphy WC. Prevalence of dental occlusal variables and intraarticular temporomandibular disorders: molar relationship, lateral guidance, and nonworking side contacts. *J Prosthet Dent.* 1999; 82 : 410-5.

24. Lowe AA, Santamaria JD, Fleetham JA, Price C. Facial morphology and obstructive sleep apnea. *Am J Orthod Dentofacial Orthop.* 1986; 90 : 484-91.
25. Marcotte MR. Head posture and dentofacial proportions. *Angle Orthod.* 1981; 51 : 208-13.
26. Moate SJ, Geenty JP, Shen G, Darendeliler MA. A new craniofacial diagnostic technique: the Sydney diagnostic system. *Am J Orthod Dentofacial Orthop.* 2007; 131 : 334-42.
27. Molhave A. A biostatic investigation: the standing posture of man theoretically and statometrically illustrated. Copenhagen: Munksgaard; 1958.
28. Molhave A. A biostatic investigation. The standing posture of man theoretically and statometrically illustrated. *Acta Orthop Scand.* 1960; 29: 291-300.
29. Nebbe B, Major PW, Prasad NG, Grace M, Kamelchuk LS. TMJ internal derangement and adolescent craniofacial morphology: a pilot study. *Angle Orthod.* 1997; 67 : 407-14.
30. Peck H, Peck S. A concept of facial esthetics. *Angle Orthod.* 1970; 40 : 284-318.
31. Poveda Roda R, Bagan JV, Díaz Fernández JM, Hernández Bazán S, Jiménez Soriano Y. Review of temporomandibular joint pathology. Part I: classification, epidemiology and risk factors. *Med Oral Patol Oral Cir Bucal.* 2007; 12 : E292-8.

32. Romero-Maroto M, Nieto-Sanchez I, Miguez-Contreras M, Lopez-de-Andres A. Visual perception of skeletal class and biotype in Spain. *Eur J Orthod.* 2012; 34 : 322-6.
33. Saxby PJ, Freer TJ. Dentoskeletal determinants of soft tissue morphology. *Angle Orthod.* 1985; 55 : 147-54.
34. Scavone H, Zahn-Silva W, do Valle-Corotti KM, Nahás AC. Soft tissue profile in white Brazilian adults with normal occlusions and well-balanced faces. *Angle Orthod.* 2008; 78 : 58-63.
35. Schwartz AM. Positions of the head and malrelations of the jaws. *Int J Orthod.* 1928; 14: 56-8.
36. Selaimen CM, Jeronymo JC, Brilhante DP, Lima EM, Grossi PK, Grossi ML. Occlusal risk factors for temporomandibular disorders. *Angle Orthod.* 2007; 77 : 471-7.
37. Smith NJ. Risk assessment: the philosophy underlying radiation protection. *Int Dent J.* 1987; 37 : 43-51.
38. Solow B. Craniocervical angulation and nasal respiratory resistance [Monograph]. Ann Arbor: University of Michigan; 1979.
39. Solow B, Kreiborg S. Soft-tissue stretching: a possible control factor in craniofacial morphogenesis. *Scand J Dent Res.* 1977; 85 : 505-7.
40. Solow B, Sandham A. Cranio-cervical posture: a factor in the development and function of the dentofacial structures. *Eur J Orthod.* 2002; 24 : 447-56.

41. Solow B, Siersbaek-Nielsen S. Cervical and craniocervical posture as predictors of craniofacial growth. *Am J Orthod Dentofacial Orthop.* 1992; 101 : 449-58.
42. Solow B, Siersbaek-Nielsen S. Cervical and craniocervical posture as predictors of craniofacial growth. *Am J Orthod Dentofacial Orthop.* 1992; 101 : 449-58.
43. Solow B, Siersbaek-Nielsen S, Greve E. Airway adequacy, head posture, and craniofacial morphology. *Am J Orthod.* 1984; 86 : 214-23.
44. Solow B, Tallgren A. Dentoalveolar morphology in relation to craniocervical posture. *Angle Orthod.* 1977; 47 : 157-64.
45. Solow B, Tallgren A. Head posture and craniofacial morphology. *Am J Phys Anthropol.* 1976; 44 : 417-35.
46. Solow B, Tallgren A. Natural head position in standing subjects. *Acta Odontol Scand.* 1971; 29 : 591-607.
47. Solow B, Tallgren A. Natural head position in standing subjects. *Acta Odontol Scand.* 1971; 29 : 591-607.
48. Soncul M, Bamber MA. Evaluation of facial soft tissue changes with optical surface scan after surgical correction of Class III deformities. *J Oral Maxillofac Surg.* 2004; 62 : 1331-40.
49. Sonnesen L, Bakke M, Solow B. Malocclusion traits and symptoms and signs of temporomandibular disorders in children with severe malocclusion. *Eur J Orthod.* 1998; 20 : 543-59.

50. Staudt CB, Kiliaridis S. A nonradiographic approach to detect Class III skeletal discrepancies. *Am J Orthod Dentofacial Orthop.* 2009; 136 : 52-8.
51. Strömmland K, Chen Y, Michael G, Svensson E, Gustavsson T. Assessment of facial features with a range camera. *Scand J Plast Reconstr Surg Hand Surg.* 1998; 32 : 91-6.
52. Thilander B, Rubio G, Pena L, de Mayorga C. Prevalence of temporomandibular dysfunction and its association with malocclusion in children and adolescents: an epidemiologic study related to specified stages of dental development. *Angle Orthod.* 2002; 72 : 146-54.
53. Vig PS, Showfety KJ, Phillips C. Experimental manipulation of head posture. *Am J Orthod.* 1980; 77 : 258-68.
54. Ward RE. Facial morphology as determined by anthropometry: keeping it simple. *J Craniofac Genet Dev Biol.* 1989; 9 : 45-60.
55. Ward RE, Jamison PL. Measurement precision and reliability in craniofacial anthropometry: implications and suggestions for clinical applications. *J Craniofac Genet Dev Biol.* 1991; 11 : 156-64.
56. White CS, Dolwick MF. Prevalence and variance of temporomandibular dysfunction in orthognathic surgery patients. *Int J Adult Orthodon Orthognath Surg.* 1992; 7 : 7-14.

57. Wong JY, Oh AK, Ohta E, Hunt AT, Rogers GF, Mulliken JB, et al. Validity and reliability of craniofacial anthropometric measurement of 3D digital photogrammetric images. *Cleft Palate Craniofac J.* 2008; 45 : 232-9.
58. Woodside DG, Linder-Aronson S. The channelization of upper and lower anterior face heights compared to population standard in males between ages 6 to 20 years. *Eur J Orthod.* 1979; 1 : 25-40.
59. Zhang X, Hans MG, Graham G, Kirchner HL, Redline S. Correlations between cephalometric and facial photographic measurements of craniofacial form. *Am J Orthod Dentofacial Orthop.* 2007; 131 : 67-71.
60. Zupancic S, Pohar M, Farcnik F, Ovsenik M. Overjet as a predictor of sagittal skeletal relationships. *Eur J Orthod.* 2008; 30 : 269-73.

ANEXO



5 ANEXOS

A1. Cópia do certificado da autorização emitido pelo Comitê de Ética em pesquisa da FoAr . UNESP.



A2. Termo de consentimento livre e esclarecido aprovado pelo Comit  de  tica em pesquisa da FoAr . UNESP.

