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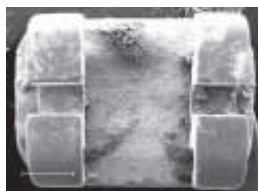
- 5 Editorial**
- 12 Events Calendar**
- 13 News**
- 16 What's new in Dentistry**
- 19 Orthodontic Insight**
- 31 Interview with Ademir Roberto Brunetto**

Online Articles

- 46** *Evaluation of the applicability of a North American cephalometric standard to Brazilian patients subjected to orthognathic surgery*
Fernando Paganeli Machado Giglio, Eduardo Sant'Ana

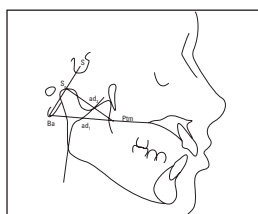


- 48** *Analysis of biodegradation of orthodontic brackets using scanning electron microscopy*
Luciane Macedo de Menezes, Rodrigo Matos de Souza, Gabriel Schmidt Dolci, Berenice Anina Dedavid



Original Articles

- 52** *Nasopharyngeal and facial dimensions of different morphological patterns*
Murilo Fernando Neuppmann Feres, Carla Enoki, Wilma Terezinha Anselmo-Lima, Mirian Aiko Nakane Matsumoto



- 62** *Cephalometric evaluation of vertical and anteroposterior changes associated with the use of bonded rapid maxillary expansion appliance*
Moara De Rossi, Maria Bernadete Sasso Stuani, Léa Assed Bezerra da Silva

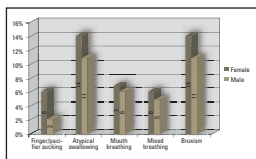


- 71** *Evaluation of maxillary atresia associated with facial type*
Marina Gomes Pedreira, Maria Helena Castro de Almeida, Katia de Jesus Novello Ferrer, Renato Castro de Almeida



- 78** *Possible etiological factors in temporomandibular disorders of articular origin with implications for diagnosis and treatment*
Aline Vettore Maydana, Ricardo de Souza Tesch, Odilon Vitor Porto Denardin, Weber José da Silva Ursi, Samuel Franklin Dworkin

I - Muscular Diagnoses	
a - myofascial pain	
b - myofascial pain with limited opening	
II - Disk Displacement	
a - disk displacement with reduction	
b - disk displacement without reduction and with limited opening	
c - disk displacement without reduction and without limited opening	
III - Arthralgia, osteoarthritis and osteoarthritis	
a - arthralgia	
b - temporomandibular joint (TMJ) osteoarthritis	
c - temporomandibular joint (TMJ) osteoarthritis	



- 87** *Factors predisposing 6 to 11-year old children in the first stage of orthodontic treatment to temporomandibular disorders*

Patrícia Porto Loddi, André Luis Ribeiro de Miranda, Marilena Manno Vieira, Brasília Maria Chiari, Fernanda Cavicchioli Goldenberg, Savério Mandetta



- 94** *Extraction of upper second molars for treatment of Angle Class II malocclusion*
Maurício Barbieri Mezomo, Manon Pierret, Gabriella Rosenbach, Carlos Alberto E. Tavares



- 106** *Evaluation of shear bond strength of brackets bonded with orthodontic fluoride-releasing composite resins*

Marcia Cristina Rastelli, Ulisses Coelho, Emídio Enrique Orellana Jimenez



- 114** *Statement of the 1st Consensus on Temporomandibular Disorders and Orofacial Pain*



Simone Vieira Carrara, Paulo César Rodrigues Conti, Juliana Stuginski Barbosa

- 121** *Race versus ethnicity: Differing for better application*

Diego Junior da Silva Santos, Nathália Barbosa Palomares, David Normando, Cátia Cardoso Abdo Quintão



- 125** **BBO Case Report**

Angle Class II, Division 2 malocclusion with severe overbite and pronounced discrepancy

Daniela Kimaid Schroeder



- 134** **Special Article**

Tooth extraction in orthodontics: an evaluation of diagnostic elements

Antônio Carlos de Oliveira Ruellas, Ricardo Martins de Oliveira Ruellas, Fábio Lourenço Romano, Matheus Melo Python, Rogério Lacerda dos Santos

- 158** **Information for authors**

Treatment of temporomandibular disorders (TMD) and orofacial pain

It is intriguing to see how information flows in the healthcare area. It is particularly curious to note that certain obsolete concepts and old, threadbare themes are sometimes reinstated and infect many practitioners. These treatment approaches are enough to spoil the mood of any scientifically-minded professional and—worse still—can wreak havoc with the victims of such treatments. The less lethal this condition, the more susceptible to such impropriety. An article in this issue provides a unique insight into one of the subjects most affected by what I just described: the treatment of temporomandibular disorders and orofacial pain.

Consider the following questions concerning TMD. Is your TMD treatment controversial? Is orthodontics an integral part of TMD treatment methods? Should TMJ CT's be routinely used to assess the problem? Is joint space relevant to the diagnosis and treatment goal? Is treatment aimed at adjusting the joint spaces? If you answered yes to one or more of these questions you must read the article by Carrara, Conti and Barbosa.

A close relationship between dentition and TMD was erroneously established decades ago. The mistaken conclusions stemmed from an interpretation of retrospective case series studies. This study design is most often performed by practitioners in the office setting, simply because that is where patients go for treatment. Thus, after a few years, material is collected from a series of cases on a given subject. To better understand why this study design is inefficient in pinpointing solutions to the problems that confront us, let us consider the following line of reasoning.

A hypothetical professional analyzes the results of orthodontic treatment of 41 patients in her office. All complained of pain and were

diagnosed with TMD at the beginning of follow-up. To simplify my reasoning, let us consider that we have two possible treatment outcomes: improvement and no improvement. If the final results indicate that 35 patients improved, treatment as a whole was a success, right? The correct answer is: wrong. We cannot conclude anything other than that this treatment might work.

Some conditions are cyclical or transitory, and it might be that the patients who improved with this TMD therapy would eventually get better anyway. Therefore, a control group should be included, provided that the researcher finds it ethically acceptable to deprive these people of treatment. Thus, if the control group was included in the study and only 20 patients improved without treatment (Table 1), we would have a statistically significant difference between treatment and control groups ($p < 0.001$), with the latter group showing more improvement than the former. Can we now conclude that this treatment is effective? No. At least not yet.

Furthermore, it is perfectly conceivable that a portion of those treated improved as a result of the placebo effect. It would be all but impossible to include a placebo effect per se in a non-drug therapy such as TMD. To achieve such effect, one could implement false treatments such as, for example, brackets bonded to teeth without de-

TABLE 1 - Results of a hypothetical study that proposes an orthodontic treatment plan for TMD.

	TREATMENT	CONTROL	FAKE TREATMENT
IMPROVEMENT	35	20	33
NO IMPROVEMENT	6	19	8
TOTAL	41	39	40

livering any actual forces, or an acrylic plate that does not cover the occlusal surfaces of the teeth.

In our hypothetical study, a Fake Treatment was evaluated. The results showed that 33 patients improved with the fake treatment and no difference was found between Treatment and Fake Treatment groups ($p = 0.63$). Thus the new therapy—or old therapy, if it happens to be the new edition of an old concept—is not more effective than the fake treatment.

The table showing the clinical trials with the three groups, described above, gives an overview of the process of assembling information for clinical decision making. However, the mere creation of the three groups is still a relatively incomplete action and therefore insufficient. Important issues regarding the randomness of patient selection for treatment, the fact that it is a prospective study, the analysis of intention to treat, among other items relevant to the design of a clinical trial, were not even mentioned. Mainly because it would require many pages to elaborate on these details.

Additionally, the sketch depicts a common shortcoming, namely, many well-intentioned professionals take advantage of conferences and other channels as a platform to disseminate

findings from a series of cases treated in their offices, without realizing the complexity that lies behind the formulation of clinical studies.

It was in an attempt to help these people, who are part of the dental and medical communities, and also the people who suffer from TMD and orofacial pain, that Carrara, Conti and Barbosa wrote the Statement of the 1st Consensus on Temporomandibular Disorders and Orofacial Pain. This article is unique because it not only reflects the authors' opinion, but also that of today's leading Brazilian professionals. They endorsed the article and proved that the subject is not controversial.

Furthermore, the article shows that the available evidence can suggest many things: that orthodontics is not an integral part of routine TMD treatment methods, that TMJ CT's should not be used routinely, that joint space analysis is not relevant to the diagnosis and that adjusting the joint spaces is not a treatment goal, among other conclusions. The article is a landmark in the area and I strongly recommend that all read it in full.

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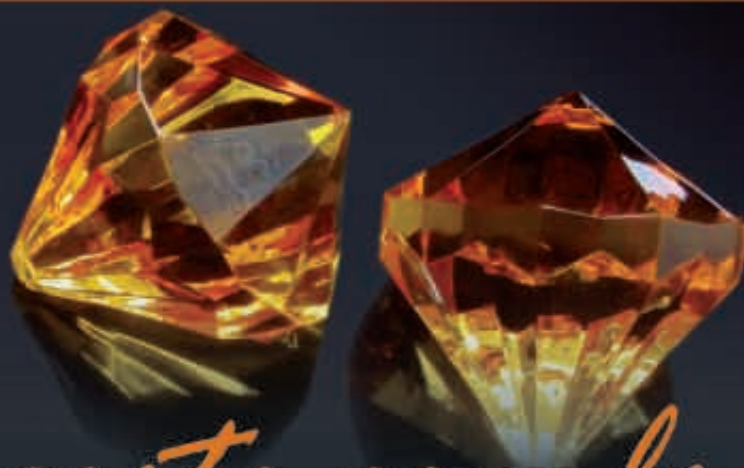


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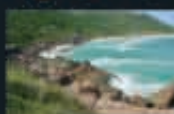


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THURSDAY - JUNE 24, 2010

Time	ROOM 01 THEME: PREPARATION IN ORTHOGNATHIC SURGERY	ROOM 02 THEME: DIAGNOSIS AND BIOMECHANICS
8 - 10 am	PREPARATION IN ORTHOGNATHIC SURGERY: YES OR NO? Jorge Faber	OCCUSION, TMJD AND ORTHODONTIC TREATMENT: WHAT DOES THE ORTHODONTIST NEED TO KNOW? Paula Conti
10 - 12 pm	PREPARATION IN ORTHOGNATHIC SURGERY IN CLASS II MALOCCLUSION Ana Maria Bolognese	ORTHODONTICS AND IMPLANTS Laurindo Furquim
1:30 - 3:30 pm	PREPARATION IN ORTHOGNATHIC SURGERY IN CLASS III MALOCCLUSION Carlos Alberto Tavares	SEGMENTED ARCH OPTIMIZING THE MECHANICS OF CONTINUOUS ARCH WIRE Arno Locks
4 - 6 pm	PREPARATION IN ORTHOGNATHIC SURGERY FOR COMBINED SURGERIES Marco Antônio de Almeida	THE BIOMECHANICS OF MINI-IMPLANTS Carlo Marassi
6 - 8 pm	THE ORTHODONTIC-SURGICAL TREATMENT ACCORDING TO BELL Mário Gabrielli	THE TREATMENTS THAT CHALLENGES US Jonas Capelli Jr.



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Undergraduate students	R\$ 180,00	R\$ 200,00	R\$ 250,00

* Brazilian currency (R\$)

FRIDAY - JUNE 25, 2010

Time	ROOM 01 THEME: ORTHOGNATHIC SURGERY	ROOM 02 THEME: INTERDISCIPLINARITY
8 - 10 am	ORTHOGNATHIC SURGERY Paulo José Medeiros	SKELETAL ANCHORAGE João Miki Neto
10 - 12 pm	 WORLD CUP  BRASIL X PORTUGAL	Come watch the game of soccer world cup Brazil vs. Portugal with us. A big screen will be available for everyone to cheer for Brazil!
1:30 - 3:30 pm	THE PHILOSOPHY OF ORTHOGNATHIC SURGERY ACCORDING TO LARRY WOLFORD Marcos Pitta	ESTHETICS IN ORTHODONTICS Carlos Alexandre Câmara
4 - 6 pm	ORTHOGNATHIC SURGERY Roberto Macoto	TRANSDISCIPLINARY APPROACH: ORTHODONTICS AND PERIODONTICS Roberto Carlos Brandão
6 - 7:45 pm	SYMPOSIUM 1 - PREPARATION FOR ORTHOGNATHIC SURGERY Coordination: Mário Gabrielli Speakers: Carlos Tavares / Jorge Faber / Aleysson O. Palla Invited Speakers: Ana Maria Bolognese Marco Antônio de Almeida Marcos Pitta Paulo José Medeiros Roberto Macoto	SYMPOSIUM 2 - DIAGNOSIS, BIOMECHANICS AND INTERDISCIPLINARITY Coordination: Roberto Rocha Speakers: Arno Locks e Roberto Brandão Invited Speakers: Carlo Marassi Laurindo Furquim João Miki Neto Carlos Alexandre Câmara Jonas Capelli Jr.

SATURDAY - JUNE 26, 2010

Time	ROOM 01 THEME: ORTHODONTICS FOR ADULTS
8 - 10 am	ORTHODONTICS FOR ADULTS Speaker: Silva Braga Reis
10 - 12 pm	ORTHODONTICS FOR ADULTS Speaker: José Nelson Mucha
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Information: www.abomg.org.br



Mini-residência em DTM/Apneia

Date: August 14 to 22, 2010

Location: Marquette University – Wisconsin, Milwaukee/USA

Information: (55 011) 3061-5584



XVI Reunião Científica ABFCOC

Date: August 17 to 20, 2010

Location: Hotel SESC Pantanal - Cuiabá / MT, Brazil

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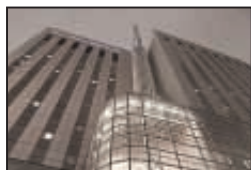


IV Congresso Sul Brasileiro de Ortodontia

Date: August 19 to 21, 2010

Location: Lajes / SC, Brazil

Information: (55 049) 3224-0838
www.oraesthetic.com



1º Straight-Wire Lingual Meeting - Diagnóstico e Planejamento em Ortodontia

Date: August 27 and 28, 2010

Location: Grand Mercure - Ibirapuera - São Paulo / SP, Brazil

Information: (55 067) 3326-0077 / (55 016) 3397-1401
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FDI Annual World Dental Congress

Date: September 2 to 5, 2010

Location: Salvador / BA, Brazil

Information: congress@fdiworldental.org



17º Congresso Brasileiro de Ortodontia - SPO

Date: October 14 to 16, 2010

Location: Anhembi – São Paulo / SP, Brazil

Information: www.spo.org.br

2010 AAO Annual Session

Jorge Faber, editor-in-chief of the Dental Press Journal of Orthodontics, was the winner of the CDABO Case Report of the Year for the best case report published during 2009. His article, published in the American Journal of Orthodontics and Dentofacial Orthopedics (AJO-DO) was voted the best case report published in 2009 by the editorial board of the Journal.

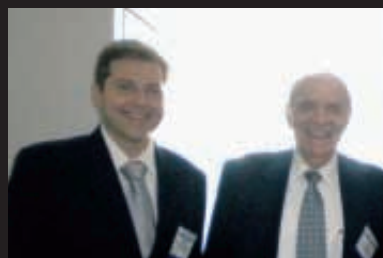
The ceremony took place during a lunch with the College of Diplomates of the American Board of Orthodontics (CDABO), in Washington DC, where the 110th AAO Annual Session (Meeting of the American Association of Orthodontists) was held between April 30 and May 4. The award was bestowed by Dr. Vincent Kokich (next editor of the AJO-DO).



Dr. Vincent Kokich handing the award to winning author, Dr. Jorge Faber, and coauthor, Dr. Flávia Velasque.



Dr. David Turpin, current editor of the AJO-DO, received a copy of the Dental Press Journal of Orthodontics issue featuring Dr. Turpin's interview.



Dr. Adilson Luiz Ramos, former editor of this Journal, and the renowned Dr. Larry White.



Dr. Orlando Tanaka and the editor of this Journal, Dr. Telma Martins de Araujo.



Trade floor of the 110th Meeting of the American Association of Orthodontists.



Drs. Bruno Furquim, Marcos A. Lenza and Eduardo B. Lenza.

Thesis defense at UEM

The Master's degree in Integrated Dentistry, State University of Maringá (UEM) graduated its first class of masters. The dissertations by Paula Scheibel and Luciana Manzotti De Marchi were noteworthy. Dr. Paula presented to the examining committee her dissertation entitled "Correlation between alveolar bone density and apical root resorption in orthodontic patients." Dr. Luciana defended the thesis "Aesthetic and functional evaluation of patients with agenesis of upper lateral incisors treated with implants or space closure and dental reanatomizations."



In photo (from left to right): Prof. Renata Corrêa Pascotto (supervisor), Prof. Dr. Adilson Luiz Ramos (examiner), Dr. Luciana Manzotti De Marchi and Prof. Dr. Ricardo de Lima Navarro (examiner).



In photo (from left to right): Prof. Dr. Júlio de Araújo Gurgel (examiner), Dr. Paula C. Scheibel, Prof. Dr. Adilson Luiz Ramos (supervisor) and Prof. Dr. Hélio Hissashi Terada (examiner).

ABOR and SBO participated in the WFO Council Meeting

The World Federation of Orthodontists (WFO) organizes the International Orthodontics Congress (IOC) every five years. The 7th IOC was held between February 6 and 9, 2010 in Sydney, Australia. The Meeting of the WFO Executive Council, where ABOR and SBO have a right to a seat and vote, was held on February 5. Drs. Flavia Artese, Slamad Rodrigues and Eustáquio Araújo represented those two Brazilian Associations. A highlight of this meeting was the election of Dr. Kurt Faltin Jr. as WFO representative for Latin America with a five-year term. The WFO representative gave a brief overview

of its activities in recent years and in recognition of their outstanding performance, all associate members were presented with a free subscription to the "World Journal of Orthodontics." The next IOC will be held in September 2015, in London. Brazil was strongly encouraged to apply as a candidate to host the 2020 IOC.

Brazil was very well represented in the science grid of the 7th IOC through the participation of several renowned Brazilian orthodontists. Dr. Guilherme Janson delivered a lecture entitled "Asymmetric malocclusion: a systematic approach to diagnosis and treatment."



ABOR and SBO participated in the WFO Council Meeting.

Dr. Kurt Faltin Jr. addressed "The orthopedic treatment of anterior open bite with Balters' Bionator." The issue of "Whether or not to abandon the early treatment of Class II" deserved a bold argument by Dr. Eustáquio Araújo. Dr. Camillo Morea gave a lecture on the "Initial healing of hard and soft tissues around unloaded mini-implants." Finally, Dr. Nelson Mucha talked about the "Long-term evaluation of anterior open bite treatment in adult patients."

On February 5, 2010 at the invitation of Dr. Roberto Justus (WFO President), Board representatives from 15 countries as well as others where a Board has not yet been established, gathered at the Symposium on Orthodontic Certifying Boards.

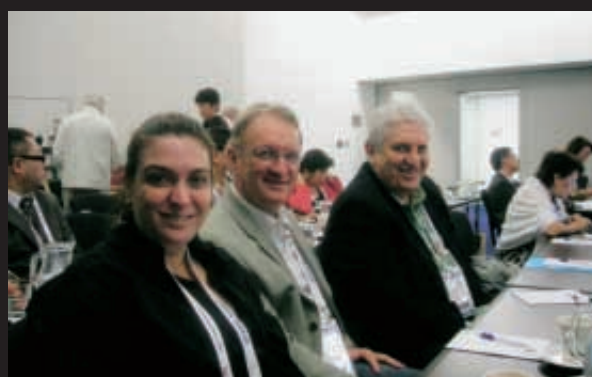
The activities started with two presentations. The first by Dr. Jeryl English of the American Board of Orthodontics (ABO) and the second by Dr. Robert Carter of the College of Diplomates of the American Board of Orthodontics (CDABO).

ABO's keynote address focused on the increased demand for Board certification, which this year has exceeded twice the expected number of entries (more than 520 applicants). Currently, the ABO boasts 79% of diplomate orthodontists.

CDABO keynote address described the functions of the American College, which include encouraging, supporting and facilitating the process of certification for orthodontists as



Brazilian orthodontists lectured at the WFO Congress.



BBO and CDBBO participated in the WFO Meeting.

well as sponsoring lectures and continuing education for its members.

Although the WFO has identified 15 countries that have a Board, few have Diplomate Colleges, which puts Brazil, once again, at the forefront of the orthodontic world.

Shared brain activity for aesthetic and moral judgments: implications for the Beauty-is-Good stereotype

Jorge Faber*, Patrícia Medeiros Berto**

The Beauty-is-Good stereotype refers to the assumption that attractive people possess socially desirable personalities and higher moral standards. The existence of this bias suggests that the neural mechanisms for judging facial attractiveness and moral goodness overlap, i.e., they are circumscribed to the same brain regions. The hypothesis of this overlap was investigated by Tsukiura and Cabeza¹ and published in the March 2010 issue of the *Journal of Social Cognitive and Affective Neuroscience*.

The research participants were scanned with functional magnetic resonance imaging while they made attractiveness judgments about faces and goodness judgments about hypothetical actions. Activity in the medial orbitofrontal cortex increased as a function of both attractiveness and goodness ratings, whereas activity in the insular cortex decreased with both attractiveness and goodness ratings. These activations support the idea of similar contributions of each

region to both judgments. The orbitofrontal and insular cortices were negatively correlated with each other, suggesting an opposing relationship between these regions during attractiveness and goodness judgments.

These findings have implications for understanding the neural mechanisms of the Beauty-is-Good stereotype. People judged to be physically attractive often have their personality also judged positively, be it as a person of good conduct, virtuous or even honest. One is capable of, at first sight, considering another human being attractive or unattractive while at the same time assigning values to that person. The study suggests a possible explanation for this fact since the same neural mechanisms are activated or deactivated during these types of assessments. So, perhaps now, we can explain why, when a person is seen as beautiful, they are likewise seen as good. In other words, how beauty becomes goodness.

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Facial expressions and how the brain decodes them

It is a fact that sociable living beings are able to perceive the social cues of their peers. The same applies to humans. In primates, the face has evolved to convey emotional states, while the brain has simultaneously evolved to decode the signals in the facial expressions of others. The study by Schyns, Petro and Smith² reviewed and integrated the evidence supporting this hypothesis.

With the aid of computer programs they co-examined facial expressions as signals that transmit information and the brain as a receiver and decoder of these signals. The authors found that facial expressions were a set of subtly correlated signals, i.e., only slightly resembling one another. For example, the eyes can share similar expressions of anger and happiness. Data from EEG's showed that the brain uses spatial frequency information that reaches the retina to identify the expressions by breaking up their correlations. Within 140 to 200 milliseconds

after stimulus onset—regardless of the expression or the brain hemisphere side—an information processing mechanism is triggered locally to take motor control of the eyes. The eyes then perform a wide zoom to process the entire face and finally a close-up zoom on specific spots for diagnostic purposes (e.g., eyes open in “fear”; mouth opens in “happiness”).

A categorizing model showed that in 200 milliseconds the left and right hemispheres process enough information to predict the behavioral category of the face being analyzed. This investigation contributes to the understanding of how facial information is quickly processed in the brain to identify emotions.

Research of this nature, which enhance our understanding of how beauty is recognized, will probably be useful in establishing treatment strategies that involve aesthetic reconstruction of the face or its subcomponents, such as the smile.

Motivation and enthusiasm over orthognathic surgery results influence treatment satisfaction

Patients' motivation to undergo orthognathic surgery can affect their satisfaction with treatment outcome. Meade and Inglehart³ investigated this relationship and published their findings in the American Journal of Orthodontics and Dentofacial Orthopedics. The goal

was to determine whether the expectations of patients and their parents regarding their possible future appearance were correlated with the patients' treatment satisfaction.

A retrospective study was performed and questionnaires were presented to 115 patients

(aged 13-21 years at surgery) and 117 parents (response rates of 41% and 42% respectively), with responses from 95 parent-patient pairs. The patients' motivation was evaluated before surgery by determining how excited they were when they envisioned themselves after surgery and how focused they were on the results. Parents completed parallel questionnaires on their children's motivation. Patient satisfaction was determined by means of a postsurgical satisfaction questionnaire. The data collected indicated that the more excited the patients were before surgery, the more satisfied they were with the results. Likewise, the more these patients focused on functional and aesthetic changes, the more satisfied they were with the results. The assessments made by the parents regarding the motivation of their children before surgery were consistent with the children's reports and correlated with patient satisfaction after the surgery. Thus, young patients' self-motivation towards

orthognathic surgery is strongly correlated with their treatment satisfaction.

The findings of this study have clinical implications for maxillofacial surgeons and orthodontists. Attention to technical excellence and the use of advanced technologies are currently the day-to-day concerns of most practitioners. They are indeed essential for ensuring a successful surgery. However, patient satisfaction should be added to the technical requirements of a surgery—it is possible the coexistence of a surgery that meets the technical criteria and a patient dissatisfied with its results, and this would be a scenario of failure. What the article suggests is the need to evaluate and encourage patients about the surgery results from the very first appointment in the pre-operative phase. The more motivated and focused are the patients, the more likely they are to experience ultimate success. Such evidence can, no doubt, be readily applied in our daily professional practice.

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Saucerization of osseointegrated implants and planning of simultaneous orthodontic clinical cases

Alberto Consolaro*, Renato Savi de Carvalho**, Carlos Eduardo Francischone Jr.***, Maria Fernanda M.O. Consolaro****, Carlos Eduardo Francischone*****

The field for Orthodontics has seen significant expansion with the advent of new diagnostic and therapeutic approaches in all specialties, such as medical and dental implantology, sleep medicine, orthognathic surgery, computed tomography, gerodontology, etc. This requires the mastery of new concepts and technical terms typical of the jargon used by each specific area. Such mastery plays a key role in discussions about diagnosis and planning of clinical cases with professionals from other specialties.

Dental osseointegrated implants, for example, completely changed the practice and scope of dentistry in the last 20 years. Many adult orthodontic patients have already had one or more osseointegrated implants installed or may be planning, or need to do so. Many young orthodontic patients have also had osseointegrated implants installed because of tooth loss caused by trauma or partial anodontia.

Osseointegrated implant saucerization is a phenomenon worthy of recognition and consideration in orthodontic planning to establish functional and aesthetic prognosis. With this insight in mind, we intend to discuss the concept of saucerization, with the specific purpose of answering a few important questions. Given the

occurrence of saucerization, should special care be given to teeth located in the neighborhood of osseointegrated implants when moving teeth and finishing orthodontic cases?

The concept of osseointegration is a peculiarity of the teeth and implants in our bodies: The importance of cervical soft tissues

Osseointegration allows the direct anchorage of an implant through bone tissue formation around the implant without the growth or development of fibrous tissue at the bone-implant interface.^{3,5}

Teeth are the only body structures that traverse or penetrate an epithelial lining or coverage (Figs 1, 2 and 3). By extension, dental implants also have this feature and the anchorage provided by osseointegration is a prerequisite for implant stability. Long-term implant survival depends on the adhesion of the epithelium and connective tissues to the titanium surface since a complete soft tissue cervical sealing protects the bone from the highly contaminated oral environment.^{8,10,15,22,23,26}

The marginal gingiva and peri-implant mucosa share many clinical and microscopic characteristics.^{1,2,19,20,25} The gingival mucosa around

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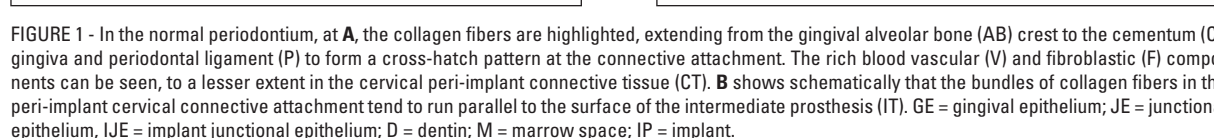
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Studies on the topography of periodontal tissue vasculature revealed that the gingiva and

The mechanical resistance between the gingiva and the peri-implant mucosa was tested in

The mechanical resistance between the gingiva and the peri-implant mucosa was tested in



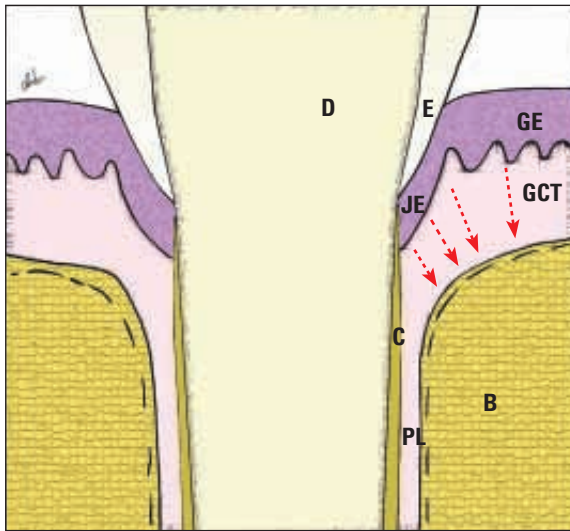


FIGURE 2 - The tooth is the only structure of the body that crosses the lining epithelium and interacts with the internal environment. Layout of the periodontal structures relative to the biological distances: dentin (D), cementum (C), alveolar bone (B), periodontal ligament (PL), junctional epithelium (JE), gingival epithelium (GE) and gingival connective tissue (GCT). The junctional epithelium has 15-30 cell layers and as it proliferates in the apical direction it enables the contact of EGF molecules with bone cells, thereby stimulating bone resorption and maintenance of the biological distances. In the human body, between the epithelium and the bone, there is always connective tissue interposition due to the presence of EGF in the underlying epithelial and connective tissues. EGF is released by the Epithelial Rests of Malassez and keeps the alveolar bone away from the cementum through the same mechanism and thus prevents dentoalveolar ankylosis.

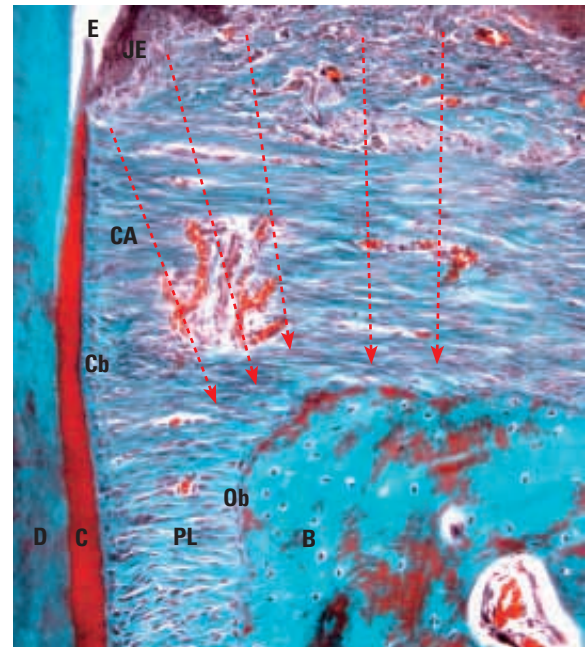


FIGURE 3 - The form of the alveolar bone crest, with its rhomboidal aspect, corresponds to the morphology of the junctional epithelium (JE) which fosters the steady release of EGF, depicted by the arrows. The collagen fibers of the connective attachment (CA) perpendicular to the cementum (C) can help limit the effect of EGF on bone cells. The cementoblasts (Cb) on the root surface have receptors for EGF and other mediators of bone turnover, which ultimately protect teeth from resorption. D = dentin; PL = periodontal ligament; B = alveolar bone, E = enamel; Ob = osteoblasts.

dogs and revealed that probe penetration was greater in implants than in teeth: 2 mm and 0.7 mm, respectively.¹⁴ In peri-implant soft tissues, the probe displaced the junctional epithelium and connective tissue on the implant's adhesion surface interface and stopped at the bone crest. Occasionally, bleeding occurred due to vessel rupture. In the teeth, the probe stopped at the apical portion of the junctional epithelium, identifying the bottom of the gingival sulcus. The bleeding was minimal, in contrast with that of the implants.¹⁴

The effects of dental bacterial plaque after three weeks and after three months in the gingiva and peri-implant tissues were comparatively

evaluated.⁶ Both tissues exhibited inflammatory lesions identical in size and composition features. Within three months the bleeding was similar and both inflammatory infiltrates had the same characteristics, but the apical extent was more pronounced in the peri-implant mucosa than in the gingiva. This finding implies that the defense mechanisms of the gingiva are more efficient than those of the peri-implant tissues in preventing future spreads of sulcus microbiota.⁶ However, the neck of an osseointegrated dental implant tends to display normal function and aesthetics, provided that adequate oral hygiene is maintained. This also applies to normal teeth.

Saucerization of osseointegrated implants: Concept and Mechanism

Saucerization occurs in all osseointegrated implants, regardless of their design, surface type, platform, connection type, commercial brand or patient conditions (Fig 12). Although the speed with which it occurs can vary, its occurrence seems to be part of the integration of implants with epithelium and gingival connective tissue.

The cervical region of osseointegrated implants, when exposed to the oral environment, usually exhibits some degree of bone resorption (Figs 4-11), of approximately 0.2 mm depth.^{4,5,11} The plane of the resorbed osseointegrated bone surface forms an open angle with the implant's cervical region on nearly all of its surfaces. Three-dimensionally, this cervical bone resorption—observed in all types of osseointegrated implants—is in the shape of a saucer, i.e., it is shallow and superficial, hence "saucerization." This process can be extended over time,

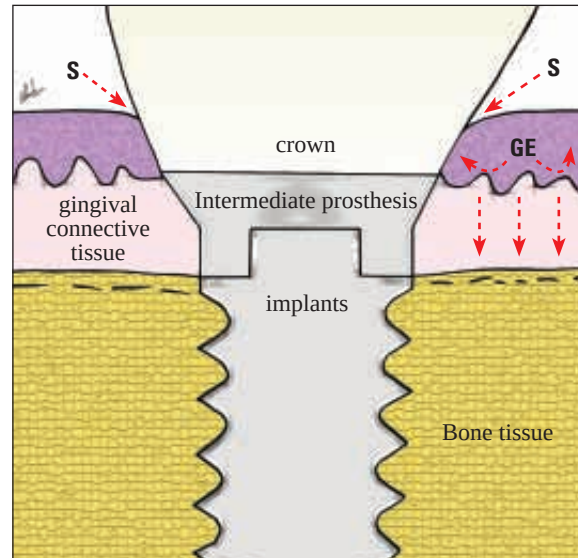


FIGURE 4 - The gingival stratified squamous epithelium (GE) is juxtaposed with its normal thickness soon after the placement of healing caps or intermediate prosthesis and crown. The ulcerated epithelium has its cell membranes exposed to mediators that interact with their receptors. Under stress the cells increase the production of mediators. The EGF (arrows) of the epithelial cells themselves stimulates peri-implant epithelial proliferation and initiates the formation of the peri-implant junctional epithelium. EGF from saliva (S) probably participates in this process because it is greatly increased during oral surgery.

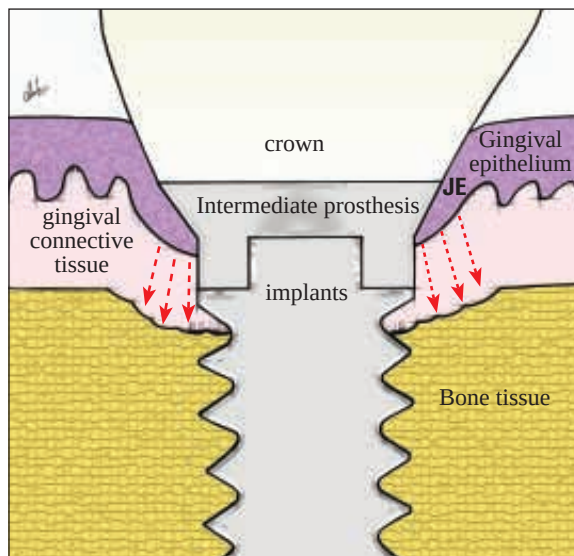


FIGURE 5 - The peri-implant junctional epithelium (JE) produces new cell layers and assumes a conformation similar to the junctional epithelium of natural teeth. This new conformation of the peri-implant junctional epithelium brings it closer to the osseointegrated surface, increasing the local concentration of EGF and, as a result, accelerating bone resorption and starting saucerization.

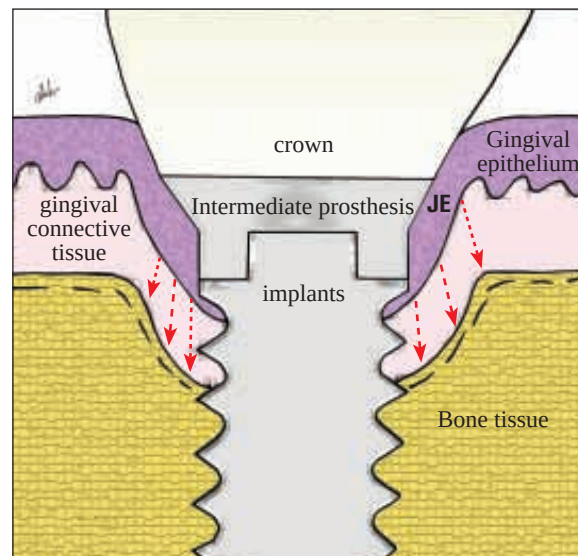


FIGURE 6 - The peri-implant junctional epithelium (JE) conformation is similar to the junctional epithelium of natural teeth. It derives structural balance from the peri-implant connective attachment to stabilize its proliferative activity. On the bone surfaces resorption decreases, approaching normal bone turnover. Thus, the peri-implant bone surface undergoes corticalization, indicative of process stabilization.

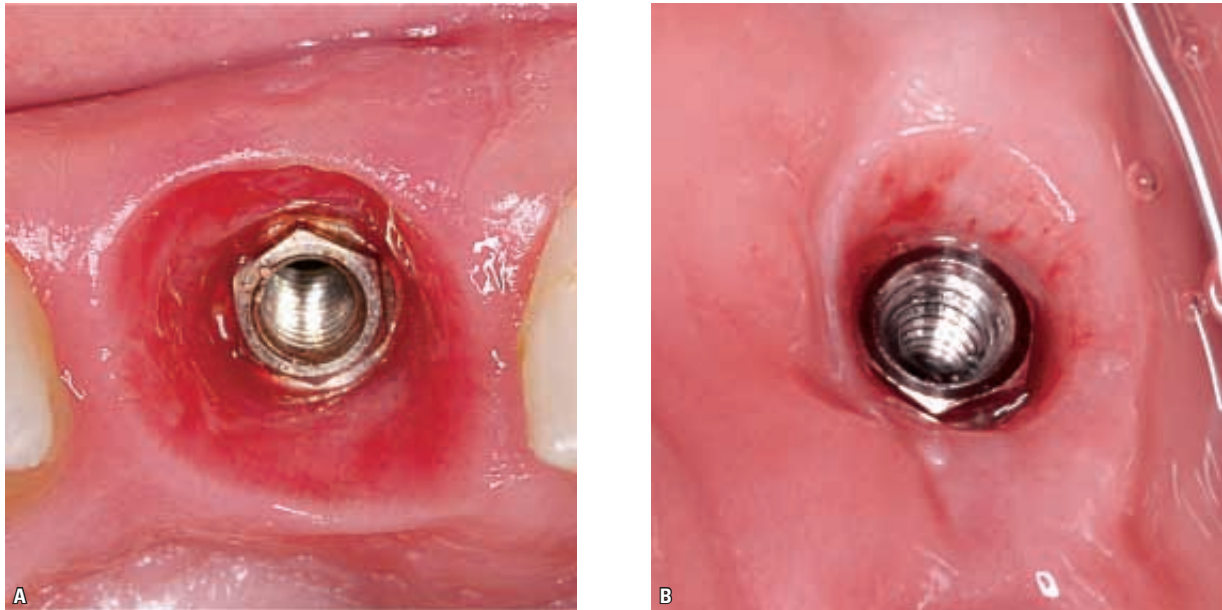


FIGURE 7 - During the removal of the healing caps or intermediate prosthesis there occurs the formation of the peri-implant junctional epithelium (JE) that covers the surface interface with the mucosa, including the gingival tissue. When it is still thin and disorganized, the peri-implant junctional epithelium tends to show a reddish appearance and can bleed if touched, given its frailty (A). When organized and mature, the peri-implant junctional epithelium appears pink, resembling the epithelium of the adjacent mucosa. Occasionally, the underlying microcirculation (B) can be seen as the JE becomes transparent.

consuming on average 0.1 mm of peri-implant cervical bone tissue each year.^{4,5,11} In a personal communication, Albrektsson reported that this cervical bone loss tends to decrease over the

years to a level even lower than that recorded in previous studies, and that these results would soon be reported in the literature.

Many theories and explanations have been provided to account for saucerization but almost all have had difficulty explaining some of its features. One of these theories attributes saucerization to the occlusal masticatory load that implants have to sustain. However, when osseointegrated implants are out of occlusion or are fitted only with the gingival healing caps for many months or even years, without ever coming into occlusion, saucerization is also present (Fig 13). On the other hand, when implants remain submerged for a few months/years, the bone moves toward the more cervical surface and may even grow over the cover screws (Fig 12). This bone gain requires osteotomy maneuvers in order to place healing caps or an intermediate prosthesis.

Shortly after the placement of healing caps, or directly from the intermediate prosthesis and crown, the stratified squamous epithelium

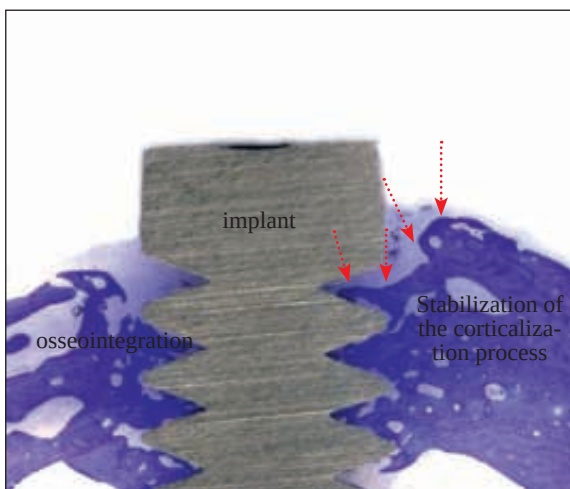


FIGURE 8 - After saucerization, the peri-implant bone surface normalizes, with corticalization (arrows) indicative of stabilization of the pericervical bone remodeling process (toluidine blue, 10X).

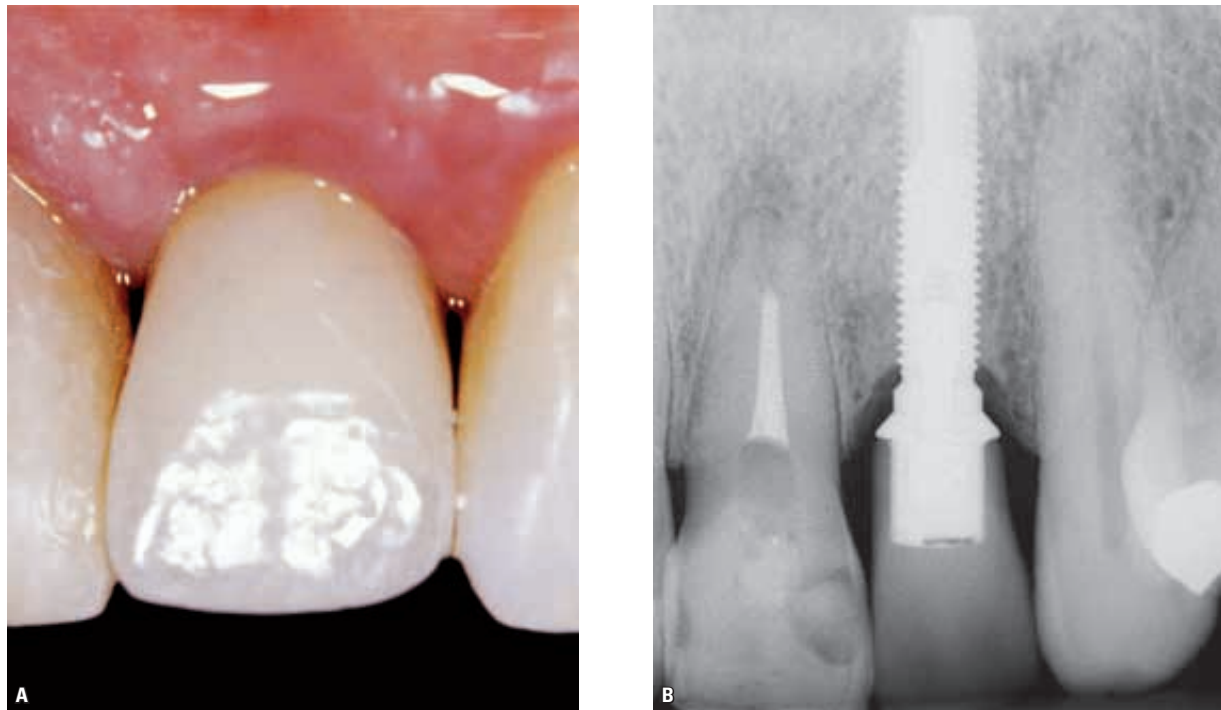


FIGURE 9 - Clinical case of implant in the upper lateral incisor region after six years, highlighting saucerization with regular bone surface and osseointegration.

of the oral mucosa is juxtaposed to the surface with its normal thickness (Fig 4). When an epithelium is ulcerated their cell membranes are exposed to mediators in order to interact with their receptors, in the same manner as in oral ulcers and surgical wounds, including in the peri-implant region.

The epidermal growth factor (EGF) in the saliva and in the epithelial cells stimulates peri-implant epithelial proliferation, thereby triggering the formation of the peri-implant junctional epithelium. The peri-implant junctional epithelium produces new cell layers and assumes a conformation similar to the junctional epithelium of natural teeth (Fig 5). This new conformation of the peri-implant junctional epithelium brings it closer to the osseointegrated surface, increasing the local concentration of EGF and, as a result, accelerating bone resorption and starting saucerization (Fig 5). Two recent papers have reviewed EGF functions and history.^{12,13}

A few weeks or months after the peri-implant junctional epithelium and saucerization are formed they start moving away from each other. A stable biological distance is then established between the implant-integrated cervical bone and the peri-implant junctional epithelium, as occurs with natural teeth. From this stage, saucerization balance and stabilization are in place, allowing the bone on the cervical surface to resume corticalization (Figs 6, 8-11). It is probably due to this stabilization over the years that bone loss resulting from cervical saucerization diminishes its rhythm,^{4,5,11} provided that the conditions of hygiene and periodontal health are close to ideal. This situation has been noted in clinical cases that were followed up for many years after placement of osseointegrated implants (Figs 10 and 11).

The reestablishment of the junctional epithelium in the peri-implant oral mucosa may be due to stimulation by the EGF of the mucous

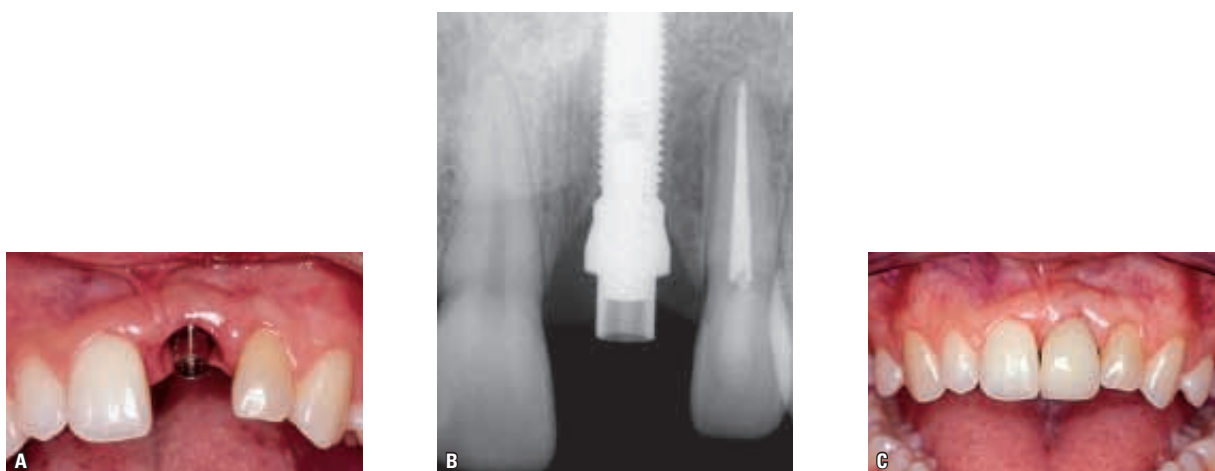


FIGURE 10 - Implant installed in the region of tooth 21 avulsed in an accident. **A** shows the abutment installed over the implant. Periapical radiograph at **B** shows the correct adjustment of the abutment on the implant; the height and shape of the bone tissue around the implant are highlighted. **C**) Prosthetic crown cemented over the abutment.