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Eu, _____, portador de RG n  _____, _____ (idade), residente   Rua (Av.) _____, n  _____, na cidade de _____, Estado: _____, autorizo a participa o do menor _____, portador de RG n  _____, _____ (idade), residente   Rua (Av.) _____, n  _____, na cidade de _____, Estado: _____, prontu rio n  _____, pelo qual sou respons vel como _____ (grau de parentesco), como volunt rio na pesquisa intitulada: “M TODOS N O RADIOGR FICOS PARA DIAGN STICO DO PADR O ESQUEL TICO CLASSE II HIPERDIVERGENTE”, tendo o Dr. Jo o Roberto Gon alves como pesquisador respons vel. Sendo assim, declaro estar ciente de que:

1 - A pesquisa em quest o tem como objetivo a realiza o do diagn stico de um problema esquel tico conhecido como *classe II esquel tica hiperdivergente*, atrav s de fotografias padronizadas e utiliza o do paqu metro facial, tendo em vista a possibilidade destes indiv duos virem a desenvolver dist rbios na articula o t mporo-mandibular (DTM), assim como manifestarem altera o na postura da coluna cervical, o que implica em problemas durante o crescimento e desenvolvimento da face. Portanto, o diagn stico precoce atrav s de m todos n o invasivos pode gerar grandes benef cios a estes indiv duos;

2 - Os procedimentos a serem realizados na crian a ser o: tomadas fotogr ficas da regi o de cabe a e pesco o, preenchimento de fichas cl nicas com as mensura o obtidas atrav s da utiliza o do paqu metro facial, e avalia o das radiografias cefalom tricas laterais, obtidas como parte da documenta o necess ria ao planejamento de todo tratamento ortop dico e ortod ntico;

3- Os pacientes ser o tratados nos pr prios centros respons veis pela solicita o das radiografias. Se houver necessidade de recrutamento de outros pacientes para compor a amostra, estes pacientes poder o ser tratados com ortodontia preventiva e interceptativa na cl nica da p s-gradua o desta faculdade;

4 - A participa o na pesquisa   volunt ria, e os respons veis legais podem desistir dela a qualquer momento, sem dar explica o sobre os motivos, e ainda, sem comprometer qualquer tratamento do paciente na Faculdade de Odontologia de Araraquara – UNESP;

5 - Os responsáveis legais podem fazer perguntas ou solicitar esclarecimentos sobre quaisquer dúvidas antes e durante o desenvolvimento da pesquisa;

6 - O pesquisador responsável garantirá o sigilo das informações confidenciais, zelando pela privacidade do paciente. Garante ainda que a identidade do paciente será preservada quando a pesquisa for exposta em congressos ou em publicações científicas;

7 - O responsável legal confirma que recebeu todas as informações relacionadas à pesquisa. Sendo assim, autoriza os pesquisadores a realizarem os procedimentos necessários.

Araraquara, ____ de _____ de 2010

Responsável pelo paciente

Dr. João Roberto Gonçalves

Pesquisador Responsável

Telefones para contato:

Comitê de Ética em Pesquisa: (16) 3301-6432/ 3301-6434

Pesquisador responsável: (16) 33016325

Membros da equipe:

- Liliane Gomes- (16) 3357-6899
- Karla Carpio- (16) 88223218

APÊNDICE



6 APÊNDICE

A2. Ficha usada para a avaliação clínica usada para o registro das mensurações faciais.

FICHA DE AVALIAÇÃO CLÍNICA- PAQUÍMETRO FACIAL

PACIENTES:				
DATA DE NASCIMENTO- IDADE				
TELEFONE:				
PNC- MALOCLUSÃO:				
EXAMINADOR				
DATA:				
Sagitais	1. Wits (OPF)'			
	2. Wits (HV)'			
	6. FNP'			
	7. ANB'			
	8. N.Sn.Pog'			
Verticais	9. N.Sn.B'			
	10. T.Go.Me'			
	11. FMA'			
	3. Prop. AFAl/AFA' (Sn-Me' / N'-Me')	AFAl':		AFAl':
		AFA':		AFA':
	4. Prop. AFA/AFP' (N'-Me' / Tr-Go')	AFA':		AFA':
		AfP':		AfP':
5. Prop. AfP'/AFAl'	AfP':		AfP':	
	AFAl':		AFAl':	
Cervicais	12. C7.TrN'			
	13. C7.FH'			
	14. TN.VER'			
	15. FH.VER'			

A3. Descrição detalhada da tecnologia (informe apresentado para a realização do processo de patenteamento).

MEDIDOR FACIAL

O Medidor facial foi desenvolvido pelos autores com ajuda de um grupo de técnicos profissionais especializados na área de construção de novas tecnologias (Fig. 1). Tem como objetivo efetuar mensurações lineares e angulares (Tabela 3 e 4) diretamente na face do paciente, importantes para realizar um adequado análise facial das discrepâncias maxilares.



Fig. 1: Medidor facial

1.1 Partes do Medidor facial (MF)

O MF é basicamente composto por 3 áreas: área de fixação, área de articulação e área de mensuração.

1. **Área de Fixação:** constituída por um suporte para a cabeça unida a um suporte do conjunto (Fig. 2).

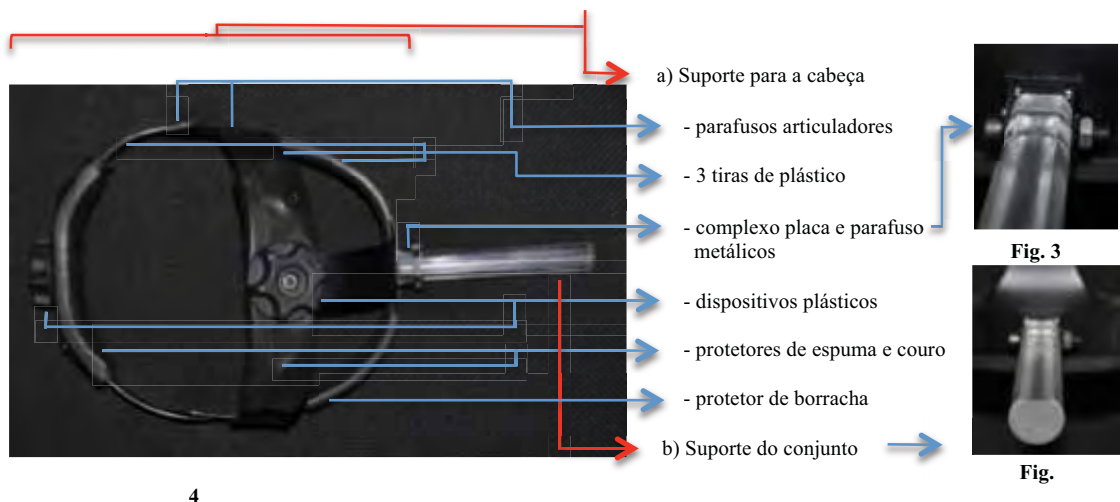
a) **Suporte para a cabeça:** basicamente composta por 3 **tiras de plástico** unidas por articulações de **parafusos** que lhe proporcionam mobilidade.

Para a regulagem do tamanho o MF possui dois **parafusos** com **dispositivos plásticos** os quais funcionam girando para direita ou esquerda, proporcionando um aumento e uma diminuição de tamanho e ao mesmo tempo um ajuste do suporte no sentido vertical e antero- posterior. Além disso, o suporte possui **protetores de espuma**, envolvidos por um couro preto, que funcionam como amortecedores das forças geradas na hora do ajuste dos dispositivos plásticos para fixação.

No setor que fica em contato com a testa do paciente o suporte apresenta um **protetor de borracha** que tem o mesmo efeito da espuma mencionada anteriormente.

A haste de acrílico está unida ao suporte da cabeça por um **complexo placa e parafuso metálicos**: parafuso Allen, arruela lisa e porca sextavada (Fig. 3).

b) **Suporte do conjunto:** é feito de acrílico transparente, possui um formato semicircular com um lado plano que serve como guia de desliz e onde o parafuso fixador é posicionado. (Fig. 4)



4

Fig. 2: Área de fixação e suas partes.

2. **Área de articulação:** composta por duas partes, a castanha suporte e a castanha articulável (Fig. 5).

a) **Castanha suporte:** é feita em acrílico transparente e possui um parafuso de polietileno chamado parafuso fixador.

A castanha suporte em conjunto com o **parafuso fixador** serve para movimentar o conjunto total de partes pertencentes à área de medida na direção antero- posterior. Isto ocorre deslizando a castanha no suporte do conjunto, tendo como guia a parte plana deste suporte. Quando a posição desejada é encontrada, o parafuso fixador é apertado, obtendo como consequência a fixação do aparelho na direção antero- posterior.

b) **Castanha articulável:** é feita de acrílico transparente e possui dois parafusos de polietileno, o parafuso castanha e o parafuso da articulação. Tem duas funções:

- A castanha articulável em conjunto com o **parafuso castanha** serve para segurar a régua principal e consequentemente a área de mensuração. Para isto acontecer, o parafuso castanha é ajustado à guia plana da régua vertical, deixando-a fixa à castanha articulável (Fig. 6).

- A castanha articulável em conjunto com o **parafuso da articulação** serve para girar o conjunto total de partes pertencentes à área de mensuração. Isto ocorre movimentando a castanha articulável no sentido horário ou anti-horário. Quando a posição desejada é encontrada, o parafuso da articulação é apertado, fixando o aparelho na direção vertical.