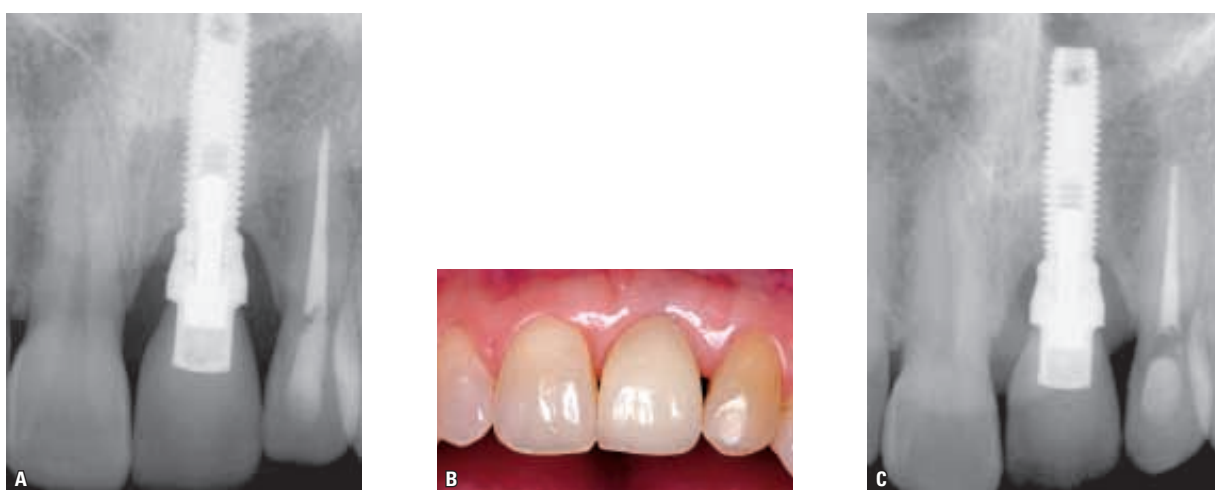


FIGURE 11 - Same clinical case as in the previous figure. **A** is a five-year control periapical radiograph showing pericervical saucerization and corticalization of peri-implant bone tissue. **B** shows 15 years of clinical control: Note normality and stability of peri-implant gingival tissue. **C** shows a 15-year control periapical radiograph: Note the stability of the bone around the implant and increased corticalization.

epithelium itself through what is known as the autocrine effect. Although it probably takes place throughout the mucosa, it is particularly active in ulcerated areas where this autocrine effect is compounded by salivary EGF. As a result, a considerable increase occurs in cell layers to the extent that the peri-implant junctional epithelium is formed. Once the

epithelium-implant integration occurs, salivary EGF penetration ceases or is drastically reduced and the process of cell-renewal epithelial proliferation goes back to normal.

The thickness of the gingival tissue appears to have a considerable effect on alveolar crest bone loss. When this thickness is 2 mm or smaller, the cervical bone loss tends to be significantly greater.²¹

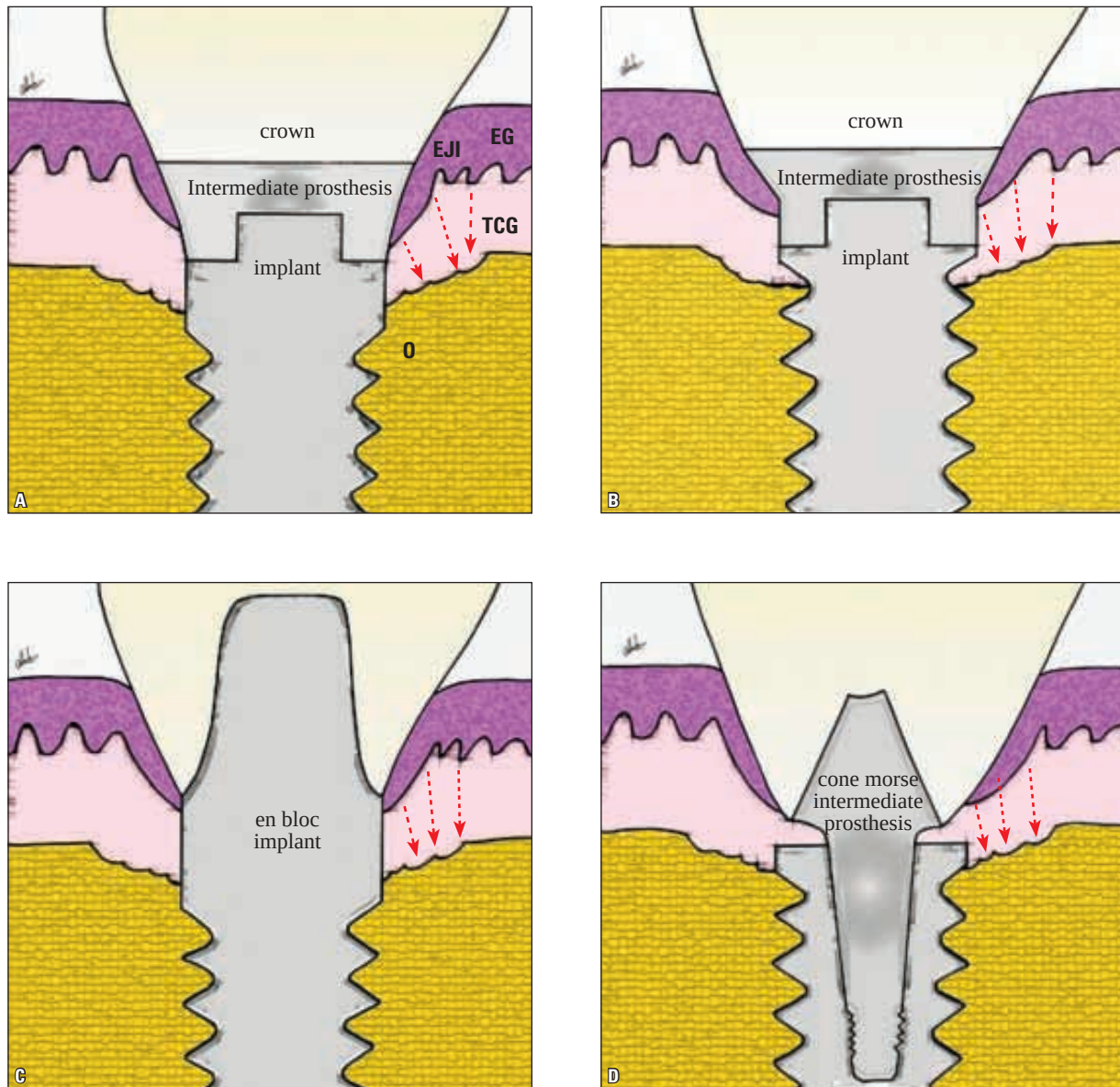


FIGURE 12 - Saucerization invariably occurs in all types of osseointegrated implants. The epithelial tissue has essentially a lining function and it is not very selective as to what it chooses to line. The epithelium will line even root surfaces which, although scraped, still manage to keep LPS (lipopolysaccharide) in its structure. LPS molecules are excessively toxic to our cells, but that does not stop the long junctional epithelium from forming, which is very important for maintaining clinical normality.

These results could probably be explained in light of the EGF. The thickness of the gingival tissue at the time of implant placement is commensurate with the distance from the implant junctional epithelium to be formed relative to bone tissue, i.e., EGF molecules rise to the bone surface in lower concentration.

Saucerization timing and orthodontic treatment

In natural teeth, the union of the junctional epithelium to the cervical enamel and surface is performed by means of several kinds of union structures, which effect an efficient sealing for salivary EGF (Figs 1, 2 and 3) in the peri-implant

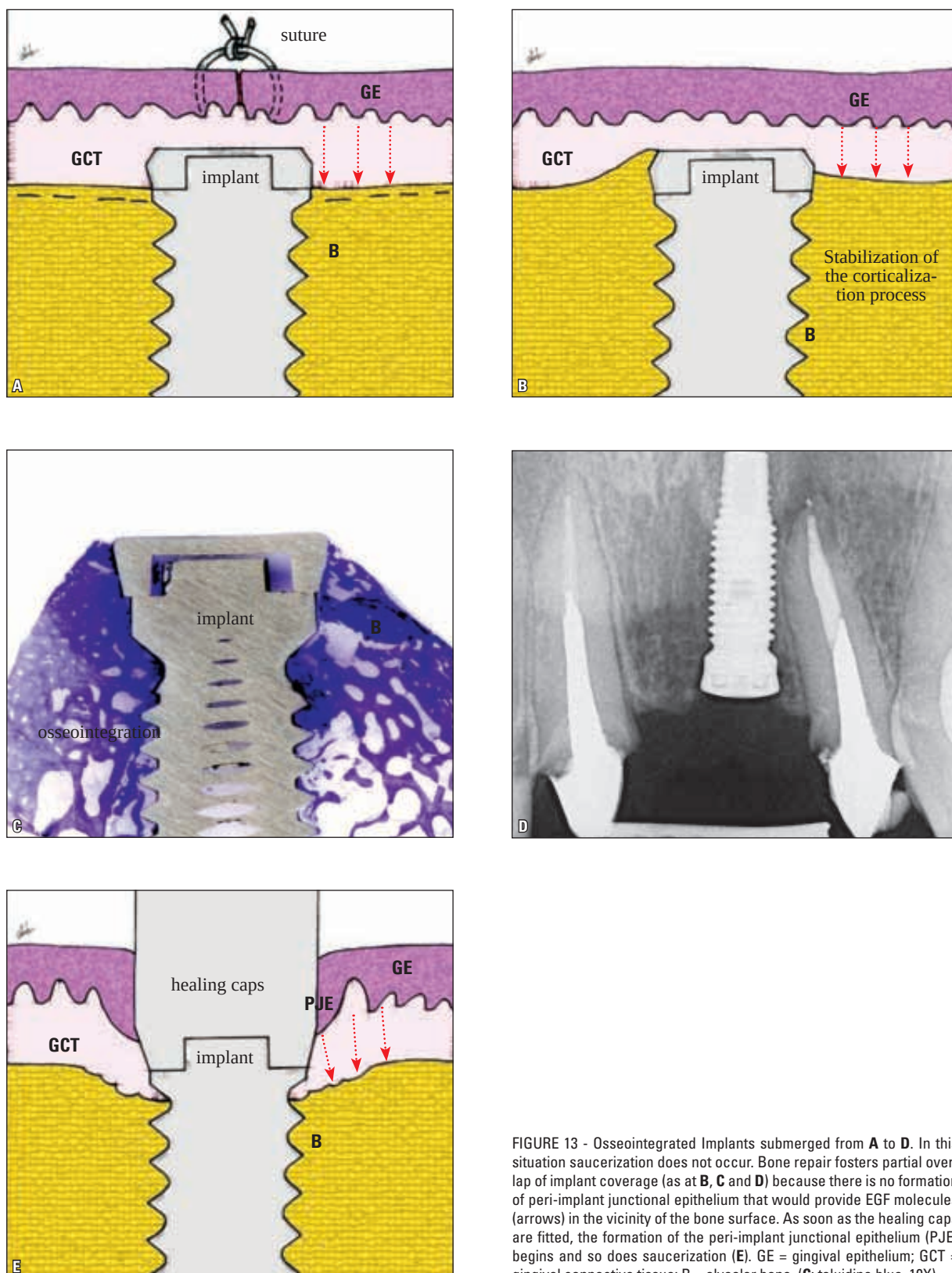


FIGURE 13 - Osseointegrated Implants submerged from **A** to **D**. In this situation saucerization does not occur. Bone repair fosters partial overlap of implant coverage (as at **B**, **C** and **D**) because there is no formation of peri-implant junctional epithelium that would provide EGF molecules (arrows) in the vicinity of the bone surface. As soon as the healing caps are fitted, the formation of the peri-implant junctional epithelium (PJE) begins and so does saucerization (**E**). GE = gingival epithelium; GCT = gingival connective tissue; B = alveolar bone. (**C**: toluidine blue, 10X).



FIGURE 14 - Implant installed in the region of tooth 12. The periapical radiograph **(A)** shows the proximity of the roots of teeth 11 and 13 due to the missing lateral incisor, which renders implant placement impossible; **B** shows the fixed orthodontic appliance for separation of the roots and crowns of teeth 11 and 13, thereby creating adequate space, suitable for implant installation in the region of tooth 12.



FIGURE 15 - The same clinical case of the previous figure with abutment mounted on the implant **(A)**. Periapical radiograph **(B)** showing adequate interradicular space between 11 and 13, which allowed the installation of the implant in the correct position. **C** shows the prosthetic crown cemented onto the abutment.

junctional epithelium. This sealing, however—provided by the epithelium-implant junction—is less efficient and supposedly allows a constant salivary EGF input which, in conjunction with the EGF of the junctional epithelium and mucosa, sets in motion a process of slow and steady approach to the cervical bone (Figs 1, 4, 5, 6, 9).

After an osseointegrated implant has been placed, peri-implant saucerization can normally be expected to occur, regardless of implant type (Figs 14 and 15). So what is the average distance that should be maintained by orthodontists between the cervical regions of neighboring natural teeth—when using osseointegrated implants—so that the cervical bone level of these implants is not affected by neighboring saucerization?

This concern may be even greater in upper anterior teeth such as, for example, lateral incisor implants (Figs 10, 11, 14, 15) in cases of partial unilateral or bilateral anodontia. Or, again, in cases of incisors and canines lost by accidental injury. The aesthetic and functional implications of the gingiva should be considered in planning and installing implants, such as the shape and size of the papillae, as well as the maintenance of a harmonious smile line.

Can saucerization, eventually, adversely affect the cervical hard and soft tissues of teeth located in the neighborhood of implants in patients treated orthodontically and whose teeth were harmoniously aligned with the implants? What special orthodontic care would be required to avoid or reduce the undesirable long-term consequences of osseointegrated implant saucerization occurring in the neighborhood of natural teeth?

The more we succeed in clarifying the phe-

nomena related to cell and tissue saucerization, the more we will be able to learn about the care, and the aesthetic and functional nuances involved. Additional refinement and details concerning the evolution of the operative and restorative procedures of dentistry as a whole come to light every day, dissolving boundaries or obstacles between the most diverse specialties.

Final considerations

Orthodontists should increasingly familiarize themselves with the jargon of other clinical specialties, including implantology, as well as their concepts and more specific issues. This need stems from increased transdisciplinary actions undertaken by professionals in the joint planning of clinical cases involving multiple specialties, and whose ultimate goal is to rehabilitate the patient's mouth.

Bone saucerization around osseointegrated implants is one such concept that forms a specific part of the implantology jargon. Orthodontists should consider the occurrence of this peri-implant bone phenomenon while simultaneously placing osseointegrated implants and moving the other teeth, realigning or relocating them harmoniously, many a time with such proximity to the cervical region that the condition should be carefully evaluated for its risks and aesthetic and functional benefits.

Further research is probably needed to answer the following question: Given the occurrence of saucerization, what are the special needs and care required by teeth located in the neighborhood of osseointegrated implants when moving teeth and finishing orthodontic cases?

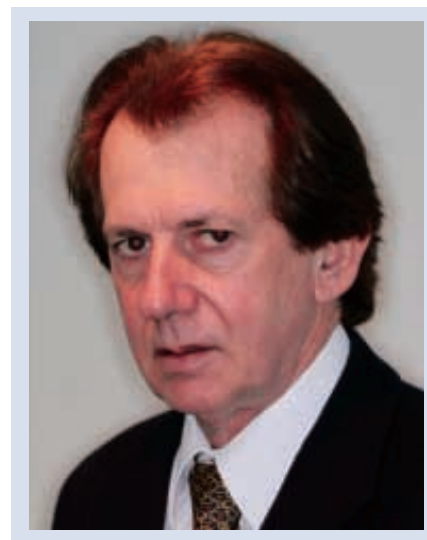
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An interview with Ademir Roberto Brunetto

- DDS, Federal University of Paraná State (UFPR), 1976.
- Postgraduate Orthodontics and Dentofacial Orthopedics, University of California, Los Angeles, USA, 1984.
- Scientific Advisor, Dental Press Journal of Orthodontics.
- Renowned Lecturer in Brazil and abroad.
- Diplomate, Brazilian Board of Orthodontics and Dentofacial Orthopedics (BBO), 2004.
- Director, Brazilian Board of Orthodontics and Facial Orthopedics (BBO).



It gives me great satisfaction and pride to conduct this interview with Prof. Dr. Ademir Brunetto, a prominent professional in today's Brazilian orthodontic scenery. This longtime friend, we forged our friendship when we sat side by side at the 1st diplomate examination of the Brazilian Board of Orthodontics and Dentofacial Orthopedics (BBO), when at the same time, we were Board candidates. A diplomate since 2004, he was later invited to join the BBO Board, which set the stage for our frequent encounters. I have since learned to increasingly admire his in-depth scientific knowledge—especially in the area of Orthodontics and Facial Orthopedics—, his ethical conduct, his composure and common sense in addressing all issues, regardless of their complexity and, last but not least, his contagious joy. Born in Concórdia, at the west end of Santa Catarina State, in southern Brazil, where he spent his childhood and adolescence, he soon moved to Curitiba where he studied Dentistry at the Federal University of Paraná, graduating in 1976. As a Dentistry undergraduate, he worked as a trainee in a number of orthodontic clinics and after graduation applied for the position of assistant professor at UFPR. Since his approval in 1981 he has taught orthodontics at UFPR. Dr. Brunetto attended his postgraduate program in orthodontics at the University of California, Los Angeles, USA (UCLA) where he was awarded the title of Master in Orthodontics in 1984. He is currently in private practice in Curitiba, Paraná State, where he seeks to apply and disseminate his extensive knowledge. Outside his professional activities, he is a very dedicated family man and an accomplished fisherman with a predilection for ocean fishing. In his replies to the interviewers, he has shown substantial knowledge of current state-of-the-art issues such as Class III correction, application of new imaging techniques using cone beam tomography, absolute anchorage and orthodontic preparation for orthognathic surgery. I am certain that our valued readers will enjoy this interview.

Deocleciano da Silva Carvalho

Regarding the early treatment of Class III, what is the state-of-the-art in terms of interceptive procedures and what protocol do you adopt, specifically in maxillary reverse pull headgear cases? What type of retainer do you use after maxillary reverse traction?

Márcio Sobral and Luís Antonio Aidar

I first started working with palatal expansion associated with protraction in 1982, as a UCLA resident. The then Head of the Department of Orthodontics, Dr. Patrick K. Turley, had just begun his work with Class III patients. Those two residence years were rather fruitful and, although fraught with doubts, also brought many surprises and knowledge. When I returned to Brazil in 1984, I continued within the same line of work, making slight changes to the expander design. A few years later, I started to use prefabricated masks, which greatly expedited my work.

My protocol begins with $\frac{1}{4}$ turn expansion per day for initial suture release.²⁴ My intent is

always to control so as not to overexpand the maxilla to prevent excessive crossbite (Brodie) because during anterior maxillary traction we are moving from a wider, posterior mandibular region and as we displace the maxilla forward and downward, we have a narrower mandible. After the expansion, I start using the face mask for at least 14 hours a day. I start with a force of 250 to 300 g/side and eventually increase it to 500 g/side.

The treatment time is approximately one year²⁴ and the goal is to turn the patient into a Class II (overcorrection). When this period is over, the expansion appliance and the face mask are removed and the patient starts being monitored every 6 months. A new traction might be necessary depending on the patient's growth pattern. The actual orthodontic treatment starts only when cervical vertebrae⁷ maturation evolves from phase 5 (maturity) to phase 6, when adolescent growth is fully established.

I don't believe the use of a retainer after reverse traction is necessary. As we can see in follow-up lateral radiographs, "point A" remains positioned exactly where it was pulled, with no relapse¹⁰ (Table 1 and Fig 1). The problem is that the maxilla grows slower than the mandible,¹⁶ which sometimes leads to the need for traction to be once again performed.

TABLE 1 - Cephalometric measurements.

MEASUREMENTS	STANDARD	A	A1	A2
SNA (Steiner)	82°	82°	85°	85°
SNB (Steiner)	80°	82°	82°	83.5°
ANB (Steiner)	2°	0	+3°	+1.5°



FIGURE 1 - Initial (A) and intermediate lateral radiographs (B and C).

The use of chin cups, although an old-time orthodontic resource, is still advocated by some professionals, mostly from the Japanese school. What is your experience and opinion on the use of chin cups in mandibular skeletal Class III cases, especially when patients display a marked vertical growth?

Deocleciano da Silva Carvalho and Mirian Nakane Matsumoto

When I started pursuing the orthodontic path, there was great concern with Class III patients. We used to keep our fingers crossed that these cases would never show up at our offices. Preferably, these patients should seek a professional we weren't so keen on. There is no telling how often professionals have been baffled to realize—during or after orthodontic treatment—that their patient has developed a skeletal Class III.

In fact, our knowledge of long-term maxillary and mandibular development was scarce. What we really did was a camouflage, compensating for an unbalanced basal bone with tipping. Orthognathic surgery was in its infancy

and in these cases surgeries were performed for mandibular reduction (maxillary surgeries were just beginning). Therefore, in Class III cases, even if due to maxillary deficiency, we had to deal with a bi-retrusion issue, which caused severe aesthetic and functional problems for these patients. Attempts to use chin cups were thwarted because patients only used them for a short time—and even that took a great deal of convincing. The literature tells us that any changes achieved by the use of chin cups are not sustained in the long term.^{19,23}

Fortunately, the number of Class III patients in our population is relatively low, around 3.3 to 4.4%,² and the vast majority's problems involve the maxilla.¹ Therefore, the number of Class III patients who require orthognathic surgery is negligible (Fig 2). Among patients indicated for surgery there are those with a vertical growth pattern, like patients with severe Class II (Fig 3) and Class I with vertical excess (long face syndrome) (Fig 4).

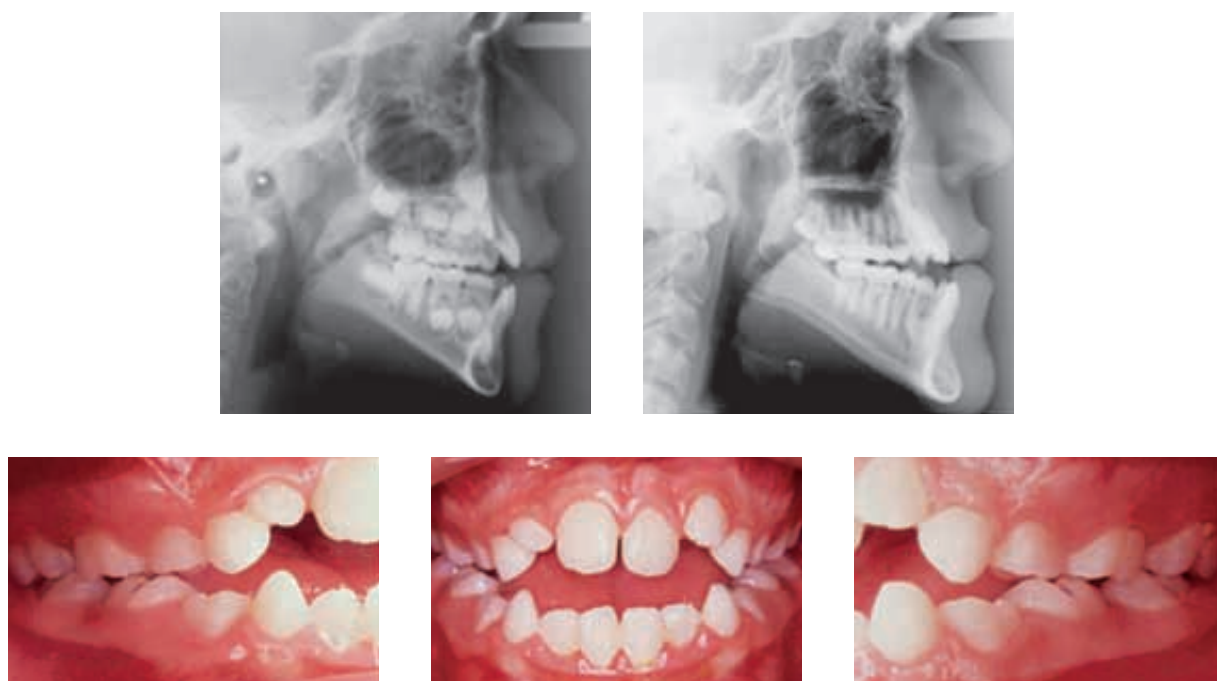


FIGURE 2 - Initial and growth control lateral radiographs; and initial intraoral photographs of a patient with Class III surgical indication.

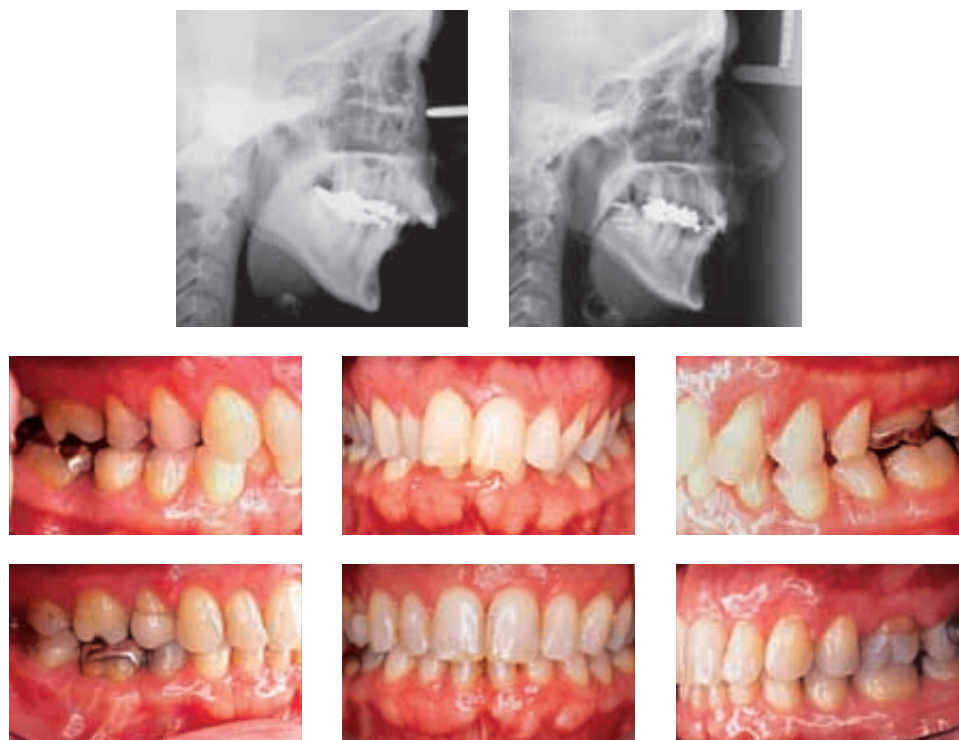


FIGURE 3 - Initial and final lateral radiographs and intraoral photographs - Class II patient with tooth extractions (15, 25, 34, 44) and surgical advancement of the mandible.



FIGURE 4 - Initial and final lateral radiographs and intraoral photographs of a Class I patient with combined surgery (maxillary impaction and mandibular advancement).

In the orthodontic treatment of Class III malocclusion in adult patients with surgical indication, the pre-surgical phase tends to “worsen” patients’ aesthetics and occlusion in order to align the teeth, coordinate the arches and restore the correct axial inclination of the teeth in their supporting bone. What is your opinion about using the Anticipated Benefit Method (ABM) in surgical treatment? Mirian Nakane Matsumoto and Márcio Sobral

With the protocol I used, the number of Class III surgical patients decreased significantly, except for patients with vertical growth pattern and adult patients who would come to me when it was already too late (Fig 5). I have never tried surgical treatment with ABM. In my opinion it can and should be used in specific cases, provided that the patient be informed that it is not the conventional procedure used in these cases and that it will entail an extra financial cost due to the placement of titanium plates

for post-surgical orthodontic movement, in addition to the future need for removing these same plates.

In my view, the main difference between the two techniques is that conventional procedure, after dental decompensation, provides better post-surgical occlusal stability in the short term since the dental arches are perfectly aligned and coordinated. ABM, on the other hand, is likely to develop occlusal instability, hindering the stability of the fragments that remain from the recently performed surgery. This could pose future problems involving the movement of fragments. This shortcoming should be carefully assessed in the new technique. It is true, though, that patient comfort is greatly enhanced, firstly because they don’t have to go through that awkward, unsightly pre-surgical phase and secondly due to a shortened treatment time. I believe it is a promising technique but it still requires further study and improvement before it is properly evaluated.

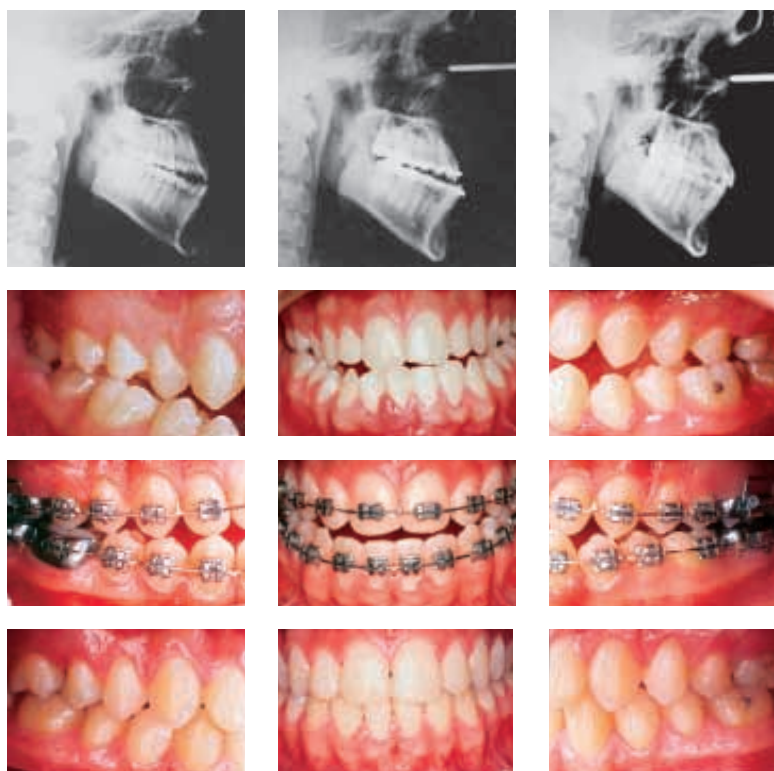


FIGURE 5 - Initial, preoperative and final phases of a Class III surgical patient.

Orthodontic planning using cone beam tomography and highly sophisticated, quality software is an undeniable reality in today's Dentistry. Do you believe that this diagnostic resource is on its way to becoming a routine in orthodontic practice? Luís Antonio Aida

In the U.S. this routine is already in place, both in clinics and in orthodontics, and oral and maxillofacial surgery programs. In Brazil, I have been keeping track of this technology's expansion and I can tell you that it has advanced dramatically. At conferences, I have noticed that the booths selling this software tend to be always crowded. Numerous professionals are purchasing and disseminating this technology in their hometowns. Years ago, I was among the first to try my hand at this software. After many years' experience and after an initial period of adjustment inherent in any major technological change, I can say that it has done much to raise the level of orthodontics as it is practiced in Brazil today. Cost still stands as the major limiting factor in our country. But I think it's an investment that has become increasingly vital to any professional who wishes to avoid obsolescence. Besides, a few years ago the number of radiological clinics that made cone-beam CT scanning available to orthodontists was extremely small. But fortunately, I see this trend changing, with clinics increasingly acquiring these devices and offering this technology, thereby making it more affordable to patients.

Now if you ask me whether it is feasible for a Brazilian orthodontist to purchase a scanner for their "own" use, like Americans are used to doing, the answer is no (due to acquisition, maintenance and infrastructure costs). Therefore, there is no way we can turn our backs on this technology since, above and beyond the many benefits it already offers, it is poised to play an

unprecedented role in the history of orthodontics. If we want Brazilian orthodontics to develop, however, the best possible initiative would be to provide this software in specialization and masters programs. Even more so than in private clinics, for it would go a long way towards leveraging our already outstanding, worldwide recognized scientific production.

How do you see the gradual replacement of conventional X-rays used in orthodontic diagnosis by cone beam computed tomography, and what tangible clinical benefits can orthodontists derive from this technological innovation? Is conventional cephalometry doomed to fall into disuse in the short term? Márcio Sobral and Deocleciano da Silva Carvalho

Recent scientific studies have shown that the location of anatomical landmarks on the images obtained through cone beam computed tomography is much more accurate^{11,14,20} and, therefore, better than those obtained from conventional cephalometric images. The actual benefit accrued from CBCT is a more reliable cephalometry, with reduced measurement error, be it due to image distortion (CT is 1:1) (Fig 6) or to a difficulty in locating anatomical landmarks (CT features better contrast and filters that help more easily identify the landmarks, in both hard and soft tissue) (Fig 7).

Even the growing number of studies in the literature demonstrate the superiority and accuracy of cephalometric radiographs obtained with cone beam CT compared to conventional radiographs. I do not believe that this transition will be so rapid, though. Mainly because the former requires more resources to do the tracing (software and hardware), while the latter does not (a pencil and some tracing paper suffice).



FIGURE 6 - Images of the same patient (A = conventional radiograph and B = radiograph taken from CT) on the same date, showing differences in quality and sharpness between the two images.



FIGURE 7 - Software-generated maximum intensification filter.

What are, in your experience, the major indications for cone beam computed tomography in orthodontics? In cases of impacted teeth, are CT scans the only means of diagnosis to establish an orthodontic treatment strategy?

Mirian Nakane Matsumoto

This is a somewhat controversial issue. Some authors recommend CT only in specific cases such as impacted teeth or facial asymmetry cases. After talking to some highly experienced professionals, however, I have come to realize that the trend is to indicate CT for all patients. The reason is simple: cost-effectiveness (not financial, but radioactive cost-effectiveness). Benefits are so significant in terms of diagnostic tomography, especially with respect to the accuracy of cephalometric measurements, that a slightly increased radiation—compared to conventional documentation—is fully justified. Furthermore, with the evolution of CT scanners that radiation tends to decrease more and more. With the new generation of CT scanners featuring extended field of view (eFOV, a must for orthodontists), we can acquire a nearly complete

patient skull in one single scan. To say nothing of the fact that, if the patient were to suffer an accident with severe trauma to the face, we would have on file a data set that faithfully reproduces all of the patient's hard and soft tissue in the face and head, in case a surgical reconstruction is required. And, just as important, we can detect—with greater ease and accuracy—a tumor or lesion that might go unnoticed in conventional panoramic radiography.

I can't say that tomography is the only diagnostic resource available for cases of impacted teeth. What I can say, however, and with absolute confidence, is that it substantially facilitates both diagnosis and treatment plan, especially in cases of impacted canines (Fig 8). I take this opportunity to mention and recommend an article by Bjerklin and Ericson,³ in which they describes how they drew up a treatment plan for 80 patients using conventional documentation. They then prepares new documentation with CT scans and draws up a new treatment plan. They reports that the plans had to be changed in almost 50% of the cases. That is a significant percentage.

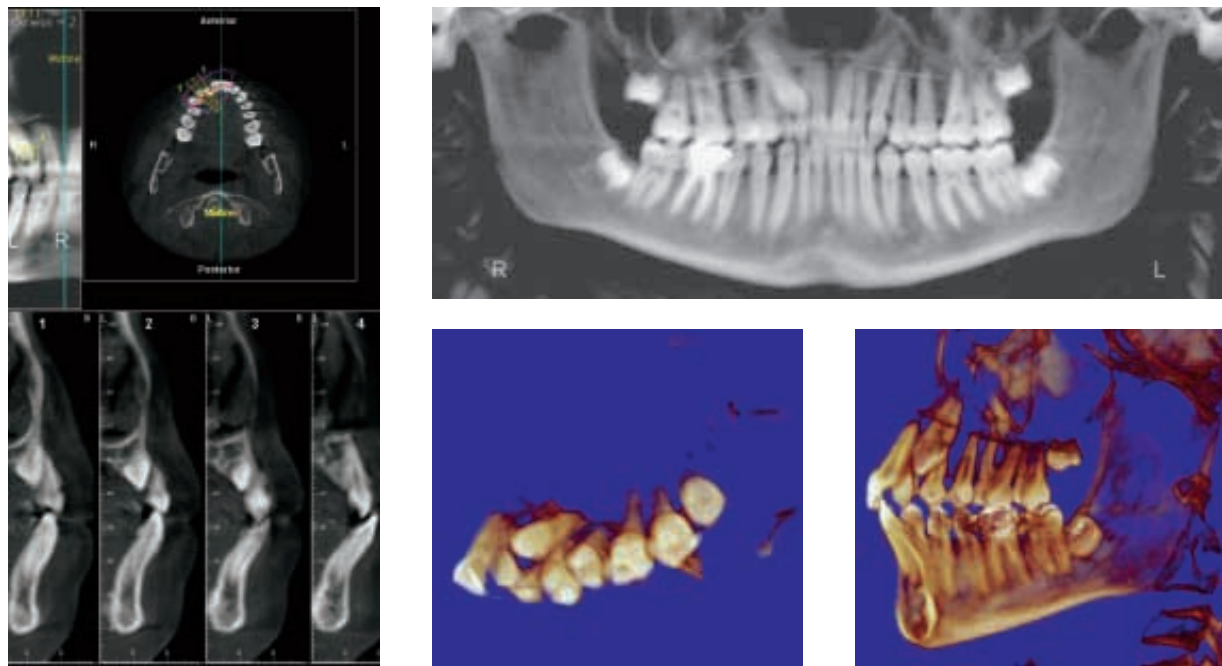


FIGURE 8 - Cone beam tomographic images.

Have you ever made orthodontic preparation of patients for orthognathic surgery (maxilomandibular advancement) in patients with severe obstructive sleep apnea, regardless of craniofacial alterations? Luís Antonio Aidar

Until recently, our concern with surgical orthodontic patients was confined to achieving aesthetic and functional results without taking into account their breathing condition. Currently, three factors are required to ensure adequate treatment outcome. With the advent of cone beam CT and advances in evaluation software, we are in a comfortable position to assess pre- and post-treatment conditions and can now determine the volume of air (in mm³) that is moved through a patient's airway. Moreover, with this type of evaluation we

have noticed very encouraging results in patients with respiratory failure who underwent surgery for maxillary advancement (Fig 9).

The problem is that we can have patients with skeletally well-positioned maxilla and mandible, a condition that contra-indicates any surgical increase in the basal bone.¹⁵ In such cases we try to address the issue in different manners (e.g., CPAP or mandibular repositioners) because we can create severe functional (especially in TMJ's) and aesthetic problems to the patient by protruding the maxillas excessively.¹⁵ Finally, we can never forget that obstructive sleep apnea (OSA) syndrome requires a multidisciplinary approach and, given its severity, we should not try to solve the problem *per se*.

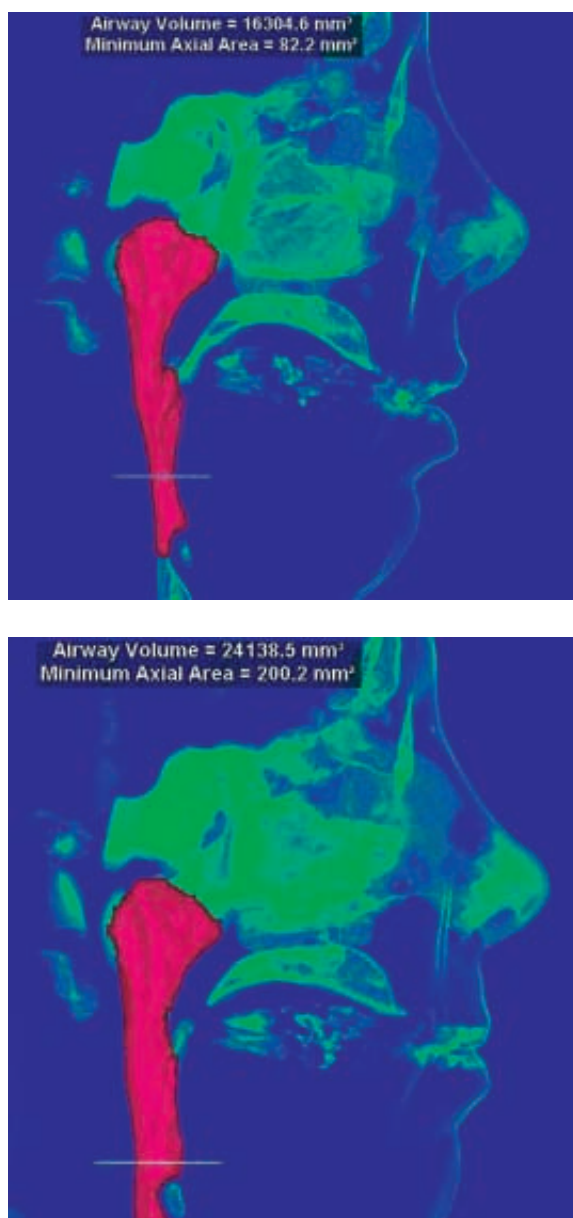


FIGURE 9 - Air volume before and after orthognathic surgery combining maxillary and mandibular advancement.

In cases of "en-masse extrusion" of upper posterior teeth, what are your criteria for choosing between intrusion orthodontic procedures and surgical procedures? Luciano Castellucci

The emergence of micro-implants and mini titanium plates considerably improved the predictability of orthodontic movements in muti-

lated patients (by reducing the number of indications for this type of surgery).

In most cases I use buccal devices (mini-plates or micro-implants) and palatal micro-implants for en-masse intrusion of posterior teeth and apply closed Nitinol springs or silk threads as elements of force.

Surgical procedures are reserved for patients with a severe vertical pattern, those with vertical maxillary excess and who would benefit from maxillary impaction surgery.

How would you advise orthodontists to deal with orthognathic surgeons during the planning of cases that require this type of therapy as well as during treatment development? What is your view on the fact that, under certain circumstances, a surgeon's mistake or inaccuracy can result in a failure for which the orthodontist might eventually take the blame? Deocleciano da Silva Carvalho

We often see patients being referred to surgeons by orthodontists to assess whether or not it is a surgery case. Actually, it should be the other way around. It is up to the orthodontist to determine the limitations of orthodontic movement. He is the one doing all the planning while the surgeon performs only one treatment phase. The orthodontist is responsible for finishing the case. Therefore, knowing who and how skillful your surgeon is, can prove vital. I usually establish the following protocol for surgical cases:

- a) First appointment and request for additional documentation.
- b) Develop diagnosis and give patient an idea of costs.
- c) Referral to surgeon for further explanation of the surgery, risks, and an idea of future costs.
- d) Patient returns to the office for further briefing on the surgical procedure. Make it perfectly clear to the patient that there

is no looking back, that is, once treatment gets started, if he or she decides not to undergo surgery, the case will likely become worse than when he or she started treatment (treatment can only begin with a committed patient, fully aware of his or her responsibility).

- e) Once the case is on track, the teeth have been uprighted on the basal bone and dental arches have been coordinated, send the patient back to the surgeon for a general pre-surgical assessment.
- f) Request new documentation and plan the surgery with the surgeon to optimize the final aesthetic and functional results. This step is very important because this is where orthodontist and surgeon must see eye to eye to ensure that results are according to plan while minimizing any future problems for those involved in the treatment (orthodontist, surgeon and patient).
- g) Placement of surgical hooks by orthodontist within the week surgery was scheduled for. Usually 1 week to 10 days after surgery the patient starts coming to the office on a regular basis for monitoring elastic use, which allows better control and stabilization of surgical fragments.
- h) Orthodontic treatment is finished.

Surely, if we follow those steps carefully, errors can be minimized and any minor discrepancies that may arise can now be corrected with the use of micro-implants to finish the case in the best possible way.

In your practice, in cases where you need to use as anchorage an implant, with a provisional crown, do you usually wait for the osseointegration period of the implant or do you go for immediate loading? Luciano Castellucci

A success rate ranging between 92% and

99% has been reported in the literature—for the maxilla and the mandible, respectively—by studies of short and long term support of fixed partial dentures. These findings have led orthodontists to use these implants as orthodontic anchorage. Because of their behavior, which resembles an ankylosis, dental implants work as an ideal anchor point for orthodontic accessories, facilitating tooth movement and avoiding the use of headgear.

A prospective study investigated seven adults who used implants as rigid anchorage. After 6 months of osseointegration, all fourteen implants remained stable during treatment, withstanding forces of 150 to 400g. There were no complications. The desired orthodontic results were achieved in all cases. A three-year follow-up has shown that rigid intraoral anchorages are predictable.⁹

The horizontal impact of orthodontic forces on dental implants has been examined in several animal studies, showing no interference with osseointegration. In particular, only small changes can be noted in marginal bone level, pocket depth, bone-implant contact and increased bone density.^{6,18}

The literature describes the application of orthodontic force to implants after a 6-month period of osseointegration. Two years after orthodontic treatment, the study found a survival rate of 87.1% in the maxilla and 100% in the mandible. No significant bone loss was observed during orthodontic treatment.²¹

Scientific studies conducted in animals and humans using implants for orthodontic anchorage suggest, in general, the existence of a healing period ranging from 12 weeks to 6 months for osseointegration to occur, thus allowing their use for orthodontic anchorage.

One of the goals of implant therapy is to reduce the healing time and treatment period of clinical cases through the development of implant macro-geometry, besides physical and

chemical surface treatment. The former increases initial stability and the latter accelerates osseointegration. Efforts have been made to develop protocols for putting the implant in function within a 45-day period.

A 5-year prospective study assessed the early loading of 104 SLA-treated implants (sand-blasting and acid etching) in 51 patients. The study showed a 99% success rate in the application of orthodontic force to implants after a period of six weeks of osseointegration. Clinical parameters were similar to other clinical studies and bone crest peri-implant stability was maintained.⁴ The chemical activation of the implant surface reduced temporary appliance installation time from 6 to 3 weeks.⁵

Ideally, before starting orthodontic anchorage with implants, you should consider the type of implant to be used. You should evaluate if the implant has some feature in its geometry and surface that can accelerate osseointegration. It is also advisable to check the placement site, if it is in the maxilla or mandible,

and note the different bone densities because if an implant is installed in low density bone it requires a longer osseointegration period than one installed in high density bone. Finally, you should observe the insertion torque and initial implant stability to determine when to activate the implant-supported anchorage.

Ordinarily, I use implants as orthodontic anchorage with two goals in mind:

1) For orthodontic anchorage.

2) To use the same implant for future oral rehabilitation.

We now know that if we apply forces to implants through immediate loading we run the risk of encountering future problems, such as implant tipping, bone loss or even implant loss, which would render our 2nd goal impossible.⁸

Figure 10 illustrates the use of implants for mesial repositioning of the left lower segment and subsequent rehabilitation of the first molar (36) in a Class II malocclusion patient, on the left side, caused by missing molars in the lower left segment.



FIGURE 10 - Use of dual-purpose osseointegrated implants (mesialization of the left lower segment to correct canine Class II and prosthetic rehabilitation of the first molar).

In cases of agenesis of upper lateral incisors, when do you distalize canines to place an implant in edentulous regions and when do you mesialize canines to close spaces? Luciano Castellucci

The answer to this question depends on an individualized assessment of each case. Several factors have a bearing on the decision: The age of the patient seeking treatment, whether it's a teenager or an adult, the need for extractions in the lower arch, the patient's aesthetic requirements. You should have a very honest, up-front chat with the patient and/or his/her legal guardians to discuss the cost-effectiveness of the different alternatives, their advantages and disadvantages in the short and long term.

Let's try to shed a little more light on the issue: Let's say it's an adolescent or adult patient who presents with agenesis of a lateral incisor and a skeletal and dental Class I. We will try to convince him or her that the best treatment option is the placement of an implant in the missing side to restore symmetry, while explaining the potential future risks, such as discolored gingiva in the implant region or even height differences due to the extrusion of the remaining teeth, especially when gingival exposure is an issue.

In the case of agenesis of lateral incisors given the same skeletal and dental condition, we have to better assess the cost-benefit analysis. In this case, we might also have to convince him or her to have an implant installed, explaining all future risks, as mentioned above.

Should any tooth extractions be required and two upper agenesis be present, we would probably opt for upper space closure and replacement of laterals with canines, and canines with first premolars. In these cases, I always perform canine extrusion and first premolar intrusion to try and improve the condition of the gingival margins in relation to the upper central incisors.¹²

As for aesthetics, we know that the sine qua non condition for a successful implant outcome is adequate bone condition,¹⁷ which should be in place before implant installation along with prior orthodontic movements or bone grafts whenever necessary.

The truth of the matter is that dental implants had their aesthetic quality greatly improved in the late 90's, so we are talking about nearly 10-years' experience, which is too short a time period for any conclusive statements. As we speak, I am in the process of putting together a list of my patients who had implants placed to replace the lateral incisors. After I have carried out a thorough evaluation of these cases I will be better equipped to answer this question.

Finally, the advent of skeletal anchorage has certainly put us in a more comfortable position to benefit patients both in the opening and closing of spaces. The Figure 11 describes a case of a patient with molar Class I and canine Class II on the right side with agenesis (12) and microdontic (22), increased clinical crown (22) and space opened for implant placement (12).



FIGURE 11 - Opening of denture space for implant (12) and clinical crown increase (22).

We constantly hear that self-ligating brackets are the future of orthodontics. What are your views on the current scientific rationale of these appliances and your personal experience with this subject? Deocleciano da Silva Carvalho

I have always been against placing too much emphasis on the role of orthodontic appliances. In my opinion there is no such thing as a smart appliance. It's the mind behind the pliers that needs to be smart. We witnessed a parade of fad techniques before the emergence of self-ligating brackets. There was the promise of lightning fast results and cases would purportedly finish of their own accord. But this is not what the literature has shown lately. In cases of minor crowding results have been faster. But in cases of severe crowding almost no statistical differences have been found.²²

Allow me to comment on our cases treated with self-ligating brackets:

a) The biggest advantage is for patients who live far away in distant cities, who can only come to the office at longer time intervals (up to 6 weeks) and whose treatment is making good headway thanks to heat-activated archwires.

b) In patients with missing teeth requiring increased sliding mechanics the response is indeed faster (due to reduced friction between bracket and archwire).¹³

c) I have also noticed a quicker response when sliding-jigs are used, especially in asymmetric Class II cases (Fig 12).

d) Hygiene is improved thanks to the absence of elastic ligatures on the brackets.

e) I had some doubts regarding the response of this appliance in surgical cases. I followed up

on a surgical case hand in hand with a maxillofacial surgeon, who gave the appliance a very positive assessment.

f) Retreatment patients who had previously used a conventional appliance also made a favorable evaluation (less discomfort).

g) My experience shows a gain of approximately 10% in treatment time—though I have

no scientific study to support this claim—especially in cases that require more sliding.

h) I noted a transverse arch development but long-term monitoring is needed to assess stability.

The most critical part is definitely bonding, given the need to reposition brackets during treatment, even if your bonding was perfect.

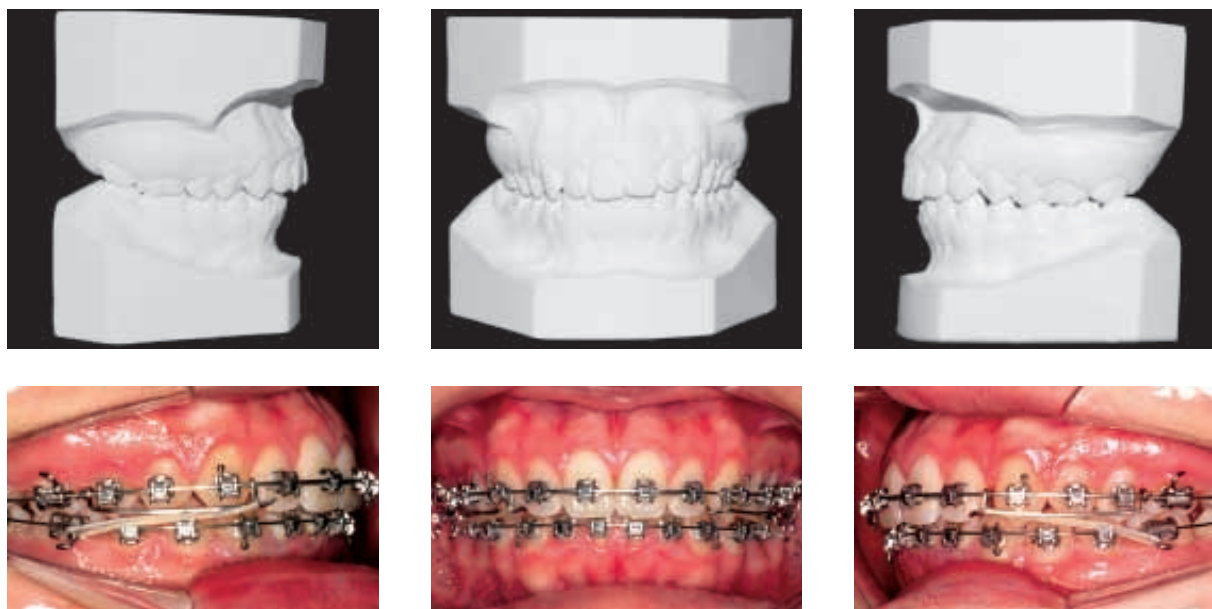


FIGURE 12 - Jig made of 0.021 X 0.025-in SS archwire and intermediate NiTi spring for maximization effect, with medium force 3/16-in intermaxillary Class II elastic.

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Evaluation of the applicability of a North American cephalometric standard to Brazilian patients subjected to orthognathic surgery

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Abstract

Objectives: To study the applicability of a North American cephalometric standard to Brazilian patients subjected to orthognathic surgery by comparing the post-surgical/orthodontic treatment cephalometric tracings of 29 patients who had undergone surgery of the maxilla and mandible with the cephalometric standard used as guidance in planning the cases. **Methods:** The tracings were generated by the Dolphin Imaging 9.0 computer program from scanned lateral cephalograms in which 48 dental, osseous and tegumentary landmarks were defined. Thus, were obtained 26 linear and angular cephalometric measurements to be compared with normative values, considering sexual dimorphism and possible modifications to the treatment plan to meet the individual needs of each case, as well as any possible ethnic and racial differences. The sample data were compared with the standard using Student's t-test means and standard deviations. **Results:** The results showed that for males, the sample means were significantly different from the standard in five of the measurements, while for women, nine were statistically different. However, despite the similarity of the means of most measurements in both genders, the data showed marked individual variations. **Conclusions:** An analysis of the results suggests that the North American cephalometric standard is applicable as a reference for planning orthodontic-surgical cases of Brazilian patients, provided that consideration is given to variations in the individual needs of each patient.

Keywords: Orthognathic surgery. Facial analysis. Cephalometric standard.

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Editor's summary

Authors from many regions of the world have established cephalometric standards for hard and soft tissue normality for their specific populations with the purpose of orienting treatment plans according to the characteristics of each ethnic-racial group. This study compared the post-treatment cephalometric results of patients who had undergone orthognathic surgery in conformity to the normative values¹ used to inform the treatment plans. The goal was to check whether or not the use of such standard would be feasible for this group of patients.

In both genders, a statistically significant difference was found for overbite, exposure of upper central incisor and lower lip thickness. In these cases, the sample data values were smaller than the standard. In men, two other measurements differed from the standard, i.e., the angle formed by the lower central incisor and the mandibular occlusal plane, and the horizontal distance between points A' and B' (anteroposterior maxillomandibular relationship of the soft tissues). In these cases, sample patient values were significantly higher than the standard. Moreover, for women, there were differences in the angle formed by the upper central incisor and maxillary occlusal plane and the interlabial space (which were smaller than the standard), whereas upper lip height, lower lip height, height of lower facial third and total facial height were higher than the standard. It is noteworthy, however, that the standards should be considered as planning, not treatment guidelines, so as to ensure the fulfillment of individual case needs.

Questions to the authors

1) What are the main cephalometric differences between North Americans and Brazilians in terms of normal/acceptable occlusion?

In fact, we found differences in almost all cephalometric landmarks and magnitudes of soft tissue profile, but the most striking finding was that the Americans have longer faces and more protrusive chins.

2) What can explain these differences?

This difference can be attributed to the fact that North Americans are basically Anglo-Saxon and Brazilians, mostly Mediterranean.

3) Were you surprised by these findings?

No, the results did not surprise us because we had already observed that with the measures proposed by Arnett, Brazilian patients tended to show stronger and more protrusive chins.

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Analysis of biodegradation of orthodontic brackets using scanning electron microscopy

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Abstract

Objectives: The purpose of this study was to analyze, with the aid of scanning electron microscopy (SEM), the chemical and structural changes in metal brackets subjected to an in vitro biodegradation process. **Methods:** The sample was divided into three groups according to brackets commercial brand names, i.e., Group A = Dyna-Lock, 3M/Unitek (AISI 303) and Group B = LG standard edgewise, American Orthodontics (AISI 316L). The specimens were simulated orthodontic appliances, which remained immersed in saline solution (0.05%) for a period of 60 days at 37°C under agitation. The changes resulting from exposure of the brackets to the saline solution were investigated by microscopic observation (SEM) and chemical composition analysis (EDX), performed before and after the immersion period (T0 and T5, respectively). **Results:** The results showed, at T5, the formation of products of corrosion on the surface of the brackets, especially in Group A. In addition, there were changes in the composition of the bracket alloy in both groups, whereas in group A there was a reduction in iron and chromium ions, and in Group B a reduction in chromium ions. **Conclusions:** The brackets in Group A were less resistant to in vitro biodegradation, which might be associated with the type of steel used by the manufacturer (AISI 303).

Keywords: Corrosion. Biocompatibility. Orthodontic brackets. Nickel.

Editor's summary

The occurrence of hypersensitivity caused by the nickel present in stainless steel alloys—widely used in orthodontic treatment—has become increasingly common. Orthodontic brackets, bands and archwires are universally made from this alloy, which contains about 6% to 12% nickel and 15% to 22% chromium. Besides allergenicity, carcinogenic, mutagenic and cytotoxic

effects have been attributed to nickel and, to a lesser extent, chromium. One of the factors that determine the biocompatibility of alloys used in dentistry is their resistance to corrosion. However, despite the high resistance of austenitic stainless steel—the major alloy employed in the manufacture of orthodontic brackets—several studies have revealed the corrosion of these brackets. In view of the wide array of factors associated with

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corrosion and the susceptibility of orthodontic brackets to this process, the purpose of this study was to analyze, using scanning electron microscopy (SEM), the chemical and structural changes in two brands of metal brackets subjected to a process of biodegradation in vitro.

Two different brackets were analyzed: Dyna-Lock Standard Edgewise (3M Unitek, Monrovia, CA, USA) and LG Edgewise (American Orthodontics, Sheboygan, Wisconsin, USA), which were divided into 2 experimental groups, according to their commercial brand names. For evaluation by SEM (Philips XL30, Eindhoven, Netherlands) 70 brackets were randomly selected and analyzed in two stages: T0 - analyzed "as received" and T5 - after 60 days immersion in saline. The specimens were immersed in test tubes containing 10 ml of saline solution (NaCl 0.05%, Biochemistry Department, PUCRS) and subjected to a process of chemical-mechanical aging. They remained under

agitation for 8 hours a day at a constant temperature of $36 \pm 1^\circ\text{C}$ (Dubnoff Bath, Nova TécnicaTM) for a period of up to 60 days.

The microscopic analysis (SEM) at T0 indicated that the brackets in Group A had a better surface finish than those of Group B. Alterations were found on the surfaces of the brackets after a 60-day immersion in saline solution (T5). These changes were more evident in Group A. As shown in Figures 2 and 3, differences were found in the composition of the metal alloy used in the brackets before (T0) and after having remained 60 days immersed in saline solution (T5). The brackets in Group A showed a reduction in the amount of iron and chromium ($p < 0.05$) and the brackets in Group B showed a decrease in chromium ions ($p < 0.05$).

It should be underscored that the use of alloys with a lower biodegradation rate would reduce the risk of harm to patient health.

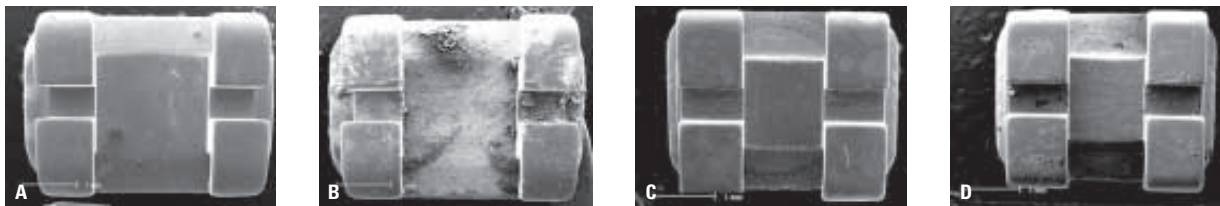


FIGURE 1 - General view (50x) of the brackets in Group A at T0 (A) and T5 (B) and general view (50x) of the brackets in group B at T0 (C) and T5 (D). Products of corrosion can be seen at T5, notably in Group A brackets.

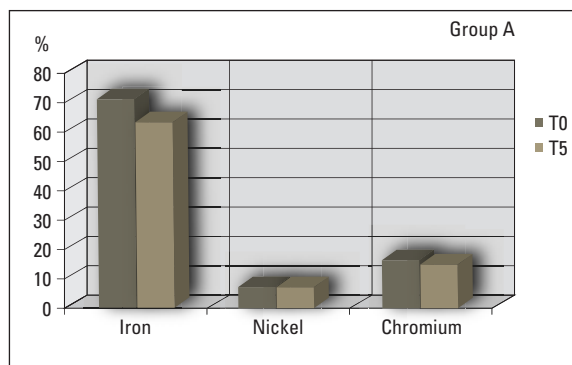


FIGURE 2 - Chemical composition (EDX) of Group A bracket alloy at T0 and T5. There was a reduction in the amount of iron ($p < 0.05$) and chromium ($p < 0.05$) ions.

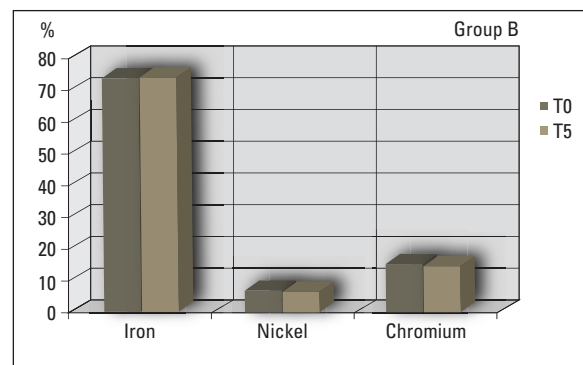


FIGURE 3 - Chemical composition (EDX) of Group B bracket alloy at T0 and T5. There was a reduction in the amount of chromium ($p < 0.05$) ions.

Questions to the authors

1) How did you develop an interest in this subject matter?

Biocompatibility began to arouse our interest because of a patient who showed an allergic reaction to the metal in his cervical headgear. At the time, the patient came to the office reporting urticaria and rash in the neck area. A clinical examination revealed an erythematous area with vesicles in the neck and with injuries on both sides, in the same size and location of the headgear metal parts. The patient's medical history disclosed allergy to non-gold earrings, which caused local inflammation and skin peeling. Thus, contact dermatitis was diagnosed. The treatment consisted in removing the stimulus (replacement of the cervical headgear by a new one with no metal contact with the skin). Fifteen days later, the patient returned with no signs of allergic reaction.¹ Since then we began to study, by means of *in vitro*² and *in vivo*³⁻⁸ studies, the causes and consequences of the organic reactions which can manifest themselves in local or distant regions of the human body. One of the determinants of biocompatibility of metallic alloys in dentistry is the resistance to corrosion.⁶ Corrosion is defined as metal loss or oxidation. In the humid environment of the oral cavity all alloys undergo corrosion, at least to a certain extent.⁹ A number of factors can affect the process of ion release by an alloy: Manufacturing method; bracket surface characteristics; features of the environment in which brackets are inserted, such as composition, temperature, pH, bacterial flora, enzyme activity and the presence of proteins;¹⁰ in addition to factors such as alloy usage (aging), which may be subject to adverse conditions such as stress, heat treatment, recycling or reuse of components, among others.¹¹

2) What can be done to reduce the biodegradation of metal brackets?

First, we should use good quality materials to minimize corrosion effects. The use of re-

cycled brackets should be avoided. This issue was investigated by assessing the patterns of ion release by new brackets and recycled stainless steel brackets. To this end, the brackets were immersed in solutions with different pH values over a period of 48 weeks. The release of nickel, chromium, iron, copper, cobalt and manganese ions was analyzed by atomic absorption spectrophotometry. The results showed that recycled brackets release more ions than new brackets. This study demonstrates that although both new and recycled brackets will suffer corrosion in the oral environment,¹² the cleaning and sterilization procedures involved in the recycling process result in microstructural changes that increase corrosion. We must also consider the possibility of using alternative products, such as nickel-free brackets, ceramic, titanium, polycarbonate or gold plated brackets.

3) Would it be important to evaluate the cytotoxicity of chemical agents released in the corrosion of steel brackets?

Material biocompatibility entails an appropriate response by the host (organism), which, in dentistry, means the non-occurrence of adverse reactions, or the occurrence of tolerable adverse reactions of the organism to the presence of a given material.¹⁴ The occurrence of any adverse reaction is what we call toxicity. On the other hand, cytotoxicity, or assessment of toxicity in cell culture, is a complex *in vivo* phenomenon, which can manifest a wide range of effects, from simple cell death to metabolic aberrations, whereby cell death does not occur, but rather changes in cell function.¹⁵

The literature contains a wealth of studies focusing on metal ion release by orthodontic brackets—especially iron, chromium and nickel, the main stainless steel corrosion products. However, other metal ions present in the silver solder used in orthodontic appliances—such as cadmium, copper and zinc—may be released

into the oral cavity. These are considered potentially hazardous chemicals, included in the list of substances and processes considered of high risk to human life. In a study on ion release and silver solder cytotoxicity, Freitas⁷ observed high toxicity of this material in fibroblasts, reflecting changes in cell adhesion, proliferation and growth. Additionally, it was found a significant release of silver solder ions, with high concentrations occurring immediately after appliance installation. These ions were, in descending order, copper, silver, zinc and cadmium, involving a risk of absorption and retention of these ions by the human body.

An in vitro study by Kerosuo, Moe and Kleven¹⁶ found that there seems to occur detectable release of nickel and chromium from orthodontic appliances, with the largest amounts being released under dynamic conditions. Even so, the

estimated amount of nickel release of a complete orthodontic appliance is less than 10% of the amount consumed in our daily diet¹⁷ and can be considered negligible from a toxicological standpoint.¹⁶ Barrett, Bishara and Quinn¹⁷ emphasize the need to determine the quantity of these corrosion products that is actually absorbed by the patient. Bergman et al¹⁸ pointed out that they had no information on when the dissolution of nickel alloy begins, nor when the maximum concentration of nickel occurs in various tissues. They also have no knowledge of the pattern or dynamics of nickel release, and the uptake and excretion of nickel by the organism.³ The real effects of nickel on the functioning of organs and tissues exposed to it is still unknown. Despite several studies, many questions still remain unanswered, pointing to the need for further research on this issue.

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Nasopharyngeal and facial dimensions of different morphological patterns

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Abstract

Objective: The purpose of this study was to compare the dimensions of the nasopharynx and the skeletal features—evaluated by cephalometric examination—of individuals with different morphological patterns. **Methods:** Were used cephalometric radiographs of 90 patients of both genders, aged 12 to 16 years, which were divided into three distinct groups, according to their morphological patterns, i.e., brachyfacials, mesofacials and dolichofacials. Measurements were performed of specific nasopharyngeal regions (ad_1 -Ptm, ad_2 -Ptm, ad_1 -Ba, ad_2 -S₀, (ad_1 - ad_2 -S₀-Ba- ad_1 /Ptm-S₀-Ba-Ptm) X 100, and Ptm-Ba), and relative to the facial skeletal patterns. **Results:** Dolichofacial patients were found to have smaller sagittal depth of the bony nasopharynx (Ptm-Ba) and lower nasopharyngeal airway depth (ad_1 -Ptm and ad_2 -Ptm). Arguably, these differences are linked to a relatively more posterior position of the maxilla, typical of these patients. No differences were found, however, in the soft tissue thickness of the posterior nasopharyngeal wall (ad_1 -Ba and ad_2 -S₀), or their proportion in the whole area bounded by the nasopharynx [(ad_1 - ad_2 -S₀-Ba- ad_1 /Ptm-S₀-Ba-Ptm) X 100]. **Conclusions:** We therefore suggest that the excessively vertical facial features found in dolichofacial patients may be the result, among other factors, of nasopharyngeal airway obstruction, since such dimensions were shown to be smaller in dolichofacials.

Keywords: Mouth breathing. Nasopharynx. Cephalometry.

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INTRODUCTION

A major difficulty encountered by researchers has been to determine the true role of airway obstruction in the development of cranio-facial features. Experimental evidence suggests a strong correlation between mouth breathing and vertical face development.^{8,12,14,20} Nonetheless, opinions differ when an attempt is made to establish a direct cause and effect link between these two variables.

While some authors^{5,16,28} believe that mouth breathing is the major etiological factor in the development of “long face syndrome”, others^{20,24} ascribe to heredity the expression of these facial features, suggesting that mouth breathing may not be regarded as a cause, but rather an aggravating factor in a context that is already peculiar to individuals with a dolichofacial pattern. After evaluating the studies published hitherto,^{5,8,12,14,16,20,23,24,26,28} one cannot state with any degree of certainty whether a specific facial pattern is directly related to an individual’s respiratory capacity.

We therefore need to investigate whether or not patients with different facial patterns can display different nasopharyngeal dimensions. In view of the need to uncover new evidence to contribute to and assist in addressing this complex issue, this study aimed to compare different facial patterns in terms of nasopharyngeal dimensions and skeletal features as demonstrated by cephalometric examination.

MATERIAL AND METHODS

This is a cross-sectional, comparative and descriptive study previously approved by the Ethics in Research Committee of the institution where it was conducted (File No. 2003. 1. 1045. 58. 4).

We used lateral cephalometric radiographs of patients of both genders aged between 12 and 16 years. Patients who had undergone adenoidectomy or orthodontic treatment in the

period prior to when the radiographs were taken were excluded from the final sample.

Once selected, the radiographs were divided into three groups consisting of 30 subjects each, according to the morphological patterns displayed by the patients (brachyfacial, mesofacial and dolichofacial). The criterion used to divide the sample into groups was the measurement of the facial axis (BaN.PtGn), indicative of mandibular growth direction, whose normal value is 90°.¹⁹ The groups were defined taking into account the 3° variation proposed by McNamara,¹⁷ as explained below.

- Brachyfacials: facial axis below 87°.
- Mesofacials: facial axis equal to or above 87° and equal to or below 93°.
- Dolichofacials: facial axis above 93°.

We subsequently took the angular (NSBa, SN.GoGn, NSGn, SNA, SNB, and ANB) and

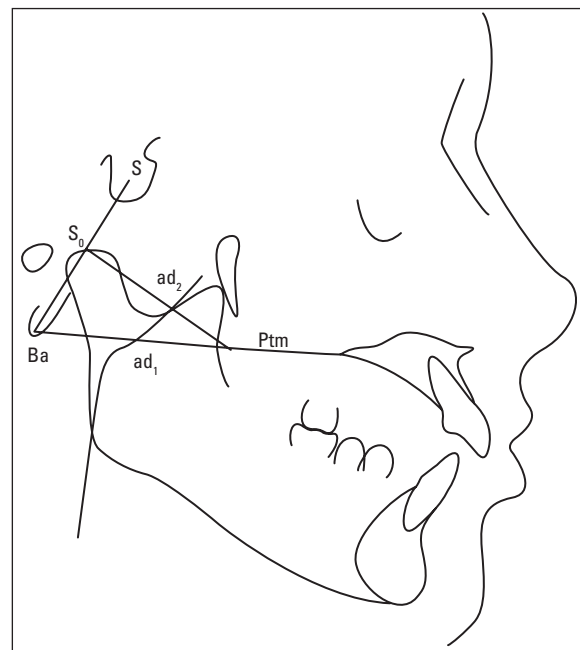


FIGURE 1 - Nasopharyngeal measurements.

linear (N-Me, ENA-Me, S-Go) skeletal cephalometric measurements.

The indices derived from the linear measurements were calculated as shown below.

- iAF (S-Go/N-Me): facial height index,
- iAFA (ENA-Me/N-Me): anterior facial height index.

Measurements of the nasopharyngeal dimensions¹⁵ were taken by scanning the images into digital files for later perusal of the formation using Cad Overlay 2000 (Autodesk, USA) computer software (Fig 1):

- ad₁-Ptm: Depth of the airway through the nasopharynx.
- ad₂-Ptm: Depth of the airway through the nasopharynx.
- ad₁-Ba: Thickness of soft tissue in the posterior wall of the nasopharynx through the Ptm-Ba line.
- ad₂-S₀: Thickness of soft tissue in the posterior wall of the nasopharynx through the Ptm-S line.
- (ad₁-ad₂-S₀-Ba-ad₁/Ptm-S₀-Ba-Ptm) X 100: Area of soft tissue in the bony nasopharyngeal area.
- Ptm-Ba: Sagittal depth of the bony nasopharynx.

Measurements were performed by a single orthodontist trained for this purpose, who did

not know to which group each of radiograph belonged.

Statistical analysis

Group characterization was conducted through descriptive data analysis. To check data normality the Shapiro-Wilks test was applied since there were fewer than 50 cases in each group. Due to the presence of normal distribution of data, parametric tests were used for inferential analysis.

Once assessed, the measurement values were compared between the groups. To assess the differences in sample characterization in terms of gender (categorical variable), the Chi-square test was applied, and for age (quantitative variable), analysis of variance (ANOVA). Comparisons between each of the cephalometric measurements (quantitative variable) and groups (categorical variable) were analyzed using ANOVA. For variables whose ANOVA value was significant ($p < 0.05$), we used the Tukey test for multiple comparison analysis. The level of significance set for statistical tests was 5% ($\alpha \leq 0.05$). All tests were performed with a computer program (SPSS 10.0 for Windows, Statistical Package for Social Sciences, version 10.0, 1999 – SPSS Inc., USA).

TABLE 1 - Characterization of children's gender groups relative to their morphological patterns.

Morphological pattern	Gender (n / %)		Chi-square (p-value)
	female	male	
Meso	12 (40.0%)	18 (60%)	0.873
Dolicho	13 (43.3%)	17 (56.7%)	
Brachy	14 (46.7%)	16 (53.3%)	

Level of significance = 5%.

TABLE 2 - Children's age groups relative to their morphological patterns.

Morphological pattern	Age (years)				ANOVA (p-value)
	minimum	maximum	mean	s.d.	
Meso	12	16	13.73	1.39	0.555
Dolicho	12	16	13.43	1.28	
Brachy	12	16	13.37	1.50	

Level of significance = 5%.

TABLE 3 - Comparison between morphological patterns in terms of angular measurements (degrees).

Angular measurements	Morphological pattern	mean	s.d.	minimum	maximum	ANOVA (p-value)	Tukey	
NSBa	MESO	128.417	6.435	119.0	143.0	0.215	-	
	DOLICHO	126.317	5.439	116.5	134.0			
	BRACHY	128.700	5.154	115.0	137.0			
SNGoGn	MESO	31.317	7.023	24.0	60.0	< 0.001	M-D	< 0.001
	DOLICHO	36.617	3.662	28.5	42.0		M-B	0.002
	BRACHY	26.750	3.674	17.0	33.0		B-D	< 0.001
NSGn	MESO	66.800	2.996	63.0	74.0	< 0.001	M-D	< 0.001
	DOLICHO	71.033	3.000	65.5	76.0		M-B	< 0.001
	BRACHY	62.450	2.440	56.0	67.0		B-D	< 0.001
SNA	MESO	81.883	4.586	70.5	91.0	0.003	M-D	0.137
	DOLICHO	79.667	3.909	70.5	85.0		M-B	0.253
	BRACHY	83.717	4.815	73.5	92.0		B-D	0.002
SNB	MESO	79.317	3.800	72.0	86.5	< 0.001	M-D	0.001
	DOLICHO	75.983	3.019	68.0	82.5		M-B	0.001
	BRACHY	82.817	3.497	75.0	91.0		B-D	< 0.001
ANB	MESO	2.733	1.700	-0.5	7.0	< 0.001	M-D	0.294
	DOLICHO	3.683	2.419	-1.0	8.0		M-B	0.013
	BRACHY	0.900	2.995	-6.5	5.0		B-D	< 0.001

Level of significance = 5%.

RESULTS

The three groups comprised a majority of male subjects aged between 13 and 14 years. They did not differ significantly from each other, both in terms of composition by gender or age (Tables 1 and 2).

Angular cephalometric measurements (Table 3)

Although the three facial patterns did not display statistically discrepant cranial base inclination angles (NSBa), they differed significantly from each other regarding SN.GoGn and NSGn. In this analysis, the dolichofacial group exhibited the greatest mandibular inclination, followed by the mesofacial patients. Compared with the other groups, brachyfacials had a significantly smaller mandibular angle.

All mandibular plane angulation differences showed considerable statistical significance.

The SNA values in the brachyfacial group were even higher. Mesofacials showed intermediate values, whereas dolichofacial patients exhibited the lowest relative values. However, these differences could only be considered statistically significant when two groups at opposite extremes (brachyfacial and dolichofacial) were compared.

Regarding the anteroposterior position of the mandible (SNB) statistically significant differences were found in all pairwise comparisons. Once again, brachyfacials attained the highest values, followed by mesofacials and dolichofacials.

As regards the ANB angle, we detected a significant difference between mesofacials and brachyfacials, since the latter's values were lower

TABLE 4 - Comparison between morphological patterns in terms of linear measurements (mm) and facial indices.

Linear Measurements	Morphological Pattern	mean	s.d.	minimum	maximum	ANOVA (p-value)	Tukey
N-Me	MESO	119.067	7.011	108.0	136.0	< 0.001	M-D 0.043
	DOLICHO	123.500	6.994	109.0	134.0		M-B 0.099
	BRACHY	115.300	7.011	102.0	132.0		B-D < 0.001
ENA-Me	MESO	66.800	6.400	58.0	85.0	< 0.001	M-D 0.003
	DOLICHO	71.600	4.773	61.500	82.0		M-B 0.232
	BRACHY	64.450	5.297	55.000	75.0		B-D < 0.001
S-Go	MESO	78.433	6.285	66.5	90.0	0.756	-
	DOLICHO	77.333	4.973	67.0	89.0		
	BRACHY	78.150	6.367	66.5	90.0		
iAF	MESO	0.65894	0.392	0.569	0.716	< 0.001	M-D 0.003
S-Go/N-Me	DOLICHO	0.62665	0.308	0.583	0.609		M-B 0.119
	BRACHY	0.67789	0.392	0.605	0.776		B-D < 0.001
iAFA	MESO	0.56037	0.302	0.504	0.627	0.003	M-D 0.012
ENA-Me/N-Me	DOLICHO	0.57983	0.222	0.535	0.628		M-B 0.964
	BRACHY	0.55865	0.237	0.509	0.607		B-D 0.005

Level of significance = 5%.

than the former's. Brachyfacials also displayed significantly lower ANB values when compared with dolichofacials. The latter, however, showed no differences with respect to mesofacials.

Linear cephalometric measurements (Table 4)

Mesofacials and brachyfacials were found to have no significant differences regarding total anterior facial height (N-Me). Dolichofacials, however, displayed considerably higher averages than the other two groups.

In a separate comparison with the other two groups, dolichofacial patients' lower anterior facial height (ENA-Me) again proved to be significantly higher. Once again, however, mesofacials and brachyfacials did not differ from each other significantly.

No statistically significant differences were found between the groups with respect to total posterior facial height (S-Go).

Facial indices (Table 4)

Dolichofacials' facial height (iAF and iAFA) indices differed from both mesofacials' and brachyfacials'. They showed lower iAF values and higher iAFA values. Nevertheless, mesofacials and brachyfacials exhibited no differences with regard to both indices.

Nasopharyngeal measurements (Table 5)

The groups did not differ in terms of soft tissue thickness in the posterior nasopharyngeal wall (ad_1 -Ba and ad_2 -S₀). Nor did they show any differences with respect to the soft tissue area in the bony nasopharyngeal region [$(ad_1-ad_2-S_0-Ba-ad_1/Ptm-S_0-Ba-Ptm) \times 100$].

When dolichofacials were compared with brachyfacials in terms of ad_2 -Ptm (airway depth through the nasopharynx), the discrepancy was found to be statistically significant. Regarding ad_1 -Ptm (airway depth through the nasopharynx), a significant difference was found when

TABLE 5 - Comparison between morphological patterns in terms of nasopharyngeal measurements (mm).

Nasopharyngeal measurements	Morphological pattern	mean	s.d.	minimum	maximum	ANOVA (p-value)	Tukey	
ad ₁ -Ptm	MESO	25.2202	2.8125	16.8	29.5	0.050	M-D	0.071
	DOLICHO	22.9436	4.4868	9.2	28.9		M-B	0.985
	BRACHY	25.0527	4.3306	16.5	32.8		B-D	0.102
ad ₂ -Ptm	MESO	19.2648	2.7616	14.4	24.4	0.039	M-D	0.124
	DOLICHO	17.5871	4.0816	8.4	25.2		M-B	0.886
	BRACHY	19.6630	2.8402	14.1	24.7		B-D	0.043
ad ₁ -Ba	MESO	22.4617	2.8870	18.4	30.7	0.272	-	
	DOLICHO	22.4550	5.7209	13.3	36.8			
	BRACHY	24.0539	4.0864	17.1	35.7			
ad ₂ -S ₀	MESO	23.1262	3.0702	16.8	28.7	0.784	-	
	DOLICHO	22.7854	4.5983	13.0	31.0			
	BRACHY	23.4690	3.54160	17.6	32.3			
(ad ₁ -ad ₂ -S ₀ -Ba-ad ₁ /Ptm-S ₀ -Ba-Ptm) X 100	MESO	74.7063	6.6228	55.3	87.1	0.793	-	
	DOLICHO	75.7773	10.9547	51.0	95.4			
	BRACHY	76.1653	7.5959	60.7	88.7			
Ptm-Ba	MESO	47.6820	3.4734	40.1	54.1	< 0.001	M-D	0.034
	DOLICHO	45.3987	3.4158	41.4	55.3		M-B	0.263
	BRACHY	49.0927	3.5361	43.040	56.680		B-D	< 0.001

Level of significance = 5%.

comparing the three groups in conjunction. In pairwise comparison, the difference was considered more meaningful, although not statistically significant when dolichofacials were compared with mesofacials. Mesofacials and brachyfacials did not differ with respect to both airway depth measurements.

As regards the sagittal depth of the bony nasopharynx (Ptm-Ba), dolichofacial patients had statistically lower means than mesofacials and brachyfacials. The latter two groups, however, did not differ significantly from each other.

DISCUSSION

The results obtained with posterior rhinoscopy when evaluating the size of the adenoids in the posterior wall of the nasopharynx are highly correlated with data derived from the

cephalometric examination, although this is a two-dimensional test.¹³ The cephalometric method is simple and yields satisfactory results in children of all ages.^{4,29} Authors such as Jakhi and Karjodkar⁷ and Wu et al²⁷ regard cephalometric radiography as an easy, affordable and appropriate exam that provides useful information about the nasopharynx. Moreover, it is a routine diagnostic tool and should therefore be considered a viable instrument for this study. It should be acknowledged, however, that the absence of an X-ray measurement method error test limits this study and does not allow its data to be extrapolated for purposes other than group comparison.

The data revealed that the criterion used for sample division (BaN.PtGn) should be considered an appropriate tool for the morphological

classification of patients, since the groups determined by this criterion—especially those with extreme facial features (brachyfacials and dolichofacials)—showed differences in most of the facial parameters measured. Although no significant differences were found with respect to posterior facial height (S-Go), dolichofacials showed higher values compared to the other facial groups regarding total anterior (N-Me) and lower anterior (ANS-Me) facial height. Thus, iAF (S-Go/N-Me) was considerably lower for dolichofacials when compared with the other two groups separately. The anterior facial height (ANS-Me/N-Me) index also differed significantly when comparing brachyfacials with dolichofacials, and between the latter and mesofacials. The index was higher for the long faced patients. Moreover, the three groups classified according to the aforementioned criterion distinguished themselves in terms of mandibular inclination levels (SN.GoGn and NSGn). We therefore consider the measuring of the facial axis angle a suitable parameter to differentiate the facial groups, particularly to recognize dolichofacials among the other morphological patterns.

After analyzing the data, we found that the measurement corresponding to the sagittal depth of the bony nasopharynx (Ptm-Ba) showed significant variation between the specific facial groups, being significantly lower in dolichofacials. Bergland² found a positive correlation between the angle of inclination of the anterior cranial base (NSBa) and nasopharyngeal depth. According to him, the more obtuse the angle of the cranial base, the greater is the sagittal depth of the bony nasopharynx (Ptm-Ba). Although dolichofacials produced significantly lower Ptm-Ba values, the inclination of the anterior cranial base angle did not change significantly in the group comparisons. Other authors^{3,9,10} further substantiate this finding, as they did not indicate any group differences

in the cranial base plane inclination (NSBa). Tourné,²⁴ in turn, argued that the cranial base angle seems to exert less influence on the development of the vertical face than is commonly assumed.

Since the anterior cranial base angle did not undergo any significant differences between the groups, we would suggest maxillary anteroposterior positioning as a potential mechanism to justify the decreased sagittal dimension of the bony nasopharynx in dolichofacials. An analysis of the averages provided by the antagonist facial pattern group (brachyfacials) disclosed that dolichofacials—who had significantly smaller SNA values—also had the lowest bony nasopharynx depth. On the other hand, brachyfacials had higher SNA values and significantly greater bony nasopharynx depth compared with dolichofacials. Sosa et al²² agrees with this theory and suggests that patients with a larger pharyngeal area and larger bony nasopharynx tend to have a more anteriorly positioned maxilla and mandible. It is therefore assumed that a more posteriorly positioned maxilla (which entails point Ptm) might have influenced the dolichofacials' bony nasopharynx depth since, the more posteriorly located is point Ptm, the smaller is its distance to point Ba.

The dolichofacials' more posteriorly positioned maxilla was accompanied, on an even larger scale, by a mandibular displacement in the same direction. The reduced SNB values found for this facial group may have resulted from a clockwise rotation of the mandible, as evidenced by high NSGn and SN.GoGn values. The opposite occurred with brachyfacials, who responded with an anterior displacement not only of the mandible, but of both maxillary bones. It is also likely that this group's anteriorly positioned mandible may result from a counterclockwise rotation, as suggested by the group's lower NSGn and SNGoGn values.

This combined “movement” of both maxillary bones, sometimes towards the posterior, as in the case of dolichofacials, sometimes anteriorly, like in the brachyfacial group, was also noted by Joseph et al⁸ when comparing normo-divergent and hyperdivergent individuals. This factor may have caused ANB values to remain within a pattern of relative normality since their means ranged from 0.9° to 3.6°, which is considered normal by advocates of this standard.^{6,21} The mandibular movement “in response” to the maxillary movement may also have caused the changes observed in anterior facial heights and in the indices of the skeletal features described above.

Mergen and Jacobs,¹⁸ Kerr¹¹ and Trotman et al²⁵ believe that the aforesaid dolichofacials’ anteriorly repositioned maxilla and mandible may also be associated with a reduced sagittal dimension of the nasopharyngeal airway. Some studies^{1,8,9,10} also reinforce the hypothesis that dolichofacials exhibit smaller nasopharyngeal airways. Joseph et al⁸ found a narrowing of the pharyngeal airway in hyperdivergent patients, as indicated by a significantly lower ad_1 -Ptm. Conversely, ad_2 -Ptm did not differ significantly between groups. Kawashima et al⁹ reported a narrower pharyngeal space in patients with pronounced vertical features, when compared to control patients. Akcam, Toygar and Wada¹ observed that patients with posterior mandibular rotation showed a decreased upper airway space. Kawashima et al¹⁰ assessed three groups that were similar to the ones in the present study with respect to the aforesaid airway measurements. Although the authors did not detect any significant differences in ad_1 -Ptm and ad_2 -Ptm, they noted lower means in the group with predominantly vertical faces.

These data, in a sense, confirm the findings of this investigation on the effective size of the airway passage. Although dolichofacials were not statistically differentiated from the other

groups in terms of ad_1 -Ptm, a statistically significant difference was found in a joint comparison of the three groups. Furthermore, hyperdivergent patients had the lowest mean for this measurement. Additionally, long-faced patients distinguished themselves effectively with respect to their opposites, in terms of ad_2 -Ptm.

This “reduction” of the nasopharyngeal airway among dolichofacials cannot be attributed to the larger adenoids or the presence of soft tissue in the posterior nasopharyngeal region. The reason for this is that the groups did not differ with respect to soft tissue thickness in the posterior nasopharyngeal wall (ad_2 -S₀ and ad_1 -Ba), nor with regard to their proportion relative to the entire area bounded by the nasopharynx $[(ad_1-ad_2-S_0-Ba-ad_1/Ptm-S_0-Ba-Ptm) \times 100]$. The results indicate that the volume of soft tissue, including the adenoid, is constant for all facial groups, both in linear and proportional terms.

Therefore, the fact that dolichofacial patients display a smaller airway cannot be attributed to adenoid size. Dolichofacials’ reduced airway may be the result of factors not fully accounted for—although perhaps suggested—by this research. The data mentioned above have led us to suspect that because dolichofacials exhibit a more posteriorly positioned maxilla, this condition may narrow the nasopharyngeal airway passage.

We therefore suggest that the excessively vertical facial features found in dolichofacial patients may be the result, among other factors, of nasopharyngeal airway obstruction, since such dimensions were shown to be smaller in dolichofacials. These considerations, therefore, are designed to motivate dentists to alert the parents and legal guardians of patients with typically dolichofacial features. These patients may be more prone to mouth breathing as a result of their relatively diminished nasopharyngeal dimensions.

CONCLUSIONS

Based on the assessment of the facial pattern data produced in this study, we found that dolichofacial patients had smaller bone depth sagittally as well as smaller nasopharyngeal airway depth, when compared with the distinct facial patterns of other patients. It could be argued that this difference is due to a distally positioned maxilla, typical of long-faced patients. Maxillary position, which proved different for each group, was accompanied by mandibular

rotation, sometimes clockwise, as in the case of dolichofacial, sometimes counterclockwise (brachyfacials). Such mandibular rotation influenced the facial heights and indices, ensuring an appropriate maxillomandibular interrelationship, irrespective of facial pattern. Based on our review and the findings evidenced by the results, it would be plausible to ascribe the decreased size of dolichofacials' nasopharyngeal airway to their characteristically vertical facial pattern.

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Cephalometric evaluation of vertical and anteroposterior changes associated with the use of bonded rapid maxillary expansion appliance

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Abstract

Introduction: Bonded rapid maxillary expansion appliances have been suggested to control increases in the vertical dimension of the face after rapid maxillary expansion but there is still no consensus in the literature concerning its actual effectiveness. **Objective:** The purpose of this study was to evaluate the vertical and anteroposterior cephalometric changes associated with maxillary expansion performed using bonded rapid maxillary expansion appliances. **Methods:** The sample consisted of 25 children of both genders, aged between 6 and 10 years old, with skeletal posterior crossbite. After maxillary expansion, the expansion appliance itself was used for fixed retention. Were analyzed lateral telerradiographs taken prior to treatment onset and after removal of the expansion appliance. **Conclusion:** Based on the results, it can be concluded that the use of bonded rapid maxillary expansion appliance did not significantly alter the children's vertical and anteroposterior cephalometric measurements.

Keywords: Bonded rapid maxillary expansion appliance. Rapid maxillary expansion. Cephalometry.

INTRODUCTION

Rapid maxillary expansion (RME) is a widely accepted procedure recommended for the correction of maxillary atresia related to posterior crossbite.^{7,8} The opening of the midpalatal suture causes increases in maxillary width and dental arch perimeter, allowing the coordination of the upper and lower basal bones and crossbite correction. As well as the correction of transverse discrepancy, however, RME also promotes changes such as inferior displacement of

the maxilla, extrusion and inclination of maxillary and mandibular molars, clockwise rotation of the mandible, with a resulting increase in facial height and anterior open bite.^{4,14,15,20,21,26}

In 1860, Angell¹ reported the first maxillary expansion case using an appliance with a screw placed across the maxilla. Since then, different appliances have been suggested for hemi maxillary separation, all featuring modifications, especially in the type of material and anchoring, and different activation modes.^{5,10,12,14,18,22,23}

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Bonded rapid maxillary expansion appliance have been proposed to control the side effects of RME, which may be associated with adverse increases in anterior facial height, especially in individuals with a predominantly vertical growth pattern and a tendency towards open bite.^{2,10,17,18,20,22,24} No consensus has been found in the literature, however, concerning the RME-related vertical and anteroposterior effects produced with this type of appliance.^{2,7,9,13,19,20,24,25}

The purpose of this study was to evaluate lateral telerradiographs for possible vertical and anteroposterior changes resulting from the use of bonded rapid maxillary expansion appliance for the correction of skeletal posterior crossbite in children.

MATERIAL AND METHODS

Sample

The sample comprised 25 children (13 girls and 12 boys), irrespective of gender, race or social class, with a mean age of 8 years and 5 months (ranging from 6 years and 11 months to 10 years and 11 months) presenting with maxillary atresia and either unilateral or bilateral posterior crossbite, indicated for maxillary expansion as the first stage of orthodontic treatment. Maxillary atresia was detected based on clinical parameters characterized by the presence of posterior crossbite associated with a deep palate, "V"-shaped maxillary arch and reduced transverse maxillary dimensions compared with the mandible. This study was approved by the Research Ethics Committee of the Ribeirão Preto School of Dentistry, University of São Paulo (FORP / USP - Case No 2003.1.1067.58.8), and the children's parents and/or guardians signed a consent form, according to resolution 196/96 of the Brazilian Health Council.

The children included in the sample had received no previous orthodontic treatment and exhibited good general and oral health. Their upper and lower first permanent molars

had erupted and were in occlusion. The orthodontic documentation comprised panoramic and occlusal X-rays, lateral and frontal cephalometric radiographs, intraoral photographs and study models.

Rapid maxillary expansion

RME was performed using bonded rapid maxillary expansion appliance, made from colorless acrylic resin covering the posterior teeth (Jet; Artigos Odontológicos Clássico Ltda, São Paulo, SP, Brazil) and a palatal expansion screw (split screw, 9 mm, code 65.05.011; Dental Morelli, Sorocaba, SP, Brazil) positioned on the midpalatine raphe at about 2 mm from the palate and between the primary second molars (Fig 1). The appliance was adjusted in the patient's mouth in order to ensure as many bilateral occlusal contacts as possible, and was then attached using dual-curing acrylic resin cement adhesive (Rely X: 3M do Brasil Ltda., Produtos Dentários, Sumaré, SP, Brazil).



FIGURE 1 - Bonded rapid maxillary expansion appliance.

Activation was carried out by the children's parents and/or guardians and amounted to $\frac{1}{4}$ turn of the screw every 12 hours, starting one week after appliance installation. When cross-bite overcorrection was observed, i.e., when the palatal cusps of the upper posterior teeth were occluding on the buccal cusps of the lower posterior teeth, the expander screw was fixed with acrylic resin and a new occlusal adjustment was made. The average interval time between activations was 20 days (ranging between 14 and 26 days) and the appliance remained in the patients' mouth as fixed retention for a minimum of 90 days (107 days average, ranging from 90 to 124 days). After this period, the appliance was removed and patients wore a removable retainer (acrylic plate with a Hawley labial clasp and retention clasps) for 6 months.

Cephalometric evaluation

Lateral telerradiographs were taken before treatment onset (T1) and after removal of the expansion appliance (T2). The cephalometric radiographs were performed in standardized fashion by a single technician in the Laboratory of Analysis and Control of Dental Radiographic Images (LACIRO), at FORP-USP.

The cephalometric tracings were performed manually by the same experienced and calibrated examiner. The following cephalometric landmarks were located and marked on the lateral cephalograms (Fig 2):

- Sella (S): Virtual point located at the geometric center of the sella turcica.
- Nasion (N): The anterior-most point of the frontonasal suture.
- Subspinal Point (A): The deepest point of the subspinal concavity.
- Supramental Point (B): The deepest point of the supramental concavity.
- Anterior Nasal Spine Point (ANS): Located at the anterosuperior end of the maxilla.
- Posterior Nasal Spine Point (PNS): Located at the posterior end of the maxilla.
- Basion (Ba): Lowest point of the image of the anterior margin of the foramen magnum.
- Pterygoid Point (Pt): Posterior-most and superior-most point in the upper contour of the pterygomaxillary fissure.
- Pogonion (Pg): Anterior-most point of the bony chin.
- Gnathion (Gn): The anterior-most and inferior-most point of the mandibular symphysis, as determined by bisecting the angle formed by the lower margin of the mandibular body and the facial line (NPg).
- Menton (Me): Located at the intersection of the outer contour of the mandibular symphysis and the inferior margin of the mandibular body.
- Gonion (Go): Located in the outer contour of the gonial angle, determined by bisecting the angle between the mandibular ramus and the lower margin of the mandibular body.