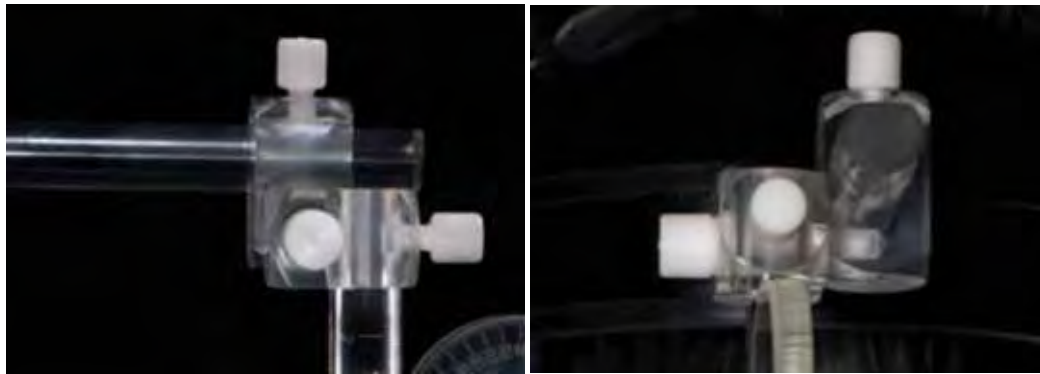
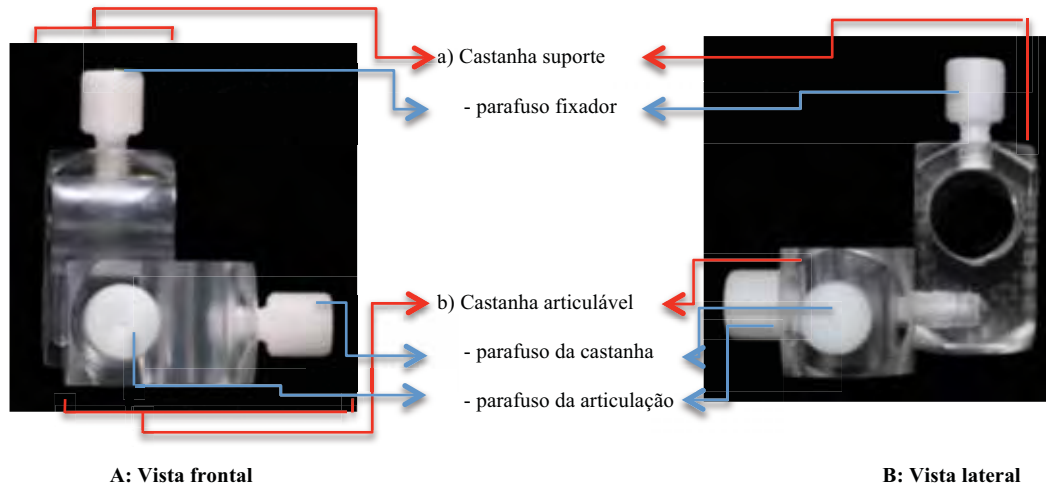


Fig. 5: Área de articulação e suas partes.

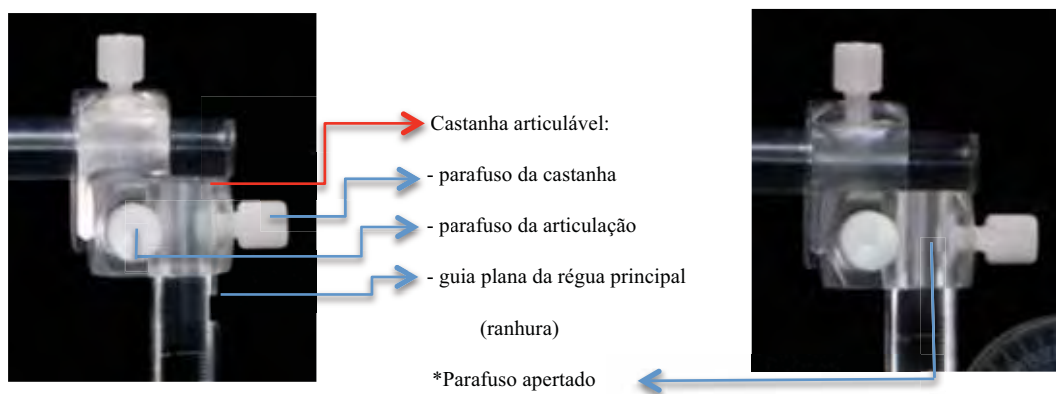


Fig. 6: Mecanismo de ajuste do parafuso da castanha.

3. **Área de Mensuração:** é composta pelo complexo régua- transferidor, o complexo da haste horizontal e o complexo das réguas horizontais (Fig. 7):



Fig. 7: Área de Mensuração e suas partes.

- a) **Complexo régua- transferidor:** É feita totalmente de acrílico e polietileno, formada pela união de 3 partes (Fig. 8):
1. Uma **régua vertical** com formato semicircular e calibrada (22.5 cm) a laser na superfície plana da mesma. Na parte superior anterior possui uma ranhura, com o formato de uma superfície plana, que serve como guia para o parafuso da castanha articulável quando este é ajustado.
 2. Um **transferidor** (360°) calibrado a laser. Possui um orifício no centro para melhorar a visualização de alguns pontos na face do paciente.
 3. **Régua principal e régua secundária do transferidor.** A régua principal do transferidor possui um orifício onde o **pêndulo** (metálico) é pendurado e uma linha de referência, feita a laser, para o correto posicionamento da régua principal quando esta última precisa ser posicionada paralela à vertical verdadeira. A régua secundária serve para realizar mensurações angulares em trabalho conjunto com a régua principal. Para mensurações de ângulos obtusos

usa-se um dispositivo chamado **haste de suporte**, o qual é inserido na régua secundária e movimentando-a no sentido horário ou anti-horário, identifica planos faciais requeridos. Assim, o ângulo formado entre a régua principal e a haste de suporte é refletido e mensurado no transferidor.

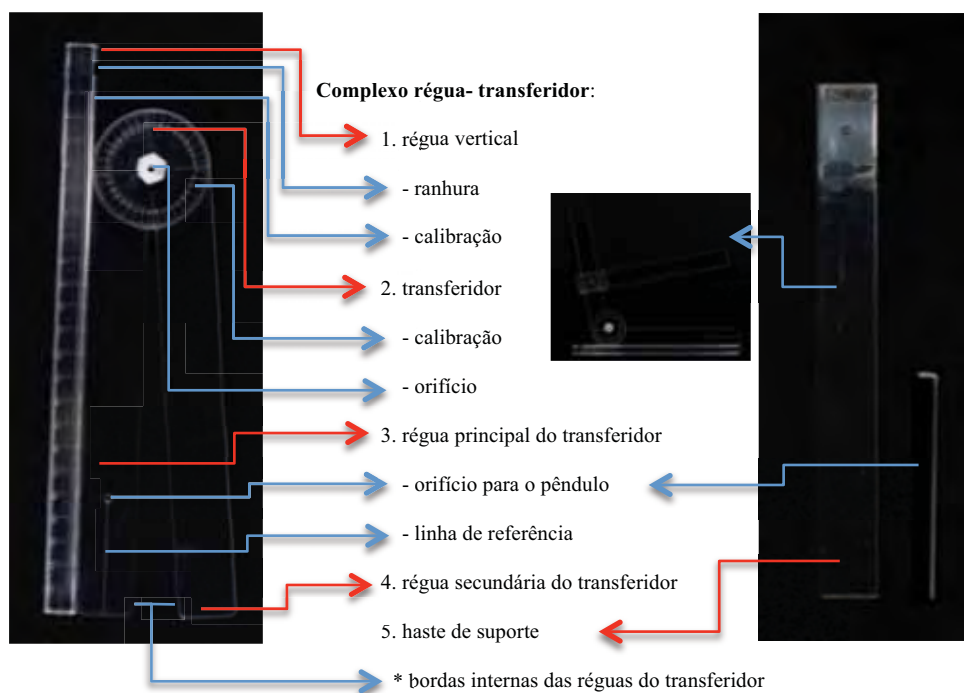


Fig. 8: Complexo régua- transferidor e suas partes

b) **Complexo da haste:** usado para posicionar a régua vertical perpendicular ao plano oclusal do paciente (dispositivo oclusal de madeira). Isto ocorre deixando a **haste** paralela ao plano oclusal do paciente. Uma vez que a régua vertical encontra-se permanentemente perpendicular à haste, esta fica automaticamente perpendicular ao plano oclusal.