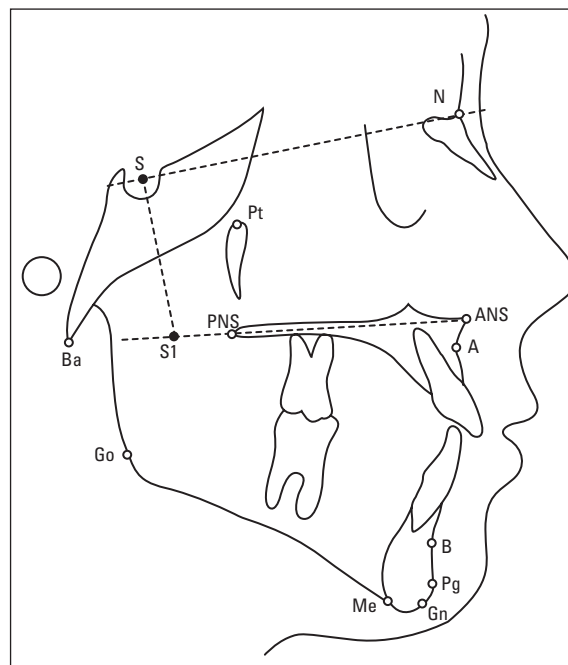


FIGURE 2 - Lateral cephalogram and location of cephalometric landmarks.

- Point S1: Connection point between a line drawn from Point S—perpendicularly to the SN line—and the palatal plane (junction of ANS and PNS).

After locating and marking the landmarks the following lines and planes of orientation were traced:

- S-N Line: Connecting S to N.
- N-A Line: Connecting N to A.
- N-B Line: Connecting N to B.
- S-Gn Line: Connecting S to Gn.
- Ba-N Line: Connecting Ba to N.
- Pt-Gn Line: Connecting Pt to Gn.
- N-ANS Line: Connecting N to ANS.
- ANS-Me Line: Connecting ANS to Me.
- N-Me Line: Connecting N to Me.
- Steiner's mandibular plane (GoGn): Determined by Go and Gn.
- Palatal plane (PP): Determined by ANS and PNS.
- Occlusal Plane (Ploc): Determined by intersecting the landmarks of the first

permanent molars and intersecting the upper and lower incisors.

To assess the anteroposterior behavior of the apical bases, the following cephalometric measurements were used (Fig 3):

- SNA Angle: Formed by intersecting the SN and NA lines. Measures the position of the maxilla relative to the anterior cranial base.
- SNB Angle: Formed by intersecting the SN and NB lines. It measures the position of the mandible relative to the anterior cranial base.
- ANB Angle: Determined by the difference between SNA and SNB. It measures the anteroposterior relationship between maxilla and mandible.

To assess the vertical behavior of the apical bases, we used the following cephalometric measurements (Fig 3 and 4):

- S-S1: linear measurement determined by the junction of the S and S1 landmarks.

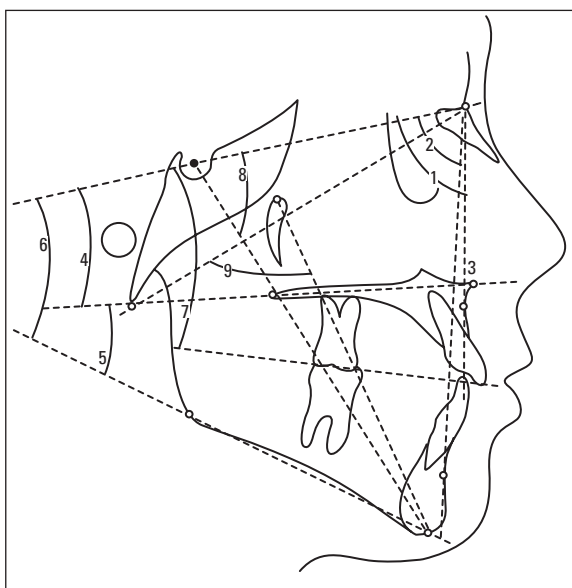


FIGURE 3 - Lateral cephalogram and location of the vertical and anteroposterior angular cephalometric measurements: (1) SNA angle, (2) SNB angle, (3) ANB angle, (4) SN.PP angle, (5) PP.GoGn angle, (6) SN.GoGn angle, (7) SN.Ploc angle; (8) SN.Gn angle; (9) Facial Axis.

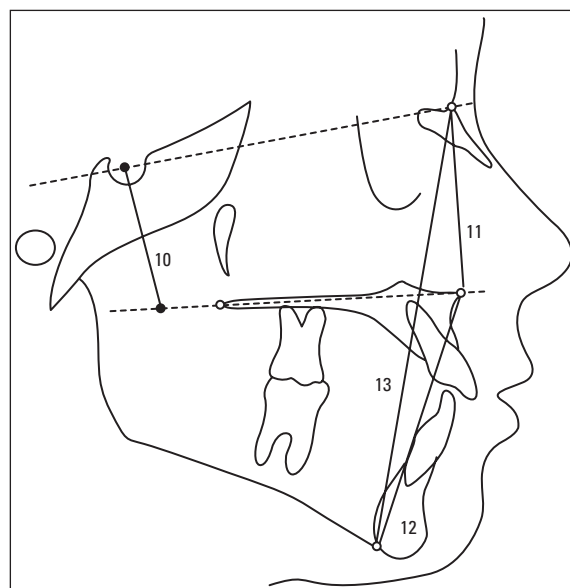


FIGURE 4 - Lateral cephalogram and location of linear cephalometric measurements: (10) Linear S-S1 measurement, (11) Linear N-ANS measurement, (12) Linear ANS-Me measurement, (13) Linear N-Me measurement.

- SN.PP Angle: Formed by intersecting the PP plane with the SN line. Reflects the degree of inclination of the maxilla relative to the anterior skull base.
- PP.GoGn Angle: Formed by intersecting the PP plane with the GoGn line. Reflects the inclination of the mandible relative to the palatal plane.
- SN.GoGn Angle: Formed by intersecting the GoGn plane with the SN line. Reflects the degree of inclination of the mandible relative to the anterior cranial base.
- SN.Ploc Angle: Formed by intersecting the SN line with the occlusal plane. Reflects the degree of inclination of the maxilla relative to the anterior cranial base.
- SN.Gn Angle: "Y"-growth axis, formed by intersecting the SN and SGn lines, shows the direction of mandibular growth.
- Facial Axis (BaN.PtGn Angle): Formed by

intersecting the BaN and PtGn lines. Shows the direction of mandibular growth.

- N-ANS: Linear measurement determined by the junction of the N and ANS landmarks. Reflects the anterior superior height of the face.
- ANS-Me: Linear measurement determined by the junction of the Me and ANS landmarks. Reflects the anteroinferior height of the face.
- N-Me: Linear measurement determined by the junction of the N and Me landmarks. Reflects the anterior facial height.

Data analysis and statistics

The cephalometric data were statistically analyzed using SPSS software version 10.0 for Windows (SPSS Inc., Chicago, IL, USA) and the paired t-test was used to compare pre and post-expansion.

TABLE 1 - Mean, standard deviation and statistical significance of the cephalometric variables before and after expansion (n = 25).

MEASUREMENTS	Pre-expansion (T1)		Post-expansion (T2)		Difference (T2-T1)		Paired t-test	
	mean	s.d.	mean	s.d.	mean	s.d.	variation	"p" values
Anteroposterior								
SNA (degrees)	80.76	4.40	81.12	4.31	0.36	1.93	-0.43 to 1.15	0.361
SNB (degrees)	77.24	4.77	77.44	4.69	0.20	1.32	-0.34 to 0.74	0.457
ANB (degrees)	3.52	2.48	3.68	2.86	0.16	1.46	-0.44 to 0.76	0.590
Vertical								
SN.PP (degrees)	7.88	3.44	7.40	3.31	-0.48	1.75	-1.20 to 0.24	0.158
PP.GoGn (degrees)	29.40	4.17	29.92	3.35	0.52	2.16	-0.37 to 1.41	0.241
SN.GoGn (degrees)	37.28	5.31	37.36	4.79	0.08	1.60	-0.58 to 0.74	0.805
SN.Ploc (degrees)	19.24	3.97	19.00	4.67	-0.24	2.87	-1.42 to 0.94	0.680
SN.Gn (degrees)	68.88	4.52	68.92	4.61	0.04	1.05	-0.39 to 0.47	0.852
Facial Axis (degrees)	85.16	3.28	85.04	4.01	-0.12	2.12	-0.99 to 0.75	0.780
N-ANS (mm)	45.96	2.92	46.52	3.76	0.56	1.41	-0.02 to 1.14	0.060
ANS-Me (mm)	63.08	4.06	63.72	3.92	0.64	1.97	-0.17 to 1.45	0.119
N-Me (mm)	106.72	5.07	107.76	5.24	1.04	1.83	0.28 to 1.79	0.009*

* Statistical significance: $p < 0.01$.

To obtain method error, 10 radiographs were retraced of 10 different, randomly selected patients after a minimum three month interval time. Dahlberg's formula¹¹ was applied to estimate error magnitude and the paired t-test to detect statistical significance.

RESULTS

The values (mean and standard deviation) of each cephalometric variable measured before treatment (T1) and after expansion and removal of the expansion appliance (T2) are shown in Table 1. The mean, standard deviation, variation in the difference between the values of T1 and T2 and statistical significance ("p" values) can be found in Table 1.

In assessing the anteroposterior behavior of the apical bases after maxillary expansion an increase in the means of the SNA (0.36°), SNB (0.20°) and ANB (0.16°) angles was observed, although the changes were not statistically significant ($p > 0.01$).

In assessing the vertical behavior of the apical bases after maxillary expansion an increase in the means of variables PP.GoGn (0.52°), SN.GoGn (0.08°) and SN.Gn (0.04°) and a decrease in SN.PP (-0.48°), SN.Ploc (-0.24°) and Facial Axis (-0.12°) were observed. These changes, however, were not statistically significant ($p > 0.01$).

As for the behavior of the facial heights, after maxillary expansion an increase in the means of variables N-ANS (0.56 mm), ANS-Me (0.64 mm) and N-Me (1.04 mm) was noted, with a statistically significant increase ($p < 0.01$) only for N-Me.

Method error was greater than 0.5 mm and statistically significant ($p < 0.05$) only for the anterior facial height measurement (N-Me).

DISCUSSION

Since the RME early studies, several investigations have evaluated transverse, vertical

and anteroposterior cephalometric changes associated with the opening of the sutures using different types of appliances. Currently, in view of RME's positive and proven results, it has become a widely accepted procedure used to increase the transverse dimension of the maxilla. On the other hand, the literature is not unanimous about the actual vertical and anteroposterior orthopedic effects associated with the RME and its potential benefits or harm in orthodontic treatment.

This study showed that, with the exception of N-Me, no vertical change exceeded 1° or 1 mm. Thus, in addition to a lack of statistical significance, the vertical changes occurring after RME—when using the bonded rapid maxillary expansion appliance—are also devoid of clinical significance. Although the 1.04 mm increase in anterior face height (N-Me) was statistically significant ($p < 0.01$), this change does not cause any clinical losses. Moreover, such change may be related to the method error, which was 0.8 mm and proved significant ($p < 0.05$) for the anterior face height measurement (N-Me).

Thus, it was found that RME—when performed using the bonded rapid maxillary expansion appliances—did not cause posteroinferior mandibular displacement, nor did it increase the children's anterior facial height. Contrary to these findings, studies conducted with Haas and Hyrax style appliances show that RME fosters inferior displacement of the maxilla, alveolar process inclination, extrusion and buccal inclination of posterior teeth, which result in posteroinferior mandibular rotation and increased lower anterior facial height.^{4,14,15,21,26}

Bonded rapid maxillary expansion appliances have been proposed by different authors, who have reported that antero-inferior facial height control may result from intrusion, inhibition of alveolar growth and eruption of posterior teeth, decreased axial inclination and extrusion of encapsulated teeth in comparison to what occurs

with conventional Haas and Hyrax type expanders^{2,10,12,17,18,20,22,23}. In agreement with the present study, Asanza et al² did not see a significant increase in anteroinferior facial height (ANS-Me) after RME had been performed using bonded rapid maxillary expansion appliances. According to the authors, both inferior displacement of the maxilla and mandibular plane inclination are greater with Hyrax-type appliances. In Sarver and Johnston's view,²⁰ inferior displacement of the maxilla and mandible is decreased when bonded rapid maxillary expansion appliances are used due to the action of the levator muscles and stretching of soft tissues provided by the occlusal acrylic.

As regards anteroposterior skeletal changes after RME, anterior maxillary displacement was observed by several authors who used conventional expansion appliance (like Haas and Hyrax) and bonded rapid maxillary expansion appliances.^{2,6-9,13,14,15,21,26} Bramante and Almeida⁷ found no significant differences in anteroposterior changes with the use of Haas/Hyrax-type appliances or bonded rapid maxillary expansion appliances. Sarver and Johnston²⁰ and Johnson et al,¹⁶ on the other hand, found that anterior maxillary displacement increased when the appliance was used with orthodontic bands, suggesting the use of bonded rapid maxillary expansion appliances to restrict maxillary movement, which is undesirable in patients presenting with skeletal Class II malocclusion.

In the present study it was observed that, following RME, a slight displacement of the maxilla and mandible occurred as could be attested by an increase of 0.36° in the SNA angle and 0.20° in SNB. Clockwise mandibular rotation was negligible and insufficient to displace point B posteriorly, which justifies the fact that the SNB did not decrease. The fact that SNA underwent a considerable increment relative to SNB caused a 0.16° increase in ANB. Skeletal anteroposterior changes, however, were not statistically significant.

Contrary to these results, Sarver and Johnston²⁰ and Asanza et al² reported posterior maxillary displacement after the use of bonded rapid maxillary expansion appliances. In this study, although SNA increased in most patients, there were cases where SNA decreased and cases where SNA remained stable (ranging from 1.15° to -0.43°), as must have been the case with Sarver and Johnston,²⁰ who found an average 0.75° decrease in SNA, and Asanza et al,² whose average SNA decrease was 0.66° (ranging from -3.6° to 1.7°). Thus, any divergence in the results can be explained by the variability of the samples used in each study.

Haas^{14,15} and Biederman⁵ reported anterior maxillary displacement after RME, which aids in the correction of skeletal Class III malocclusion and anterior crossbite. After the retention period, however, values tend to revert close to those found at the start.^{7,9,13,14} The relapse of anteroposterior cephalometric changes after RME using Haas-type appliance was also found using Hyrax-type and bonded rapid maxillary expansion appliances.^{7,9,19} The maxilla is projected anteriorly as an immediate response to therapy, but throughout the retention period it tends to return to the starting position, which may explain the fact that anterior maxillary displacement was significant in some studies where analysis was carried out immediately after expander activation^{3,5,8,14,15} and not in others where, similarly to the present study, assessments were made after the retention period.^{7,9,13,19,21}

Based on the results of this study, where increases in SNA, SNB and ANB were not significant, RME, by itself, should not be performed with the purpose of accruing any possible benefits from anteroposterior changes in the maxilla and/or mandible. In cases where, in addition to RME, maxillary advancement also proves necessary, treatment should include the use of specific appliances for maxillary protraction after the phase of expander activation.

Similarly, although vertical changes were not significant, in cases of transverse discrepancy associated with a predominance of vertical growth, the latter should be treated with orthopedic appliances for this specific purpose during the active phase of RME.

Cephalometric variations found in this study were small and may have been caused by measurement errors or normal changes expected during growth. We therefore believe that expansion bonded rapid maxillary expansion appliances present an option for the correction of posterior crossbite and maxillary atresia, regardless of vertical problems and the patient's facial pattern. By not using bands clinical work is reduced, facilitating the preparation and installation of the bonded rapid maxillary expansion appliance. However, one should pay special attention to occlusal adjustment to ensure that the contact of the acrylic with the lower teeth is bilateral and balanced, thereby preventing the appliance from falling while reducing patient discomfort.

Finally, it should be underscored that our sample was selected based only on reduced

maxillary transverse dimension and we did not take into account any aspects related to growth pattern and maxillomandibular sagittal relationship. Further investigation is therefore needed involving a sample that is standardized according to growth pattern and maxillomandibular relationship with the aim of raising awareness about the possible benefits brought by bonded rapid maxillary expansion appliances to Class II and hyperdivergent patients.

CONCLUSIONS

In view of the specific conditions of this study, it can be concluded that rapid maxillary expansion performed in children using bonded rapid maxillary expansion appliance did not bring about any vertical or anteroposterior cephalometric changes.

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Evaluation of maxillary atresia associated with facial type

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Abstract

Objectives: To associate maxillary atresia with facial types, investigating whether dimorphism occurs between males and females and evaluating the percentage of such dimorphism according to gender and facial type. **Methods:** Initially, the sample consisted of 258 lateral cephalometric radiographs. After analyzing Ricketts' VERT index, 108 radiographs were excluded for not meeting the selection criteria. Therefore, the sample consisted of 150 lateral cephalometric radiographs and 150 models of 150 Caucasian individuals aged 14 years to 18 years and 11 months, regardless of malocclusion type. The sample was divided into 50 mesofacials, 50 brachyfacials and 50 dolichofacials. The Schwarz's analysis was applied to all 150 models. **Results:** The presence of maxillary atresia in the sample consisted of 64% in dolichofacials, 58% in brachyfacials and 52% in mesofacials. **Conclusions:** There was no evidence showing that atresia is in any way associated with facial type. Gender dimorphism was proportionally greater in dolichofacial males while females did not exhibit different proportions.

Keywords: Maxillary atresia. Schwarz's analysis. Facial types.

INTRODUCTION AND LITERATURE REVIEW

Dental arch shape is essential for the diagnosis of malocclusion given the fact that ideal stability and function require perfect dental intercuspation.

Maxillary atresia is a dentofacial deformity

characterized by a discrepancy in the maxilla/mandible relationship in the transverse plane, which may exhibit unilateral or bilateral posterior crossbite. It consists of a narrowing of the upper arch with a deep gothic palate often associated with respiratory dysfunction.

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It may be hidden due to the sagittal position of the maxilla and mandible with no apparent transverse deficiency.³

Witzig and Spahl¹⁰ affirm that Pont, in 1909, after assessing Basque individuals of southern France, established a fixed constant for the ideal shape of the dental arches in the premolar (80 mm) and molar (64 mm) regions using the formula: SI x 100 divided by 80 or 64, respectively.

Later, however, in disagreement with Pont, Schwarz and Gratzinger¹² developed a formula for each facial type.

For a better diagnosis of maxillary atresia Schwarz's analysis system is commonly used to determine the magnitude of the discrepancy, in millimeters, by measuring the actual arch width versus the ideal width of the upper and lower dentitions, thus indicating whether there is more need for anterior or posterior expansion.¹²

Arch morphology can assume different forms given their relationship with face width. Brachyfacials feature a larger transverse axis than do dolichofacials, whose faces are longer and narrower.⁴

The combined analysis of models and facial pattern can assist in choosing the mechanical procedure to be adopted by professionals, thereby optimizing the chances of a successful treatment.

By analyzing the maxilla transversely using Ricketts analysis and Schwarz's analysis, we realized it is possible to contribute with more evidence to orthodontic treatment diagnosis and planning, thereby increasing the likelihood of stability and successful results.

OBJECTIVE

The purpose of this study was to employ Ricketts vertical growth (VERT) analysis and Schwarz's model analysis to evaluate:

- The percentage of maxillary atresia in the dolichofacial, mesofacial and brachyfacial

facial types.

- Gender dimorphism, considering these facial types.
- Association of atresia with these facial types.

MATERIAL

Initially, our sample consisted of 258 lateral cephalometric radiographs. When performing cephalometry using Ricketts (VERT) analysis we selected 150 lateral cephalometric radiographs, i.e., 50 of brachyfacials, 50 of mesofacials and 50 of dolichofacials. Inclusion criteria required that all subjects should have complete permanent dentition with no agenesis, supernumerary teeth, extractions or extensive restorations.

The sample also comprised 150 stone casts of maxillary arches of 150 Caucasian individuals of both genders, aged 14 years to 18 years and 11 months, regardless of malocclusion type.

The models were analyzed using Schwarz's analysis to determine the extent of maxillary atresia.

METHODS

On the lateral cephalometric radiographs we highlighted the landmarks to perform Ricketts' (VERT) analysis and determine the facial pattern of each individual in the sample.

The following measurements were evaluated (Fig 1, Tables 1 and 2): lower facial height (angle formed by lines Xi-ENA and Xi-Pm), facial axis (posterior angle formed by the basion-nasion line and Pt-Gn), facial depth (angle formed by the intersection of the facial and Frankfurt planes), mandibular plane angle (formed by the intersection of the Frankfurt and mandibular planes), and the mandibular arch [obtained by extending the Xi-Pm and Xi-DC lines (condyle axis)]. With the resulting measurements we calculated the VERT index using the age standard, obtained according to the growth prediction method used by Ricketts to determine normal values for 9 year-old children.

The cephalometric analysis was performed

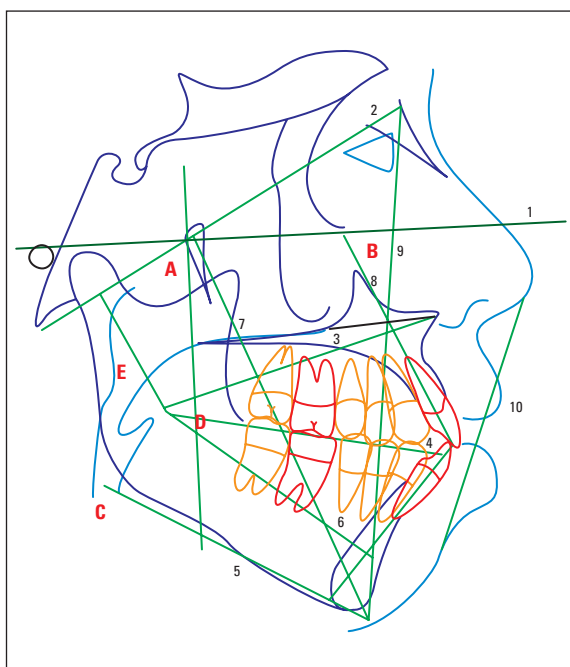


FIGURE 1 - Ricketts cephalometric analysis with lines, planes and angles in the CFX 2000 software.

Angles	
A	Lower facial height
B	Facial axis
C	Facial depth
D	Mandibular plane angle
E	Mandibular arch

TABLE 1 - Ricketts' VERT angles.

Lines and Planes	
1	Horizontal Frankfurt plane
2	Cranium-base plane
3	Xi-ENA line
4	Occlusal plane
5	Mandibular plane
6	Axis of the mandibular body
7	Facial axis
8	Long axis of the upper incisors
9	Facial plane
10	Aesthetic plane (line E)

TABLE 2 - Lines and planes in Ricketts' cephalogram.

in a Radiology Center with the aid of a computer program (CFX 2000, Cuiabá, Mato Grosso, Brazil).

In maxillary arch dental casts a pencil was used to mark landmarks on the occlusal surfaces of the following teeth: distal fossae of the first premolars and distal fossae of the first molars (Fig 2).

A bow divider was positioned over the landmarks on the first right and left premolars and subsequently, on the landmarks of the first right and left molars (Fig 5). The measurements (in mm) were recorded. With this procedure we obtained the transverse measurements between the first premolars and first molars in order to determine the presence of maxillary atresia.

Using a bow divider we measured the mesio-distal widths of the central and lateral maxillary incisors (in mm) (Fig 3 and 4).

The sum total of the mesiodistal diameters of the four incisors was represented by SI. The standard formulas of Schwarz used to compare models and cephalometric radiographs were: SI+6 = ideal premolar width and SI+12 = for molars (for leptoprosopics or dolichofacials), SI+7 = ideal premolar width and SI+14 = for molars (for mesoprosopics or mesofacials), SI+8 = ideal premolar width and SI+16 = for molars (for eurioprosopics or brachyfacials).

The value of SI, added to the value for each facial type, resulted in the ideal width of the transverse distances between first maxillary premolars and first maxillary molars.

Ub and um acronyms were used: the optimal distance measured in a linear fashion directly on the arch between the distal fossae of the first premolars was represented by ub and the ideal arch distance between the central fossae of the first molar was defined as um.

The actual distances between the distal fossae of the first premolars and the distal fossae of the first molars were measured with a bow divider.

The actual values were subtracted from the ideal values. When ub and um were identical in



FIGURE 2 - Landmarks (distal fossa of the first premolars and distal fossa of the first upper molars).



FIGURE 3 - Measurement of mesiodistal widths of upper central incisors.

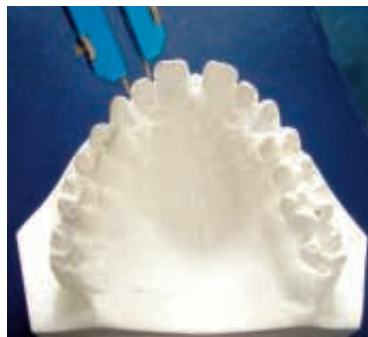


FIGURE 4 - Measurement of mesiodistal widths of upper lateral incisors.



FIGURE 5 - Bow divider measuring the actual inter first premolar and intermolar widths.



terms of discrepancies, it indicated that they required identical lateral expansion of the maxillary arch, when discrepancy $ub > um$ it indicated that it required further anterior lateral expansion, and when discrepancy $ub < um$ it indicated that it required more posterior lateral expansion. All of these results were defined as maxillary atresia.

On the other hand, when the two discrepancies equaled zero, or when the actual distance was greater than the ideal distance, such discrepancies were not defined as maxillary atresia.

To investigate the association of atresia and gender with facial type the Pearson's chi-square test was used. For the comparison between the

TABLE 3 - Facial types and atresia.

Facial Types	Atresia		Total (%)
	Yes (%)	No (%)	
Dolichofacial	32 (64.00)	18 (36.00)	50 (100.00)
Mesofacial	26 (52.00)	24 (48.00)	50 (100.00)
Brachyfacial	29 (58.00)	21 (42.00)	50 (100.00)
Total	87 (58.00)	63 (42.00)	150 (100.00)

mean deviations of the premolars and molars in relation to gender for each facial type the Student's t test was used when the data approached a normal distribution (Shapiro-Wilk test) and the Mann-Whitney U test was used for data without normal distribution. $P < 0.05$ values were considered significant.

As reference the computer software Statistica (version 6, from StatSoft Inc., 2001, www.statsoft.com) was employed.

The presence of maxillary atresia in the sample consisted of 64% in dolichofacials, 58% in brachyfacials and 52% in mesofacials.

No evidence was found ($p = 0.4776$) of any association between atresia and facial type (Table 3).

Regarding gender dimorphism, however, Table 4 shows that the presence of atresia in men is proportionally higher in dolichofacials ($p = 0.0455$), while women, as shown in Table 5, did not show different proportions ($p = 0.5229$).

DISCUSSION

In this study we found 32 dolichofacial individuals with maxillary atresia, 26 mesofacials with maxillary atresia and 29 brachyfacials with maxillary atresia (Fig 6) in a total of 50 individuals for each facial type. We found that 64% of dolichofacials, 52% of mesofacials and 58% of brachyfacials presented with maxillary atresia. However, there was no evidence indicating that maxillary atresia is in any way associated with facial type. These results confirm findings showing no statistically significant differences

TABLE 4 - Atresia in males and facial types.

Facial Types	Male Atresia		Total (%)
	Yes (%)	No (%)	
Dolichofacial	19 (70.37)	8 (29.63)	27 (100.00)
Mesofacial	10 (38.46)	16 (61.54)	26 (100.00)
Brachyfacial	11 (44.00)	14 (56.00)	25 (100.00)
Total	40 (51.28)	38 (48.72)	78 (100.00)

TABLE 5 - Atresia in females and facial types.

Facial Types	Female Atresia		Total (%)
	Yes (%)	No (%)	
Dolichofacial	13 (56.52)	10 (43.48)	23 (100.00)
Mesofacial	16 (66.67)	8 (33.33)	24 (100.00)
Brachyfacial	18 (72.00)	7 (28.00)	25 (100.00)
Total	47 (65.28)	25 (34.72)	72 (100.00)

between the three facial types in a study⁷ that used transverse maxillary measurements. A later study⁸ eventually found no correlation between the asymmetry of the maxillary hemiarches and the three facial types, and no statistical difference between the asymmetries.

By comparing Pont's index with mesofacials and dolichofacials, no differences were found in the interpremolar and intermolar widths associated with the facial types. These findings, however, disagreed with the report⁵ in which the transverse measurements were correlated with the mandibular plane angle because it was found that any increase in this angle (in dolichofacials) contributed to a higher incidence of atretic arches. It was also observed that in dolichofacial individuals with nasal obstruction there was a greater prevalence of maxillary atresia.⁹

When distributing the sample by gender (Figs 7 and 8) we found that 51.28% presented with maxillary atresia with a significant proportion of dolichofacials (70.37%). This disagrees with the study¹ in which the Class I and Class II male dolichofacial groups had significantly increased interpremolar and intermolar widths

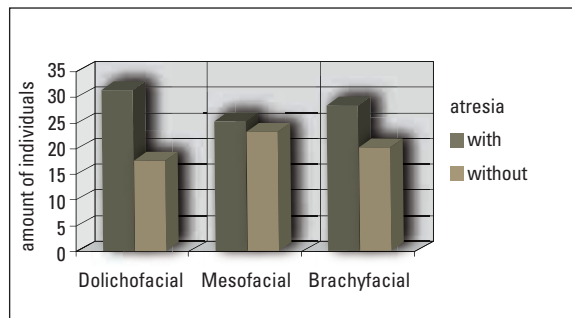


FIGURE 6 - Association of maxillary atresia with facial type.

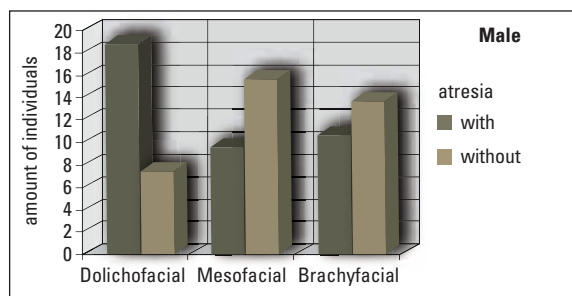


FIGURE 7 - Association of maxillary atresia with facial types in males.

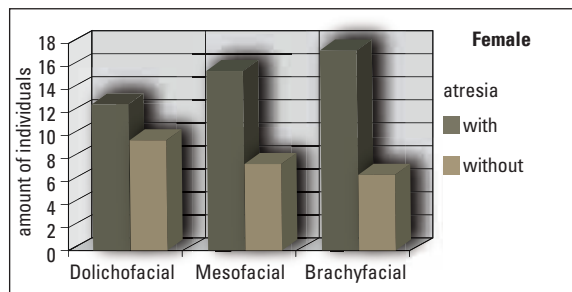


FIGURE 8 - Association of maxillary atresia with facial types in females.

when compared with females. The transverse, intercanine, interpremolar and inter-first-molar dimensions of the male patients exhibited higher values than females.²

A total of 65.28% of female patients had maxillary atresia, although different proportions were not found in terms of facial types, which disagrees with a study⁷ which found a statistically

significant difference when comparing the maxilla of the mesofacial and dolichofacial groups (males and females). The male group showed larger dimensions than the female, while in brachyfacials no significant differences were found.

A thorough analysis of the three facial types disclosed that 62.28% of females and 51.28% of males presented with maxillary atresia. No different proportions were found between the genders.

Regarding the presence of maxillary atresia associated with gender,¹¹ the results confirmed the aforementioned study since we demonstrated that there is a difference in maxillary interpremolar and intermolar widths, which are smaller—indicating maxillary atresia—for both males and females, with no differences between them.⁶

Therefore the study sample did not show an association between maxillary atresia and facial type, but in dolichofacial males, where a statistically significant value was found, it became clear that measuring the transverse width of the maxilla—in both genders—is of paramount importance since it contributes to diagnosis and planning, thereby avoiding unnecessary expansion and ensuring improved orthodontic treatment results.

CONCLUSIONS

The results and discussion of this study indicate that:

1. In our sample, 64% of dolichofacials, 58% of brachyfacials and 52% of mesofacials presented with maxillary atresia.

2. There was no gender dimorphism in terms of facial types and presence of atresia, but in males the percentage of dolichofacials presenting with atresia was proportionally higher. Women, on the other hand, did not show different proportions between facial types.

3. No association was found between maxillary atresia and facial types.

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Possible etiological factors in temporomandibular disorders of articular origin with implications for diagnosis and treatment

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Abstract

The authors reviewed the factors involved in the etiology, diagnosis and treatment of temporomandibular joint disorders (TMD). Although essential, specific criteria for inclusion and exclusion in TMD diagnosis have shown limited usefulness. Currently, the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) offer the best evidence-based classification for the most common TMD subgroups. The RDC/TMD includes not only methods for physical diagnostic classification, comprised in Axis I, but also methods to assess the intensity and severity of chronic pain and the levels of non-specific depressive and physical symptoms, in Axis II. Although historically malocclusions have been identified as risk factors for the development of TMD—including those predominantly joint-related—in many cases the association established between these variables seems to have taken opposite directions. Regarding internal TMJ derangements, the results of studies on the induced shortening of the mandibular ramus, secondary to anterior articular disk displacement, indicate that repositioning the displaced disk in children or young adolescents may make more sense than previously imagined. The therapeutic use of dietary supplements, such as glucosamine sulfate, seems to be a safe alternative to the anti-inflammatory drugs commonly used to control pain associated with TMJ osteoarthritis, although evidence of its effectiveness for most TMD patients has yet to be fully established.

Keywords: Temporomandibular disorders. RDC/TMD. Disk displacement. Osteoarthritis. Malocclusion.

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INTRODUCTION

Temporomandibular disorders (TMD) refers to a set of conditions that affect the masticatory muscles and/or the temporomandibular joint (TMJ).³⁰ These conditions have failed to demonstrate a common etiology or biological basis in terms of clear signs and symptoms and, therefore, are considered a heterogeneous group of health problems related to chronic pain. Characteristic symptoms such as muscle and/or joint pain and/or pain on palpation, limited mandibular function and joint noises may be prevalent in isolation or in association, with a prevalence of up to 75% in the adult population.¹⁵ Nevertheless, the emergence of some symptoms, such as joint noises, does not appear to be related—in the majority of the population—to pain or other important risk factors that require treatment.

Epidemiological studies suggest that the prevalence of symptoms such as pain and restricted movement range from 5-15%, with most cases occurring in young adults aged between 20 and 40 years, especially in females.¹⁵ The low prevalence of TMD among older age groups, as seen in cross-sectional and longitudinal studies,¹⁸ is consistent with the typically limiting nature of the symptoms.

The current classification is largely descriptive, based more on the presence of signs and symptoms than on etiology, mainly due to the fact that a full understanding of the relationship between etiological factors and pathophysiological mechanisms has not yet been achieved. From a clinical standpoint, however, it is probably irrelevant to extend the division of so-called diagnostic subgroups if all disorders within the same subgroup can be controlled using similar therapeutic procedures.

Therefore, specific inclusion and exclusion criteria for the diagnosis of these disorders would only prove crucial if tested to determine their validity. Currently, the Research Diagnostic Criteria for Temporomandibular Disorders

(RDC/TMD) provides the best evidence-based classification for the most frequent TMD subgroups,⁶ i.e., those subgroups which experts now agree are different, based on criteria that can be replicated and scientifically evaluated. Thus, the RDC/TMD, a dual axis diagnosis and classification system designed for clinical research on TMD, comprises methods for the physical classification of TMD diagnoses (Axis I) as well as methods to assess the intensity and severity of chronic pain and levels of non-specific depressive and physical symptoms (Axis II). RDC/TMD reliability has been tested and found to be satisfactory in adult populations,^{7,8} whereas in children and adolescents²⁹ its validity and clinical utility has been demonstrated for Axis I but not completely for Axis II (although extensive studies by the National Institutes of Health/NIH are currently well underway to examine the validity of all RDC/TMD components).

RDC/TMD Axis I addresses the physical conditions of TMD and aims to establish standardized diagnostic criteria for use in scientific research. The suggested system is hierarchical, allowing not only group diagnosis but also the possibility of multiple diagnoses for the same individual. It is thus divided into three major groups representing the vast majority of clinical TMD cases, i.e.: myofascial pain; articular disk displacement; and arthralgia, osteoarthritis and osteoarthritis (Table 1).

The purpose of this study was to address possible etiologic factors involved in the development of temporomandibular disorders of articular origin (groups II and III according to the RDC/TMD) and suggest implications for diagnosis and treatment.

INTERNAL TMJ DERANGEMENTS

Internal TMJ derangement is an orthopedic term defined as a mechanical failure related to improper positioning of the TMJ articular disk combined with an interference in normal

TABLE 1 - Categories of clinical TMD conditions according to the RDC/TMD.

I - Muscular Diagnoses	
a	myofascial pain
b	myofascial pain with limited opening
II - Disk Displacement	
a	disk displacement with reduction
b	disk displacement without reduction and with limited opening
c	disk displacement without reduction and without limited opening
III - Arthralgia, osteoarthritis and osteoarthritis	
a	arthralgia
b	temporomandibular joint (TMJ) osteoarthritis
c	temporomandibular joint (TMJ) osteoarthritis

mandibular movements. Articular disk displacement is only a subset of these disorders. When it is called articular disk displacement with reduction, it can be recognized by a 'pop' or 'click' sound in opening and closing the mouth, which only subsides when the mouth is open and maintained at maximum protrusion (RDC/TMD Axis I, Group IIa).

Patients presenting with articular disk displacement have been characterized in terms of occlusion by the presence of unilateral posterior crossbite and long shifts from centric relation (CR) to maximal habitual intercuspation (MHI).²⁶ This correlation, however, was established without sufficient and unequivocal evidence to support the fact that this malocclusion is a risk factor for disk displacement.

Whereas the anterior articular disk displacement asymptomatic and unaccompanied by any other TMD indication (RDC/TMD Axis I, Group IIa) is quite common, with a prevalence of 20-35% of the population, on the other hand, disk displacement without reduction—which need not necessarily to be associated with pain, but may be associated with limitations in mouth opening (RDC/TMD Axis I groups IIb

and IIc)—is relatively rare, with occurrence frequency ranging from 1-5% according to studies conducted in TMD clinics around the world.³⁰

In some animal studies, where anterior displacements of the articular disk were surgically created in rabbits—keeping the ligament intact in the posterior condyle—their mandibles became significantly smaller in the side where the disk had been displaced, resulting in a midline shift in the affected side. Mandibular asymmetry was not observed in the group that had their articular disk displaced.¹⁶ These results suggest that displacement of the articular disk may precede the development of mandibular asymmetry and can therefore be considered as a risk factor for the development of transverse malocclusion. Whether or not this sequence of events is relevant to the growth and development of the human mandible has not yet been established.

For appropriate treatment protocols to be implemented, however, it is first necessary to determine under what conditions and for which individuals it might prove wise to control and prevent these diseases. Future investigations are required, preferably focusing on the study of the biomechanical and biochemical events that can trigger disk displacement, such as changes in joint lubricating,^{22,23} to determine whether there are specific conditions for the emergence of specific malocclusions.

Biomechanical analyses of TMJ hard and soft tissues have revealed that these tissues are normally capable of withstanding and adapting to the functional loads and pressures that occur during physiological mandibular movement. These tissues, however, cannot withstand compression for a long period of time, such as that associated with clenching in some individuals and at certain levels.²²

In assessing the levels of intra-articular pressure in the TMJ of awake patients undergoing arthrocentesis procedures, Nitzan²² found that voluntary clenching produced high levels of

intra-articular pressure (as high as 200 mm Hg). Intra-articular pressure above 40 mmHg exceeds peripheral capillary pressure and can cause temporary intra-articular hypoxia followed by re-oxygenation as soon as the compression subsides, resulting in the release of free radicals.

A variety of effects caused by free radicals in articular tissue has been described²², including the degradation of hyaluronic acid, which, once degraded, loses the ability to inhibit enzyme phospholipase A2 and break the active surface of phospholipids, which are primarily responsible for the process of TMJ lubrication. Potentially, any increase in friction accompanied by a lack of proper lubrication is aimed at preventing the smooth functioning of the articular disk in conjunction with the mandibular condyle during normal functional movements. This condition may hypothetically trigger the anterior displacement of the articular disk, as described in detail by Nitzan²³. However, these hypotheses have not hitherto been scientifically confirmed.

Theories and clinical observation have ascribed to articular disk displacement the occurrence of joint pain, limited mandibular movement, joint noises and degenerative TMJ changes. These reports are not at present supported by longitudinal data of any kind and suggest the possibility that the articular disk effectively protects the underlying tissues and that its displacement might expose these tissues to an additional, excessive pressure, thereby causing degenerative changes. This assumed sequence of events has led to the use of surgical procedures seeking to restore normal mandibular anatomy and movements, often resulting in serious complications²⁰ and eventually forcing professionals to question their belief in a necessary relationship between articular disk displacement and TMD related pain.⁵

Clinical observation has shown that articular disk displacement may be present in asymptomatic as well as symptomatic patients.¹⁴

Likewise, the drainage of the upper TMJ compartment during arthrocentesis—in the presence of articular disk displacement without reduction—proved, in the short term, to be able to relieve pain and restore function without modifying the mandibular relationship between condyle and articular disk.²⁴

Thus, as the symptoms associated with disk displacement are not always the outcome of this internal TMJ derangement, the concept of second stage therapy—whereby irreversible changes such as occlusion adjustment, prosthetics, orthodontics or orthognathic surgery are indicated—does not appear justified at this time².

TMJ DEGENERATIVE CHANGES

TMJ degenerative changes are characterized by the presence of clinical signs of continuous crackling noises (crepitus) in the joint. According to the RDC/TMD, crackling may be accompanied by arthralgia. It is named osteoarthritis or, in the absence of pain, osteoarthrosis.⁶ Temporomandibular arthralgia is characterized by spontaneous pre-auricular pain or palpation and/or function induced pain, which is occasionally referred to the temporal region.

Patients with osteoarthritis are more consistently characterized by long shifts from CR to MHI, increased overjet and a tendency towards anterior open bite. An increased risk for these disorders is predominantly associated with extremes of these conditions.²⁶ Practitioners, however, are confronted with a dilemma to determine whether these malocclusions are etiological factors or consequences of dysfunctional joint remodeling.

It should be underscored that while osteoarthritis is a prevalent joint disease affecting multiple joints in the body with increasing prevalence in old age, TMJ osteoarthritis is a rare disorder according to epidemiological studies. Spontaneous pain in the TMJ decreases in prevalence with advancing age, especially in men over 55-60 years of age, where the prevalence of TMJ pain is

extremely low. The possible relationship between osteoarthritis and anterior open bite does not seem to be frequent but may be a clinical finding that does not necessarily correlate to TMJ pain.

Morphological changes in the TMJ that are not associated with any significant change in joint dynamics or occlusion are features of functional remodeling. This remodeling becomes dysfunctional when it adversely affects mechanical joint function or occlusion and is therefore characterized by reduced condyle head volume, ramus size decrease, progressive mandibular retrusion in adult patients or perhaps a reduction in growth rate between children. This condition can be generated by excessive mechanical stress applied to or sustained by joint structures to the extent that the pressure exceeds the joint's ability to adapt to such changes.¹

Again, although there is radiological evidence of extensive TMJ remodeling, this remodeling may be within a normal biological variation because the occurrence of pain or TMJ pathology requiring treatment is a relatively rare phenomenon in older people.

In some cases, extensive remodeling of the mandible can lead to occlusal instability reflected in open bite, increased overjet and sometimes, in cases where the mandibular muscles manage to secure an MHI position, an increase in the distance between this position and the so-called centric relation position. These relations were demonstrated by Pullinger and Seligman,²⁶ although the hypothesis that the degenerative process is an etiological factor for malocclusion still remains inconclusive.

Multiple variables, including genetic and environmental factors, such as behaviors or harmful breathing habits, have been shown to influence facial growth rate.¹² The data mentioned above suggest that dysfunctional remodeling can also produce defects in mandibular growth, which together with the other variables mentioned, could be contributing factors to the final mandibular

position and may cause specific malocclusions, such as, for example, anterior open bite.

The balance between anabolic and catabolic events appears to be highly individual and subject to a wide range of functional and genetic factors.¹⁷ There is a need, however, to enhance the understanding of normal, biological and biomechanical TMJ function, including the identification of variables associated with changes and increases in joint pressure levels. These variables can lead to microtraumatic stimuli to the tissue and, consequently, can trigger a series of events that could lead to degeneration and joint pain.

Proinflammatory cytokines have been isolated in samples of synovial fluid drawn from the TMJ of symptomatic patients, since recent evidence shows that free radicals can stimulate the synthesis of cellular proteins by increased expression of specific genes.²⁷

The cytokines predominantly involved in intra-articular degenerative processes are interleukin-1 beta (IL-1beta), interleukin-6 (IL-6) and tumor necrosis factor alpha (TNF-alpha).²¹ Together, these cytokines stimulate the breakdown of arachidonic acid thus causing a major proinflammatory effect and triggering the synthesis and activation of metalloproteinases, which are responsible for the breakdown of extracellular structure, accelerating the joint degeneration process.

THERAPEUTIC IMPLICATIONS

As regards therapies, clinical trials are especially useful and, therefore, required by the U.S. NIH as the gold standard to evaluate treatment effectiveness. Clinical trials play an even more important part in conditions such as TMD, where pain intensity can vary over time and placebo and nonspecific effects can be just as important as in other chronic pain conditions.¹³

Dworkin et al^{8,9} conducted randomized clinical trials which compared standard, conservative TMD treatment with self-control interventions and cognitive-behavioral techniques.

After monitoring the groups for one year, both showed improvements in all clinical categories as well as those observed by the patients themselves. Patients undergoing alternative treatment programs, however, exhibited a more satisfactory response, defined as greater reduction in (a) pain intensity, (b) level of interference in daily activities and (c) number of masticatory muscles painful to palpation.

These results indicate that the use of psychosocial assessment criteria such as, for example, those included in Axis II of the RDC/TMD, can contribute to the success of clinical decision making regarding the control of TMD, especially muscle generated TMD. Conversely, predominantly articular disorders appear to suffer greater influence of localized phenomena.

In light of the wide array of studies that evaluate the efficacy of stabilizing plates in TMD pain control, Ekberg et al¹¹ argues that the differences raised in these studies may be due to the inclusion of different painful TMD subgroups, such as myofascial pain³ and temporomandibular arthralgia.¹¹ The latter group has been shown to achieve significant therapeutic results in short¹¹ and long-term¹⁰ follow-up.

In the study by Dao et al³, a randomized group used stabilizing plates only in the dental office during consultations. No significant effect was found on any clinical parameter that could distinguish it from other groups in the randomized study, i.e.: one group that used a stabilizing plate 24 hours a day and another that used a plate with no flat occlusion surface. In a randomized clinical trial scheduled for publication in the near future, a comparison was made between a group using a flat acrylic plate, another using a prefabricated soft device and a control group with no plates. No difference was found between the groups in course of pain, mandibular function or emergence of side effects after a one year follow-up.

Flat surface stabilizing acrylic plates may,

however, continue to be recommended for the treatment of TMJ arthralgia, although they still require further clarification as to the physiological mechanisms involved in their therapeutic effect, such as the reduction of parafunction-related mechanical stress.

Another study²² that evaluated intra-articular pressure during functional and parafunctional movements also investigated 22 patients for intra-articular pressure against an interocclusal device, which uniformly increased the occlusion plane, reducing the force applied to the TMJ. A decrease in intra-articular pressure was observed at around 80% within a range of 0-40 mmHg.

The functional integrity of articular cartilage is determined by the balance between the synthesis of extracellular structure by chondrocytes and the breakdown of said structure. Glucosamine is normally found in human tissues and is directly involved in the synthesis of substances that are essential to maintaining joint function integrity, such as glycosaminoglycans, proteoglycans and hyaluronic acid,¹⁹ although the precise mechanism behind this function has not yet been determined.

In osteoarthritis, this balance is disrupted by the increased presence of enzymes such as metalloproteinases, which are capable of breaking down the extracellular structure. Preliminary results of laboratory experiments⁴ indicate that the dietary supplement glucosamine sulfate can stimulate the protein levels of the extracellular structure while simultaneously inhibiting the enzymatic production and activity of metalloproteinases in the chondrocytes of osteoarthritic joints.