É composto por 3 partes feitas de acrílico, polietileno e metal (Fig. 9):

1. **Suporte da haste:** a castanha do suporte da haste possui um orifício interno de forma circular com a parte anterior aberta. Esta área serve para unir o complexo haste horizontal com a régua vertical. Além disso, permite fazer movimentos de deslize com direção superior ou inferior ao longo do eixo da régua vertical. Uma vez encontrada a posição desejada o parafuso da castanha é ajustado deixando o complexo da haste horizontal fixo em algum ponto da régua vertical.

O suporte propriamente dito possui forma semicircular com uma ranhura plana na parte superior que serve como guia para o deslize da castanha da haste.

2. **Castanha da haste:** possui forma retangular e dois orifícios. O orifício maior serve para se unir ao suporte da haste e o menor para segurar a haste permitindo o deslize da mesma. Há ainda um parafuso que serve para fixar a posição da haste no sentido lateral.

3. **Haste:** feita de metal de 16 cm de comprimento e formato circular.

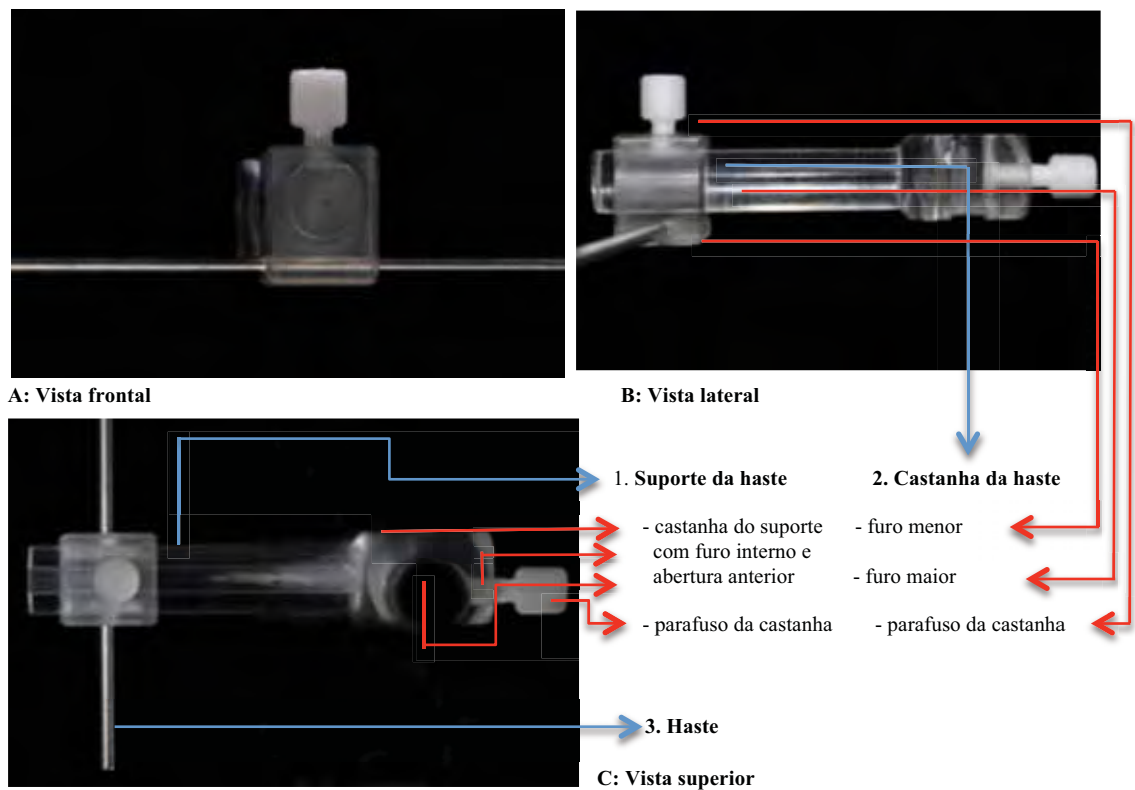


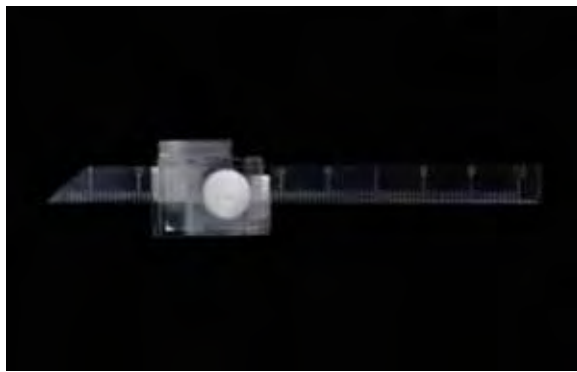
Fig. 9: Complexo da haste horizontal e suas partes

c) **Complexo de réguas horizontais:** serve para realizar as mensurações na direção antero- posterior (plano sagital) e vertical (plano axial). Esta última função é realizada em conjunto com a régua vertical (Fig. 10).

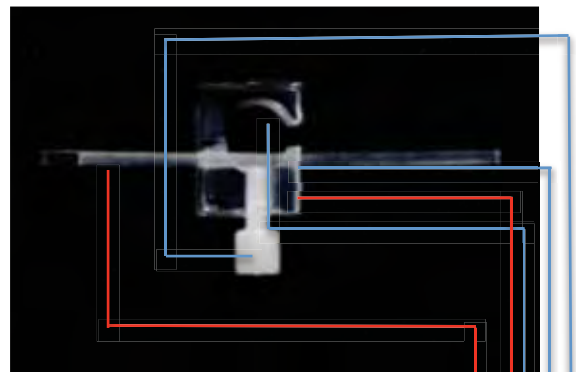
1. **Réguas horizontais:** feitas de acrílico, com formato retangular e calibradas a laser (10 cm), servem para realizar mensurações no plano sagital e axial.

2. **Castanhas das réguas horizontais:** de forma retangular, cada uma possui dois orifícios. O orifício maior arredondado serve para unir o complexo de réguas horizontais à régua vertical. O orifício retangular serve para segurar a régua horizontal permitindo o deslizamento da mesma. Além disso, há um parafuso que serve para fixar a posição da régua horizontal na régua vertical na direção

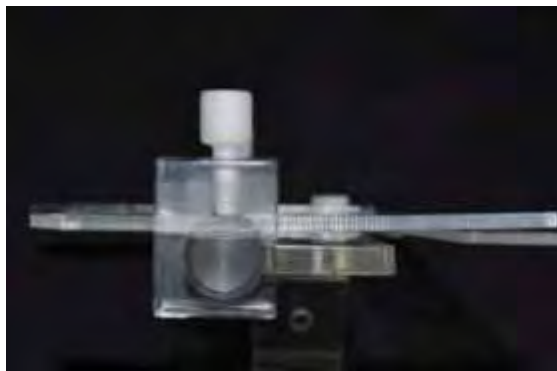
antero- posterior. Conseqüentemente, o complexo de réguas horizontais é fixado na régua vertical na direção vertical (superior / inferior).



A: Vista frontal



B: Vista superior



B: Vista inferior do complexo de réguas horizontais montado no M. F.

Complexo de réguas horizontais

1. Réguas horizontais

2. Castanhas das réguas horizontais

- orifício maior

- orifício menor

- parafuso

Fig. 10: Complexo de réguas horizontais

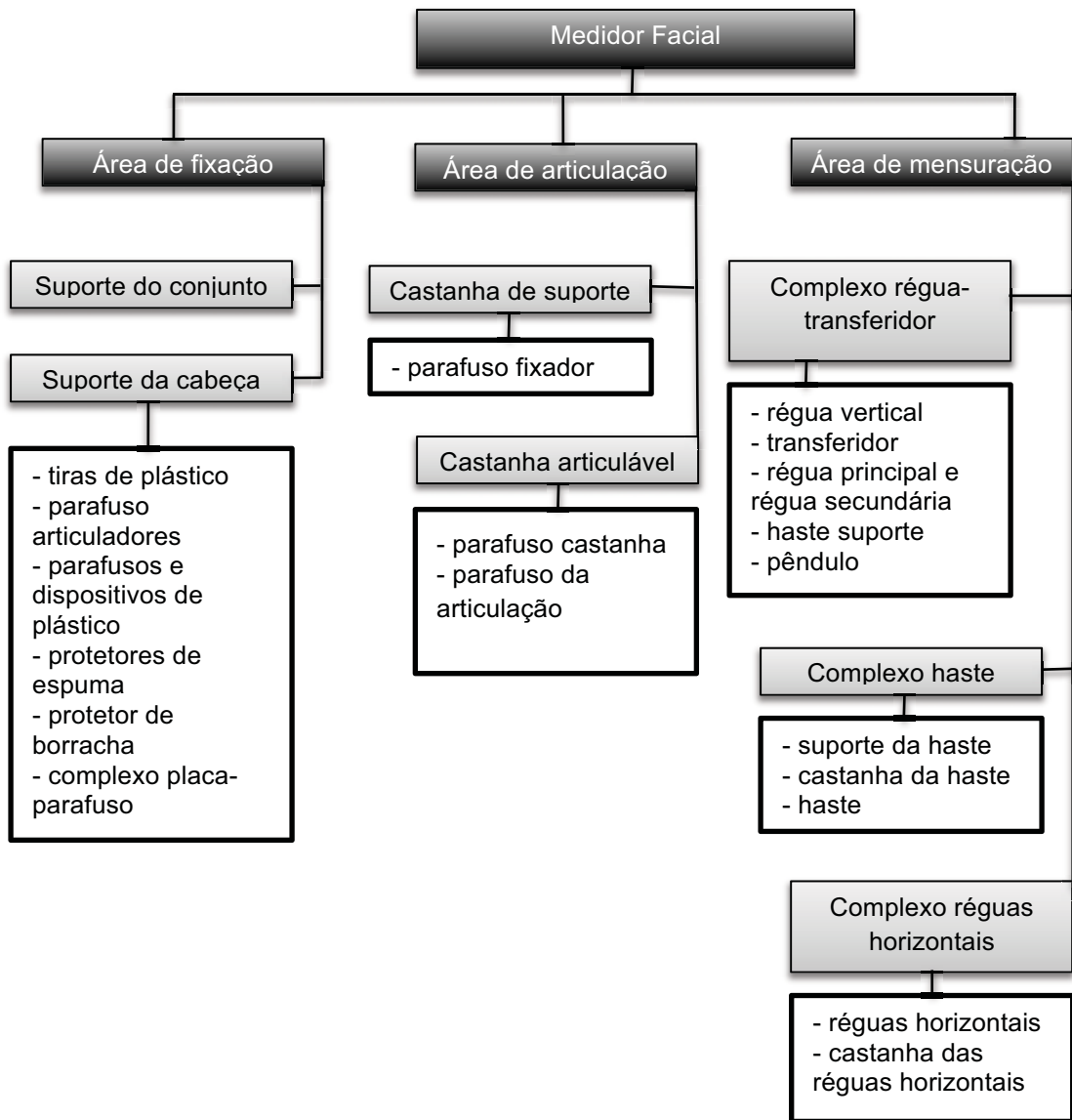


Diagrama de fluxo das partes do medidor facial

1.2 Método de utilização do medidor facial

Tendo em vista uma melhor padronização na coleta dos dados, as mensurações realizadas usando o medidor facial devem ser obtidas mantendo o indivíduo em máxima intercuspidação habitual (MIH), com posição natural da cabeça (o paciente precisa estar sentado ou em pé, dependendo da medida a ser mensurada, frente a um espelho olhando para a imagem dos seus olhos nele), e fazendo uso de adesivos circulares localizados em pontos faciais específicos (Fig. 11) e um dispositivo de madeira (Fig. 12). É importante ressaltar que o tempo total aproximado para a realização de todos os procedimentos é de 15 minutos aproximadamente.

A identificação dos pontos faciais que são usados na análise clínica com o uso do MF (fig. 11 e tabela 1) deve de ser realizada através da visualização e em alguns casos da palpação dos mesmos. Em seguida, em alguns desses pontos deverão ser posicionados adesivos circulares hipoalergênicos (esparadrapo *Cremer*, reg. ANVISA), com o objetivo de facilitar a localização destes para posterior mensuração das grandezas angulares e lineares.

Tabela 1. Descrição dos pontos anatômicos utilizados no exame clínico.

PONTOS ANATÔMICOS	DESCRIÇÃO
<i>N'</i> (<i>nasio em tecido mole</i>)	Ponto mais anterior da sutura frontonasal, localizado na curvatura da ponte nasal*
<i>Tr'</i> (<i>tragus</i>)	Ponto mais superior do tragus auricular
<i>C7'</i>	Ponto mais proeminente do processo espinhoso da vértebra C7*
<i>Or'</i> (<i>orbitário em tecido mole</i>)	Ponto mais inferior do contorno da órbita*
<i>A'</i> (<i>subspínhal em tecido mole</i>)	Ponto mais profundo da concavidade do contorno anterior do lábio superior
<i>B'</i> (<i>supramental em tecido mole</i>)	Ponto mais profundo da concavidade do contorno anterior do lábio inferior
<i>Go'</i> (<i>gônio em tecido mole</i>)	Ponto mais posterior e inferior do ângulo mandibular (ângulo goníaco)*
<i>Pog'</i> (<i>pogônio mole</i>)	Ponto mais proeminente no contorno anterior do mento
<i>Me'</i> (<i>mentoniano em tecido mole</i>)	Ponto mais inferior do mento
<i>Sn'</i> (<i>subnasal</i>)	Ponto mediano do ângulo da base da columela, onde a borda inferior do septo nasal e a superfície do lábio superior se encontram
<i>Gl'</i> (<i>glabella</i>)	Ponto Glabella no tecido mole

*Pontos anatômicos que serão obtidos através da palpação. O resto dos pontos serão localizados por visualização.

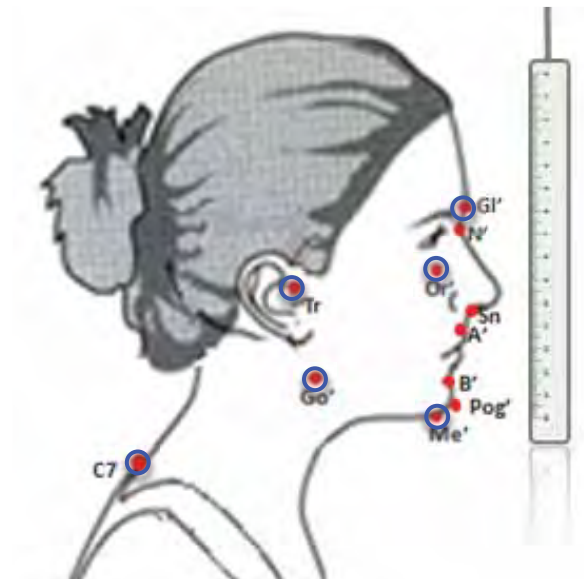


Figura 11. Pontos anatômicos usados (●). Pontos assinalados com mini-bolinhas e adesivos circulares hipoalergênicos: Tr, Or', Go', Me', N' e C7 (⊙).



Figura 12: Modelo do dispositivo de madeira.

Instalação, manipulação e realização das mensurações usando o medidor facial

O MF deve ser completamente montado, com exceção do pêndulo, tendo a régua vertical perpendicular ao suporte do conjunto, para o qual a castanha articulável foi previamente posicionada paralela ao suporte do conjunto e o parafuso da articulação apertado.

O examinador posiciona-se em frente ao paciente, o qual encontra-se sentado, e ajusta o suporte do MF na cabeça dele de forma que este esteja confortavelmente posicionado, buscando coincidir sua borda anterior inferior centralizada na altura da glabella (Gl'), e verificando se as

régua horizontal encontram-se direcionadas ao plano sagital mediano. Em seguida, o suporte é ajustado à cabeça do paciente tanto no sentido antero- posterior e vertical girando os dispositivos plásticos do mesmo. A castanha da haste deve ser movimentada lateralmente, de modo que a haste fique aproximadamente a 2 cm da face direita do paciente onde o parafuso é apertado mantendo a haste fixa na direção lateral.

Subsequentemente, o examinador posiciona-se frontalmente à face direita do examinado e ajusta o MF na direção horizontal. Para isto a castanha suporte é movimentada no sentido antero-posterior deixando a régua vertical a aproximadamente 2 cm da ponta da nariz do paciente, onde o parafuso fixador é apertado para manter estável esta posição. Imediatamente, o M.F. será ajustado na direção vertical de acordo com a posição A, B ou C, tendo em vista o tipo de mensuração a ser realizada,:

Na posição A, o complexo da haste deve ser movimentado superior ou inferiormente na régua vertical, até ficar próxima ao dispositivo de madeira, que é mantida pela mordida do hemiarco direito do paciente (área de molares e pré-molares) e que por tanto reflete o plano oclusal exteriormente. A castanha articulável deve ser movimentada no sentido horário ou anti-horário, até que a haste fique paralela ao dispositivo de madeira. Definidas essas condições, o parafuso da articulação é apertado estabelecendo e mantendo constante o posicionamento do instrumento (Fig. 13).