Glucosamines were evaluated for their effectiveness in reducing pain associated with osteoarthritis in joints other than the temporomandibular joint and for its potential to change the course of the disease. In short-term clinical trials, symptom improvement was achieved in patients with osteoarthritis as well as promising results in altering disease progression after

three years of follow-up,¹⁹ although these findings have not yet been carefully evaluated.

Thie et al²⁸ compared the therapeutic potential of glucosamine sulfate with ibuprofen in patients with TMJ osteoarthritis. Both groups showed a significant improvement in the variables studied when these data were compared with those at the beginning of treatment. A comparison between these two groups showed that during the time period that patients used glucosamine sulfate they had a significant pain reduction in the affected joint and a decreased influence of pain on the patients' daily activities, thus reducing their related disability.

The specific effects of pain relief associated with the use of glucosamine sulfate are probably due to their anabolic properties in the cartilage. These effects, which change the degenerative condition of the disease, are not observed with the use of routine analgesics and can yield substantial benefits.

CONCLUSIONS

Although historically malocclusions have been identified as risk factors for the development of TMD—including those predominantly joint-related—in many cases the association

established between these variables seems to wide of the mark. Thus, prospective clinical and laboratory investigations addressing issues related to the etiology of these conditions, especially in the early stages of development, can shed light on the future of therapy.

According to Legrell and Isberg,¹⁶ the findings on induced mandibular ramus reduction—secondary to articular disk displacement—indicate that the repositioning of the disk in children and young adolescents may make more sense than previously believed.

In view of the above, the use of orthopedic devices for mandibular advancement, such as the Herbst appliance, which has demonstrated effectiveness in improving the prior positioning of disks displaced in the early stages of this process,²⁵ should be tested by means of appropriate randomized clinical trials.

Whereas the therapeutic use of dietary supplements such as glucosamine sulfate seems to be a safe alternative to the use of anti-inflammatory drugs commonly used to control pain associated with TMJ osteoarthritis—in the same fashion as stabilizing plates—the evidence of their effectiveness for most TMD patients has not yet been fully established.

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Factors predisposing 6 to 11-year old children in the first stage of orthodontic treatment to temporomandibular disorders

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Abstract

Introduction: The etiology of temporomandibular disorders (TMD's) is currently considered multifactorial, involving psychological factors, oral parafunctions, morphological and functional malocclusion. **Objectives:** In keeping with this reasoning, we evaluated children who seek preventive orthodontic treatment, to better understand their grievances and to assess the prevalence of TMD signs and symptoms in these patients. **Methods:** Two examiners evaluated 65 children aged 6 to 11 years. **Results:** In our sample, bruxism featured the highest prevalence rate, whereas atypical swallowing displayed the highest rate among predisposing factors. **Conclusion:** We therefore recommend that the evaluation of possible TMD signs and symptoms in children be adopted as routine in the initial clinical examination.

Keywords: Temporomandibular joint disorders/diagnosis. Temporomandibular Joint Dysfunction Syndrome. Epidemiology. Children.

INTRODUCTION

Temporomandibular disorder (TMD) is a generic term that encompasses signs and symptoms involving the masticatory muscles, temporomandibular joint and associated structures. TMD etiology is currently considered multifactorial, involving psychological factors, oral

parafunctions, morphological and functional malocclusion. There is growing evidence that temporomandibular joint (TMJ) dysfunctions may originate in early craniofacial development and that early signs and symptoms of TMJ problems are frequently associated with morphological malocclusions.¹⁰

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TMJ dysfunction studies have always been more geared towards adult diagnosis and treatment, with all this adult information being extrapolated to children. Although some conditions are similar major differences exist, such as the stage of craniofacial growth and development and the extreme ability exhibited by children in adapting to changes in the masticatory system.¹¹ Some conditions such as malocclusion, bruxism, sucking habits and psychological behavior may be related to TMJ dysfunction symptoms and signs. The dysfunction is more common in tense/nervous children. Recurrent headaches may be indicative of this problem, whereas certain malocclusions and sucking habits can cause dysfunction symptoms.⁴

Open bite patients have been positively associated with muscle tension, and patients with crossbite, negative or excessively positive overjet are related to joint noises. These occlusal characteristics have a statistically significant correlation with TMD signs and symptoms, and this correlation is greater in young adults.¹³

Professionals are strongly advised to perform an anamnesis with all patients who come to the office, regardless of their apparent need or lack of need for treatment, in order to identify subclinical TMD signs and symptoms.

Children evaluations performed by means of a clinical examination and patient history have revealed a 16% to 27% prevalence^{1,2,12} of temporomandibular disorders and the presence of symptoms such as headache, earache and/or tinnitus, and ear clicks in most children,^{2,5,14} as well as a high prevalence of parafunctional habits, especially mouth breathing and bruxism.^{3,15} Therefore, any factor capable of interfering with the optimal functioning of the stomatognathic system can cause the emergence of one or more signs or symptoms.^{2,3}

More recently, it was found that in any given group of children the habit of nail biting (onychophagy) can be found in 47.5% of

the children, the habit of gritting or grinding teeth (bruxism), in 35%, followed by headache (22.5%), TMJ noises (18.7%) and earaches or pain in the TMJ region (13.7%). The most frequently found malocclusions were anterior open bite (56.2%) and posterior crossbite (38.7%).¹⁵

Although the factors underlying these conditions, such as occlusal problems, parafunctions and emotional state are well known, we cannot as yet determine to what extent each of these, alone or in combination, may indicate that the patient will develop temporomandibular disorder. Be it as it may, the examination of children and adults for signs and symptoms of TMJ dysfunction should be adopted as a routine procedure in the initial clinical examination.^{14,15,16}

Therefore, our goal is to contribute to the existing knowledge on TMD in children by monitoring its development in order to better understand its origins and predispositions.

MATERIAL AND METHODS

Our sample consisted of 65 male and female patients whose ages ranged from 6 to 11 years, selected from among the patients applying for orthodontic treatment in the Children's Clinic of the School of Dentistry, UMESP.

To allow us to gather data on the presence of TMD signs, all patients were identified and evaluated by means of a standardized clinical examination. Evaluations were performed by 2 examiners. All examinations were performed at the Clinic of the School of Dentistry, UMESP.

All participants in this study underwent an evaluation that consisted of the following:

- 1) Anamnesis (patient history).
- 2) Clinical Examination.

Anamnesis

Anamnesis or patient history is an interview conducted with the purpose of learning about the patient's symptoms. Since it is a subjective

analysis, which depends on the patient's cognition and his or her age group, the assessment was performed using a literature-based questionnaire¹² administered to the subjects' parents or legal guardians (Table 1).

Methodist University of São Paulo Children's Clinic (2004) Patient history form for TMD diagnosis Name: _____ age _____ Address: _____ Telephone No.: _____	
1) Do you have difficulty opening the mouth?	☐ Yes ☐ No
2) Do you find it difficult to move your mandible sideways?	☐ Yes ☐ No
3) Do you feel any discomfort or muscle pain when chewing?	☐ Yes ☐ No
4) Do you have frequent headaches?	☐ Yes ☐ No
5) Do you feel pain in the neck and/or shoulders?	☐ Yes ☐ No
6) Do you feel earaches or pain near the ear?	☐ Yes ☐ No
7) Have you noticed any noises in the TMJ?	☐ Yes ☐ No
8) Do you consider your bite "normal"?	☐ Yes ☐ No
9) When chewing food, do you use only one side of your mouth?	☐ Yes ☐ No
10) Do you feel pain in your face when you wake up in the morning?	☐ Yes ☐ No
11) Have you ever felt your jaw "lock up" or "dislocate"?	☐ Yes ☐ No
12) Have you ever been treated for unexplained facial pain or any TMJ problem?	☐ Yes ☐ No
13) Do you grind your teeth? (bruxism)	☐ Yes ☐ No

TABLE 1 - Patient history form.

Clinical examination

The physical examination consisted in evaluating the malocclusion features, palpating the masticatory muscles and the TMJ, TMJ auscultation, measuring the degree of mouth opening and observing any midline shifts (Table 2).

Inspection

The clinical examination revealed the morphofunctional characteristics of the occlusion, such as malocclusion classification according to Angle, crossbite, open bite, early tooth loss, tooth crowding, oral habits such as sucking, swallowing and phonation.

Palpation

I) Muscle palpation

The following regions were palpated in a systematic manner: Deep masseter, superficial masseter, anterior and posterior portions of the temporal muscle. Palpation was performed by applying digital pressure, using the middle fingers of the left and right hands and palpating the muscles on both sides simultaneously. Muscle pain on palpation was recorded only if palpation produced a sharp reaction in the patient, or if the patient reported that the palpated area felt distinctly more sensitive than the corresponding structures on the opposite side.

II) TMJ palpation

The temporomandibular joints were palpated laterally, at first with the patient's mouth closed and shortly thereafter, while the patient was opening and closing the mouth. Palpation was performed using the middle fingers of both hands on the lateral portions of the two joints simultaneously. Only the sharp reactions of patients to palpation were recorded.

TMJ auscultation

Joint noises were evaluated without the aid of a stethoscope during the opening and closing

Patient ID _____				
Age _____				
Gender _____				
Address : _____				
Phone No.: _____				
1 - Muscle palpation:				
a - Deep masseter	(0) ____	(1) ____	(2) ____	(3) ____
b - Superficial masseter	(0) ____	(1) ____	(2) ____	(3) ____
c - Anterior temporal muscle	(0) ____	(1) ____	(2) ____	(3) ____
d - Midtemporal muscle	(0) ____	(1) ____	(2) ____	(3) ____
e - Posterior temporal muscle	(0) ____	(1) ____	(2) ____	(3) ____
f - Medial pterygoid	(0) ____	(1) ____	(2) ____	(3) ____
g - Upper lateral pterygoid	(0) ____	(1) ____	(2) ____	(3) ____
h - Lower lateral pterygoid	(0) ____	(1) ____	(2) ____	(3) ____
i - TMJ	(0) ____	(1) ____	(2) ____	(3) ____
2 - TMJ auscultation				
normal ()				
click ()	opening ()	right laterality ()	left laterality ()	protrusive ()
crepitation ()	opening ()	right laterality ()	left laterality ()	protrusive ()
3 - Maximum Opening	>40 mm ____	<40 mm ____		
	pain:	Yes ()	No ()	
4 - Mandibular opening path				
• No shift ()				
• Shift centralized at maximum opening ()		Right ()	Left ()	
• Shift accentuated at maximum opening ()		Right ()	Left ()	

TABLE 2 - TMD physical examination form.

movements of the mouth, as well as the right and left lateral movements and mandible protrusion.

Recording the movement of mouth opening

We used a millimeter ruler (Desetec™) to record the linear measurements of maximum mouth opening, measured from maximum habitual intercuspation (MHI). Maximum mouth opening was measured by instructing patients to open their mouth to the fullest, and by measuring the distance between the incisal edges of the opposite upper and lower incisors.

Patients were inquired whether they felt any pain during these movements, but we only recorded the presence of pain when it was clearly identified by the patient.

During this phase we also noted their mandible opening and closing pattern and only recorded midline shifts greater than or equal to 2 mm.

RESULTS AND DISCUSSION

Data were tabulated and distributed in graphs (Figs 1, 2, 3 and 4) and data prevalence was evaluated using a percentage rate.

The study was conducted with children who applied for orthodontic treatment at the School of Dentistry, UMESP. Sixty-five patients were selected, consisting of 38 female (58.46%) and 27 male (41.54%) subjects.

Among the symptoms reported, headache was the most frequently found (55.38%), corroborating other authors,^{2,3,5} with 38.46% of females

reporting this condition, compared with 16.94% of males. The second most frequent complaint was earache (23.07%). These data are difficult to compare because the concept of headache and earache may be related to other pathologies. This study did not investigate the source of such pain, which can result from a series of problems other than TMJ dysfunction.

The prevalence of tenderness to palpation of masticatory muscles was 52.30%, which is high compared to the findings of Almeida et al.² Twenty percent of the sample exhibited sensitivity in the masseter and 4.61% in the temporal muscle.

Upon lateral palpation, 20% of the patients reported TMJ pain, a finding that was similar to that of Almeida et al.² (21.7%), lower than Guedes and Bonfante⁵ (30%) and higher than Cyrano et al.³ (5.55%).

Joint noises, typical of TMJ dysfunction, affected 16.9% of the sample, i.e., 6 female (9.23%) and 5 male (7.6%) patients.

Bruxism was reported by 38.46% of the sample (21.53% female and 16.9% male subjects). These data are similar to the findings of Cyrano et al.,³ but slightly higher than other studies that found rates ranging between 7% and 20%. Prevalence of this habit was foremost among girls. This finding has been justified by several authors as

being due to the faster development and heightened tension experienced by the female gender.

Similar to other findings, the least frequently reported signs were difficulty in opening the mouth (1.54%) and moving the mandible (3.07%). It is highly likely that the absence of these signs is due to the adaptability of the child at a stage of primary and mixed dentition, when the stomatognathic system is undergoing development and major changes impact on the oral cavity.

Two cases (3%) of mandibular locking were reported. A similar number was found by Almeida et al.² (4%). However, Egermark-Erikson et al.⁴ found luxation or locking in only 1% of 402 children tested.

The mean maximum extent of mouth opening among the children was 45.4 mm, a finding similar to that of Almeida et al.² (43 mm).

As regards the opening movement, 21 patients (32.30%) displayed midline shifts. Seventeen of them (26.15%) centered their upper and lower midlines at maximum opening while 6.15% did not.

Among the risk factors we found a high prevalence of parafunctional habits (57.57%), contradicting reports from other studies. The habit of atypical swallowing was the most common, affecting 38.46% of patients, followed by

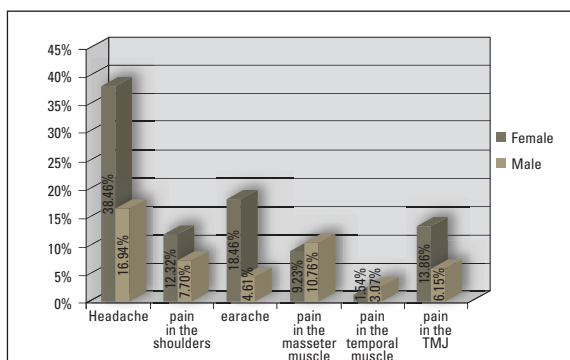


FIGURE 1 - Graphical representation of TMD symptoms.

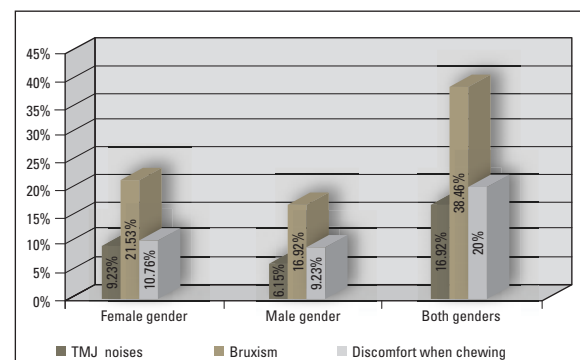


FIGURE 2 - Graphical representation of TMD signs.

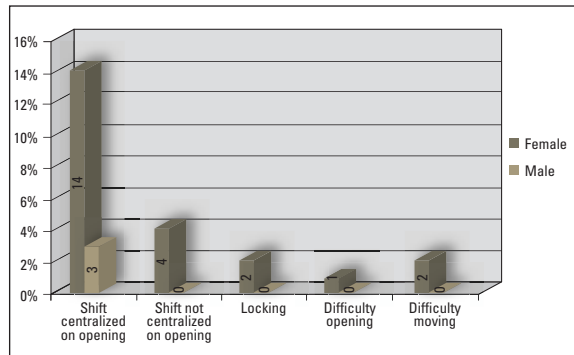


FIGURE 3 - Number of female and male patients with mandibular alterations.

mouth breathing (36.9%) and sucking habits (12%). Although usually not included in TMD studies, these factors deserve special attention because they are linked to the development of malocclusion, which can be correlated with TMD signs and symptoms.

The surveyed data include only TMD predisposing signs and symptoms. The findings of this study should raise dental surgeons' awareness of the need for a detailed patient history (anamnesis) and a thorough review of the stomatognathic system in children—in view of the likelihood of TMD—as well as the need to monitor patients with evidence of any TMJ alterations, thereby preventing the development of severe dysfunction or major sequelae in future.

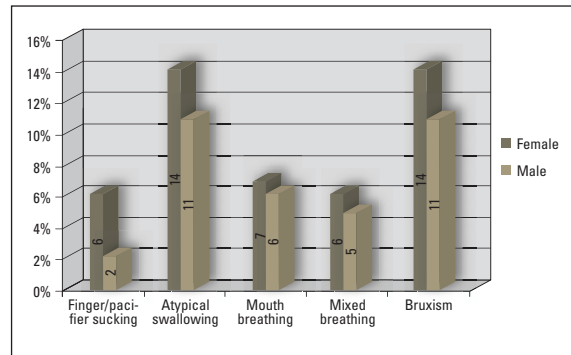


FIGURE 4 - Number of females and males patients with TMD predisposing factors.

CONCLUSIONS

Based on the results of this study we have concluded that because some TMD signs and/or symptoms exhibited high prevalence, it is of paramount importance to evaluate the data with caution to rule out any association with other diseases. Professionals are also advised not to make their final diagnosis based on one single factor since we now know that TMD has a multifactorial etiology.

Bruxism displayed the highest prevalence rate of all signs and atypical swallowing the highest rate among predisposing factors.

It is recommended that the evaluation of possible signs and symptoms of TMD in children be adopted as routine during the initial clinical examination.

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Extraction of upper second molars for treatment of Angle Class II malocclusion

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Abstract

The purpose of this article is to present an alternative approach to the orthodontic treatment of Angle Class II malocclusion. According to a literature review it was observed that the extraction of upper second molars has proven to be a viable alternative for the treatment of this type of malocclusion. This therapeutic option enables faster first molar retraction and requires less patient compliance. However, the level of development, intraosseous position and morphology of the third molar should be carefully evaluated to ensure its correct positioning in place of the extracted second molar. Two clinical case reports will demonstrate that the sequence of diagnosis and treatment used with this mechanics yields satisfactory functional and aesthetic results.

Keywords: Orthodontic treatment. Second molars. Extractions. Class II.

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LITERATURE REVIEW

The extraction of permanent teeth as part of the orthodontic treatment has given rise to conflicting opinions since it was first performed by Angle and Tweed. Currently, the extraction of premolars, especially the first, is a routine part of orthodontic planning. Such tooth extractions are indicated in cases of crowding, biprotrusion and presence of an unsightly profile (when the retraction of anterior teeth is desirable). These teeth are positioned near the center of each arch quadrant and usually near the site of the crowding. Under certain circumstances, however, extracting other teeth may prove more appropriate and convenient.

Molar extractions are not a recent practice. As early as 1939, Chapin⁶ suggested the removal of these teeth as an alternative to premolar extraction. Several authors have recommended the removal of the second molar for the correction of Class II, division 1 malocclusions with excessive buccal inclination of the incisors, no diastema, minimal overjet and the presence of conveniently positioned and shaped third molars.^{3,8} Patients with dolichocephalic facial pattern, a tendency towards vertical growth and the need for first molar retraction particularly benefit from second molar extraction thanks to a decreased likelihood of open bites.²²

Despite clear indications for this treatment approach, some criteria must be satisfied. The presence of third molars is vital and these teeth must feature appropriate size and shape, with crowns partly or wholly formed and cusps clearly identified. Adequate axial inclination is also required to allow for proper tooth eruption. The best age to assess these teeth is between 12 and 14 years when their crowns are almost completely calcified and their position relative to the second molar has been established. The ideal procedure to ensure compliance with these requirements is a radiographic analysis since in most cases third molars have not yet erupted at

the beginning of treatment, thereby rendering impossible any clinical assessment.^{1,7,16,18,20,22,25}

Second molars may also be indicated for extraction in the case of existing pathologies—such as buccal eruption, crown or root anomalies, caries or extensive restorations and enamel defects—and be replaced by healthy third molars.²⁰

Extraction timing

The findings of most studies agree about the right time to carry out the extractions. The best outcomes are achieved when second molars are removed and third molars are in a stage of development where the crown is fully developed, with little or no root formation.^{3,5,7,16,18,20,22,25}

Advantages

Second molar extraction is followed by distalization of the first molars of the same arch to achieve a Class I relationship. Some authors have reported that this distalization movement is rendered easier after second molar extraction.^{18,28}

Besides facilitating first molar distalization, because this is a bodily movement (translation) it requires the delivery of lighter forces.^{2,18} Intraoral mechanics can be used in first molar distalization and rapid correction of molar relationship.¹¹

One of the concerns of orthodontic treatment is with the effects of orthodontic mechanics on the patient's profile. It is a known fact that tooth movement has effect on it, especially after anterior segment retraction or projection. When second molars are extracted, the impact on patient profile is minimal compared with conventional treatments performed with first premolar extraction.^{11,13,15,17,18,20,21,25,26,28}

Some authors, however, have noted the occurrence of upper incisor retraction, causing significant changes and affecting soft tissue profile. They asserted that the upper lips had undergone retraction although the second molars were posteriorly positioned.^{3,24}

Third molar eruption is facilitated by second molar extraction. This fact is widely discussed in the literature and can be regarded as a major advantage of this treatment approach. When the second molar is extracted and the possibility of third molar impaction is decreased, the third molar usually comes into occlusion and in most cases spontaneously assumes a favorable position relative to the first molar.^{3,5,14,17,19,20,22}

One of the goals of any orthodontic treatment is ensuring the stability of the results obtained at the end of therapy. The authors agree that second molar extraction provides stability that is unequaled by other forms of treatment. Since there is no need for space closure in this treatment modality, the issue of space reopening (relapse) in the middle of the arch is successfully addressed.^{14,16,20,21,25,29} Some authors, after comparing groups with and without second molar extraction, ascribed their result stability to the fact that—unlike the non-extraction group—no lower incisor proclination was observed in the extraction group.²⁷

Second molar extraction for the correction of Class II, division 1 malocclusions often streamlines therapy and significantly shortens treatment time by making first molar distalization easier and faster.^{4,9,16,18,28}

Overbite control is facilitated when second molar extraction is performed. The increment pattern of facial height is in opposition to the mechanics deployed, i.e., even though the posterior teeth move distally, facial height is decreased, rather than increased, as would be expected.^{3,28}

Disadvantages

Supraeruption of the second molar can occur while third molar eruption is still on its way. This problem is mainly related to the distal portion of these teeth, which have no contact with the first molar. The use of a fixed orthodontic appliance, a lingual arch or a removable plate can prevent this undesirable lower second molar movement.^{2,9,23}

When orthodontic treatment is completed, the third molar, which will take up the position previously occupied by the extracted second molar, is usually not yet erupted. After the eruption of this tooth, should it be in a position considered less than ideal for a satisfactory occlusion from the functional point of view, resumption of the orthodontic treatment is required in order to ensure successful treatment results.^{3,4,11,13,16,20,21,25,28}

Basdra, Stellzig and Komposch³, after analyzing models of cases treated with second molar extractions, found that all reexamined third molars had erupted with a mesial contact point, adequate mesiodistal axial inclination and no periodontal damage.

Some authors argue that second molar extraction creates space away from the region where crowding is common, and that this might be a disadvantage.^{2,10,21}

Haas¹⁰ remarked that the extraction of these teeth creates much more space than is necessary to solve crowding problems. However, the space created by extraction is not entirely used by first molar distalization. The first molar is moved distally only to the extent that molar relationship is corrected and the remaining space is occupied by the subsequent third molar eruption.^{3,9}

Patient compliance

Patient compliance is of paramount importance during orthodontic treatment. Treatment requires patient participation in all its different aspects and, in cases where maxillary first molar distalization is needed, headgear use requires patient compliance, especially in the early treatment stages.¹³ In view of this factor, some authors have proposed the use of intraoral distalization devices to achieve first molar distalization since these devices do not rely on patient compliance.^{11,22}

However, considering that first molar distalization is easier and faster when extracting the second molar, patient cooperation is needed for only a short period of time.¹⁸

Risks

One of the major risks of this alternative treatment lies in the possible non-eruption of the third molar or its improper root formation.^{2,5,13,18,21,25}

It should be emphasized that predicting third molar eruption with absolute certainty is a daunting task. Moreover, the ideal time to extract the second molar is when the crown of the third molar is fully developed but the root is not formed, which implies the risk of small, too short or malformed roots that can compromise the replacement of the extracted tooth.¹²

Haas¹⁰ found that the third molar may erupt with irregular size and shape. Haas also mentioned the limitation of bone growth in this region as yet another problem arising from second molar extraction.

Contraindications

Contraindications for second molar extraction are as follows: Third molars with small or malformed roots; exceedingly large-sized third molars; missing third molars; the possibility of third molars involving the sinus area; horizontally positioned third molars; congenital absence of premolars or incisors; severe space

deficiency and the possibility of third molar eruption failure. Additionally, patients with severe anterior space deficiency or patients with minimal space problem and patients with pronounced incisor protrusion.^{4,7,20}

CLINICAL CASE STUDY 1

Female patient aged 17 years and 01 month, who sought orthodontic treatment complaining of lack of space for her canines.

Diagnosis

A clinical examination showed a slightly asymmetrical face; lip asymmetry (increased muscle contraction on the left side); lip seal at rest; a low smile line and asymmetry when raising the lips; mesocephalic facial pattern; balanced facial thirds; and convex profile (Fig 1).

An intraoral examination revealed parabolic shaped arches; Class II relationship of molars and canines; 4 mm overjet; 50% overbite; teeth 25 and 34 in crossbite; light curve of Spee; lower midline shifted 0.5 mm to the right; severe crowding in the upper arch (-11 mm discrepancy) and crowding in the lower arch (-5 mm discrepancy) (Fig 2).



FIGURE 1 - Initial facial photographs.



FIGURE 2 - Initial intraoral photographs.

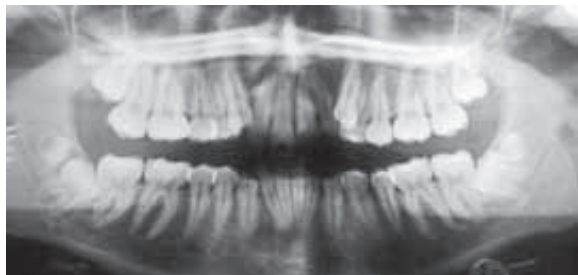


FIGURE 3 - Initial panoramic radiograph.



FIGURE 4 - Initial lateral cephalometric radiograph.

Measurements	Pre-treatment values	Post-treatment values
SNA	84°	81°
SNB	77°	76°
ANB	7°	5°
SND	73°	73°
1.NA	19°	19°
1-NA	4.5 mm	3 mm
1.NB	42°	37°
1-NB	10.5 mm	7 mm
Pog-NB	0	1.5
Pog-1NB	10.5 mm	5.5 mm
1:1	112°	118°
Ocl:SN	22°	22°
GoGn:SN	35°	34°
S – Ls	1 mm	-3 mm
S – Li	1 mm	-2.5 mm
Y axis	58°	58°
Facial Angle	88°	87°
Convexity Angle	17°	9°
Wits	3 mm	1 mm
FMA	29°	24°
FMIA	41°	50°
IMPA	110°	106°

TABLE 1 - Pre and post-treatment cephalometric data of patient (clinical case study 1).

The radiographs confirmed the presence of intraosseous third molars with normal anatomy. The upper third molars had fully formed crowns with two-thirds of root formation. The lower third molars were impacted. Supernumerary teeth were also present (Fourth right and left lower molars, and fourth right upper molar), and visible lack of space for correct positioning of the upper canines (Fig 3).

Cephalometric analysis revealed a skeletal Class II (ANB = 7°; Wits = 3 mm); a predominantly vertical facial growth pattern (Ocl-SN = 22°; GoGn-SN = 35°); mandibular deficiency (SNB = 77°); proclined lower incisors (I.NB = 42°; IMPA = 110°); and dental double protrusion (I-NA = 4.5 mm, I-NB = 10.5 mm) (Fig 4 and Table 1).

Treatment

In order to establish a Class I molar relationship as soon as possible and because the patient did not exhibit any growth potential, we opted for upper second molar extraction to facilitate distalization of the upper first molar and Class II correction.

Additionally, we also extracted the lower third molars that were impacted and the lower supernumerary teeth. We decided against extracting the upper supernumerary molar given the possibility of damage to the third molar when doing so. The extraction of this tooth was postponed to a future, more convenient occasion.

After extraction, the upper first molars were banded and a cervical traction headgear was installed (350 g - 16 h / day) for first molar distalization, which was achieved after a period of four months.

The first upper and lower premolars were extracted to address the severe crowding and the protrusion. Subsequently, brackets were bonded to the lower second premolars, canines and central incisors. Brackets were not bonded to the upper and lower lateral incisors on account

of the crowding. We used 0.016-in Multiloop "Tweed" style archwires to correct canine mesio Buccal inclination.

After alignment and leveling, the canines were retracted with chain elastics. Brackets were then bonded to the lateral incisors followed by realignment and releveling.

Any residual space was then closed by retraction of the upper and lower incisors using rectangular archwires with bull loops.

Twenty-two months after the extraction of the second molars, third molars were erupted and ready for banding or bonding.

After treatment completion, an upper wraparound removable appliance and a fixed lower canine-to-canine lingual arch were installed for retention.

Results

The patient's extraoral aspect remained as it was initially (Fig 5), except for her profile, which had its convexity reduced.

Intraorally, a Class I relationship was achieved for molars and canines as well as appropriate overbite and overjet. The crossbite was corrected, the curve of Spee leveled and the lower midline corrected, with the upper and lower midlines coinciding with the facial midline. Both upper and lower crowding were eliminated (Fig 6).

The radiographs disclosed adequate root parallelism. Moreover, upper third molars were found to be appropriately positioned. At this time the removal of the supernumerary upper molar was performed (Fig 7).

From a cephalometric standpoint, the skeletal pattern was maintained. The most significant changes occurred in the upper and lower incisors and lips. The upper and lower incisors were retracted. Thus, correction of the dental double protrusion was achieved by moving the incisors to their original position. Due to these dental changes, the lips were retracted, reducing the patient's profile convexity (Figs 5 and 8 and Table 1).



FIGURE 5 - Final facial photographs.



FIGURE 6 - Final intraoral photographs.



FIGURE 7 - Final panoramic radiograph.



FIGURE 8 - Final lateral radiograph.

CLINICAL CASE STUDY 2

Male patient aged 16 years and 05 months, who sought orthodontic treatment complaining of unsightly smile caused by the position of the canines.

Diagnosis

A clinical examination revealed a symmetrical face. The patient's nearly expressionless smile reduced his upper incisor exposure. He had a brachycephalic facial pattern, well balanced facial thirds and convex profile (Fig 9).

The intraoral examination revealed parabolic shaped arches; Class II canine and molar relationship; 5.5 mm overjet; 30% overbite; reverse crossbite between teeth 17 and 47; mild curve of Spee; lower midline shifted 0.5 mm to the left; severe crowding in the upper arch (discrepancy of -11 mm) and moderate crowding in the lower arch (discrepancy of -6 mm) (Fig 10).

The radiographs confirmed the presence of intraosseous third molars with normal anatomy.

The upper third molars had fully formed crowns with two-thirds of root formation. Space was also lacking for the correct positioning of the upper canines (Fig 11).

The cephalometric analysis revealed a skeletal Class I ($ANB = 2^\circ$; $Wits = 2$ mm), horizontal facial growth pattern ($GoGN-SN = 24^\circ$); mandibular deficiency ($SNB = 78^\circ$) compensated by maxillary retrusion; incisor proclination ($I.NB = 33^\circ$; $IMPA = 110^\circ$); and dental double protrusion ($I-NA = 10$ mm; $I-NB = 6$ mm) (Fig 12 and Table 2).

Treatment

Since the patient had low growth potential, we opted for extracting the upper second molars to facilitate first molar distalization and Class II correction.

After extraction, the upper first molars were banded and a cervical traction headgear was installed (350 g - 16 h / day) for first molar distalization, which was achieved after a period of five months.

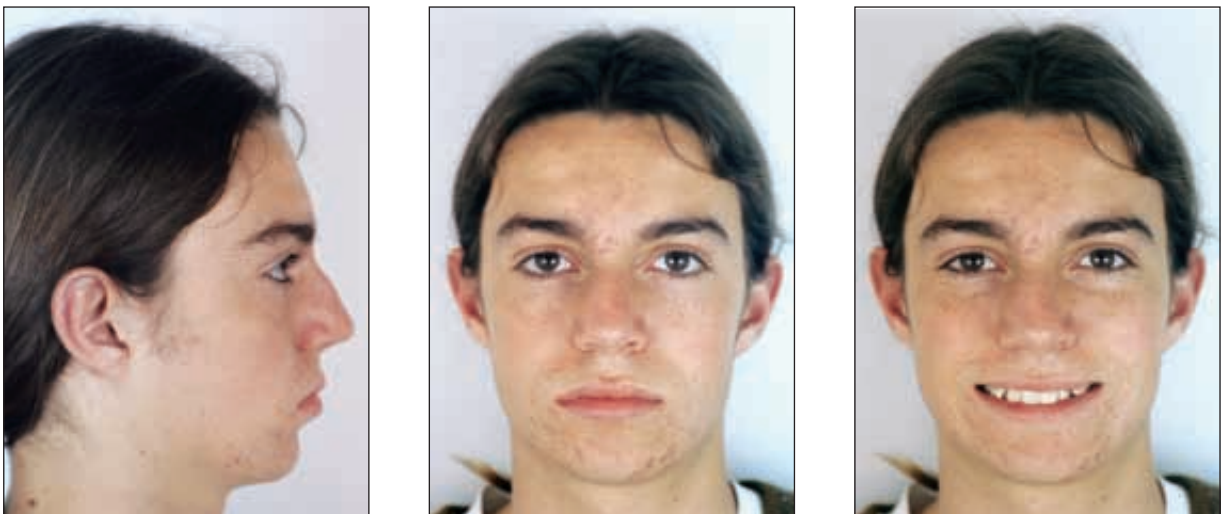


FIGURE 9 - Initial facial photographs.



FIGURE 10 - Initial intraoral photographs.



FIGURE 11 - Initial panoramic radiograph.



FIGURE 12 - Initial lateral cephalometric radiograph.

Measurements	Pre-treatment values	Post-treatment values
SNA	78°	77.5°
SNB	76°	78°
ANB	2°	-0.5°
SND	74°	76°
1:NA	34°	23°
1-NA	10 mm	6 mm
1:NB	33°	20°
1-NB	6 mm	2 mm
Pog-NB	1.5	1.5
Pog-1NB	4.5 mm	0.5 mm
1:1	110°	135°
Ocl:SN	15°	15°
GoGn:SN	24°	24°
S – Ls	2 mm	-2 mm
S – Li	5 mm	0 mm
Y Axis	58°	56°
Facial Angle	89°	89°
Convexity Angle	3°	-3°
Wits	2 mm	2 mm
FMA	14°	14°
FMIA	56°	69°
IMPA	110°	97°

TABLE 2 - Pre and post-treatment cephalometric data of patient (clinical case study 2).

The first upper and lower premolars were extracted because of the severe upper crowding and the lower protrusion and proceeded to bond the lower fixed appliance. Initially, no brackets were bonded to the upper incisors. Firstly, the canines were retracted to create enough space to accommodate all teeth in the arch.

After treatment completion, an upper wrap-around removable appliance and a fixed lower canine-to-canine lingual arch were installed for retention.

Results

Extraorally we observed significant changes in the patient's expression when smiling, with proper exposure of the upper incisors and significant improvement in the appearance of the profile (Fig 13).

Intraorally, a Class I relationship was achieved for molars and canines as well as appropriate overbite and overjet. The crossbite was corrected, the curve of Spee leveled and the lower midline corrected, with the upper and lower midlines coinciding with the facial midline (Fig 14).



FIGURE 13 - Final facial photographs.



FIGURE 14 - Final intraoral photographs.

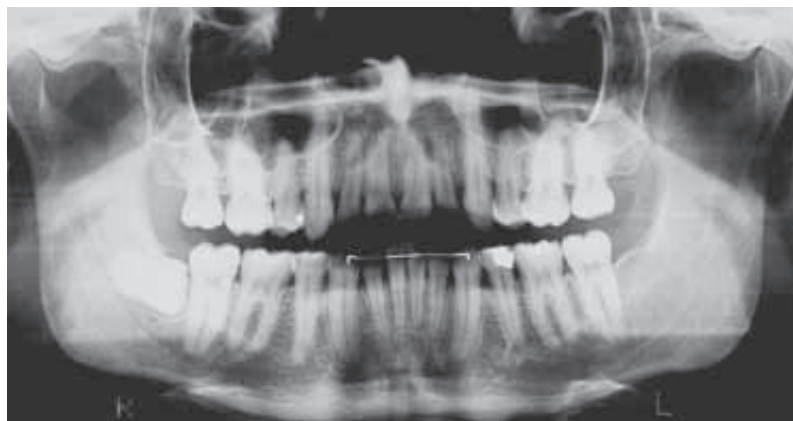


FIGURE 15 - Final panoramic radiograph.



FIGURE 16 - Final lateral cephalometric radiograph.

The radiographs presented adequate root parallelism. Moreover, upper third molars were found to be properly positioned. Tooth 48 was extracted and tooth 38 had already been removed (Fig 15).

From a cephalometric standpoint, we observed a small retraction of point A due to a retraction in the upper incisors while the mandible (point B) advanced by 2°, which decreased facial convexity. The upper and lower incisors were moved back to their original sites, which improved lip positioning (Fig 13 and 16 and Table 2).

FINAL CONSIDERATIONS

When properly indicated, second molar extraction can prove a beneficial treatment option for patients. It can shorten treatment time and

simplify treatment mechanics. It is essential, however, that all available diagnostic resources be used for an accurate selection of cases best suited for this kind of therapy.

In the clinical cases presented in this article, second molar extraction was performed to enable first molar distalization and, consequently, Class II correction in patients not undergoing facial growth. First molar extraction was performed to improve the facial profile and correction of anterior discrepancy caused by either severe crowding or excessive protrusion of the incisors.

These clinical cases serve as examples of how a proper diagnosis coupled with a compliant patient can result in a treatment that enhances both the patient's aesthetics and function.

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Evaluation of shear bond strength of brackets bonded with orthodontic fluoride-releasing composite resins

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Abstract

Objective: To evaluate the shear bond strength of stainless steel brackets bonded with fluoride releasing composite resins, comparing them with a conventional resin and to analyze the amount of resin left on the enamel surface. **Methods:** Sixty premolars were randomly divided into three groups: Group I – Concise (3M), Group II – Ultrabond (Aditek do Brasil) and Group III – Rely-a-Bond (Reliance). After bonding, the samples were thermocycled (500 cycles) at 5°C and 55°C temperatures. After 48 hours they were subjected to shear bond strength testing, in the occluso-gingival direction, using an MTS 810 Universal Testing Machine with load speed of 0.5 mm/min. **Results:** The results demonstrated a mean shear bond strength of 24.54 ± 6.98 MPa for Group I, 11.53 ± 6.20 MPa for Group II, and 16.46 ± 5.72 MPa for Group III. Analysis of Variance (ANOVA) determined a statistical difference in the mean shear bond strengths between groups ($p < 0.001$). The Tukey test evidenced that the averages of the three groups were significantly different ($p < 0.05$), with the highest values for Group I and the lowest for Group II. The Kruskal-Wallis test did not show significant differences in the amount of resin left on the enamel in any of the three groups ($p = 0.361$). **Conclusion:** All materials exhibited adequate adhesive bond strength for clinical use. Concise exhibited the highest degree of shear bond strength but no significant differences were found in Adhesive Remnant Index (ARI) between the groups.

Keywords: Shear bond strength. Brackets. Composite fluoride resin.

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INTRODUCTION

Several advances have contributed to the improvement of the technique of bonding orthodontic accessories, such as, the introduction of enamel acid etching by Buonocore,⁷ and its association with composite resins based on bisphenol A glycidyl methacrylate (Bis-GMA). As a result, this technique has become the method of choice for bonding orthodontic accessories.^{11,12}

However, during treatment with fixed orthodontic appliances certain problems may occur, such as: (1) fractures or even loss of enamel, which may be related to the pretreatment of the enamel surface during prophylaxis²⁷ and/or during phosphoric acid etching;⁶ (2) additional loss of enamel during bracket debonding, removal of debris from the tooth, or rebonding procedures;² and (3) decalcification of the enamel around the brackets, which is considered the most common problem in patients undergoing orthodontic treatment with fixed appliances.^{2,4,14,17,23,26}

The presence of brackets and resin predisposes to a greater accumulation of plaque around the brackets,² which can cause white spot lesions likely to occur after the first four weeks of orthodontic treatment.¹⁷ These changes appear mainly in the cervical region of upper incisors.¹

The risk of demineralization can be countered by performing plaque control and fluoride application.^{1,17} However, it has been found that the fluoride toothpaste brushing program did not prevent enamel decalcification around the brackets because the effectiveness of plaque control depends on the daily routine followed by the patient.¹⁶

Given the fact that it is difficult to secure patient compliance in plaque control and the use of fluoride, and due to the inconvenient effects caused by the unsightly white spots, researchers started to develop adhesives with the addition of fluoride to prevent enamel demineralization around the brackets.²⁵ These materials were investigated for their fluoride

releasing efficacy, which has been confirmed by several studies.^{9,16,23,26,28,29}

Fluoride inhibits bacterial activity and can remineralize enamel.²⁵ However, such materials are relatively new and the need therefore arises to ascertain that the bond strength is sufficient to meet clinical needs, and also whether or not the fluoride comprised in these materials decreases its strength. For these reasons, the authors set out to evaluate the shear bond strength of stainless steel brackets bonded with fluoride-releasing resins, compare them with conventional resins and assess the amount of adhesive left on the enamel surface.

MATERIAL AND METHODS

This study used 60 freshly extracted permanent premolars—all extractions indicated for orthodontic purposes—of patients aged between 12 and 14 years. The design of this study was submitted to and approved by the Ethics Committee of the Ponta Grossa State University.

After extraction, the teeth were cleaned with a scalpel blade n° 11, spatula LeCron and a spray of bicarbonate, washed and stored in chilled distilled water changed weekly. Prior to the preparation of the specimens, the teeth were immersed in a 0.5% chloramine solution for disinfection for 48 hours in a closed container, as directed by the ISO/TS 11405 (2003) standard. A 6.5X magnification stereomicroscope was used to select teeth with the following characteristics: A healthy enamel surface or at least an intact facial surface, i.e., should not present decay, decalcification, restorations, cracks, fractures, and should not have undergone any treatment with chemical agents, such as formaldehyde, hydrogen peroxide, alcohol or thymol. The teeth selected for this study were healthy and free of any flaws that might impair adhesion.

For the preparation of the samples an acrylic square was used to standardize the position of the teeth on a PVC tube. This square was



FIGURE 1 - Tooth-square set bonded to PVC tube with sticky wax.

made from two 2 mm thick acrylic sheets. Each acrylic sheet was 5 mm wide, one measuring 10 mm in length and one 20 mm. These sheets were glued with universal instant adhesive. Each tooth was attached to the acrylic square with sticky wax while keeping the buccal surface parallel to the surface of the square and the cemento-enamel junction was used as the lower limit. The tooth-square set was bonded with sticky wax to a PVC tube measuring 25 mm in diameter and 35 mm in height (Fig 1).

The crown was centered and the root completely inserted inside the tube, which was filled with hard plaster type IV (SS White, Rio de Janeiro, Brazil). After the hard plaster had set the square was removed. The bonding area ran perpendicular to the base of the PVC tube to keep the buccal surface parallel to the force during the shear bond strength test. All traces of wax and plaster were removed from the samples, which were stored in distilled water for 24 hours in a closed container.

Prior to bonding, buccal surface prophylaxis was performed using a rubber cup and pumice and water, ensuring that the rubber cup was replaced following five prophylaxis procedures. The teeth were washed with water sprays for 15 seconds and dried with moisture-free air sprays for 15 seconds.^{12,24}

Buccal surface enamel etching was performed

with 37% phosphoric acid gel (Dentalville, Joinville, Brazil) for 30 seconds in all groups. The buccal surfaces were then washed with air and water sprays for 20 seconds and dried with moisture-free air sprays for 10 seconds.

Premolar stainless steel brackets (Morelli, Lot No. 664362) were bonded with the following orthodontic resins: Concise (3M/ESPE, Dental Products Division, St. Paul, Minnesota, USA - Lot No. 17093), Ultrabond with fluoride (Aditek do Brazil, Cravinhos, São Paulo, Lot No. 9776) and Rely-a-Bond with fluoride (Reliance Orthodontic Products, Itasca, Illinois, Lot No. 046602). The brackets were pre-adjusted with -7° torque, 0° angulation and had a 13.02 mm² base area, which was automatically obtained using Solidworks software (SolidWorks Corp., USA), according to the manufacturer's instructions. The samples were divided into three groups with twenty sampling units, according to the orthodontic resin that was used.

After etching the enamel, a sealant—specific for each group—was applied, followed by the resin. Bonding was then performed according to manufacturer's recommendations.

During bonding, an ABZ-0179 (Ormco Corp., USA) positioner was used at a distance of 4 mm from the occlusal surface to the bracket slot to standardize bracket positioning. A standard seating pressure of 300 grams was used throughout bonding of all teeth, with the aid of a Correx dynamometer (Haag-Streit, Switzerland).^{3,4,5} Excess resin was removed with an explorer probe prior to polymerization.

After bonding, the samples were stored for 24 hours in distilled water at room temperature in sealed plastic containers and labeled according to each group. The samples were then subjected to thermocycling in an MSCT-3 machine (Marcelo Nucci ME, Brazil), applying 500 cycles at 5°C ($\pm 3^\circ\text{C}$) and 55°C ($\pm 3^\circ\text{C}$) temperatures. Each cycle was performed for 20 seconds with 7-second intervals.

After a 48-hour interval, counted from the end of thermocycling, the samples were subjected to shear bond strength tests in the occluso-cervical direction and with the chisel positioned at the tooth-bracket interface. The tests conformed to the ISO/TS 11405 (2003) standard and were performed with a universal electronic machine for mechanical tests (MTS 810, MTS Systems Corp., USA), with 1 kN load cell, and crosshead speed of 0.5 mm/min. The breaking loads were recorded in Newtons and converted to Megapascal. This conversion was carried out automatically by the test machine itself, or else it could have been calculated using the following formula: $R = F/A$, where R = shear bond strength in Megapascal, F = breaking load or debonding force in Newtons, and A = bracket base area in mm^2 .

After debonding, the teeth with their respective brackets were stored in individual plastic bags for later analysis of the amount of adhesive remnant. The teeth and brackets were examined with the help of a stereomicroscope using 40X magnification and classified according to the adhesive remnant index (ARI) proposed by Artun and Bergland¹, with scores of 0 to 3, indicating:

- Score 0 = no adhesive remnant left on the tooth.
- Score 1 = less than 50% adhesive remnant left on the tooth.
- Score 2 = more than 50% adhesive remnant left on the tooth.
- Score 3 = 100% adhesive remnant left on the tooth.

Statistical analysis

Analysis of Variance (ANOVA) is a useful statistical procedure, provided that certain conditions are met, such as: (1) data should be obtained randomly and independently—which is true on this study; (2) there should be homogeneity of variance between experimental groups and residuals should be within a normal range. Homogeneity of Variance, i.e., the requirement

that the variances or standard deviations of the bond strength measurements be equivalent across the three experimental groups, was tested using Levene statistics. Normality of Residuals, which can be defined as estimates of experimental errors determined by the difference between each bond strength measurement and the average of the group to which each measurement belongs, was tested using Shapiro-Wilk statistics. A 5% significance level was adopted.

Analysis of Variance was utilized to assess shear bond strength of brackets bonded with two resins, both containing fluoride (Ultra-bond and Rely-a-Bond) and a conventional resin (Concise). Analysis was complemented by the Tukey test for multiple comparison of means in pairs.

In addition, 95% confidence intervals were constructed for the population means of the experimental groups. These intervals allow researchers to quantify the differences between the means since the tests only indicate whether or not there is evidence that these differences are significant at 5%.

The Kruskal-Wallis nonparametric test was used—at 5% significance level—to evaluate the adhesive remnant index.

RESULTS

Table 1 shows the means and standard deviations in MPa, according to the experimental groups analyzed: Group I - Concise (3M/ESPE), Group II - Ultrabond with fluoride (Aditek do Brasil) and Group III - Rely-a-Bond with fluoride (Reliance Orthodontic Products).