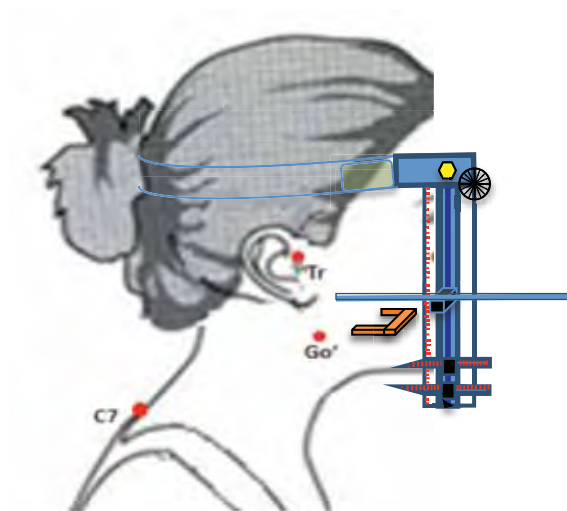


Figura 13. Posição A da instalação do Medidor facial

Em seguida o dispositivo oclusal é retirado da boca do paciente, e é realizada a mensuração do Wits (POF)', onde as pontas arredondadas das régua horizontais serão posicionadas nos pontos A' e B' movimentando as suas respectivas castanhas e posteriormente apertando seus parafusos. São medidas, então, a distâncias do ponto A' até a régua vertical e do ponto B' até a régua vertical. O resultado da medida Wits (POF)' é a diferença entre as distancias acima mencionadas (Fig. 14). Quando o valor da distância do ponto A' até a régua vertical for menor do que o ponto B' até a régua vertical são atribuídos valores positivos. Quando o valor da distância do ponto B' até a régua vertical for menor do que o ponto A' até a régua vertical são atribuídos valores negativos e, finalmente, se estas distâncias forem iguais o valor é zero.

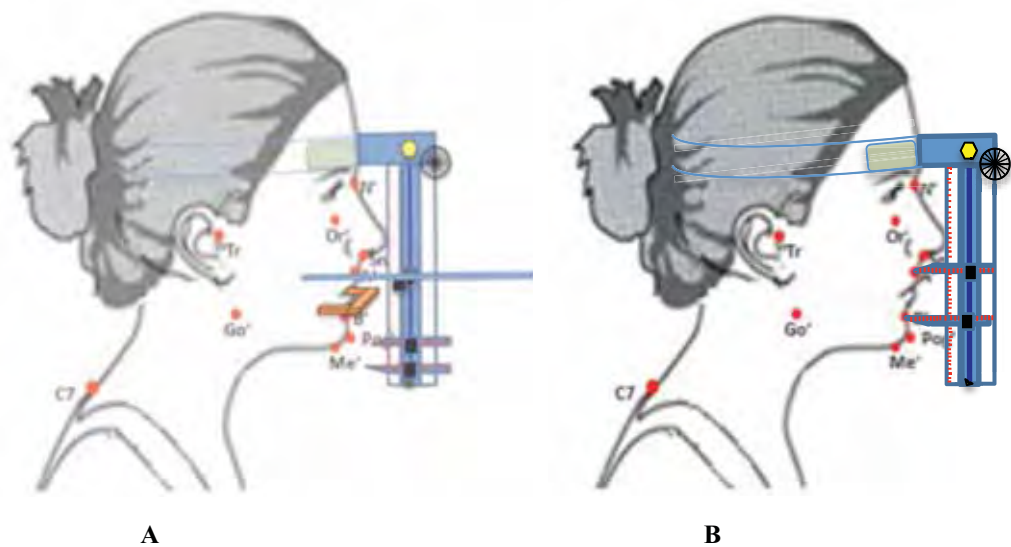


Fig. 14. Posição A. (A); Mensuração do Wits (POF)' (B).

Subsequentemente, para realizar o segundo posicionamento, o parafuso da castanha articulável é desajustado, e o complexo da haste é posicionado o mais superior possível. Em seguida o parafuso é apertado para que a haste fique fixa nessa posição.

Para a obtenção da posição **B**, o examinador continua na posição acima mencionada e realiza as seguintes ações:

1. Pendura o pêndulo no orifício da régua principal do transferidor.

2. Movimenta a castanha articulável no sentido horário ou anti-horário, até que a linha desenhada na régua principal do transferidor coincida com o longo eixo do pêndulo e como consequência a régua vertical estará paralela à vertical verdadeira. Definidas essas condições, o parafuso da articulação é apertado estabelecendo e mantendo constante o posicionamento do instrumento na direção vertical (Fig. 15).

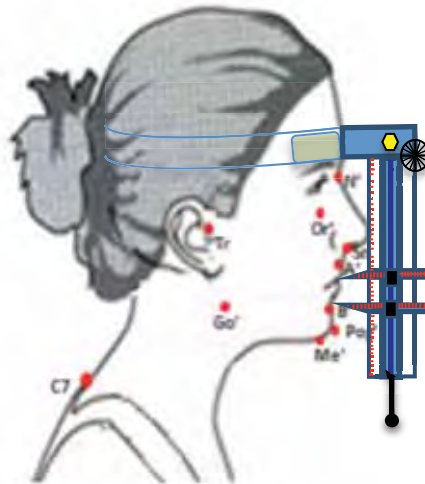


Fig. 15. Posição B da instalação do medidor facial.

Subsequentemente, o pêndulo é retirado e são realizadas medidas fazendo uso das réguas horizontais, deslizando-as superior / inferiormente e anterior / posteriormente até pontos especificamente usados em cada medida:

1. Wits (HV)', ou seja, o valor Wits medido em relação à horizontal verdadeira (as réguas horizontais são perpendiculares à régua vertical a qual encontra-se paralela à vertical verdadeira). A movimentação das réguas horizontais, a distância mensurada e os parâmetros mencionados são iguais aos descritos para mensuração do Wits (FOP)' (Fig. 16).

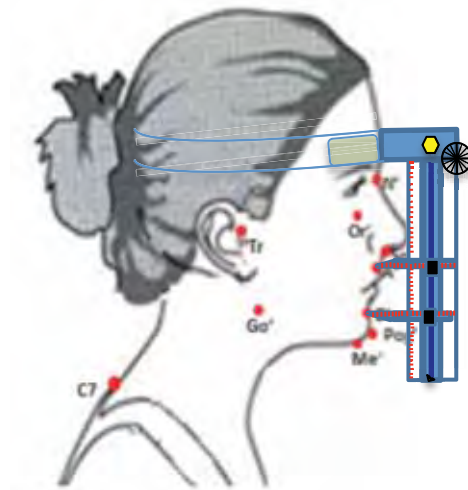


Fig. 16. Representação do Wits HV'.

2. Altura facial anterior (AFA'), distância entre os pontos N'-Me'.
3. Altura facial anterior inferior (AFAI'), distância entre Sn'-Me'.

Tendo estas duas medidas é então possível achar a mensuração proporção altura facial anterior / altura facial anterior inferior (AFA' / AFAI') (Fig. 17).

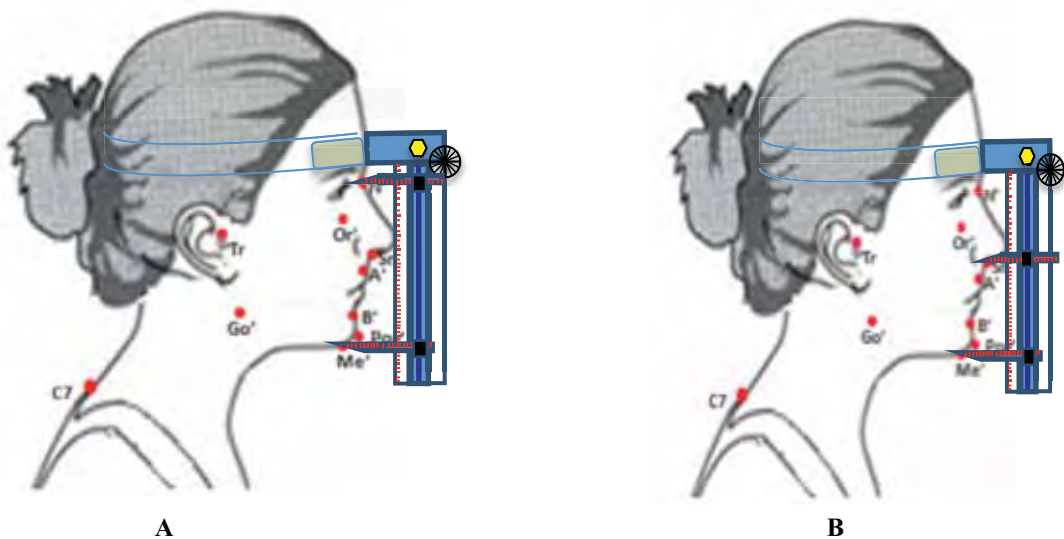


Fig. 17. Representação da proporção AFA / AFAI:

AFA (A: N'-Me') / AFAI (B: Sn'-Me')

Após a realização dessas medidas o MF é removido da cabeça do paciente, soltando o suporte da cabeça por meio do giro dos seus dispositivos de plástico.