The result of the Levene Statistics ($p = 0.366$) and the result of the Shapiro-Wilk Statistics ($p = 0.164$) demonstrated that there was homogeneity of variance and normality of residuals since the p values are greater than 0.05 (Table 2), which ensured that analysis of variance could be applied.

Analysis of variance (Table 2) showed compelling evidence of significant differences be-

TABLE 1 - Mean and standard deviation by experimental group.

SAMPLE	GROUP		
	I	II	III
mean	24.54	11.53	16.46
standard deviation	6.98	6.20	5.72

TABLE 2 - Summary of analysis of variance applied to compare the study groups in terms of shear bond strength.

EFFECT	DEGREES OF FREEDOM	RMS	F	p
Group	2	862.66	21.59	< 0.001
Residuals	57	39.95		

Homogeneity of variances: $p = 0.366$ (Levene).

Normality of residuals: $p = 0.164$ (Shapiro-Wilk).

TABLE 3 - p values of the Tukey test for comparison of shear bond strength means between groups.

GROUP	GROUP		
	I	II	III
I		< 0.001	0.001
II	< 0.001		0.044
III	0.001	0.044	

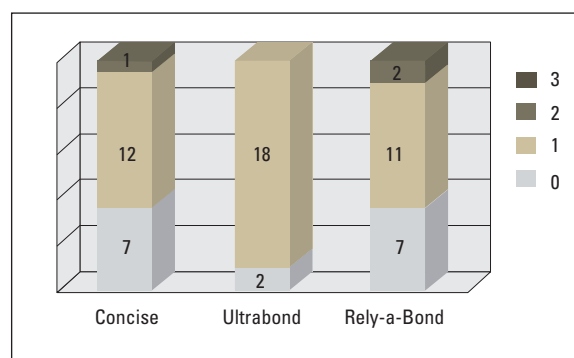


FIGURE 2 - Graphical representation of the frequencies of ARI scores.

tween the means of shear bond strength between the groups ($p < 0.001$).

The p values of the Tukey test, for comparing the means in pairs, were all lower than 0.05 (Table 3), showing that the means of the three

groups were significantly different. Group I (Concise) had a significantly higher mean than the means of the fluoride-releasing resin Groups ($p < 0.001$), while group III (Rely-a-Bond) had a significantly higher mean ($p = 0.044$) than group II (Ultrabond).

Figure 2 presents the observed frequencies of ARI scores for each resin used for bonding. There was no score 3 and only one or two scores 2. Although Ultrabond showed a tendency to have more scores 1 (and consequently fewer scores 0) compared with other resins, the Kruskal-Wallis test showed no statistically significant difference between the three procedures in terms of debonding ($p = 0.361$).

DISCUSSION

Many researchers have investigated alternative materials to the use of conventional resins with the purpose of preventing enamel decalcification around the brackets—through the release of fluoride for a prolonged period of time—thus increasing enamel strength and promoting its remineralization. These authors have also investigated whether these materials have an adequate shear bond strength.^{3,4,8,10,11,13,14,24,25}

Fluoride-releasing resins are a new generation of preventive orthodontic materials for bracket bonding, which combine the appropriate enamel-bonding physical properties and fluoride releasing agents. They also provide clinically desirable shear bond strength features, easy cleaning after bonding and easily removable residual materials in debonding procedures.²⁵

Practitioners should be aware of the properties of resins used for bracket bonding, especially with respect to their efficiency during accessory placement.³ This feature is essential as an orthodontic resin must be capable of keeping accessories firmly adhered to the teeth throughout treatment, resisting masticatory forces as well as those generated by orthodontic mechanics.^{21,24} The minimum shear strength

of any adhesive should be between 60 Kgf/cm² (5.88 MPa) and 80 Kgf/cm² (7.84 MPa) if it is to meet clinical needs.^{21,22} When the results of this study were compared with the values of reference,^{21,22} all adhesives showed strength values suitable for clinical use.

Several factors can affect the final outcome of shear bond strength tests. Therefore, in an attempt to achieve more reliable results the methods were standardized according to the ISO/TS11405 (2003) standard, which is specific for shear tests and recommends that to obtain a pure shear stress it is necessary that the action of the force be parallel to the tooth surface.

This study compared two fluoride-releasing composite resins (Ultradond and Rely-a-bond) and a conventional composite resin (Concise). All were employed as per manufacturer's recommendations. It is a known fact that improper manipulation and/or the use of inadequate quantities of resin may affect shear bond test results.

The results show that the three groups are significantly different from one another. Group I (Concise = 24.54 ± 6.98 MPa) had the highest shear bond strength mean compared with the other groups. These findings corroborate the work of Kawakami et al¹³ (48 hours = 20.10 ± 1.44 MPa and 10 days = 20.62 ± 1.53 MPa), and Meister¹⁵ (29.99 ± 15.89 MPa), which also found higher shear bond strength values when using Concise.

Kawakami et al¹³ evaluated Concise using 48-hour and 10-day periods after the polymerization of the material. They related their results to the time used for acid etching, whether or not etching had been performed and the time consumed in debonding brackets, since full polymerization does not occur before a period of 24 hours has elapsed. Within 10 days there was an increase in shear bond strength but for Concise no statistically significant difference was found in both periods. Meister¹⁵ ascribed their results to method standardization and the use of

premolar-specific brackets given their better fit to the tooth surface.

Concise exhibited the highest shear bond strength due to its high filler content since the content of inorganic particles directly influences the resistance of composite resins.¹² The results found by Correr Sobrinho et al¹⁰ (after 10 min = 6.22 ± 0.28 MPa and after 24 hours = 7.73 ± 0.21 MPa) were lower than those found in this study. This is probably due to the shorter time taken to debond the brackets, which delayed polymerization. Nevertheless, Concise still showed higher shear bond strength compared with the other materials.

Group III (Rely-a-Bond = 16.46 ± 5.72 MPa) showed a significantly higher shear bond strength mean than Group II (Ultradond = 11.53 ± 6.20 MPa). This difference becomes more pronounced when these two groups (II and III) were compared with Group I (Concise = 24.54 ± 6.98 MPa).

The results of Ultradond (Group II) and Rely-a-Bond (Group III) were smaller and could be explained as follows. Since these are 1-paste resins the catalyst is applied to the tooth and to the base of the brackets while the paste is placed on the base of the brackets. Since these are chemical polymerization materials and are not manipulated prior to use the catalyst is mixed with the base paste only by the seating pressure exerted on the bracket during bracket placement, this procedure can lead to incomplete polymerization of some portions of the material, which compromises its strength and makes it difficult to attain the homogeneity of results for this bonding system.

When the results for the fluoride-releasing resins used in this study were observed—Ultradond (Group II = 11.53 ± 6.20 MPa) and Rely-a-Bond (Group III = 16.46 ± 5.72 MPa)—they were found to be similar to those obtained by Sinha et al,²⁵ who used a fluoride-releasing self-curing resin (Rely-a-Bond = 19.0 MPa).

Simplicio²⁴ also found similar results when using a self-curing resin (Rely-a-Bond = 13.16 ± 4.87 MPa). Komori and Ishikawa,¹⁴ however, found a different result for the same self-curing resin (Rely-a-Bond = 25.7 ± 3.6 MPa).

As regards the adhesive remnant index, bonding failures were found to occur more frequently at the adhesive-enamel interface in all three groups assessed since there was little or no adhesive left on the teeth after debonding. Moreover, there was no damage to the enamel surface after debonding, with the exception of two samples of Group 1 (Concise), which showed fractures on the enamel. Penido et al¹⁸ also noted a greater number of fractures at the adhesive-enamel interface in an in vitro study. However, in an in vivo study, Penido et al¹⁸ found that bonding failures occurred at the adhesive-bracket interface, and remarked that this type of fracture, often found in clinical practice, is the most desirable since any fracture at the adhesive-enamel interface can damage the enamel. This is due to the entanglement of the resin in the bracket mesh, which makes this area more brittle. Pithon et al^{19,20} found that the fracture occurred at the adhesive-bracket interface and underscored the importance that

bonding materials allow for a greater amount of adhesive to be left on the tooth surface after bracket removal as this will provide greater security and maintain tooth integrity while preventing enamel damage. Removal of resin remnants is not a difficult procedure. It is part and parcel of the orthodontic office routine. Nevertheless, it does require skill as it can also damage the enamel.

CONCLUSIONS

A careful review of the results yields the following conclusions:

1. All materials tested in this investigation have adequate shear bond strength to meet clinical needs, i.e., sufficient strength to withstand the stresses generated by orthodontic mechanics and chewing. However, Concise showed greater resistance than the other two resins (Rely-a-Bond and Ultrabond).

2. Regarding the adhesive remnant index, no difference was found between the groups, and although the fractures occurred at the adhesive-enamel interface, no damage was found to have been caused to the enamel surface after debonding, except in two samples of Group 1 (Concise), which exhibited enamel fractures.

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Statement of the 1st Consensus on Temporomandibular Disorders and Orofacial Pain

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Abstract

This Statement of the 1st Consensus on Temporomandibular Disorders and Orofacial Pain* was created with the purpose of substituting controversies for scientific evidence within this specialty field of dentistry. The document provides clear and well-grounded guidance to dentists and other health professionals about the care required by patients both in the process of differential diagnosis and during the stage when they undergo treatment to control pain and dysfunction. The Statement was approved in January 2010 at a meeting held during the International Dental Congress of São Paulo and draws together the views of Brazil's most respected professionals in the specialty of Temporomandibular Disorders and Orofacial Pain.

Keywords: Bruxism. TMJ. Temporomandibular joint disorders. Headache. Dentistry. Cervicalgia (neck pain).

INTRODUCTION

By definition, orofacial pain is any pain associated with soft and mineralized tissues (skin, blood vessels, bones, teeth, glands or muscles) of the oral cavity and face. This pain can usually be referred to the head and/or neck region or even be associated with cervicalgia (neck pain), primary headaches and rheumatic diseases such as fibromyalgia and rheumatoid arthritis.¹

The main sources of orofacial pain are odon-

togenic problems, headaches, neurogenic diseases, musculoskeletal pain, psychogenic pain, cancer, infections, autoimmune phenomena and tissue trauma.¹

Historically, dentistry has been geared primarily to the diagnosis and treatment of odontogenic—pulp and periodontal—pain. We should not, however, neglect to identify other sources of orofacial pain, such as typical inflammatory processes (sinusitis, parotitis),

* Note from the rapporteurs: Although the Federal Council of Dentistry designates the specialty, in Portuguese, with the term "Têmporo-mandibular", its correct spelling is still under debate. A query on the website of the Brazilian Academy of Letters (www.academia.org.br) yielded the alternative "Temporo-mandibular" and no mention of the hyphenated spelling. For this reason, this is the term used throughout the Portuguese version of this document, as we anticipate that, in future, it will go into force as the official designation.

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continuous or intermittent neuropathic pain (neuralgia, deafferentation pain, sympathetically maintained pain), headache and temporomandibular disorder.

Referring orofacial pain patients, as speedily as possible, to the appropriate therapist is an integral part of the quality of care provided by health professionals. Any professional willing to treat these patients must possess an in-depth knowledge of the differential diagnosis of orofacial pain and its subtypes, and apply evidence-based techniques to control the symptoms.

Orofacial pain is highly prevalent in the population. It causes patients great suffering and can, moreover, stem from life-threatening diseases. Hence the crucial importance of dentists in conducting an appropriate diagnostic process.

It has been estimated that approximately 22% of the population presented with at least one type of orofacial pain in the 6 months prior to data collection.² The most frequent cause of orofacial pain pointed out in that study had an odontogenic origin (12.2%), followed by temporomandibular disorders (TMD), found in 5.3% of the population.

From now on, this Statement will be focusing on the discussion of temporomandibular disorder.

DEFINITION OF TEMPOROMANDIBULAR DISORDER (TMD)

According to the American Academy of Orofacial Pain, TMD is defined as a group of disorders involving the masticatory muscles, the temporomandibular joint (TMJ) and associated structures.¹

The symptoms most often reported by patients include pain in the face, TMJ, masticatory muscles and pain in the head and ear. Other symptoms reported by patients are ear manifestations such as tinnitus, ear fullness and vertigo.¹

The signs are primarily muscle and TMJ tenderness to palpation, limitation and/or incoordination of mandibular movements and joint noises.¹

EPIDEMIOLOGY

Epidemiological studies estimate that 40% to 75% of the population have at least one TMD sign, such as TMJ noises, and 33%, at least one symptom such as pain in the face or TMJ.¹

Few studies in Brazil have assessed the prevalence of TMD signs and symptoms in population samples. A recent study found that 37.5% of the population had at least one TMD symptom.³ An estimated 41.3% to 68.6% of college students showed at least one TMD sign or symptom.⁴⁻⁷

There is a difference between the prevalence of TMD signs and symptoms in the population and the actual need to treat these individuals. In a systematic review and meta-analysis published recently, the prevalence of treatment need for TMD in the adult population was estimated at 15.6%, while the estimates for the younger population, 19 to 45 years, was higher than for older adults (above 46 years old).⁸

Factors such as a dearth of studies, the diversity of features found in the samples and the methodology used to determine TMD signs and symptoms preclude the extrapolation of results to the entire Brazilian population. It is important that a national study with appropriate methodology be conducted to gain knowledge of the actual situation. It would be of vital importance to include TMD and other non-dental diseases whose symptoms are characterized by orofacial pain in the "Survey of oral health conditions among the Brazilian population", conducted by the Ministry of Health.

DIAGNOSIS

No reliable method currently exists that can be unconditionally used by researchers

and clinicians to diagnose and measure the presence and severity of temporomandibular disorders. For diagnosis of individual cases, patient history (anamnesis) remains the most important step in formulating the initial diagnostic impression.

Physical examination, comprising muscle and TMJ palpation, measurement of active mandibular movements and joint noise analysis—when performed by calibrated, well-trained professionals—is an invaluable instrument in the diagnosis and therapy planning, as well as in monitoring the efficacy of proposed treatments.¹

Ancillary diagnostic methods such as polysomnography (PSG) and TMJ images are considered auxiliary means that prove useful only in some individual cases and in research work.^{9,10,11} No direct association has been made, however, between the results of such tests and the presence of TMD signs and symptoms.

In clinical practice, the initial evaluation questionnaire should include some questions concerning TMD signs and symptoms. Any positive response to these questions may signal the need for thorough evaluation by a professional specialized in TMD and Orofacial Pain (Table 1).

DIAGNOSTIC CLASSIFICATION OF TMD'S

The American Academy of Orofacial Pain (AAOP) recently established, in the 4th edition of its manual, new guidelines for the diagnosis and classification of different forms of TMD, which are divided into two major groups (Muscular TMD and Articular TMD) with their respective subdivisions (Tables 2 and 3).¹

The International Classification of Headache Disorders (ICH) of the International Headache Society (IHS) includes a specific type of headache secondary to TMD in its 11th class (IHS 11.7 – Headache or facial pain attributed to TMJ disorder).¹²

1 - Do you have trouble, pain or both when opening the mouth, to yawn for example?
2 - Does your jaw get "locked", "stuck" or does it "drop"?
3 - Do you have difficulty, pain or both, when chewing, talking or using the jaws?
4 - Have you noticed any noises in the jaw joints?
5 - Do you usually feel your jaw tired, stiff or tense?
6 - Do you have any pain in the ears, temples or cheeks?
7 - Do you often have headaches, neck pain or toothache?
8 - Did you recently suffer any trauma to the head, neck or jaw?
9 - Have you noticed any recent change in your bite?
10 - Have you received any previous treatment for unexplained facial pain or a jaw joint problem?

TABLE 1 - Examples of questions to screen patients for possible signs and symptoms of temporomandibular disorder.

Source: Leeuw¹, 2010.

11.7.1.1 - Disc derangement disorders
11.7.1.1.1 - Disc displacement with reduction
11.7.1.1.2 - Disc displacement without reduction
11.7.1.2 - TMJ displacements
11.7.1.3 - Inflammatory disorders
11.7.1.3.1 - Synovitis and capsulitis
11.7.1.3.2 - Polyarthritis
11.7.1.4 - Non-inflammatory disorders
11.7.1.4.1 - Primary osteoarthritis
11.7.1.4.2 - Secondary osteoarthritis
11.7.1.5 - Ankylosis
11.7.1.6 - Fracture (condylar process)

TABLE 2 - Recommended changes in the IHS 11.7.1 diagnostic classification: Headache or facial pain attributed to TMJ dysfunction.

Source: Leeuw¹, 2010.

11.7.2.1 - Local myalgia
11.7.2.2 - Myofascial pain
11.7.2.3 - Centrally mediated myalgia
11.7.2.4 - Miospasm
11.7.2.5 - Myositis
11.7.2.6 - Myofibrotic contracture
11.7.2.7 - Neoplasia

TABLE 3 - Recommended changes in the IHS 11.7.2 diagnostic classification: Headache or facial pain attributed to masticatory muscle dysfunction.

Source: Leeuw¹, 2010.

However, this seems incomplete because it does not address the two major TMD groups and their subtypes, as described in the AAOP classification. In this regard, it is noteworthy that the AAOP has issued a proposal to the IHS to modify that ICH item (Tables 2 and 3), so far unsuccessfully.

ETIOLOGY

The attempt to identify a clear and universal TMD cause has not as yet proved successful. Recent studies have concluded that TMD's have a multifactorial origin.

To be complete, a medical history should identify predisposing factors (which increase the risk of TMD), trigger factors (which cause the installation of TMD) and perpetuating factors (which interfere with TMD control). Among these factors we will mention those that are, in principle, more relevant.¹

Trauma

- Direct trauma or macrotrauma.
- Indirect trauma: Represented by whiplash injuries.
- Microtrauma: Caused by minor trauma performed repetitively, such as parafunctional habits (bruxism, teeth clenching, etc.).

Psychosocial factors

- Anxiety, depression, etc.

Physiopathological factors

- Systemic factors: degenerative, endocrine, infectious, metabolic, neoplastic, neurological, vascular and rheumatological diseases.
- Local factors: change in synovial fluid viscosity, increased intra-articular pressure, oxidative stress, etc.
- Genetic factors: presence of haplotypes associated with soreness.

Researchers and clinicians specializing in orofacial pain have reached consensus that

dental occlusion can no longer be considered a primary factor in the etiology of TMD.¹³⁻¹⁷ Some occlusal relationship factors are cited as predisposing to TMD. These studies, however, show that the correction of these factors in symptomatic individuals has shown little effectiveness in controlling TMD.^{18,19,20}

This scientific fact, however, does not diminish the importance of occlusion in the practice of dentistry. Occlusal pathologies produce significant aesthetic and functional effects on the masticatory apparatus. Dental surgeons must pay special attention to occlusion when performing physical examination or any clinical procedure.

TREATMENT

Scientific advances in this area require professionals to be continually upgrading their knowledge. Inappropriate therapies can cause iatrogenic complications, allow chronicity of pain and induce patients to mistakenly believe that their disease should be treated by a professional from another specialty.

The goal of TMD treatment is to control pain, restore masticatory apparatus function, re-educate patients and minimize adverse loads that perpetuate the problem.

The fact that the etiology of TMD is unknown and its character self-limiting recommends the initial use of noninvasive and reversible therapies, whose efficiency has proved extremely high in TMD patients.

Some studies report the control of signs and symptoms in more than 90% of patients receiving conservative treatment. Patient education, self-management, behavioral intervention, use of drugs, interocclusal splints, physical therapy, postural training and exercises make up the list of options applicable to almost all TMD cases.²¹⁻²⁵

The practice of Evidence-Based Dentistry (EBD) does not support the prescription of

techniques that promote complex and irreversible changes such as occlusal adjustment by selective grinding, orthodontic therapy, functional orthopedics, orthognathic surgery or prosthetic oral rehabilitation techniques, in the treatment of temporomandibular disorder.¹⁹

TMJ surgery can prove necessary in a few specific cases, such as ankylosis, fractures and certain congenital or developmental disorders. In exceptional cases, it can be applied to complement the treatment of internal TMJ disorders.^{1,26}

RESPONSIBILITIES TOWARDS TMD PATIENTS

Some factors can clearly explain the reasons why more attention should be given to temporomandibular disorders: high prevalence in the population, significant social cost and, especially, substantial personal cost.

Currently, TMD and orofacial pain are not mandatory topics of discussion in the curriculum of educational institutions. Such disregard leads to the inadequate training of dental surgeons in recognizing and guiding TMD patients. An incomplete semiology denies patients the opportunity to have an appropriate treatment with improvement in their quality of life.

Few public policies are currently aimed at raising awareness of TMD and treating TMD patients. In this respect, the health care service provided by the state is negligible. This lack of assistance and information invariably frustrates patients, leading them to a wild goose chase for other specialties that treat similar symptoms, but do not promote proper control of TMD. The specialty called Temporomandibular Disorders and Orofacial Pain, regulated by the Federal Council of Dentistry, has been all but forgotten within the scope of oral health.

It is also important to underscore that the procedures geared to the treatment of TMD are not included in the fee schedules published by unions, dentistry associations and

health plans. This omission can undermine the relationship between professionals and patients as well as hinder the dissemination of appropriate treatment techniques to professionals in other specialties.

Regarding service provider liability in the field of orofacial pain, agreements enforce obligations to provide therapeutic means but not necessarily results. The reason being that even when a professional makes use of all resources available in the scientific literature, these may not produce the desired results. The existence of refractory patients is quite common in the management of chronic diseases.

Service provision proposals, however, must inform patients that the resources are aimed at reducing levels of pain, improving quality of life and restoring function.

FINAL CONSIDERATIONS

The TMD and Orofacial Pain specialty was created in 2002 by the Brazilian Federal Council of Dentistry. Nonetheless, even among health professionals this specialty is still quite unknown. The need to include the TMD and Orofacial Pain discipline in the curriculum of undergraduate Dentistry courses is not only vital but urgent. The acknowledgement and support of the authorities that manage public health policies are necessary if primary care to patients with orofacial pain is to be effectively implemented. These measures will reduce the suffering and financial burden of these individuals.

Protocols or continuing education courses that support the use of occlusal therapy as a form of definitive treatment to control the signs and symptoms of TMD should be regarded as unscientific practice.

Research on orofacial pain has contributed to improve treatments, but it is essential that new studies elucidate important issues and that the other dental specialties absorb and support these new achievements.

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Race versus ethnicity: Differing for better application

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Abstract

Studies involving populations are often questioned as to the homogeneity of their samples relative to race and ethnicity. Such questioning is justified because sample heterogeneity can increase the variability of and even mask results. These two concepts (race and ethnicity) are often confused despite their subtle differences. Race includes phenotypic characteristics such as skin color, whereas ethnicity also encompasses cultural factors such as nationality, tribal affiliation, religion, language and traditions of a particular group. Despite the widespread use of the term “race”, geneticists are increasingly convinced that race is much more a social than a scientific construct.

Keywords: Ethnicity and health. Distribution by race or ethnicity. Ethnic groups.

INTRODUCTION

Although categorizing individuals according to race and ethnicity is common practice both in diagnosis and scientific research, the meanings of these words are often confused or even unknown in the academic environment.

The custom of using race as a distinguishing characteristic in populations or individuals seeking medical assistance is perfectly acceptable in the health care setting. Despite the fact that this practice is grounded in deep-rooted prejudices, its current use has been advocated as a useful means of improving diagnosis and therapy.⁷

Race classification can be used to check whether or not randomized trials have proved successful. It can also be useful for readers as a description of the population participating in a

particular study.¹² In orthodontics, the attempt to identify a racial group in a sample is, in actuality, an attempt to control the various facial features specific to certain racial groups.

The purpose of this article is twofold:

(1) Clarify the conceptual difference between race and ethnicity.

(2) Clarify the racial categories established by some studies.

HISTORY OF THE TERM “RACE”

The first racial classification of humans can be found in the *Nouvelle division de la terre par les différents espèces ou races qui l'habitent* (New division of land by the different species or races which inhabit it) by Francois Bernier, published in 1684.¹¹

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In 1790, the first North American census classified the population as composed of free white men, free white women and other people (Native Americans and slaves). The 1890 census, in turn, classified the population using terms such as white, black, Chinese, Japanese and Indians.³

Carolus Linnaeus (1758), creator of modern taxonomy and the term *Homo sapiens*, recognized four varieties of humans:

1) American (*Homo sapiens americanus*: red, ill-tempered, subduable).

2) European (*europaeus*: white, serious, strong).

3) Asian (*Homo sapiens asiaticus*: yellow, melancholy, greedy).

4) African (*Homo sapiens afer*: black, listless, lazy).

Linnaeus also recognized a fifth race without geographical definition, the Monster (*Homo sapiens monstrosus*), comprised of various real types (e.g., Patagonians from South America, Canadians Flatheads) and other types contrived by the imagination that did not fit into the four 'normal' categories. Linnaeus' biased classification assigned to each race specific physical and moral characteristics.¹¹

In 1775, the Linnaeus' successor, J. F. Blumenbach, recognized "four varieties of mankind":

1) European, East Asian, and part of North America.

2) Australian.

3) African.

4) The rest of the New World.

Blumenbach's vision continued to evolve and in 1795, resulted in five varieties—Caucasian, Mongolian, Ethiopian, American and Malayan—which differed from the previous groups, whereby Eskimos began to be classified together with Eastern Asians.¹¹

In 1916, Marvin Harris described the theory of hypodescence, useful in classifying the offspring of two different races. According to his theory, this offspring would belong to a

biologically or socially inferior race: "The cross between a white and a Indian is a Indian, a cross between a white and a black is a black, a cross between a white and a Hindu is a Hindu, and the cross between a European and a Jew is a Jew." In some countries, a 1/8 or 1/16 rule was established to properly determine the racial identity of individuals born from miscegenation. Under these rules, if an individual's lines of descent is 1/8 or only 1/16 black (uniform black), such individual is also black.¹¹

IS THERE A DIFFERENCE BETWEEN "RACE" AND "ETHNICITY"?

The term race has a wide array of definitions commonly used to describe a group of people who share certain morphological characteristics. Most authors have learned that race is an unscientific term, which can only have a biological meaning when the human being is fully homogeneous or 'thoroughbred', as in some animal species. These conditions, however, are never found in humans.¹³ The human genome is composed of 25,000 genes. The most apparent differences (skin color, hair texture, shape of nose) are determined by a handful of genes. The differences between a black African and a white Nordic comprise only 0.005% of the human genome. There is widespread agreement among anthropologists and human geneticists that, from a biological standpoint, human races do not exist.¹

Historically, the word ethnicity stems from the Greek adjective *Ethnikos* and means "heathen." The adjective is derived from the noun *ethnos*, which means foreign people or nation. It is a multifaceted concept, which builds the identity of an individual through: kinship, religion, language, shared territory and nationality, and physical appearance.^{4,9}

In Brazil, indigenous peoples constitute a racial identity. However, because of different socio-cultural characteristics, groups are defined by ethnicity. In the state of Amazonas, for example,



FIGURE 1 - Indian of the Xicrin ethnicity; Kaiapó language from the Jê linguistic family; inhabitant of the Bacajá River, a tributary of the Xingu-Pará river. One of the cultural characteristics of this ethnic group is the gift of oratory exhibited by the tribesmen. The hair is shaved across the middle of the head and dyes are used by women and children.

home to more than 80,000 Indians, there are 65 ethnic (indigenous) groups.⁵ Although the concept of race is often associated with ethnicity, the terms are not synonymous. Race includes phenotypic characteristics such as skin color, whereas ethnicity also encompasses cultural factors such as nationality, tribal affiliation, religion, language and traditions of a particular group (Fig 1).⁸

ARE RACIAL CATEGORIES PROPERLY ATTRIBUTED?

One of the best known classifications to collect data on race is the U.S. Office of Management and Budget, whose guideline No. 15,

developed in the 1970's, standardized data on racial and ethnic categories.³

The U.S. census of 2000 increased the number of race categories to five: American Indians or Alaska Natives, Caucasians or whites, blacks or African-Americans, Native Hawaiians, and Asians.³

In Brazil, according to the Brazilian Institute of Geography and Statistics (IBGE), the census of 2000 surveyed the race or color of the Brazilian population through self-classification, thus: White, black, mulatto, Indian (indigenous) or yellow.⁶ Although there is a wealth of literature on racial classifications, it is inherently contradictory.

A recent study used a questionnaire to compare the accuracy of the classification of race and ethnicity through the respondents' self-report and the researchers' perception. The results showed that the researchers' perception of the respondents' race was more accurate for blacks and whites, while for other races, in many cases, researchers were often in doubt about an individual's race and classified him or her as "unknown." Thus, we concluded that the race and/or ethnicity of an individual should be obtained by self-report and not through the view of the researcher since self-reported ethno-racial classification proved more accurate.² Numerous orthodontic studies in Brazil have attempted to define the race based on skin color and terms such as leucoderms, xantoderms and melanoderms are often employed, referring to whites, Asians and blacks, respectively. Skin color does not determine even the ancestry. This is especially true of the Brazilian people owing to widespread racial interbreeding, aptly named miscegenation. A study on the genetics of the Brazilian population found that 27% of blacks in a small town in Minas Gerais state had genes which were predominantly of non-African ancestry. Meanwhile, 87% of white Brazilians have at least 10% African ancestry.¹⁰

CONCLUSIONS

The concepts of race and ethnicity belong to two different realms.

Race is related to the biological realm. In reference to humans, this term has been historically used to identify socially defined human categories. The most common differences refer to skin color, hair type, face and skull shape, and genetic ancestry. Therefore, skin color, although extensively described as a racial characteristic, is only one of the

features that define a race. Despite its frequent use in orthodontics, a new concept is beginning to take shape grounded in the belief that skin color does not determine ancestry, mainly among such racially mixed people as the Brazilian population.

Ethnicity lies within the cultural realm. An ethnic community is determined by linguistic and cultural affinities and genetic similarities. These communities often claim to have a distinct social and political structure, and a territory.

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Angle Class II, division 2 malocclusion with severe overbite and pronounced discrepancy*

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Abstract

This article reports the treatment of a young patient at 13.8 years of age who presented with an Angle Class II, division 2 malocclusion, prolonged retention of deciduous teeth, dental crossbite and severe overbite, among other abnormalities. At first, the approach involved rapid maxillary expansion followed by the use of Kloehe headgear and fixed orthodontic appliance. Treatment results demonstrate the importance of careful diagnosis and planning as well as the need for patient compliance during treatment. This case was presented to the Brazilian Board of Orthodontics and Facial Orthopedics (BBO). It is representative of the free category and fulfills part of the requirements for obtaining the BBO Diploma.

Keywords: Class II, division 2. Crossbite. Severe overbite. Prolonged retention of deciduous teeth.

HISTORY AND ETIOLOGY

The patient sought orthodontic treatment at 13.8 years of age. Her main complaint was the fact that her teeth took too long to fall and she was ashamed to smile. No significant information was found in her past medical and dental records. Her malocclusion, mainly presented lack of space for the alignment of certain teeth, which compromised her facial aesthetics significantly (Fig 1), and had as major etiological factor the prolonged retention of deciduous teeth. Her menarche had occurred at age 12.

DIAGNOSIS

Her dental pattern (Fig 1, 2) was an Angle Class II, division 2, right subdivision, excessively upright upper and lower incisors, severe deep bite (100%), upper and lower midlines shifted 3 mm to the right, lack of space for eruption of tooth 13 and alignment of other teeth, dental crossbites and atretic arches.

She displayed skeletal harmony, with ANB equal to 4°, and adequate maxillary and mandibular positioning. As mentioned, the upper and lower incisors were excessively upright with

* Case report, free category - approved by the Brazilian Board of Orthodontics.

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FIGURE 1 - Initial facial and intraoral photographs.

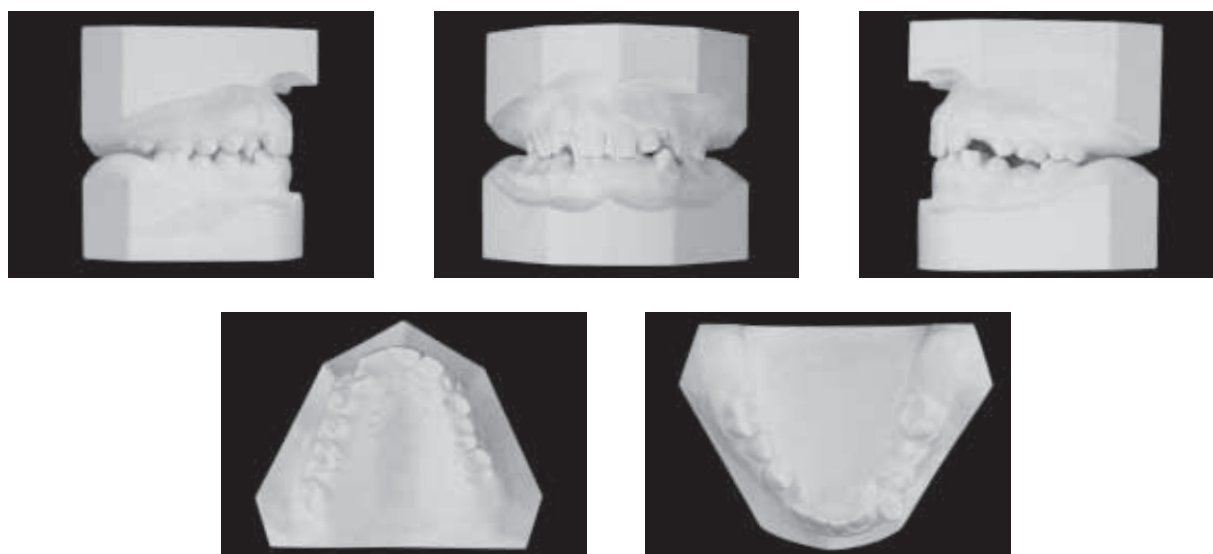


FIGURE 2 - Initial dental casts.

an interincisal angle of 157° , IMPA of 75° , 1-NA of 7° and 2.5 mm, and 1-NB of 12° and 4 mm. These features can be seen in figure 4 and table 1.

An analysis of the periapical and panoramic radiographs (Fig 3) reassured that the patient did not present with any condition that might compromise her orthodontic treatment.

The patient had a slightly convex profile and an unpleasant smile due to crowding and incorrect tooth inclinations (Figs 1 and 4).

TREATMENT GOALS

In the anteroposterior direction, the aim was to establish an Angle Class I relationship and improve upper and lower incisor inclination. In the vertical direction, it would be necessary to reduce the severe overbite by leveling the upper and lower arches. In the transverse direction, upper and lower arch expansion was performed to increase intercanine width.



FIGURE 3 - Initial panoramic (A) and periapical (B) radiographs.

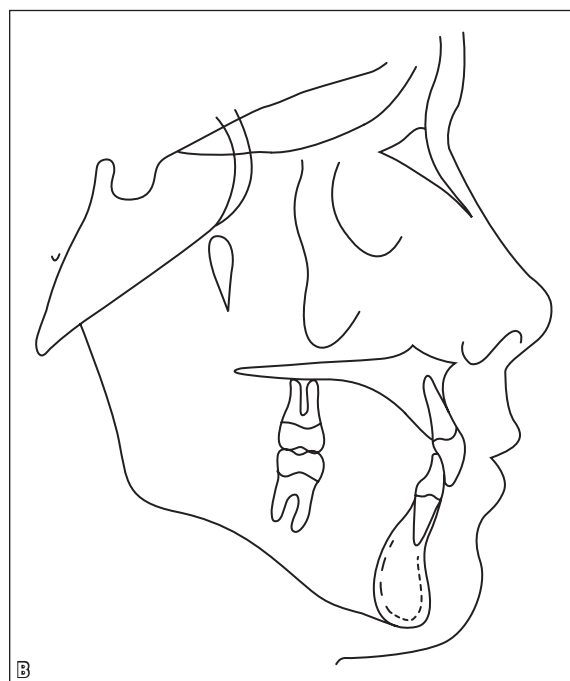
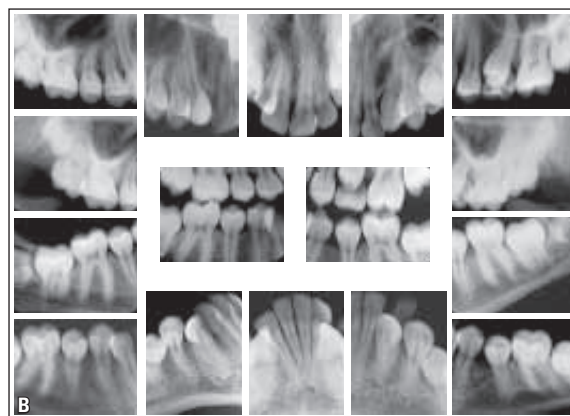


FIGURE 4 - Initial profile cephalometric radiograph (A) and cephalometric tracing (B).

With this, it was expected that crossbites would be eliminated, and adequate overbite and upper and lower midline correction would be achieved, significantly improving smile aesthetics.

TREATMENT PLAN

A treatment plan was established, starting with palatal expansion to increase the transverse maxillary dimension and make room for tooth alignment.

After removing the expansion appliance, an asymmetric Kloechn headgear (AKHG) would be used with the purpose of correcting the molar relationship and creating space. Concurrently with the AKHG, upper orthodontic appliance would be installed, alignment and leveling started in this arch, and only when the amount of overbite permitted, the lower orthodontic appliance would be bonded. To improve the form of the lower arch and make room for alignment and leveling of the lower teeth, the plan was to use archwires featuring greater intercanine width, since the canine lingual inclination and an atretic arch would allow such expansion.

To assist in opening space for tooth 13 and thus correct the upper midline, a compressed open spring would be placed between teeth 12 and 14, starting from the 0.018-in archwire.

To finish the case, the use of upper and lower 0.019 x 0.025-in archwires would be coordinated, with first and third order bends, and individualized intermaxillary elastic mechanics would be applied, according to the needs of this particular case.

After the active treatment phase, an upper wraparound-type retention plate would be used and, in the lower arch, a 0.028-in intercanine arch.

TREATMENT PROGRESS

To expand the palate a modified Haas appliance was employed with activation of 2/4 turn of the screw once a day. The same appliance was

used as a retainer for 6 months. The maxilla was expanded, which enhanced the form of the upper arch and consequently of the lower arch.

After removing the expansion screw, the asymmetric AKHG was adjusted by keeping its external right arm longer and open, with a force of 350g, to be worn for approximately 14 hours/day. This corrected the molar relationship and helped to make space for upper tooth alignment.

Slot 0.022 x 0.028-in standard edgewise metal brackets with no torques or angulations were used. The orthodontic appliance was initially installed on the upper arch. It was only after adequate space and height had been achieved that the lower arch appliance was bonded.

On the upper arch, 0.014-in to 0.020-in archwires were used for alignment and leveling and from the moment that 0.018-in archwires began to be used, an open spring was compressed between teeth 12 and 14 to help create space for positioning tooth 13 and subsequent midline correction. After alignment and leveling of all teeth, individualized 0.019 x 0.025-in stainless steel archwires were inserted on the upper arch to finish the case.

The same alignment and leveling procedures used for the upper arch were also performed on the lower, although the archwires were contoured in order to expand the lower arch by uprighting the canines and premolars and allowing protrusion of the incisors, which were retroclined before treatment. This enabled a correct alignment, leveling and midline correction. To finish the case, a 0.019 x 0.025-in stainless steel archwire with custom-made bends was used.

After ensuring that all the intended goals had been achieved, the fixed orthodontic appliance was removed and the retention phase begun. An upper wraparound-type retention plate and an 0.028-in stainless steel lower intercanine arch were used. The patient was instructed to wear the retainer plate full time during the first six months and then only for nighttime use.

The patient had her upper and lower third molars extracted.

TREATMENT RESULTS

In reviewing the patient's final records, it became clear that the major goals set at the beginning of treatment were attained (Figs 5, 6, 8). In the maxilla, ANB was reduced by 2° and the position of the maxilla relative to the overall profile improved considerably, reducing the angle of convexity from 8° to 1°. In addition, there was adequate vertical control and considerable enhancement of the upper arch form (Figs 5, 6, 8).

The teeth exhibited adequate alignment and improved incisor inclination. The overbite was also corrected and intercanine width increased by 11 mm, as initially planned, while the intermolar width was maintained.

In the mandible, a clockwise rotation occurred as the FMA angle (Tweed) increased from 28° to 32° (Figs 8, 9 and Table 1) due to the use of the headgear as well as leveling. From a dental standpoint, adequate alignment was achieved, the curve of Spee was leveled and the incisors were protruded with an increase in the IMPA angle (Tweed) from 75° to 90° (Figs 8, 9 and Table 1).



FIGURE 5 - Final facial and intraoral photographs.

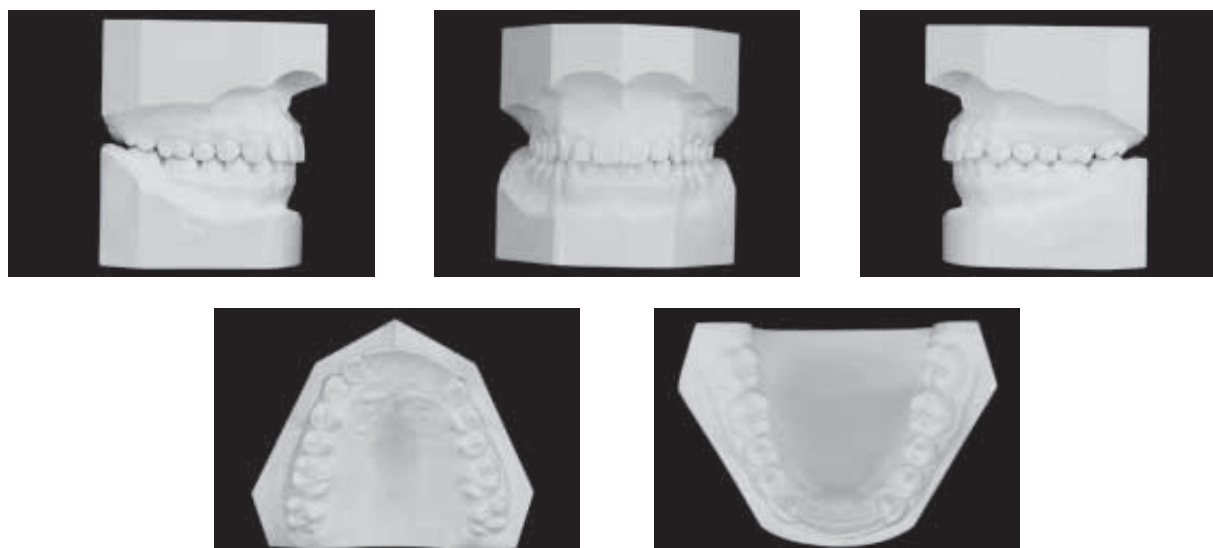


FIGURE 6 - Final casts.

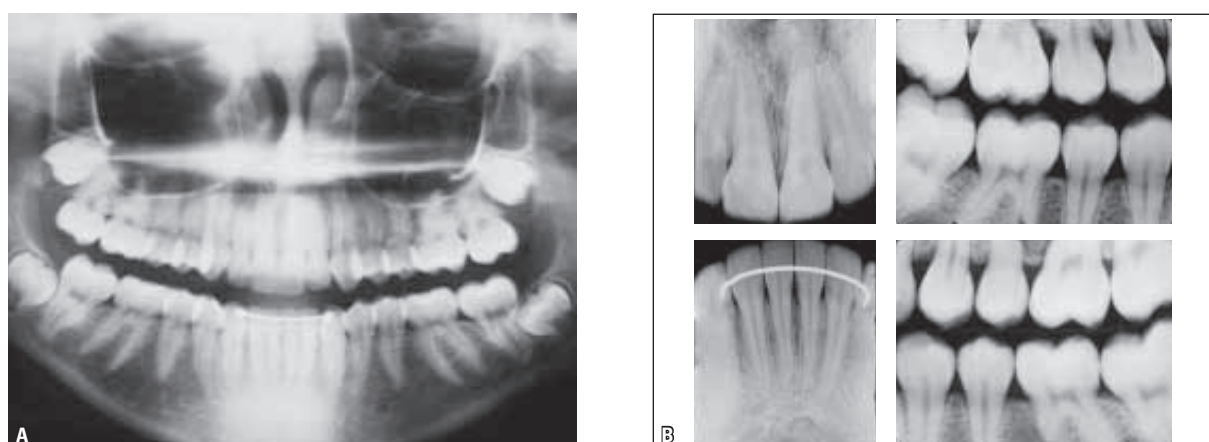


FIGURE 7 - Final panoramic (A) and interproximal periapical (B) radiographs.

Regarding occlusion, the dental midlines were coincident to the facial midline, the molars and canines came into normal occlusion, vertical overbite became appropriate and disocclusion guides satisfactory.

The panoramic radiograph (Fig 7A) revealed adequate root parallelism. The gentle rounding of the apices of the upper incisor roots observed

in the Figure 7B is compatible with the amount of movement produced. The profile cephalometric radiograph (Fig 8A) shows improved overbite and interlabial relationship.

Due to the correction of the asymmetries and severe overbite, a significant improvement in smile aesthetics was achieved, which also benefited the patient's face (Fig 5).

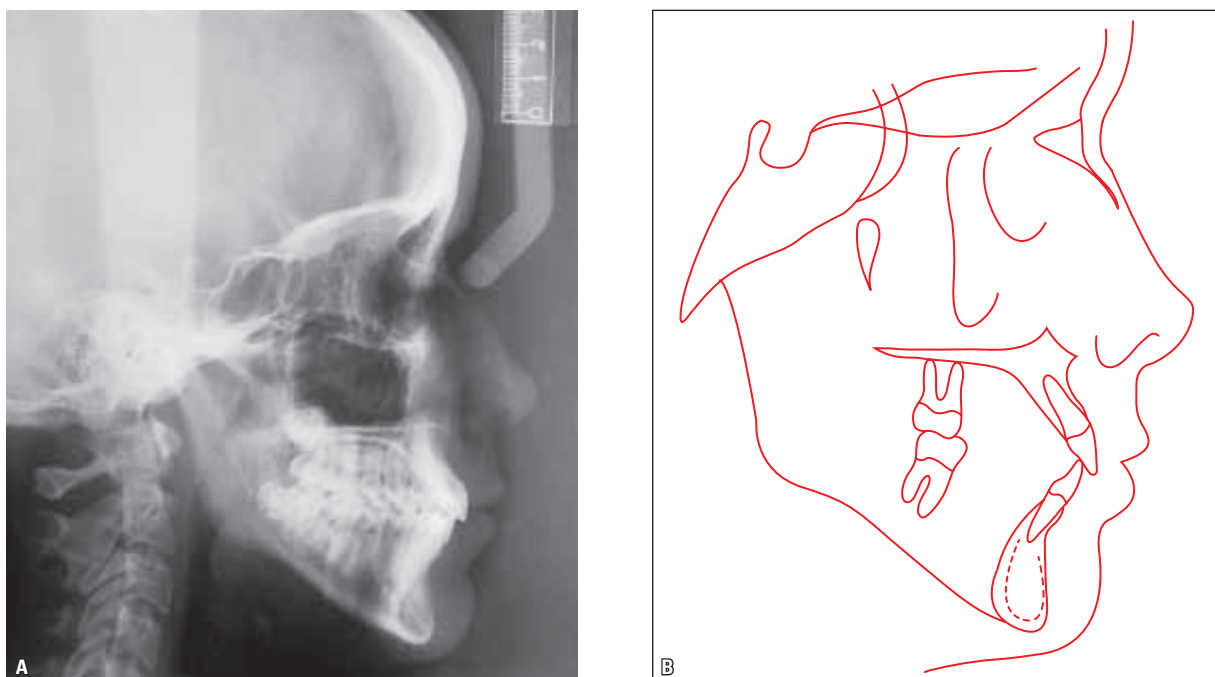


FIGURE 8 - Final profile cephalometric radiograph (A) and cephalometric tracing (B).

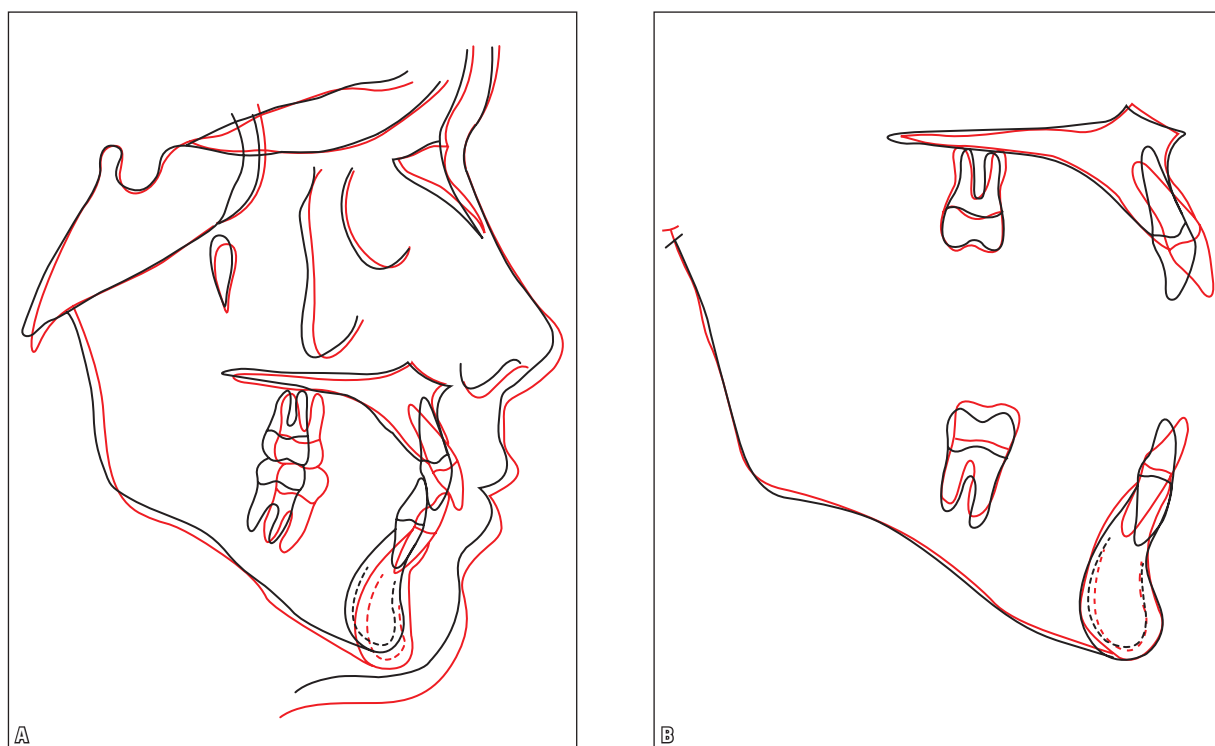


FIGURE 9 - Total (A) and partial (B) superimposition of initial (black) and final (red) cephalometric tracing.

TABLE 1 - Summary of cephalometric measurements.

	MEASUREMENTS	Normal	A	B	DIFFERENCE A-B
Skeletal Pattern	SNA (Steiner)	82°	84°	82°	2
	SNB (Steiner)	80°	80°	80°	0
	ANB (Steiner)	2°	4°	2°	2
	Convexity Angle (Downs)	0°	8°	1°	7
	Y axis (Downs)	59°	59°	63°	4
	Facial Angle (Downs)	87°	89°	86°	3
	SN – GoGn (Steiner)	32°	34°	36°	2
	FMA (Tweed)	25°	29°	32°	3
	IMPA (Tweed)	90°	75°	90°	15
Dental Pattern	$\underline{1}$ – NA (degrees) (Steiner)	22°	7°	28°	21
	$\underline{1}$ – NA (mm) (Steiner)	4 mm	2.5 mm	8 mm	5.5
	$\bar{1}$ – NB (degrees) (Steiner)	25°	12°	28°	16
	$\bar{1}$ – NB (mm) (Steiner)	4 mm	4 mm	7 mm	3
	$\frac{1}{1}$ – Interincisal angle (Downs)	130°	157°	121°	36
Profile	$\bar{1}$ – APo (mm) (Ricketts)	1 mm	1.5 mm	5 mm	3.5
	Upper Lip – S Line (Steiner)	0 mm	2 mm	1 mm	1
	Lower Lip – S Line (Steiner)	0 mm	1 mm	1 mm	0

FINAL CONSIDERATIONS

At first, the possibility of treating this case with tooth extractions was raised due to an apparent lack of space for the upper and lower teeth. However, the lack of space was the result of altered axial inclinations, tooth migration and atresia of the dental arches. The patient's age allowed these problems to be corrected using orthodontic resources, whereby space was created without compromising periodontal support, esthetics and function.^{2,3,4,5} Stability is yet

another factor that should be taken into account when protruding teeth and expanding dental arches. It is believed that because intercanine distances were widened by correcting upper and lower canine position and not by bringing the teeth out of their bone bases, it is highly likely that stability will be maintained after correction.¹ Even so, retention was carefully planned and half-yearly follow-up visits scheduled.

Treatment was expected to take up 30 months. However, the patient had to relocate

to another town for two years, for educational purposes. During this period, she missed too many appointments, significantly increasing treatment time to 48 months.

The patient's compliance in wearing the headgear was unstable, alternating moments

of total collaboration with others of sheer negligence, despite our constant reminders and encouragement. As can be seen in the final records, the overall result was considered adequate in terms of occlusion and facial and dental aesthetics.

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Tooth extraction in orthodontics: an evaluation of diagnostic elements

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Abstract

Certain malocclusions require orthodontists to be capable of establishing a diagnosis in order to determine the best approach to treatment. The purpose of this article was to present clinical cases and discuss some diagnostic elements used in drawing up a treatment plan to support tooth extraction. All diagnostic elements have been highlighted: Issues concerning compliance, tooth-arch discrepancy, cephalometric discrepancy and facial profile, skeletal age (growth) and anteroposterior relationships, dental asymmetry, facial pattern and pathologies. We suggest that sound decision-making is dependent on the factors mentioned above. Sometimes, however, one single characteristic can, by itself, determine a treatment plan.

Keywords: Corrective Orthodontics. Diagnosis. Tooth extraction. Orthodontic planning.

INTRODUCTION

Since the early days of orthodontics the need for tooth extractions in certain orthodontic situations has been discussed. In the early twentieth century, Angle favored non-extraction orthodontic treatment based on the concept of the occlusion line.²³ He believed it possible to correctly position all of the 32 teeth in the dental arches and, as a result, the adjacent tissues (tegument, bone and muscle) would adapt to this new position. Grounded in this belief, he taught his students and treated numerous cases.²⁴

One of Angle's chief opponents was Calvin Case, who advocated orthodontic treatment with extraction in some cases. He asserted that dental extractions should never be undertaken in order to facilitate orthodontic mechanics but rather to provide the best possible treatment for the patient.²

Tweed, one of Angle's brightest disciples faithfully followed his master's recommendation to perform treatment without extractions. Tweed was a judicious clinician who soon noted that many of his cases relapsed, particularly

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those in which the lower incisors did not end in a vertical position relative to its bony base. In such cases, he re-treated patients by extracting four premolars, thereby achieving better functional and aesthetic results. Tweed went from staunch follower to strong opponent of Angle's non-extractionist ideas, despite sustaining heavy criticism by his peers.²³

This dichotomy remains to this day. The diagnosis of some malocclusions can be ambiguous in terms of the need for extractions. According to Dewel,⁷ the challenge of orthodontic diagnosis is not in those cases that reportedly require extractions or those that clearly do not, but in a large group known as borderline cases. The literature is not consistent with respect to the value of negative discrepancy in the lower arch, a feature that would characterize such cases. Total discrepancy variations ranging between -3 mm and -6 mm are, however, acceptable to define the case as borderline. Keedy¹¹ remarked that diagnosis is determined by muscle tension and post-treatment stability. Williams²⁶ noted that in most borderline cases patients exhibit an appropriate and acceptable skeletal pattern and adequate soft tissue balance, a condition that is often indicated for extraction—in 5% to 87% of cases—by different professionals.

In any malocclusion, and particularly in a borderline case, it is necessary to evaluate the patient's dental, facial and skeletal characteristics to establish a correct diagnosis and effective treatment plan. We will discuss some of these characteristics, known as diagnostic elements, which must be carefully considered in deciding whether or not to perform extractions in orthodontic treatment planning.

Deciding on extraction involves more than just the need to obtain space in the arches, be it designed to align teeth or retract anterior teeth. Sometimes, an extraction made to align teeth can compromise facial esthetics, rendering the profile more concave. However, obtaining space

at the expense of moving posterior teeth distally can also compromise aesthetics by making the lower facial third longer, which can make it more difficult to achieve adequate lip closure. We set out to evaluate seven issues to help us make the right decision and to serve as qualitative guides. In other words, it does not mean that the presence of six favorable items will determine an extraction, since there are cases where only one item can be crucial to the decision.

COMPLIANCE

All orthodontic treatment requires patient compliance in, for example, maintaining adequate oral hygiene, not breaking or damaging the orthodontic accessories, or simply attending regular appointments. Certain types of malocclusion, however, require additional compliance to ensure treatment success. To correct certain types of Class II malocclusion, especially those of a skeletal origin, patients must wear a headgear. Moreover, in the treatment of Class III malocclusion with maxillary deficiency (patient with growth potential), the use of maxillary protraction face mask is also indicated.¹⁸ In most treatments, the regular use of intermaxillary elastics as an aid in the correction of malocclusion or in the final treatment stage—for intercuspation—also requires patient compliance. All the resources mentioned above pose patient compliance difficulties involving potential aesthetic concerns.

At first, it is extremely difficult to determine whether or not a patient will cooperate, but by observing certain criteria, such as patient behavior in the office, the nature of their relationship with their escort and through an interview with the parents, we can venture some predictions regarding compliance. These remarks apply mainly to adolescent patients. Overall, adult patients are more compliant than youths because they are more emotionally mature and can, therefore, better understand the importance of

this factor in their treatment. When significant cooperation is required it is suggested that a restudy be conducted after a certain period of time since, if compliance is indeed an issue, the orthodontist will not be able to fully rely on this factor to resolve borderline cases.

Sometimes lack of compliance can extend treatment time and even lead to reviews of the initial planning, requiring dental extractions.

Class II malocclusions with an adequate lower arch can be corrected by moving the upper teeth distally with the use of elastics or headgear. Both require substantial patient compliance. Alternatively, distal movement can be achieved with mini-implant support, or orthodontic correction can be accomplished by extracting upper premolars, which requires virtually no patient cooperation.

Some treatment plans can achieve similar results whether conducted with or without extractions (especially borderline cases). However, others may have their treatment outcome jeopardized if planning was based on patient-dependent mechanics and the patient failed to respond accordingly.

TOOTH-ARCH DISCREPANCY

This discrepancy should be evaluated in both the upper and lower arches. But for diagnostic purposes, the lower arch is a priority because of greater difficulty in obtaining space.

When orthodontists are faced with a marked negative tooth-arch discrepancy (TAD) in the lower arch, they will be hard pressed to treat the patient by performing tooth extractions. Small negative discrepancies can, in most cases, be treated without extractions. Thus, space can be obtained by using leeway space (if still possible), stripping, correction of pronounced mesial tipping of lower posterior teeth and small expansions and/or protrusions with the goal of restoring normal tipping to the lower teeth, especially if accompanied by rapid maxillary expansion (RME).

The clinical case 1 illustrates the situation of using leeway space to avoid extractions. The 9 year-old patient had a negative discrepancy in the upper and lower arches (Fig 1). To solve this case, we could choose for upper and lower premolar extractions. Although the profile was slightly convex, we opted for treatment using leeway space in the lower arch, placement of lingual arch during the mixed dentition (Fig 1G) and rapid maxillary expansion in the upper arch. With this therapeutic approach we achieved tooth alignment without the need to perform extractions and obtained a straight profile, which probably would have been in worse shape if the case had been conducted with tooth extractions (Figs 2 and 3).

Another situation typical of negative discrepancy cases is when the need arises to perform tooth extractions but no changes can be made to the facial profile. In the clinical case 2, the patient's facial profile was straight with negative discrepancy in the upper and lower arches and asymmetry in the lower arch (Fig 4) with lower midline shift to the right. To solve this case we chose to extract three premolars (14, 24 and 34). To avoid excessive retraction of anterior teeth towards lingual and deepening of the profile, we used resistant torque in the upper and lower teeth during retraction and avoiding incisor up-righting. The result at the end of treatment was dental harmony in the existent space, with maintenance of the facial profile (Fig 5).

Zero or positive model discrepancies require that treatment be performed without extractions, unless the patient has some other associated problem that indicates extraction.

Proffit and Fields¹⁶ developed a guide of contemporary procedures for evaluating extraction in Class I cases with crowding and/or protrusion. The authors reported that in negative lower arch discrepancies below 4 mm tooth extraction is rarely required, except in cases of incisor protrusion or posterior vertical

discrepancy. Negative discrepancies in the lower arch between 5 mm and 9 mm allow treatment to be performed with or without extractions, depending on the characteristics of the patient and the orthodontic mechanotherapy that was used. Finally, for negative discrepancies of more than 10 mm extraction is almost always required, preferably of first premolars because second premolar extraction is not suitable for large discrepancies.

When deciding to solve a TAD with extractions, changes in the profile due to retraction of anterior teeth and likely decrease in the lower face should be considered. But if the decision is for addressing the negative TAD without extractions, the likelihood of an increased lower face caused by the distal movement of posterior teeth in order to create space should be taken into account. These mechanisms are directly related to the facial pattern, as discussed below.



FIGURE 1 - Clinical case 1: initial photographs: **A, B**) facial, **C to F**) intraoral; **G**) lingual arch installed to use leeway space.



FIGURE 2 - Clinical case 1: final facial and intraoral photographs.



FIGURE 3 - Profile photographs: Pre (A) and post-treatment (B), and 3 years after case completion (C).



FIGURE 4 - Clinical case 2: initial facial and intraoral photographs.

CEPHALOMETRIC DISCREPANCY (CD) AND FACIAL PROFILE

In situations of pronounced labial tipping of the incisors with a high CD and expressive facial convexity, extractions are often necessary to retract these incisors, improving the patient's profile.

The current trend in orthodontic diagnosis is to focus more on facial features and rely less on cephalometric measurements. Therefore, sometimes a case is finished with protrusive incisors

so as not to alter a satisfactory profile, whereas one can resort to stripping to create spaces that would allow these teeth to be slightly uprighted.

Certain profile changes expected during orthodontic treatment do not always occur. Boley et al³ studied 50 patients undergoing orthodontic treatment with and without extractions. Extraoral photographs of patients before and after treatment were sent to US orthodontists and practitioners inquiring to what kind of treatment they had been subjected.

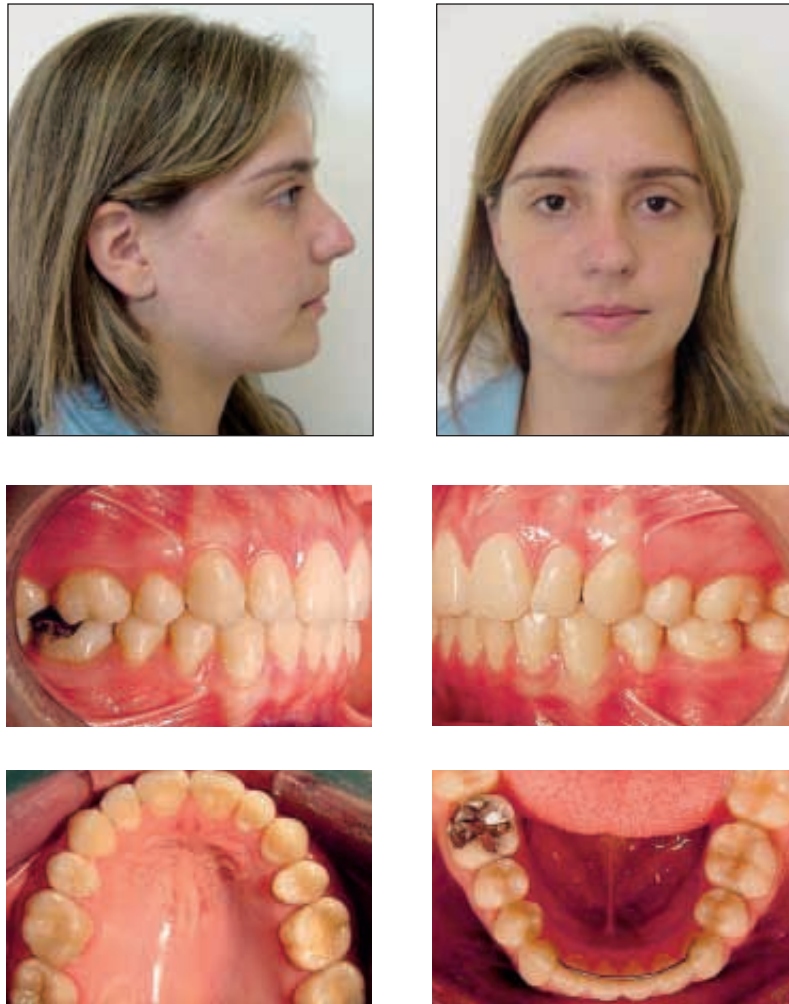


FIGURE 5 - Clinical case 2: final facial and intraoral photographs.



FIGURE 6 - Total superimposition.

Subsequently, the changes in the patients' profile were evaluated using cephalometric measurements. There were no significant differences in both evaluations, which led the authors to conclude that changes in the profile were not as evident for each type of treatment.

Patients can have different degrees of concave or convex profiles (strong, moderate or mild) or straight profiles. According to the profile type, one can determine the need for extractions in orthodontic treatment because the profile will respond to the changes effected in the teeth. According to Ramos et al,¹⁷ for each 1 mm of retraction of the upper incisor the upper lip retracts

0.75 mm. Other authors found lower values for this ratio (1/0.64 - Talass et al;²⁰ 1/0.5 - Masahud and Totti¹⁴). Regarding the lower lip, for every 1 mm of lower incisor retraction, it retracts 0.6 mm¹² or 0.78 mm¹⁴. Thus, space closure performed by retracting anterior teeth tends to render the profile more concave.

There are situations where although the facial profile is concave, orthodontic planning indicates extraction in order to address issues of crowding and/or anteroposterior dental asymmetries.

It is noteworthy that facial esthetics is increasingly valued by patients and that facial profile becomes more concave with age. Cases should therefore be preferably finished with slightly protruding profiles to prevent them from becoming concave in future. Adult patients should avoid excessive relocation of anterior teeth towards lingual for it may highlight creases and wrinkles, and impart an immediate perception of facial aging.

Figures 7 and 8 (clinical case 3) show a patient aged 11 years, convex profile, skeletal Class II (ANB = 6°), dental Class I, zero lower TAD, 2 mm overjet, 3 mm open bite, well positioned upper incisor (1. SN = 103°) and protruding lower incisor (IMPA = 110°). As aggravating factors, the patient presented with mouth breathing and difficulty in sealing the lips. Also noticeable were an increased lower facial third and lack of space for eruption of maxillary canines.

Based on these assessments, we opted for orthodontic treatment combined with extractions of teeth 14 and 24 with the goal of aligning and leveling the upper canines and teeth 35 and 45 for lower incisor retraction and mesial movement of teeth 36 and 46. A vertical chin cup was also used during nighttime for vertical control, thereby avoiding extrusions.

At the end of treatment there was improvement in the facial profile and correction of

dental relations (Figs 9 and 10). The final profile was not fully repositioned and was finished with a slight protrusion in order to avoid the premature aging of the patient.

SKELETAL AGE (GROWTH) AND ANTEROPOSTERIOR RELATIONSHIPS

In malocclusions with skeletal discrepancies it is crucial—for the diagnosis and prognosis of the case—to check whether the patient is still undergoing significant facial growth. Maximum pubertal growth spurt occurs approximately at around 11-12 years in girls and 13-14 years in boys, subject to individual variations.¹⁶ The most widely used method for assessing skeletal age is through a hand and wrist radiograph, by analyzing the size of the epiphyses relative to the diaphyses.⁹ If a patient is in his/her development period it is not possible to correct a skeletal dysplasia with the use of appliances that produce orthopedic effects.

If a malocclusion can be corrected with growth response (growth redirection), clinicians can handle the case without extractions.

Figures 11 and 12 show a case with these characteristics. We achieved skeletal and dental correction using headgear associated with a fixed orthodontic appliance. Initially, this 11 year-old patient had a convex profile, Skeletal Class II (ANB = 8°), Angle Class II, division 1, 2 mm lower TAD, 8 mm overjet, 5% overbite, well positioned upper incisors (1. SN = 101°), protruding lower teeth (IMPA = 99) and increased lower facial third. As an aggravating factor, the patient had a thumb-sucking habit, mouth breathing and a predominantly vertical resultant growth (SN.GoGn = 40°).

In this case, we opted for the use of combined pull headgear with a greater vertical component to correct the Class II by differential anterior displacement of the mandible (due to growth) associated with the use of Class III elastics to reposition the lower incisors.



FIGURE 7 - Clinical case 3: initial facial and intraoral photographs.

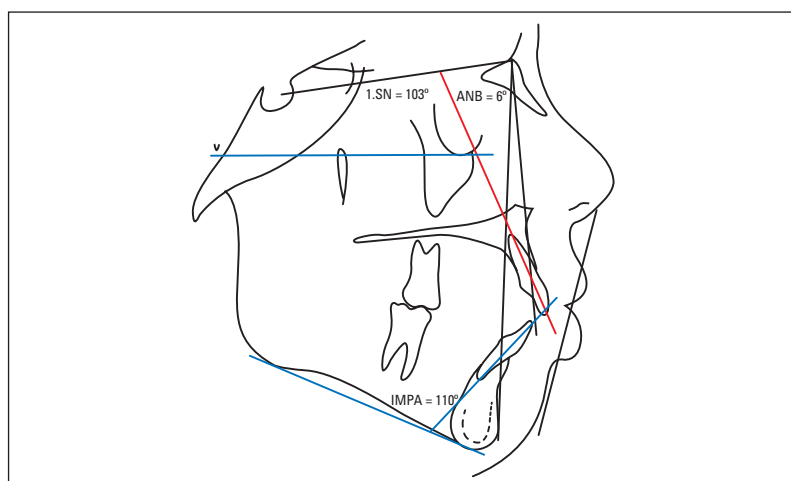


FIGURE 8 - Initial cephalometric tracing.



FIGURE 9 - Clinical case 3: final facial and intraoral photographs.

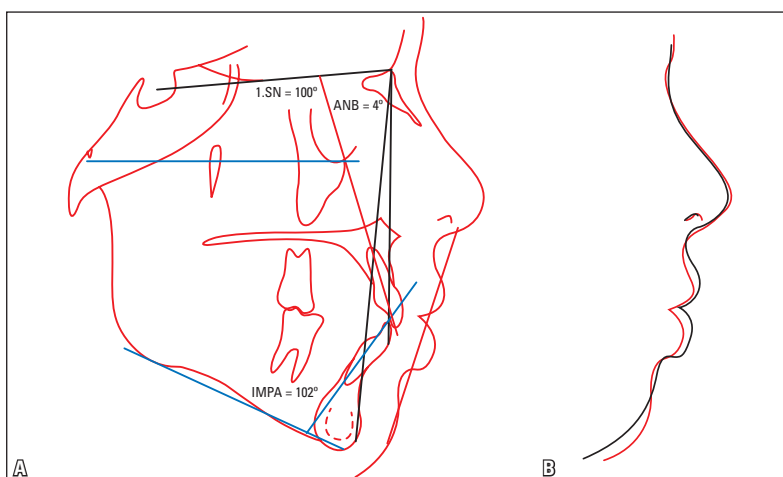


FIGURE 10 - **A)** Final cephalometric tracing. **B)** Comparison of initial and final profiles.

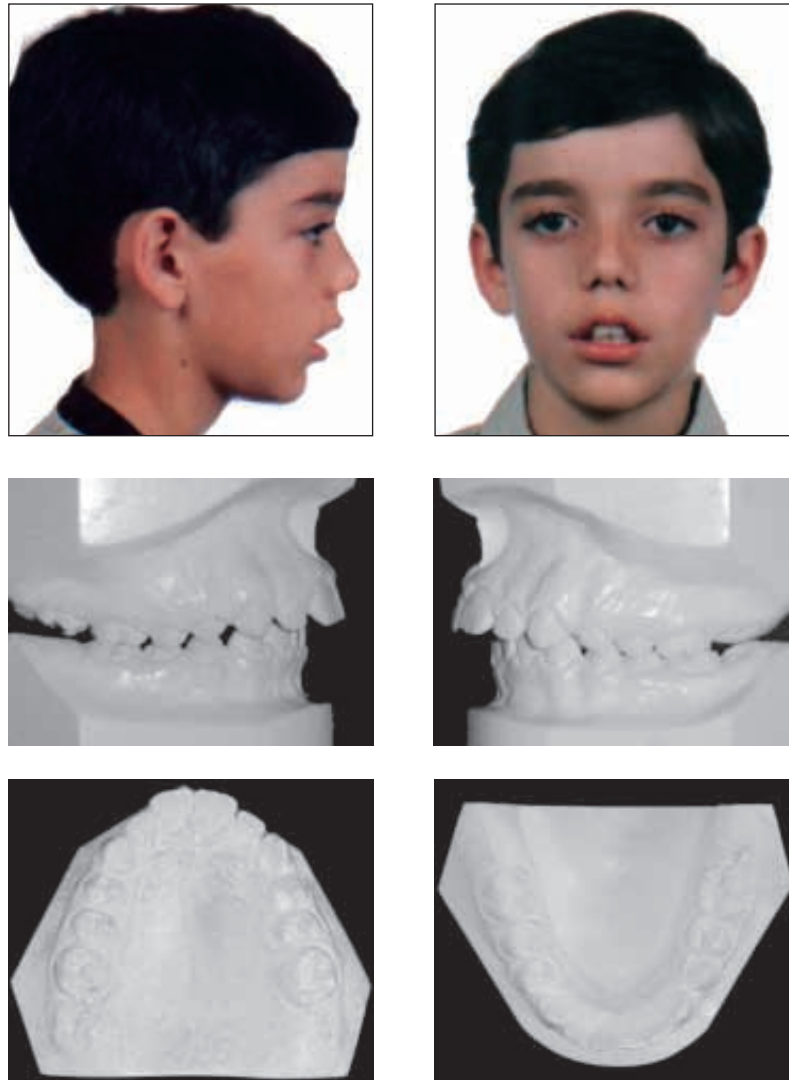


FIGURE 11 - Clinical case 4: initial facial and casts photographs.

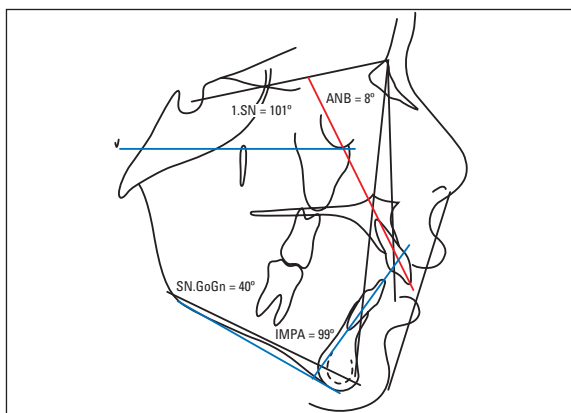


FIGURE 12 - Initial cephalometric tracing.

At the end of treatment we achieved the correction of dental and skeletal relationships ($ANB = 3^\circ$) at the expense of restricting the anteroposterior and vertical maxillary growth, in addition to the distal movement of the upper teeth and adequate anterior mandibular growth response.

As a result of a better dental and skeletal positioning the patient developed a passive lip seal (Figs 13 and 14).

In adult patients, who obviously do not exhibit sufficient growth to correct skeletal problems⁸

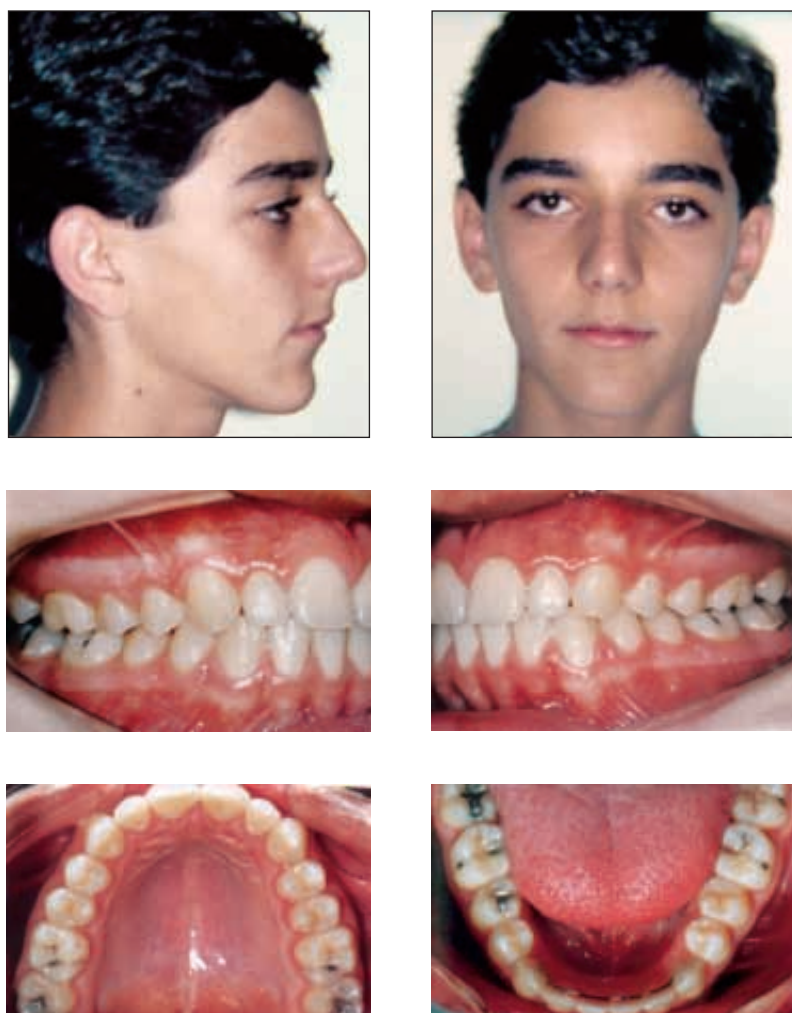


FIGURE 13 - Clinical case 4: final facial and intraoral photographs.

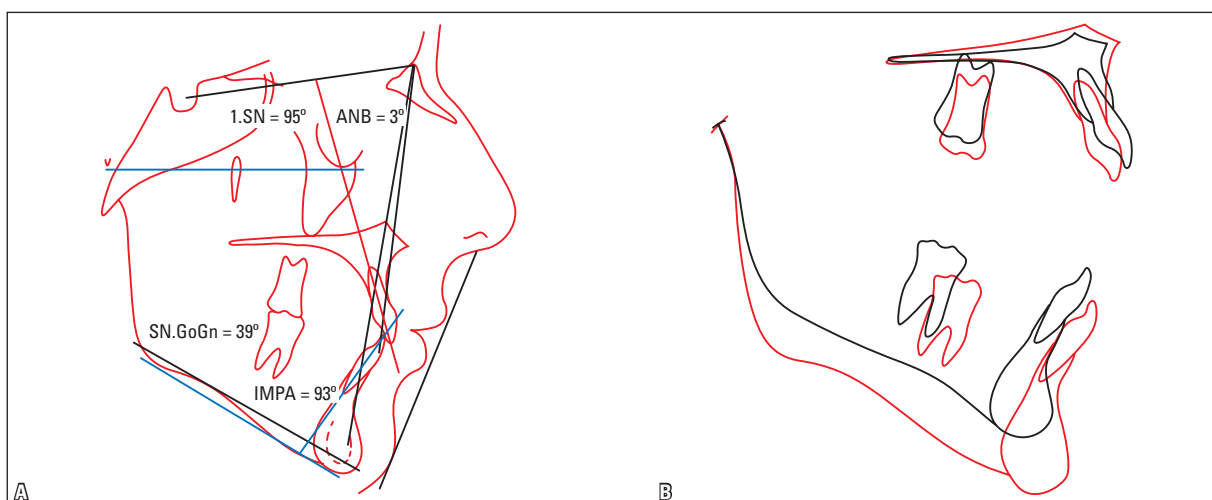


FIGURE 14 - A) Final cephalometric tracing. B) Partial superimpositions - maxilla and mandible.

a viable alternative would be the extraction of teeth to solve occlusal disorders, which would mask the skeletal problem, or otherwise perform orthognathic surgery.

Orthodontic retreatment often occurs because the correction of the skeletal problem, which could have been performed during the growth spurt period, sometimes is not appropriately addressed. Therefore, during retreatment, extractions arise as a possible solution to solve anteroposterior discrepancies. Retreatment can become more complex due to some usual limitations: the best option has already been wasted, teeth have been extracted, root resorption may be present, the patient is under emotional distress and is no longer growing.

When a first treatment was performed in which growth was not been used for malocclusion correction and dental extractions were made, one approach to be discussed is the orthodontic treatment combined with orthognathic surgery. Clinical case 5 clearly illustrates this situation.

Figures 15 and 16 show a 26 year-old female patient with a convex profile, skeletal Class II, Angle Class II, division 2 malocclusion, zero lower TAD, 4 mm overjet, 40% overbite, excessive exposure of maxillary incisors, increased lower facial third, teeth 35 and 45 congenitally missing, teeth 14 and 24 extracted in a previous treatment. The patient's main complaint regarded her dental and facial aesthetics. The two possible solutions to this case would be either to distalize some upper teeth to achieve dental correction only, which would probably worsen her facial aesthetics, or to eliminate any dental tipping used as compensation, subsequently performing orthognathic surgery with maxillary impaction and mandibular advancement.

Based on the patient's complaint, we opted for the surgical treatment with leveling and alignment, elimination of dental compensations,

extraction of teeth 18, 38 and 48, impaction of the maxilla, mandibular advancement and genioplasty.

The results included harmonic occlusal relationships with adequate positioning of the teeth in their bony bases and correction of skeletal disharmonies (Figs 17 and 18).

DENTAL ASYMMETRY

The assessment of dental and facial aesthetic is an important factor in the process of orthodontic diagnosis and treatment planning. One of the biggest challenges in these two tasks is the correct positioning of the upper and lower dental midlines relative to each other and to the face.⁴

According to Strang,¹⁹ the harmonic positioning of the midlines relative to each other and to the face is what characterizes normal occlusion, and any variation in this combination is indicative of improper relationship between the teeth or dental arches. This requires a careful diagnosis because properly assessing the causes behind midline shifts allows professionals to use unique mechanics and asymmetric extractions.²¹

According to Lewis,¹³ several methods are proposed for diagnosing midline shifts. Chiche and Pinault⁶ reported that assessment should be based on three factors: the center of the upper lip, the position of the papilla and central incisor tipping. The diagnosis can also be accomplished using well-molded plaster casts,⁵ marking two or three points in the posterior-most region of the midpalatal raphe and positioning the reticulate plate over these points.¹⁶

In Class II malocclusions, in subdivisions with bony base symmetry but dental asymmetry, orthodontists must determine which dental segment deviation is responsible for the shift and evaluate the dental midline in relation to the face in order to prepare a treatment plan that is compatible with the situation.²⁵



FIGURE 15 - Clinical case 5: initial facial and intraoral photographs.

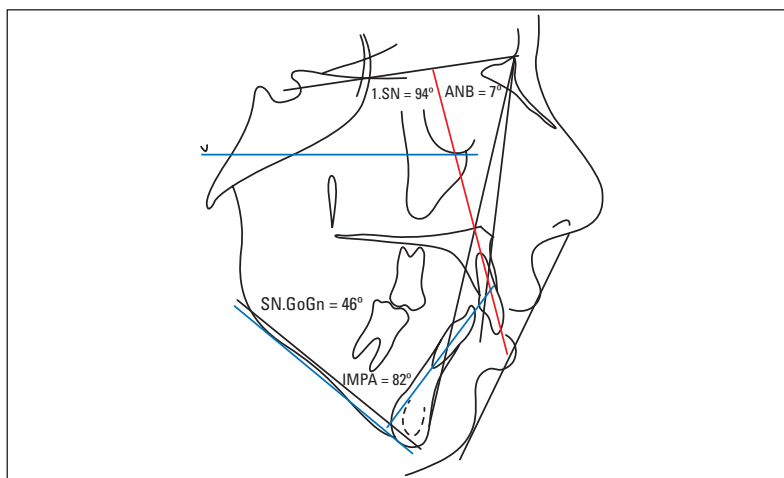


FIGURE 16 - Initial cephalometric tracing.



FIGURE 17 - Clinical case 5: final facial and intraoral photographs.

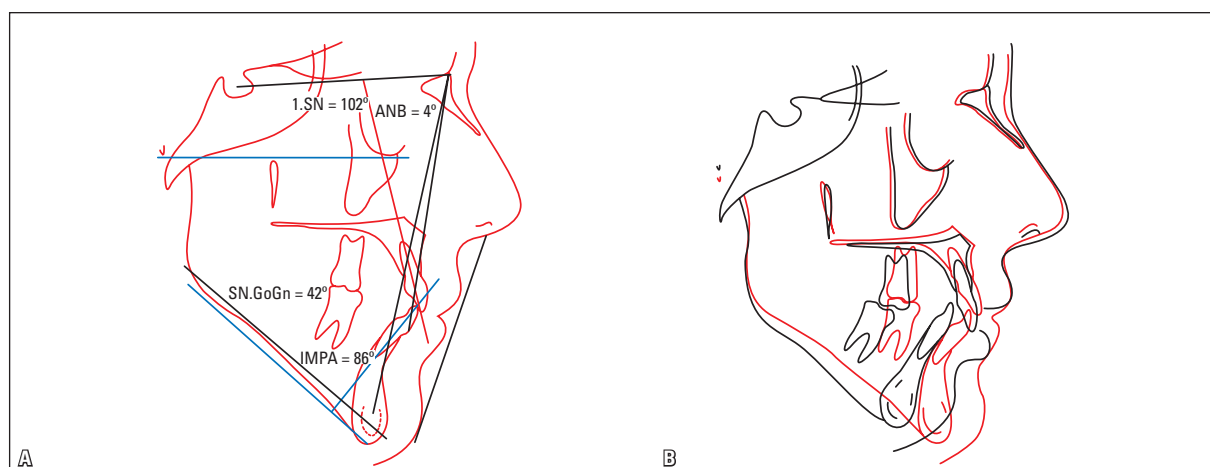


FIGURE 18 - **A)** Final cephalometric tracing. **B)** Total superimposition.

Patients presenting with severe dental midline deviation relative to the face (especially in the lower arch) require tooth extractions. Small asymmetries can be corrected with intermaxillary elastics or mini-implants (in some cases, unilateral mechanics), asymmetric extractions, stripping, and in a few situations, orthodontists will have to settle for completing orthodontic treatment with a little midline deviation. The lack of coincidence between the dental and facial midlines is more noticeable in the upper arch and is unsightly. This deviation can be the main reason for many patients to seek orthodontic treatment.

To illustrate this situation we will discuss clinical case 6, an 18 year-old female patient, who had a skeletal Class II malocclusion (ANB = 8°), upper and lower incisors well positioned (1.SN = 104° and IMPA = 92°), straight facial profile (UL-S = 2 mm and LL-S = 1 mm). Regarding the dental relationship, the case presented with a large lower asymmetry due to a prior treatment which had extracted tooth 44 only, a -3 mm lower TAD, 2 mm overjet, 50% overbite (Figs 19 and 20).

Based on these diagnostic data, we opted for extracting tooth 34 to correct the lower asymmetry. Although the extraction of this tooth alone would correct the lower asymmetry it would also cause the left canine relationship to go into Class II. To avoid this undesired effect, the upper second premolars had to be extracted (teeth 15 and 25). The extraction of tooth 25 enabled the maintenance of normal occlusal relationship in the left canines, and of tooth 15 maintained the upper arch symmetry.

Initially, a question may still remain unanswered when evaluating this clinical case. How can we prevent dental extractions from worsening the profile of this patient, which looked so appropriate at the start of treatment? To avoid worsening the profile, we used mechanical resistant torque resources, labial

crown in the lower incisors and omega loops that were well adjusted to the second molar tubes so as to avoid the lingual repositioning of the lower incisors, as well as mini-implant support to lose anchorage in the lower right hemi-arch. By following the procedures described above we were able to complete treatment having achieved the correction of the Class II malocclusion without compromising the facial profile (Figs 21 and 22).

It should be emphasized that after treatment completion, the patient underwent a rhinoplasty to further improve her profile aesthetics.

FACIAL PATTERN

Patients with different facial patterns require different mechanics, and responses to orthodontic treatment are not similar. Dolichofacial patients feature increased facial height relative to the width, exhibiting a long, narrow and protruding face. Furthermore, they have hypotonic facial muscles in the vertical direction and can therefore present with anterior overbite.⁸ These patients normally suffer from greater anchorage loss, which helps in closing spaces. Greater control should be exercised, however, in order to avoid excessive anchorage loss and the consequent lack of space to ensure the planned correction. Extrusive mechanics should be avoided, as well as distal tooth movement.

Brachyfacial patients' facial width is greater than their facial height, displaying a broad, short and globular face.⁸ These patients are not as prone to anchorage loss due to certain muscle characteristics (hypertonic masticatory muscles) that hinder tooth movement. Many patients have brachycephalic overbite. Since in these cases tooth extractions tend to worsen the vertical overlap, adequate mechanical control is required. Although normally dolichocephalics experience greater anchorage loss than brachycephalics, this is not always the case. Therefore, extra care must be taken during space closure.



FIGURE 19 - Clinical case 6: initial facial and intraoral photographs.

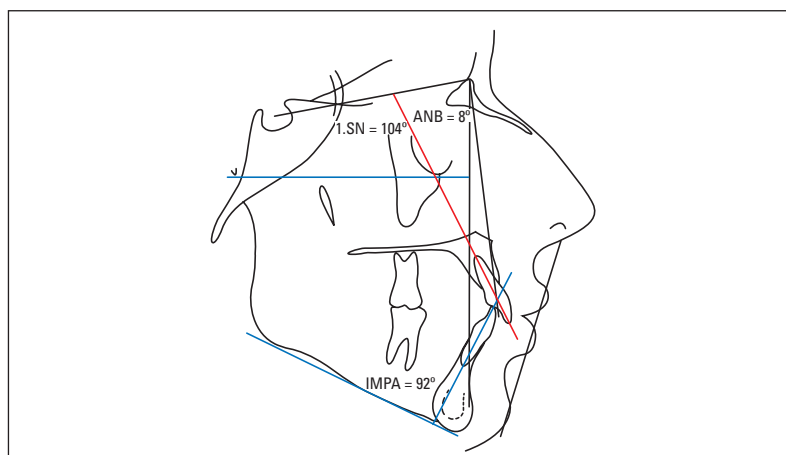


FIGURE 20 - Initial cephalometric tracing.



FIGURE 21 - Clinical case 6: final facial and intraoral photographs.



FIGURE 22 - A) Final cephalometric tracing. B) Total superimposition.

The literature suggests the removal of posterior permanent teeth first, with subsequent loss of anchorage, to correct anterior open bite by means of counterclockwise rotation of the mandible.^{1,15} Moreover, some authors¹⁰ question this association between growth reduction and vertical extractions.

However, clinical experience shows that moving the posterior teeth distally tends to cause the opening of the mandibular plane, especially in patients who have already gone through the growth spurt or those who exhibit an unfavorable growth pattern (predominantly vertical), which leads to the need for more extractions. On the other hand, extractions performed in association with vertical control (use of vertical chin cup, high-pull headgear, mini-implants, non-use of extrusive mechanics) may result in the closure of the mandibular plane and/or control of vertical facial growth, with decreased lower facial third, improving lip seal (Figs 7-10).

To clarify this situation we present clinical case 7 (Fig 23), where we performed orthodontic treatment in a patient with a vertical facial pattern. The clinical examination revealed anterior and posterior open bite. According to the treatment plan there was an indication for the extraction of upper second molars, preserving teeth 18 and 28, besides the placement of orthodontic mini-implants to intrude the maxillary molars, moving them distally while maintaining anchorage during retraction. Mandibular crowding was resolved by stripping, especially incisors with a triangular shape and with the presence of black spaces, when aligned. The results achieved in this case were the correction of the Class II dental relationship with bite closure by intrusion of the upper molars (Fig 24). The superimposition shows the total intrusion of the upper molars, a decreased mandibular plane as a result of the counterclockwise rotation of the mandible, and the consequent open bite closure (Fig 25).

PATHOLOGIES

Some pathologies play a key role in defining orthodontic treatment planning. Patients can have half-formed teeth, agenesis, ectopias, abnormal shapes or even carious processes, and endodontic lesions that indicate tooth extraction. During diagnosis these conditions should be considered as they may change—in certain situations—the choice of the tooth or teeth to be extracted.

In patients with an indication for premolar extraction due to a sharp negative model discrepancy, but with extensive decay in the first permanent molars, these teeth are a viable extraction alternative for the premolars.²² In asymmetric malocclusions, where only one tooth must be extracted, if the patient happens to have an anomalous tooth, this tooth should be selected for extraction. Many other pathological conditions such as cysts, abnormal roots and periodontal problems indicate the extraction of teeth. Thus, the different pathologies greatly contribute to orthodontic treatments involving extraction.

Clinical case 8 is of a female 10 year-old patient and illustrates the importance of pathologies in deciding which tooth to extract. She was in the mixed dentition phase and had an Angle Class I malocclusion, 3 mm anterior open bite, mouth breathing, upper midline shifted due to a missing tooth (21) and skeletal Class II relationship. The maxilla was slightly contracted with no crossbite and she had a 6 mm lower arch model discrepancy (Figs 26 and 27).

An analysis of the lateral radiograph (Fig. 27B) showed skeletal Class II ($ANB = 6^\circ$), vertical facial growth pattern ($SNGoGn = 42^\circ$ and $Y\text{ axis-SN} = 74^\circ$), upper incisors retroclined ($I.NA = 16^\circ$) and linguoversion ($I-NA = 3\text{ mm}$) and lower incisors protruding and in labioversion ($I.NB = 29^\circ$ and $I-NB = 5\text{ mm}$), although the latter were well established in the mandible ($IMPA = 89^\circ$). The profile was straight ($S-UL = +1 / S-LL = +1$).



FIGURE 23 - Clinical case 7: initial facial and intraoral photographs.

The panoramic radiograph (Fig 27A) disclosed an inverted (intraosseous) position of tooth 21 with an irregularity in the root portion suggestive of laceration. The lateral cephalometric radiograph showed an angle of approximately 90° between the root and crown of the central incisor.

The patient had a prior habit of thumb sucking, which accounted for the anterior open bite

and was maintained thereafter by the anterior posture of the tongue.

The excessive vertical pattern and negative TAD were regarded as the decisive factors to determine the extraction of the four premolars. However, the pathology (ectopia and laceration) of tooth 21 determined the need for its extraction instead of tooth 24. We carried out the transposition of tooth 23 to the location of



FIGURE 24 - Clinical case 7: final facial and intraoral photographs.



FIGURE 25 - Total superimposition.



FIGURE 26 - Clinical case 8: initial facial and intraoral photographs.

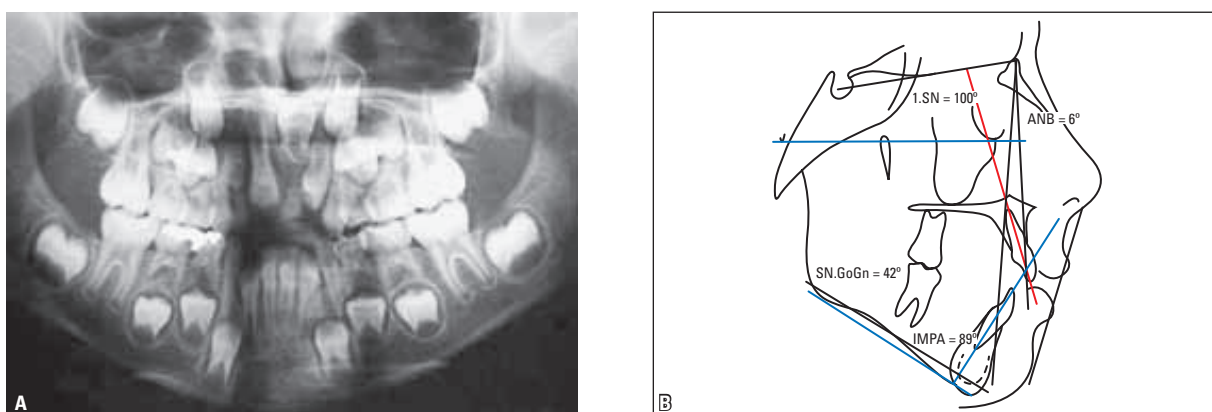


FIGURE 27 - A) Initial panoramic radiograph. B) Initial cephalometric tracing.

tooth 21. Thus, the case was treated with the extraction of teeth 14, 21, 34 and 44.

At the end of treatment, the patient's vertical pattern was maintained ($\text{SNGoGn} = 40^\circ$ / $\text{YSn axis} = 73^\circ$) thanks to the dental extractions and use of a combined extraoral traction

headgear, and minimizing—with this mechanics—the extrusive vector. The headgear improved the anteroposterior relationship of the bony bases ($\text{ANB} = 2^\circ$), changing the case from a skeletal Class II to a Class I relationship (Figs 28 and 29).