A **Posição C** é conseguida desmontando o MF e usando unicamente o complexo régua-transferidor. Assim as seguintes medidas são realizadas usando sempre as bordas internas da régua principal e da régua secundária do transferidor (Fig. 8):

1. Ângulo ANB' , o qual é determinado pela intersecção do plano $N'-A'$; localizado com a régua secundária, e o plano $N'-B'$; localizado com a régua principal. Apresenta valores positivos quando o ponto A' estiver posicionado anteriormente ao ponto B' , e valores negativos quando o ponto B' estiver posicionado anteriormente ao ponto A' (fig. 18).
2. Ângulo FNP' , que é a medida do ângulo facial de Downs modificado, é determinado pela intersecção do plano facial ($N'-Pog'$) localizado com a régua secundária, e o plano de Frankfurt' localizado com a régua principal (fig. 19).
3. Ângulo de convexidade do perfil ($N.Sn.Pog'$), onde o plano $N'-Sn'$ é localizado com a régua principal e o plano $Sn'-Pog'$ com a régua secundária (fig. 20).
4. Ângulo $N.Sn.B'$, onde o plano $N'-Sn'$ é localizado com a régua principal e o plano $Sn'-B'$ com a régua secundária (fig. 21).
5. Ângulo $Tr.Go.Me'$, onde o plano mandibular ($Go'-Me'$) é localizado com a régua principal e a união dos pontos $Tr'-Go'$ com a régua secundária (fig. 22).
6. Ângulo FMA' , formado pela intersecção dos planos mandibular ($Me'-Go'$), localizado com a régua principal e o plano de Frankfurt' localizado com a régua secundária. Dependendo do grau de abertura deste ângulo, para pacientes com ângulo mais obtuso é utilizada a haste de suporte (fig. 23).

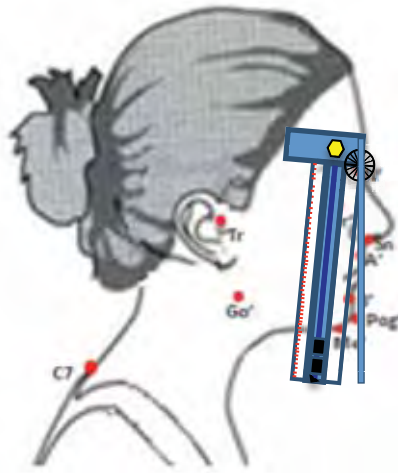


Fig. 18: Representação do ângulo ANB'

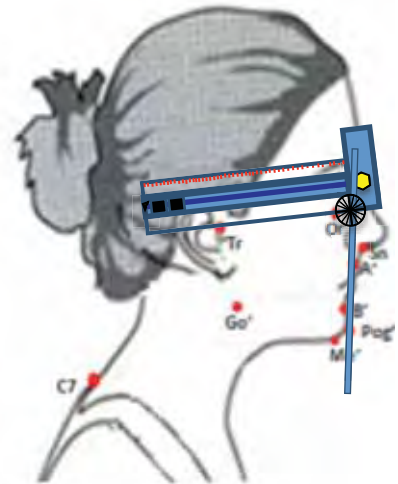


Fig. 19: Representação do ângulo FNP'

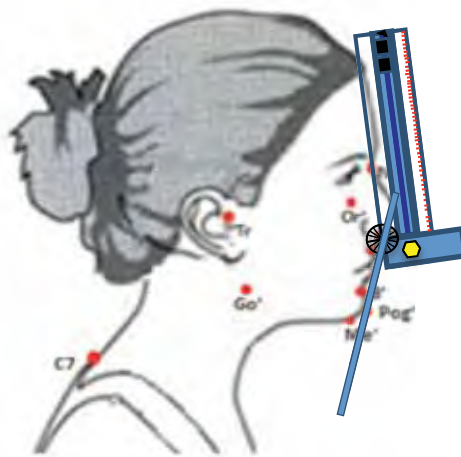


Fig. 20: Representação do ângulo de convexidade do perfil (N.Sn.Pog').

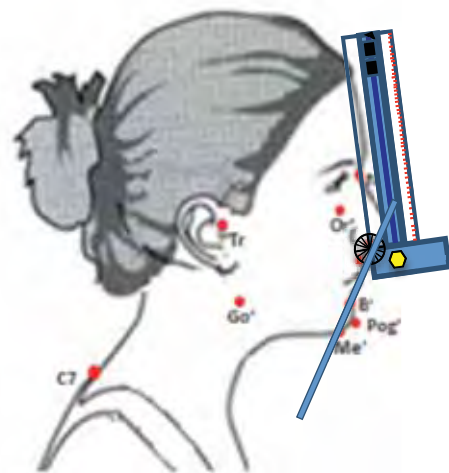


Fig. 21: Representação do ângulo N.Sn.B'

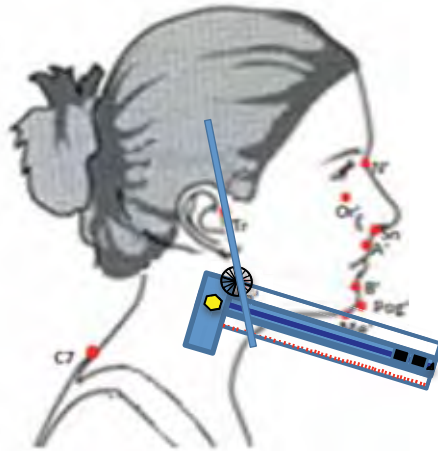


Fig. 22: Representação do ângulo Tr.Go.Me'

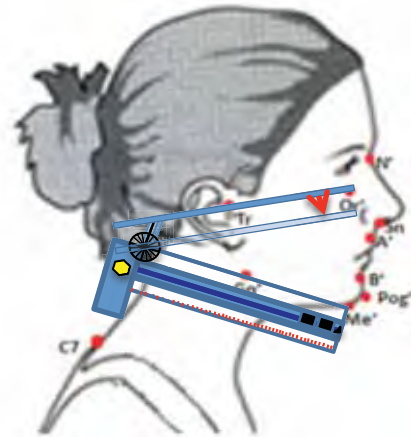


Fig. 23: Representação do ângulo FMA'

7. Altura facial posterior (AFP') é a distância Tr'-Go', encontrada usando a régua vertical.

Esta mensuração associada a outras encontradas anteriormente possibilita a mensuração de duas proporções: proporção entre altura facial anterior e altura facial posterior (AFA' / AFP') (fig. 24) e proporção entre altura facial posterior e altura facial anterior inferior (AFP' e AFAI') (fig. 25).

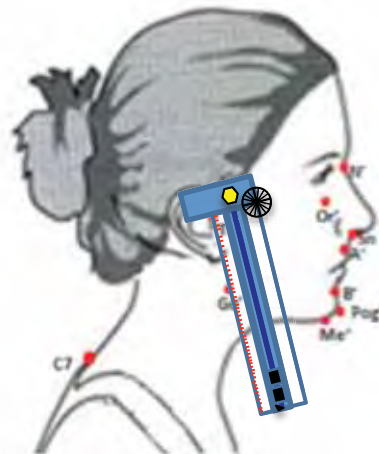
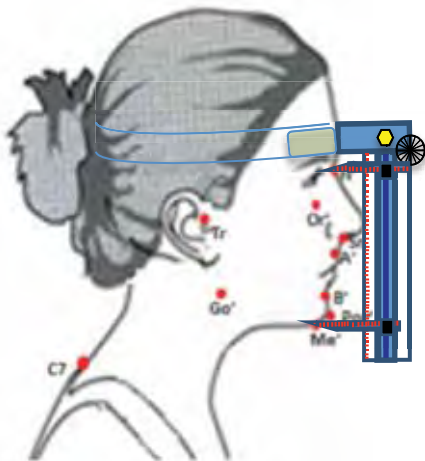


Fig. 24. Representação da proporção AFA' (N'-Me') e AFP' (Tr'-Go')

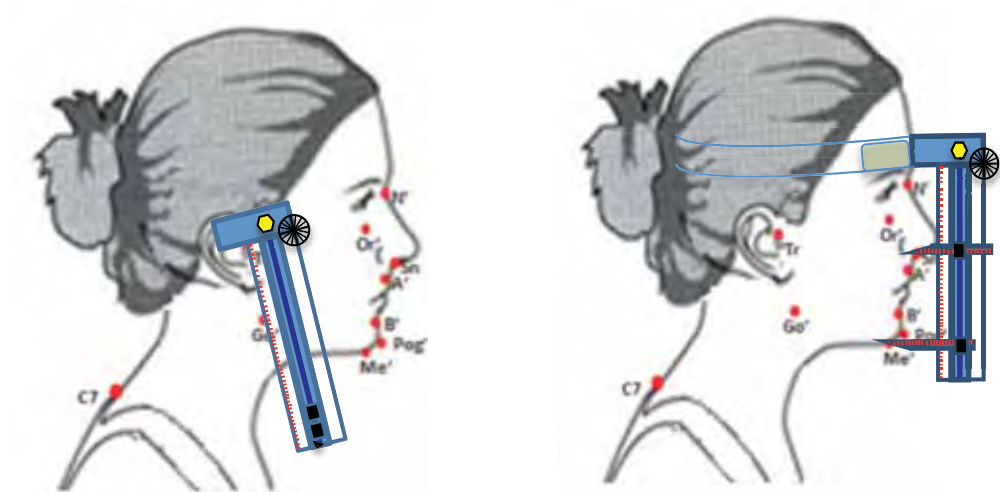


Fig. 25. Representação da proporção AFP' e AFAI'.

Em seguida, o paciente deve ficar de pé para realizar-se as medidas que caracterizam a postura da cabeça dos pacientes:

8. Ângulo TrN.VER', onde o plano Tr'-N' é localizado com a régua secundária e o plano VER' com a régua principal posicionada paralela à vertical verdadeira. Para tanto, o pêndulo deve ser utilizado fazendo coincidir o desenho a laser na linha principal com o longo eixo do pêndulo. (Fig. 26).
9. Ângulo FH.VER', onde o plano FH' (Tr'-Or') é localizado com a régua secundária e o plano VER' com a régua principal como descrito no parágrafo anterior (Fig. 27).
10. Ângulo C7.TN', onde o plano C7'-Tr' é localizado com a régua principal e o plano Tr'-N' com a régua secundária (Fig. 28).
11. Ângulo C7.FH', o plano C7'-Tr' é localizado com a régua principal e o plano FH' com a régua secundária (Fig. 29).

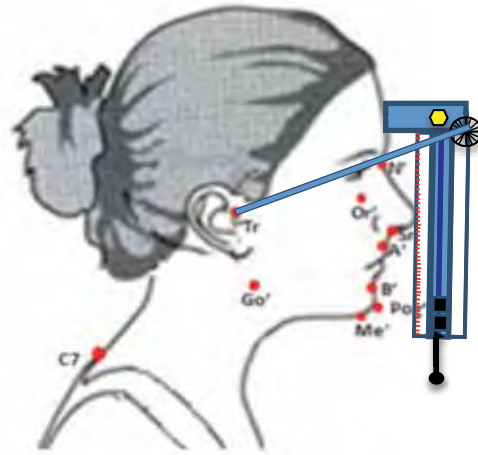


Fig. 26: Representação do ângulo TN.VER'.

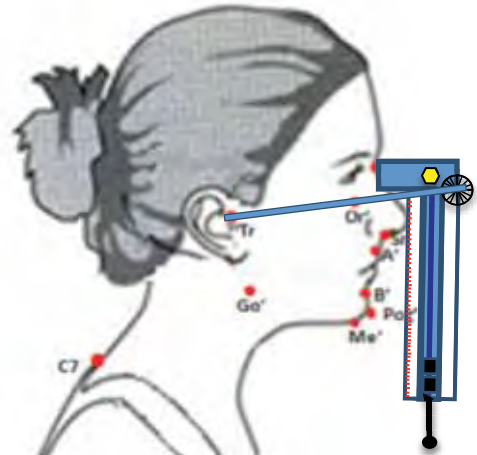


Figura 27. Representação do ângulo FH.VER'.

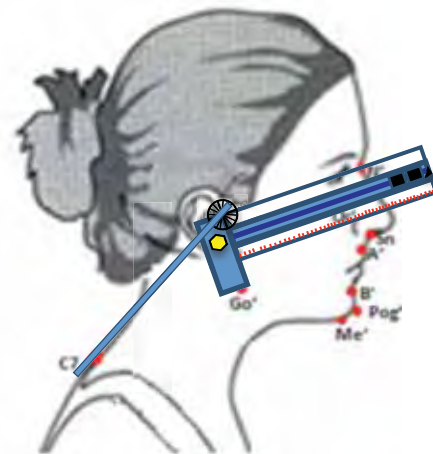


Fig. 28: Representação do ângulo C7-TrN'.

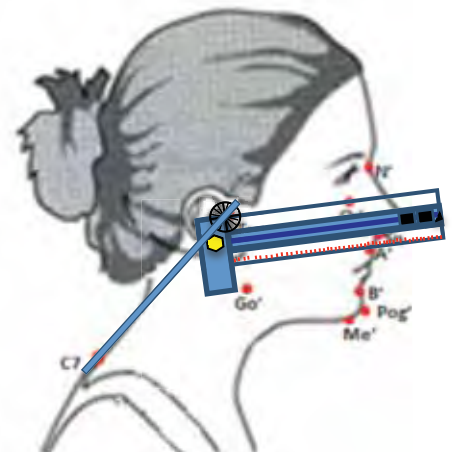


Fig. 29: Representação do ângulo C7.FH'

Tabela 1: Medidas faciais que determinam as relações maxilo- mandibulares e suas caracterizações.

	MEDIDA FACIAL	CARACTERIZAÇÃO*
PLANO ÂNTERO-POSTERIOR	Wits (POF) ^a	1
	Wits (HV) ^b	1
	ANB'	1
	FNP'	1
	N.Sn.Pog'	1
	N.Sn.B'	1
PLANO VERTICAL	Tr.Go'.Me'	2
	FMA'	2
	Proporção AFAI/AFA' (Sn'-Me'/N'-Me')	2
	Proporção AFP'/AFA' (Tr'-Go'/N'-Me')	2
	Proporção AFP'/AFAI' (Tr'-Go'/Sn'-Me')	2

*

1: Medidas que fazem a análise das displacias maxilo-mandibulares no sentido antero-posterior, caracterizando os pacientes em classe II esquelética e em outros padrões (Classe I ou classe III esquelética).

2: Medidas que fazem a análise das displacias maxilo- mandibulares no sentido vertical, caracterizando os pacientes em hiperdivergentes e em outros padrões (normodivergentes e hipodivergentes).

^a Wits (POF)'= Wits plano oclusal facial

^b Wits (HV)'= Wits horizontal verdadeira

Tabela 2: Medidas para acessar a postura da cabeça e suas caracterizações.

	VARIÁVEIS FACIAIS	CARACTERIZAÇÃO*
Ângulos Crânio- Verticais	TrN.VER	3
	FH'.VER	3
Ângulos Crânio- Cervicais	C7.TrN'	4
	C7.FH'	4

*

3: Mensurações que indicam o posicionamento da cabeça (para acima ou para abaixo i.e. extensão e contração da cabeça) no sentido vertical, em decorrência da postura da cabeça em relação à vertical verdadeira.

4: Mensurações que indicam o posicionamento da cabeça no sentido vertical, em decorrência da postura da cabeça em relação à coluna crânio- cervical. Uma vez que a coluna crânio- cervical está envolvida, os valores maiores destes ângulos indicam também uma posição mais anteriorizada da cabeça. Por outro lado, valores menores destes ângulos determinarão uma posição mais posterior da cabeça.

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Araraquara, 25 de Junho de 2012.

Juana Gentil Biagioli
Responsável pelo paciente

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