FIGURE 28 - Clinical case 8: final facial and intraoral photographs.



FIGURE 29 - **A)** Final cephalometric tracing. **B)** Total superimposition.

CONCLUSIONS

Any decision regarding the need for extraction of teeth during orthodontic therapy is not only dependent on the presence or absence of

space in the dental arches. Other issues should be evaluated in order to achieve proper malocclusion correction, maintenance or improvement of facial aesthetics and result stability.

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Evaluation of the applicability of a North American cephalometric standard to Brazilian patients subjected to orthognathic surgery

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Abstract

Objectives: To study the applicability of a North American cephalometric standard to Brazilian patients subjected to orthognathic surgery by comparing the post-surgical/orthodontic treatment cephalometric tracings of 29 patients who had undergone surgery of the maxilla and mandible with the cephalometric standard used as guidance in planning the cases. **Methods:** The tracings were generated by the Dolphin Imaging 9.0 computer program from scanned lateral cephalograms in which 48 dental, osseous and tegumentary landmarks were defined. Thus, were obtained 26 linear and angular cephalometric measurements to be compared with normative values, considering sexual dimorphism and possible modifications to the treatment plan to meet the individual needs of each case, as well as any possible ethnic and racial differences. The sample data were compared with the standard using Student's t-test means and standard deviations. **Results:** The results showed that for males, the sample means were significantly different from the standard in five of the measurements, while for women, nine were statistically different. However, despite the similarity of the means of most measurements in both genders, the data showed marked individual variations. **Conclusions:** An analysis of the results suggests that the North American cephalometric standard is applicable as a reference for planning orthodontic-surgical cases of Brazilian patients, provided that consideration is given to variations in the individual needs of each patient.

Keywords: Orthognathic surgery. Facial analysis. Cephalometric standard.

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INTRODUCTION

Recent years have seen an increase in the demand for orthodontic treatment and surgical correction of severe skeletal discrepancies. The main reasons for this phenomenon are a growing aesthetic concern, a large number of adult patients in need of occlusal correction, and improvements in surgical techniques.⁷

The treatment plan for performing facial changes is complex, especially due to the need to integrate them with occlusal correction. It should include clinical judgment, familiarity with the functional relationship between hard and soft tissues, knowledge of tegumentary responses to dentoskeletal movements, experienced professionals and the patients' willingness to undergo treatment. As a result, occlusion and facial aesthetics should become interdependent and be treated as concurrent treatment goals.¹⁸

Cephalometric analyses based on lateral radiographs play an important part in diagnosis, planning, prognosis and follow-up of cases involving orthodontics and orthognathic surgery.²¹ Some of these analyses aim to qualify and/or quantify aesthetic facial profiles. Diagnoses based only on cephalometry, however, may not produce satisfactory cosmetic results as they focus predominantly on dental and skeletal structures, with little or no attention to overlying soft tissue.⁴

Given their paramount importance, normative cephalometric values have been sought to guide diagnoses and decisions pertaining to bone and tooth movements.² However, although such values contribute to determining the goals of treatment, it should be noted that the appearance of soft tissues is only partially dependent on the underlying hard tissues. Several authors have therefore suggested the need for a detailed analysis of soft tissues to guide the treatment of malocclusion and facial aesthetic changes, in combination with radiographs, photographs and models.³

Authors from many regions of the world

have established cephalometric standards for hard and soft tissue normality for their specific populations with the purpose of orienting treatment plans according to the characteristics of each ethnic-racial group.¹⁷ Arnett et al,⁵ for example, launched their soft tissue cephalometric analysis based on the clinical examination of lateral and frontal facial features.^{2,3} It was designed to serve as a guide as well as a planning and diagnostic tool for orthodontists and surgeons to use in patients with malocclusions associated or not with skeletal discrepancies. The authors used a true vertical line²⁰ (TVL) as the main parameter for determining anteroposterior relationships. This line is perpendicular to the horizontal plane, as determined by the natural head position, passing through the subnasal point, as illustrated in Figure 1, a radiograph used to determine method error. One of the peculiarities of this analysis is an objective approach to the final positioning of the soft tissues that comprise the profile for subsequent planning of the dental and skeletal changes needed to achieve those aesthetic goals. It is one of the most comprehensive analyses currently employed in orthognathic surgery and it is based on normative cephalometric values proposed by the authors, which were obtained from a population in the State of California, USA.

The purpose of this study is to assess the applicability of this North American cephalometric standard⁵ to Brazilian patients subjected to orthognathic surgery, taking into account any adjustments made to the plan owing to possible differences between populations, and finally comparing the postoperative results with the cephalometric standard employed in the treatment plan.

MATERIAL AND METHODS

Sample

The sample was selected among adult Caucasian patients who had undergone surgical-orthodontic treatment with bimaxillary surgery.



FIGURE 1 - Representation of the true vertical line (TVL).

They were analyzed and planned with the aid of Dolphin Imaging 9.0 software (Dolphin Imaging Systems) following the cephalometric standard proposed by Arnett et al.⁵ The sample included 29 lateral cephalograms taken after orthodontic treatment had been completed. To be eligible, radiographs had to be of good quality, allowing proper identification of cephalometric landmarks of interest and had to be taken with the head in a natural position, in centric occlusal relation and lips at rest.²

The sample consisted of 14 male and 15 female patients aged between 16 and 44 years (mean of 27.2). All patients were of Mediterranean stock and hailed from different cities located in São Paulo and Paraná States, Brazil. They were treated by four experienced orthodontists and operated on by the same surgeon. Thirteen patients underwent maxilla, mandible and chin surgery, while the other 16 patients had no chin intervention. It is worth noting that all patients were treated without premolar extraction and no sample inclusion criteria were adopted with respect to facial

pattern. Surgical procedures included: Le Fort I osteotomy for the maxilla, with or without multisegmentation; bilateral sagittal split osteotomy of the mandible, with or without midline osteotomy; and mentoplasty.

Cephalometric tracing preparation

Dolphin Imaging 9.0 is a program used for the analysis and generation of facial cephalometric tracings for diagnosis, planning, prognosis and follow-up of orthodontic and/or surgical patients. It allows the insertion and comparison of intra and extraoral photographs and models, working as a case storage and management tool in a convenient and orderly fashion.^{10,16}

For inclusion in the program, the radiographs were scanned on a HP Scanjet 4C/T scanner with 300 dpi of resolution and processed in Adobe Photoshop 7.0 for brightness and contrast adjustments, thereby improving the visualization of the structures of interest. Following the steps outlined by the program, we used the mouse to determine the 48 dental, osseous and tegumentary cephalometric landmarks for preparation of the cephalometric tracing, namely: porion, orbital, pterygomaxillary, saddle, nasion, basion, soft glabella, soft nasion, nose tip, bridge of the nose, subnasal, soft "A", upper lip, upper stomion, lower stomion, lower lip, soft "B", soft pogonion, soft menton, soft gnathion, neck/mandible, "B", pogonion, menton, gnathion, gonion, mandibular ramus, medium third of ramus, sigmoid notch, articular, condyle, anterior nasal spine, "A", posterior nasal spine, upper first molar occlusal (Mx6), lower first molar occlusal (Md6), Mx6 distal, Mx6 mesial, Md6 distal, Md6 mesial, amelocemental junction (ACJ), labial of the lower central incisor (Md1), Md1 incisal, Md1 root apex, lingual ACJ of Md1, labial ACJ of upper central incisor (Mx1), Mx1 incisal, root apex of Mx1 and lingual ACJ of Mx1. All tracings were made by the same professional.

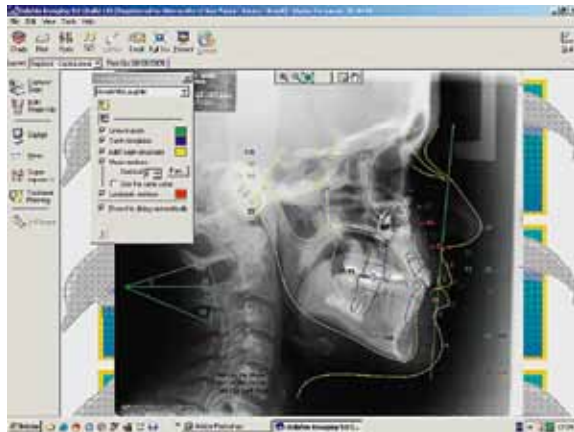


FIGURE 2 - Completed cephalometric tracing.

After all landmarks had been determined the program brought them together to draw the tracing (Fig 2). The values corresponding to each linear or angular measurement appeared automatically on the radiographic image. The program's measuring tool provides a list of all cephalometric data measured and compared with the standard and its corresponding standard deviation (Fig 3).

Method error

Dolphin Imaging, as described, requires the operator to use the mouse to mark reference points of interest in the radiograph for the tracing. Despite the clear definition of each of the points, the tracing may still be biased by subjectivity. With the purpose of checking for the presence or absence of such variations, it was necessary to evaluate the error or reliability of the method.

To calculate the error of the method, 24 lateral cephalograms were randomly selected from the archives of the discipline of Surgery at the School of Dentistry of Bauru, University of São Paulo, according to one single criterion: adequate image quality. Once again, all radiographs were scanned and processed with the computer program to obtain two cephalometric tracings with an interval of 15 days between the two. Determination of method error consisted in an analysis of differences

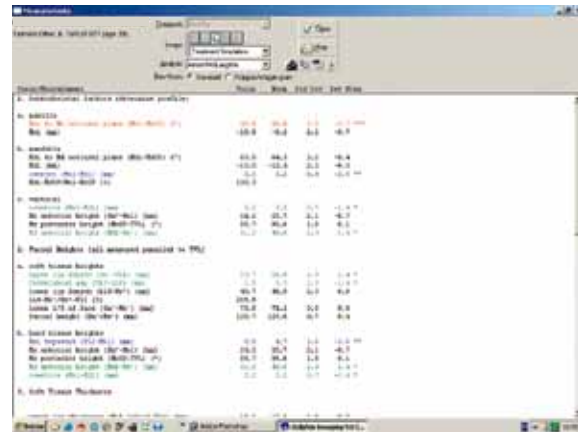


FIGURE 3 - All listed measurements.

between values obtained on both occasions, using 25 linear cephalometric measurements. Systematic (paired t-test) and casual (Dahlberg) errors were calculated. Method error calculation results are summarized in Table 1 and show no statistically significant differences between the tracings, suggesting that the error inherent in the method did not influence the results.

Cephalometric measurements

The next step consisted in interpreting the data on hand. To this end, we used the following 26 cephalometric measurements to compare the sample's postoperative results with the standard used in planning:

1. Angle between Mx1 and the maxillary occlusal plane.
2. Projection of Mx1 onto TVL.
3. Angle between Md1 and the mandibular occlusal plane.
4. Projection of Md1 onto TVL.
5. Overjet.
6. Overbite.
7. Anterior maxillary height (Sn-Mx1).
8. Anterior mandibular height (Md1-Me').
9. Upper lip height.
10. Interlabial space.
11. Lower lip height.
12. Height of the lower facial third (Sn-Me').

13. Total facial height (Na'-Me').
14. Mx1 exposure.
15. Upper lip thickness.
16. Lower lip thickness.
17. Mentum thickness (Pog-Pog').
18. Nasal projection onto TVL.
19. Projection of point A' onto TVL.
20. Projection of upper lip onto TVL.
21. Nasolabial angle.
22. Projection of lower lip onto TVL.
23. Projection of point B' onto TVL.
24. Projection of point Pog' onto TVL.

25. Tegumentary maxillomandibular distance (A'-B').

26. Horizontal distance between the upper and lower lips.

Student's t-test was applied to compare the patients' postoperative means with the standard for each cephalometric measurement, taking into account sexual dimorphism.

RESULTS

Tables 2 and 3 show the results for male and female subjects, respectively.

TABLE 1 - Method error (systematic and casual errors - values in mm).

Radiographs	1 st tracing		2 nd tracing		t	p*	error (Dahlberg)*
	mean	s.d.	mean	s.d.			
X-ray 1	18.96	35.16	18.66	35.29	1.831	0.077	0.54
X-ray 2	16.95	28.30	16.40	28.51	1.856	0.074	0.98
X-ray 3	17.33	33.92	17.82	33.78	1.804	0.082	0.91
X-ray 4	20.48	30.64	20.64	30.63	2.027	0.052	0.27
X-ray 5	17.61	32.73	18.06	32.86	1.586	0.124	0.93
X-ray 6	16.38	29.89	16.44	30.84	0.228	0.821	0.78
X-ray 7	15.45	31.23	15.34	31.54	0.428	0.672	0.83
X-ray 8	19.43	32.79	19.50	33.07	0.414	0.682	0.55
X-ray 9	17.55	33.89	17.53	33.20	0.117	0.907	0.65
X-ray 10	16.92	31.04	17.16	30.94	1.270	0.214	0.62
X-ray 11	20.56	35.70	20.01	35.50	1.967	0.059	0.96
X-ray 12	14.61	30.73	14.65	30.26	0.161	0.873	0.71
X-ray 13	13.10	30.28	13.23	31.01	0.428	0.672	0.95
X-ray 14	17.07	35.04	16.68	35.15	1.339	0.191	0.95
X-ray 15	15.20	30.27	15.58	30.66	1.742	0.092	0.72
X-ray 16	16.24	32.11	16.48	32.66	1.206	0.238	0.67
X-ray 17	16.03	35.11	15.68	35.69	1.519	0.140	0.75
X-ray 18	15.52	36.10	15.77	36.00	0.811	0.424	0.98
X-ray 19	16.75	35.24	17.23	34.90	1.892	0.068	0.85
X-ray 20	17.16	30.15	16.96	30.22	1.850	0.075	0.36
X-ray 21	15.65	29.54	15.56	29.59	0.650	0.521	0.41
X-ray 22	12.02	26.77	12.05	26.79	0.113	0.911	0.67
X-ray 23	17.92	32.66	17.93	33.47	0.027	0.979	0.94
X-ray 24	15.67	30.91	15.62	30.17	0.208	0.837	0.73

* Significance: for p < 0.05 and Dahlberg > 1.

TABLE 2 - Results for males.

Measurement	Sample	s.d.	Standard	s.d.	Difference	Classification*	t	p**
1	55.2	6.2	57.8	3	2.6	0	1.630	0.1130
2	-12.3	4.8	-12.1	1.8	0.2	0	-0.171	0.8654
3	70.1	7.5	64	4	6.1	+++	3.078	0.0043
4	-14.9	4.5	-15.4	1.9	0.5	0	0.446	0.6589
5	2.6	1.2	3.2	0.6	0.6	0	-1.927	0.0630
6	1.8	1	3.2	0.7	1.4	---	-4.812	0.0000
7	28.3	4.5	28.4	3.2	0.1	0	-0.076	0.9400
8	54.4	2.1	56	3	1.6	0	-1.719	0.0953
9	25.7	3.6	24.4	2.5	1.3	0	1.245	0.2221
10	2.1	1.7	2.4	1.1	0.3	0	-0.626	0.5359
11	53.3	3.1	54.3	2.4	1	0	-1.060	0.2969
12	81	5.6	81.1	4.7	0.1	0	-0.056	0.9553
13	138.7	7.8	138	6.5	0.7	0	0.285	0.7777
14	2.6	1.8	3.9	1.2	1.3	---	-2.532	0.0165
15	14.9	2.5	14.8	1.4	0.1	0	-0.149	0.8824
16	11.9	1.4	15.1	1.2	3.2	---	7.146	0.0000
17	14.5	2.5	13.5	2.3	1	0	-1.204	0.2374
18	17.2	1.8	17	1.7	0.2	0	-0.330	0.7438
19	0.5	1.9	-0.3	1	0.8	0	-1.599	0.1196
20	3.8	2.6	3.3	1.7	0.5	0	-0.679	0.5019
21	103.2	8.7	106	7.7	2.8	0	0.989	0.3299
22	0.6	5.4	1	2.2	0.4	0	-0.299	0.7667
23	-8.2	7.2	-7.1	1.6	1.3	0	0.785	0.4382
24	-3.7	8.8	-3.5	1.8	0.2	0	0.099	0.9215
25	9	6.1	6.8	1.5	2.2	+++	-1.556	0.1294
26	3.1	3.4	2.3	1.2	0.8	0	-0.974	0.3372

* --- = below standard, 0 = standard, +++ = above standard.

** Statistically significant difference for $p < 0.05$.

DISCUSSION

Diagnosis, treatment plan and treatment implementation are the three steps of malocclusion care.² This triad is interdependent, so that failure in one of the steps can lead to case failure. It should be emphasized that the goal should not focus on malocclusion correction alone but also on enhancing or maintaining the components of facial aesthetics, as determined by bone, soft tissue and teeth. Although a normal occlusion

is important for facial harmony it does not mean that once it has been achieved the profile will always be balanced. A balanced facial contour can often be found even if a malocclusion is present and vice versa.¹⁵ This has led orthodontists and maxillofacial surgeons to invest in studies and resources to provide their patients with improved diagnosis and treatment. In this context, advanced computer programs have been developed that allow treatment planning

TABLE 3 - Results for females.

Measurement	Sample	s.d.	Standard	s.d.	Difference	Classification*	t	p**
1	54.1	7	56.8	2.5	2.7	---	1.792	0.0809
2	-9.2	3.5	-9.2	2.2	0	0	0.000	1.000
3	67	6.7	64.3	3.2	2.7	0	1.749	0.0882
4	-12.1	3.2	-12.4	2.2	0.3	0	0.355	0.7242
5	2.9	1.1	3.2	0.4	0.3	0	-1.263	0.2142
6	2.2	0.7	3.2	0.7	1	---	-4.406	0.0001
7	26.6	3.9	25.7	2.1	0.9	0	0.964	0.3409
8	50.4	4.2	48.6	2.4	1.8	0	1.753	0.0874
9	23.6	3.1	21	1.9	2.6	+++	3.340	0.0019
10	1.7	1.3	3.3	1.3	1.6	---	-3.796	0.0005
11	49.5	5.1	46.9	2.3	2.6	+++	2.248	0.0303
12	74.8	7.2	71.1	3.5	3.7	+++	2.218	0.0324
13	130.1	8.5	125	4.7	5.1	+++	2.484	0.0174
14	2.9	2.5	4.7	1.6	1.8	---	-2.817	0.0076
15	12.6	2.2	12.6	1.8	0.6	0	0.000	1.000
16	11.2	1.5	13.6	1.4	2.4	---	5.152	0.0000
17	12.9	2.2	11.8	1.5	1.1	0	-1.903	0.0645
18	17.3	1.9	16	1.4	1.3	0	-2.510	0.0163
19	-0.2	1.9	-0.1	1	0.1	0	0.222	0.8258
20	2.9	2.4	3.7	1.2	0.8	0	1.427	0.1616
21	105.6	8.2	104	6.8	1.6	0	-0.673	0.5050
22	1.3	3.8	1.9	1.4	0.6	0	0.729	0.4702
23	-6.1	3.8	-5.3	1.5	0.8	0	0.959	0.3437
24	-2.2	4.5	-2.6	1.9	0.4	0	-0.399	0.6924
25	5.8	3	5.2	1.6	0.6	0	-0.838	0.4069
26	1.6	1.7	1.8	1	0.2	0	0.476	0.6366

* --- = below standard, 0 = standard, +++ = above standard.

** Statistically significant difference for $p < 0.05$.

and visualization. These programs are becoming increasingly useful in the communication between patients and professionals before and during treatment,¹⁴ especially when it comes to predicting results. Among the advantages of computerized methods are the ability to manipulate the images, allowing enhanced viewing of areas with low resolution or too much

overlapping, time savings, convenient selection and exchange of cephalometric analyses, speedy superimposition of serial radiographs, streamlined data storage and retrieval as well as the ability to promptly compare data for retrospective studies.¹⁶

This study compared the post-treatment cephalometric results of patients who had

undergone orthognathic surgery in conformity to the normative values used to inform the treatment plans. The goal was to check whether or not the use of such standard would be feasible for this group of patients. This study did not aim to assess the prognostic accuracy of the results, although such results can be extrapolated to the extent that the treatment followed certain normative values. We therefore expected the results to be within the scope of these values, which became our “gold standard” prognosis and—subject to any changes required for each specific case—can be used as a communication tool between patients and professionals.

The Dolphin Imaging computer program, version 9.0 (Dolphin Imaging Systems) was used to generate cephalometric tracings by marking a series of dental, osseous and tegumentary landmarks on previously scanned radiographic images. This program was chosen because it is one of the most comprehensive available in the market today. Despite all the advantages and the fact that nowadays such software plays a key role in the treatment of malocclusion, it does have certain limitations, which are also present in manual methods, such as a potential inaccuracy in identifying reference points (landmarks), leading to distortion in the tracings.⁶ By calculating the method error the tracings became more reliable by ensuring that the investigator who marked the reference points was duly calibrated.

In studies of this nature, the uniformity of patient features is extremely important. Ethnic and racial differences, sexual dimorphism, inclusion of young patients with growth potential after treatment, or patients with cleft lip and palate, can compromise the outcome. Our sample for this study comprised Caucasian individuals hailing from the states of São Paulo and Paraná, of Mediterranean stock, separated into groups according to gender. Patients who had undergone any type of corrective or reconstructive

plastic surgery were excluded from the sample.

Determining the extent of the discrepancy found between the treatment plan or the cephalometric standard and the final treatment results in patients subjected to orthognathic surgery is a challenging task due to the numerous potential sources of inaccuracy, such as: Landmark identification, radiographic scanning method, accuracy in the transfer of planned movements to the articulator, accuracy in the model surgery and in fabricating the surgical guide, implementation of the surgical technique, the team's skill and experience (orthodontists and surgeons), settlement of the soft tissues on the dental and skeletal movements and relapse.⁸ It is also important to bear in mind that most planning methods use two-dimensional representations of three-dimensional structures.¹⁹ The method used in this study aimed to eliminate or at least minimize these shortcomings.

Another noteworthy factor is that as the extent of the surgical movements increases, so does the potential inaccuracy of the results.¹ In this study, all patients underwent maxillary and mandibular surgery, with or without mentoplasty. Therefore, they experienced significant spatial changes in teeth, bones and soft tissues, thereby increasing the likelihood of inaccurate—especially long-term—results. Surgeries involving only the maxilla or only the mandible enable greater predictability and easier achievement of planned results.⁹

The period of patient follow-up also seems to influence interpretation of the results. Studies that use immediate postoperative radiographs tend to display more accurate data and the longer the interval between surgery and final radiographs, the greater the inaccuracies between treatment plan and final profile. For proper evaluation of the results, a follow-up period of at least 18 months is necessary to ensure that the data collected are stable. Short-term data are prone to considerable variability

in spatial changes between hard and soft tissues, occurring over time. This is due to tissue adaptations following abrupt changes in bone caused by the surgery.¹³ To minimize this variable, in our sample we chose to use radiographs taken at the end of postoperative orthodontics since the average time for completion of orthodontic treatment was 1.4 year.

In orthodontic practice, diagnosis and planning are determined in part by comparing the cephalometric measurements of patients with normative values, although most of these standards were established based on samples of Caucasian European or North American patients.¹¹ Given a wide variation in the mean values of cephalometric standards expressed by large standard deviation values, cephalometric standards should be used with caution, always taking into account their respective standard deviations in analyses, diagnoses and planning.¹²

In our particular study, concordance was found between the means of the results and the standard used in the treatment plan in 21 cephalometric measurements of men and 17 of women (80.8% and 65.4% respectively). In both genders, we found a statistically significant difference for overbite, exposure of upper central incisor and lower lip thickness. In these cases, the sample data values were smaller than the standard. For men, two other measurements differed from the standard, i.e., the angle formed by the lower central incisor and the mandibular occlusal plane, and the horizontal distance between points A' and B' (anteroposterior maxillomandibular relationship of the soft tissues). In these cases, sample patient values were significantly higher than the standard. Moreover, for women, there were differences in the angle formed by the upper central incisor and maxillary occlusal plane and the interlabial space—which were smaller than the standard—, whereas upper lip height, lower lip height, height of lower facial third and total facial height were

higher than the standard.

Despite a high correlation found between result means and the standard, there was great individual variation, which can be explained by the high standard deviation values of the sample. One likely source of variation between our data and the standard stems from the fact that although the treatment plans followed a specific cephalometric standard, they were not standardized among themselves. This may mean that plans were subject to variations geared to meeting the needs of each specific case and achieving the best possible result, i.e., after the treatment plans had been prepared based on the normative values advocated by Arnett et al,⁵ these plans could be modified so as to ensure a better outcome in a particular area of the facial profile.

This was precisely the purpose of this study, namely, to evaluate the feasibility of using a North American cephalometric standard to plan the orthognathic surgery of Brazilian patients, taking into consideration possible changes in the plans to suit the specific needs of each case. In short, we sought to assess whether the racial/ethnic differences between these two populations—although already intensely intermingled—are sufficient to contraindicate the use of cephalometric standards adopted by one population in planning the treatment of the other population's patients. It is noteworthy, however, that the standards should be considered as planning guidelines, not treatment guidelines, so as to ensure the fulfillment of individual case needs.

The use of three-dimensional facial reconstruction using CAT scans and facial scanners are currently under study. Hopefully, in the near future the two will combine definitively or even replace the current two-dimensional models so that orthognathic surgery planning and treatment predictability can be further refined, especially with regard to soft tissues.^{22,23}

Version 10 of the Dolphin Imaging computer program already features these 3D capabilities.

CONCLUSIONS

After analyzing and discussing the findings of this study, we concluded that, despite significant

individual variations, it is feasible to apply the cephalometric standard proposed by Arnett et al⁵ in Brazilian patients who have undergone orthognathic surgery, although some planning adjustments are required to offset possible racial/ethnic differences between the two populations.

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Analysis of biodegradation of orthodontic brackets using scanning electron microscopy

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Abstract

Objective: The purpose of this study was to analyze, with the aid of scanning electron microscopy (SEM), the chemical and structural changes in metal brackets subjected to an in vitro biodegradation process. **Methods:** The sample was divided into three groups according to brackets commercial brand names, i.e., Group A = Dyna-Lock, 3M/Unitek (AISI 303) and Group B = LG standard edgewise, American Orthodontics (AISI 316L). The specimens were simulated orthodontic appliances, which remained immersed in saline solution (0.05%) for a period of 60 days at 37°C under agitation. The changes resulting from exposure of the brackets to the saline solution were investigated by microscopic observation (SEM) and chemical composition analysis (EDX), performed before and after the immersion period (T0 and T5, respectively). **Results:** The results showed, at T5, the formation of products of corrosion on the surface of the brackets, especially in Group A. In addition, there were changes in the composition of the bracket alloy in both groups, whereas in group A there was a reduction in iron and chromium ions, and in Group B a reduction in chromium ions. **Conclusions:** The brackets in Group A were less resistant to in vitro biodegradation, which might be associated with the type of steel used by the manufacturer (AISI 303).

Keywords: Corrosion. Biocompatibility. Orthodontic brackets. Nickel.

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INTRODUCTION

Over the past 20 years, the biocompatibility of dental alloys has been the target of extensive research. However, studies in this area have generated many unanswered questions, confirming the need to learn much more about the biocompatibility of these materials. Given the fact that this process is not thoroughly understood, orthodontists are hard pressed to select a biologically safe alloy for their patients.

Hypersensitivity caused by nickel in stainless steel alloys, widely employed in orthodontic treatment,^{4,20} has become increasingly frequent. Orthodontic brackets, bands and archwires are universally made from this alloy, which contains about 6% to 12% of nickel and 15% to 22% of chromium.²⁴ Besides allergenicity, carcinogenic, mutagenic and cytotoxic effects have been attributed to nickel and, to a lesser extent, chromium.

One of the factors that determine the biocompatibility of alloys used in dentistry is their resistance to corrosion.^{19,27} However, despite the high resistance of austenitic stainless steel, the major alloy employed in the manufacture of orthodontic brackets, several studies have revealed the corrosion of these brackets.^{3,9,13,16,18,28,29} The very bracket manufacturing process exposes them to physical and chemical factors that stimulate corrosion. Noteworthy, among these, are thermal treatment,¹² welds⁵ and polishing agents.¹⁷

Macroscopically, bracket corrosion is characterized by loss of gloss, discoloration and superficial roughness often associated with the deposition

of products of corrosion.³⁰ These features, when present, can contribute to increased frictional resistance and interfere with orthodontic mechanics, affecting treatment progress.¹¹

According to Edie, Andreasen and Zaytoun,⁷ the observation of surface characteristics in order to detect corrosion constitutes the most straightforward method to evaluate biodegradation. It is worth noting that the methodology used in this study to evaluate the homogeneity of the metal matrix, i.e., visual analysis of microscopic images, has proved effective for such evaluation. Chappard et al⁶ found a positive relationship between levels of roughness measured by contact profilometry and roughness analysis in microscope images (SEM).

In view of the wide array of factors associated with corrosion and the susceptibility of orthodontic brackets to this process, the purpose of this study was to analyze, using scanning electron microscopy (SEM), the chemical and structural changes in two brands of metal brackets subjected to a process of biodegradation in vitro.

MATERIAL AND METHODS

Microscopic bracket analysis (SEM)

Two different brackets were analyzed: Dynalock Standard Edgewise (3M Unitek, Monrovia, CA, USA) and LG Edgewise (American Orthodontics, Sheboygan, Wisconsin, USA), which were divided into two experimental groups, according to their commercial brands names (Table 1). For evaluation by SEM (Philips XL30,

GROUP	BRACKETS					
	n	Brand	Specification	Type of steel	Chemical composition (max%)	Remark
A	140	3M/ Unitek	Dynalock, Standard Edgewise, Slot 0.022-in	AISI 303	C=0.15%, Chr=17-19%, Ni=5.0-10%, Mn=2.0%, Si=1.0%, Iron=remainder	No welding joining body to base
B	140	American Orthodontics	LG Standard Edgewise, Slot 0.022-in	AISI 316L	C=0.030%, Chr=16-18%, Ni=10-14%, Mn=2.0%, Si=1.0%, Iron=remainder	Silver solder joining body to base

TABLE 1 - Division of the experimental groups.

Eindhoven, Netherlands) 70 brackets were randomly selected and analyzed in two stages: T0 (analyzed “as received”) and T5 (60 days after immersion in saline solution).

The specimens that simulated a hemi-mandible consisted of incisor ($n = 2$), canine ($n = 1$) and pre-molar ($n = 2$) brackets. Upper incisor brackets were used on the molars (1st and 2nd), totaling 7 brackets. The brackets were attached to archwires with elastic ligature and the bracket bases covered with wax #7. This procedure was meant to prevent corrosion in that region and facilitate the removal of bonding material from the bracket bases after experiment completion. The specimens were immersed in test tubes containing 10 ml of saline solution (NaCl 0.05%, Biochemistry Department, PUCRS) and subjected to a process of “chemical-mechanical aging”. They remained under agitation for 8 hours a day at a constant temperature of $36 \pm 1^\circ\text{C}$ (Dubnoff Bath, Nova TécnicaTM) for a period of up to 60 days.

Photomicrographs were taken of the same regions and the same brackets under the same

magnification at both times (T0 and T5).

To perform a SEM analysis, the brackets were mounted on stubs and observed by an examiner. The following images were recorded (Fig 1):

1 - Frontal (general) view - whole bracket (50x magnification).

1s - Frontal (specific) view - 2 pre-determined regions of each bracket were observed: Region a, on the left occlusal/incisal wing, and region b, on the left slot (500x magnification).

2 - Inferior (general) view - whole bracket (50x magnification).

2s - Inferior (specific) view - 2 regions were observed on each bracket at 500x (regions a and b) and 2000x (region 2m) magnification.

At T0 the differences in surface finish of the orthodontic brackets in Groups A and B were qualitatively evaluated. In the following step, the images obtained initially (T0) were compared with those obtained after the brackets had remained immersed in saline solution for 60 days (T5).

All images were qualitatively evaluated by a single examiner.

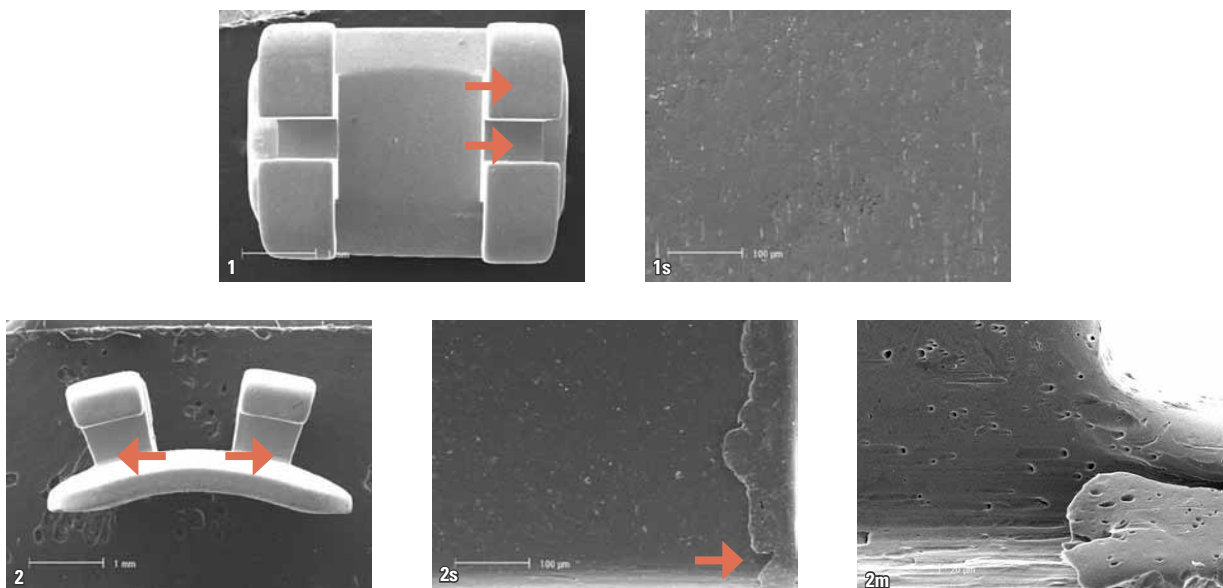


FIGURE 1 - 1) Frontal image (general): The arrows indicate regions a and b where specific images at 500x magnification were taken. 1s) Frontal (specific) image. 2) Inferior image (general): The arrows indicate regions a and b, where specific images at 500x magnification were taken; 2s, 2m) Frontal (specific) images at 500x and 2000x magnification, respectively.

Analysis of the chemical composition of the brackets

An EDX (Energy Dispersive X-Ray) was used, which is a SEM resource that allows for the evaluation of the chemical composition of the brackets. SEM procedures were standardized. EDX was performed on 8 brackets for each group, on the buccal and gingival wing surfaces (frontal and inferior images, respectively). It was therefore possible to quantify and compare the iron, nickel and chromium ions found in the metal alloys of the brackets, prior to (T0) and following a 60-day immersion in saline solution (T5).

Statistical treatment

The data gathered from microscopic observation were not treated statistically since such information involved a qualitative comparison between images.

The computer program SPSS version 10.0 (Chicago, IL, USA) was used to analyze the data pertaining to the chemical composition of the brackets. The means for iron, nickel and chromium ions present in the metal alloy of the brackets were compared, "as received" (T0) and after 60 days immersed in saline solution (T5). For intra-group analysis of the EDX values at T0 and T5, the Wilcoxon nonparametric test was used.

RESULTS

Microscopic bracket analysis (SEM)

The microscopic (SEM) analysis at T0 indicated that the brackets in Group A had a better surface finish than those of Group B. Alterations were found on the surfaces of the brackets after a 60-day immersion in saline (T5). These changes were more evident in Group A (Fig 2).

In the frontal images, both general and specific (50x and 500x magnification), products of corrosion were identified in both groups. These products appeared in three different manners, i.e., in a pinhead shape, in clusters and in layers. Group A brackets displayed most often a cluster and layer

formation, i.e., their surfaces seemed more altered than the surfaces of Group B brackets (Figs 2 and 3). EDX was performed on the products of corrosion and showed that they were primarily composed of iron (48.82%), oxygen (19.56%), chromium (17.9%) and nickel (4.73%).

On the other hand, an analysis of the inferior images, both general and specific, indicated that the regions most significantly affected in Group A were the wing edges, especially the angle formed between the wing and the bracket base. Regarding the brackets in Group B, the weld regions located between the base and the wing were the most affected by the corrosive process (Fig 4).

Analysis of the chemical composition of the brackets

As shown in Figures 5 and 6, differences were found in the composition of the metal alloy used in the brackets before (T0) and after having remained 60 days immersed in saline solution (T5). The brackets in Group A showed a reduction in the amount of iron and chromium ($p < 0.05$) and the brackets in Group B showed a decrease in chromium ions ($p < 0.05$).

DISCUSSION

Microscopic bracket analysis (SEM)

The superficial homogeneity of the metal alloy is an important factor in the prevention of corrosion pits and cracks.^{2,21} Rough surfaces with numerous imperfections facilitate the corrosion process and increase the area of metal dissolution.^{2,15}

The role of the bracket manufacturing process in corrosion should be emphasized. Group A brackets are manufactured in one piece (monobloc) using one single type of metal alloy. Group B brackets, in turn, are manufactured in 2 pieces (body and base) joined by silver solder. According to Maijer and Smith²³ the solder used in bracket manufacture appears to be a significant factor in the onset of the corrosion process. In 2001, Lee

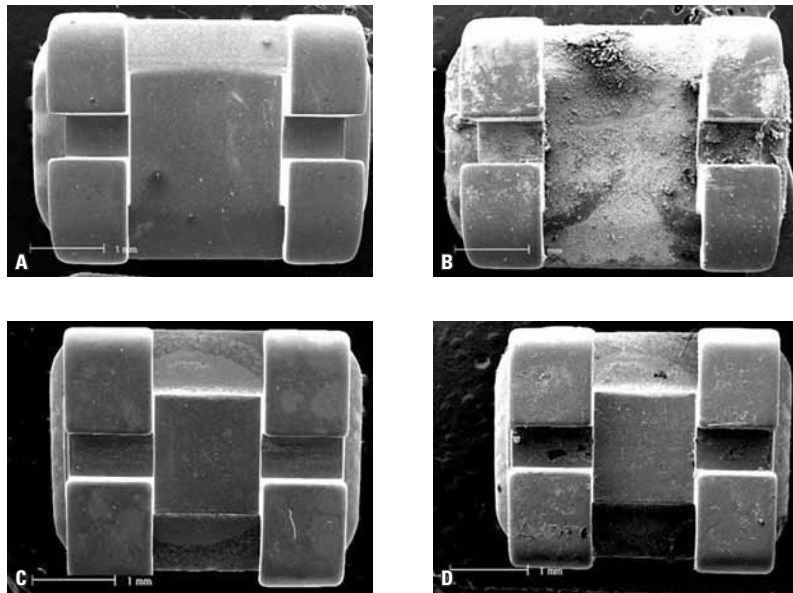


FIGURE 2 - General view (50x) of the brackets in Group A at T0 (A) and T5 (B) and general view (50x) of the brackets in Group B at T0 (C) and T5 (D). Products of corrosion can be seen at T5, notably in Group A brackets.

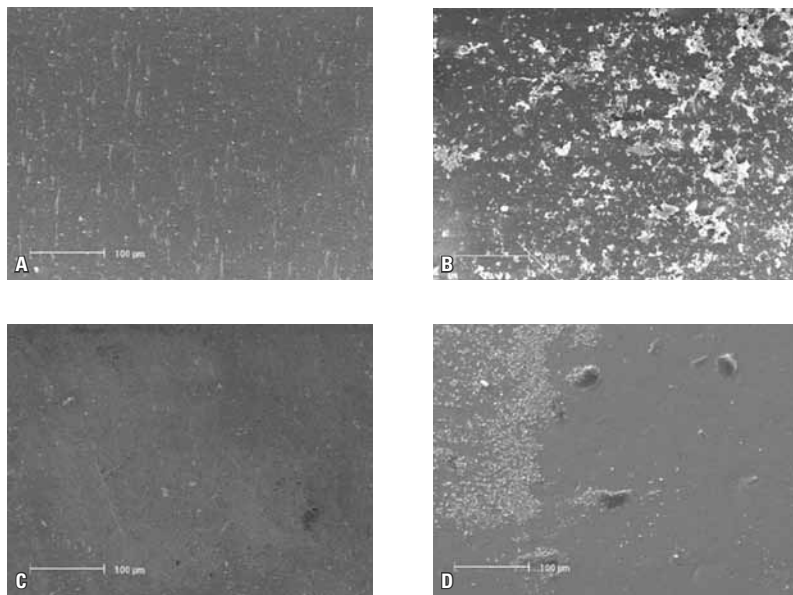


FIGURE 3 - Frontal (specific) images of Group A brackets at T0 and T5 (A and B respectively) and frontal (specific) images of Group B brackets at T0 and T5 (C and D respectively). Products of corrosion can be seen at T5, notably in Group A brackets.

and Chang²² found that heating orthodontic wires (NiTi and Optimalloy) to 250°F for 20 minutes leads them to develop an increased number of pits, worsening corrosion.

Thus, Group B brackets seem to be more susceptible to corrosion because they displayed a

greater number of metal matrix irregularities beyond the silver solder used to join bracket body to bracket base. However, after a 60-day immersion, the microscopic images indicated an increased concentration of products of corrosion in the Group A brackets (Figs 2, 3 and 4). It is believed

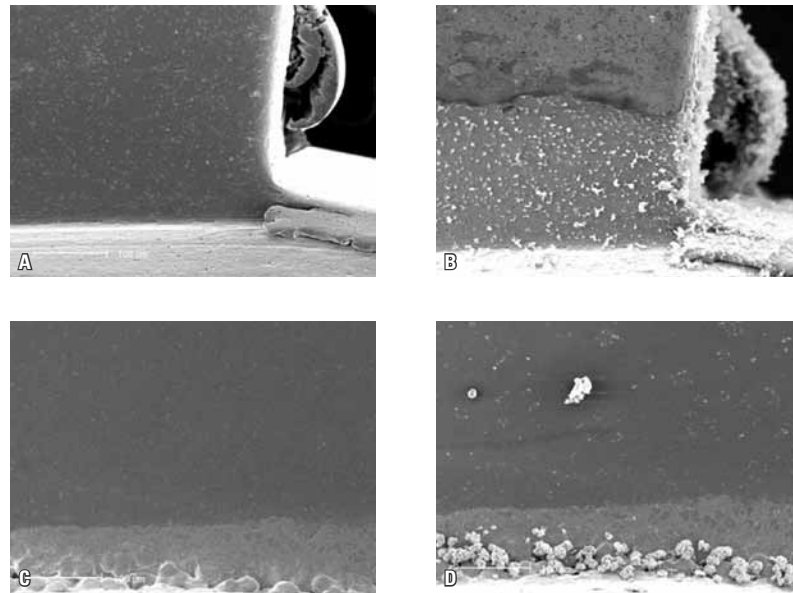


FIGURE 4 - Inferior (specific) images (500x) of Group A brackets at T0 and T5 (**A** and **B** respectively) and inferior (specific) images of Group B brackets at T0 and T5 (**C** and **D** respectively). Products of corrosion can be seen at T5, notably in Group A brackets.

that this result is linked to the composition of alloys used in the different groups: Group A (AISI 303) and Group B (AISI 316L).

It should be emphasized that although the biodegradation of the Group B brackets is less intense, the silver solder area was the most affected by the corrosive process (Fig 4), in agreement with previous studies.^{5,12}

Moreover, we observed at T5 that the brackets in Group A often showed the formation of superficial corrosion layers. It is assumed that such corrosion layers is one stage in the dynamics of the corrosive process. In 2000, Oliveira et al²⁶ emphasized that the corrosive process begins with the penetration of electrolytes into irregularities in the metal matrix (pits and cracks), which react with the metal and form oxides/hydroxides that accumulate gradually. The results of this study seem to confirm this corrosive process dynamics, suggesting the occurrence of a corrosion cycle of metal brackets, which is determined by the following events: 1) Filling of pits by products of corrosion, 2) formation of clusters of products of

corrosion on the surface of the brackets, 3) layers of products of corrosion covering specific parts of the bracket surface, 4) removal of corrosion layers from the surface (probably due to mechanical factors) and the start of a new corrosion cycle. In this last stage changes can be observed in the anatomy of the metal brackets.

It is essential to bear in mind that, in this study, the regions most affected by corrosion were those that exhibited some type of defect in the metal matrix, corroborating with other studies.^{2,17,21,25} This seems to prove that a pronounced surface roughness is a predisposing factor to the corrosion process since it tends to increase the contact area between the metal matrix and the immersion solution. Furthermore, Grimsdottir and Hensten-Pettersen¹⁵ emphasized that the surface defects noted in nickel-titanium orthodontic wires are not large enough to act as corrosion-prone areas. This seems to be a controversial issue and, therefore, it should be reminded that the corrosive process is determined by multiple factors.^{1,14,16}

Analysis of the chemical composition of the brackets

The EDX is a SEM tool that allows us to identify and quantify the metals comprised in an alloy, and this identification is roughly proportional to the fractions by weight of each element. Thus, we can measure the release of nickel, chromium and iron in an indirect fashion. According to Eliades et al¹⁰ this method has clinical relevance and achieves results with a significant degree of reliability.

An analysis of alloy composition indicated that the brackets in Group A, analyzed “as received”, had amounts of iron, nickel and chromium ions compatible with those described for the composition of AISI 303 steel. On the other hand, Group B brackets (AISI 316L), analyzed “as received”, showed an amount of nickel ions lower than that quantity established for this type of steel. This lower content of nickel in the alloy could affect characteristics such as ductility, weldability and corrosion resistance.

At T5, we found a significant reduction of iron and chromium ions in Group A alloy and decreased chromium ions in Group B alloy (Figs 5 and 6). These data are consistent with the findings obtained by microscopic analysis, whereby Group A brackets were also the most extensively affected.

FINAL CONSIDERATIONS

Despite numerous studies investigating the ionic release of orthodontic brackets, no conclusive evidence has yet been produced with respect to the kinetics and composition of corrosive products.⁸ It should be noted that the use of alloys with lower biodegradability would reduce the risk of harm to patient health. Therefore, researchers have been trying to investigate the main factors that determine the corrosive process.

The alloy and manufacturing process of

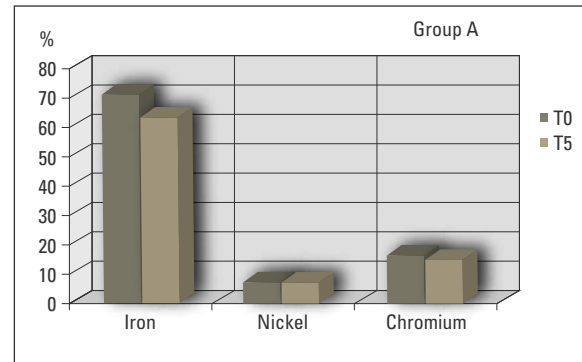


FIGURE 5 - Chemical composition (EDX) of Group A bracket alloy at T0 and T5. There was a reduction in the amount of iron ($p < 0.05$) and chromium ($p < 0.05$) ions.

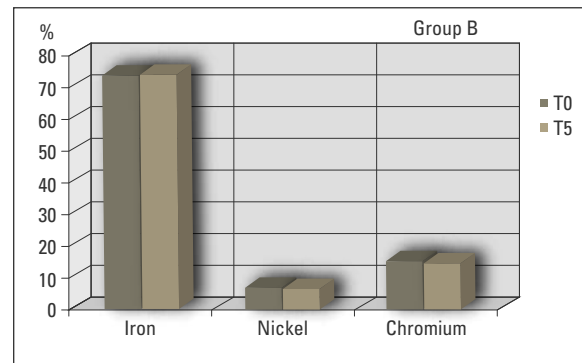


FIGURE 6 - Chemical composition (EDX) of the Group B bracket alloy at T0 and T5. There was a reduction in the amount of chromium ions ($p < 0.05$).

orthodontic brackets seem to play an important role in their corrosion resistance.¹³ The fact remains that the relationship between corrosion and biocompatibility of orthodontic appliances seems to be an issue that is still far from settled in the literature. Therefore, the findings of this study concerning the biodegradation of orthodontic brackets should not be discarded as negligible or clinically insignificant, since further investigations are needed to explain this phenomenon.

CONCLUSIONS

Based on the results of this study we concluded that:

a) Using SEM, we observed the presence of products of corrosion on the brackets, especially in Group A. The regions most affected were those that showed some irregularity of

the metal matrix.

b) An analysis of the chemical composition of the brackets, prior to (T0) and following the in vitro experiment (T5), revealed changes in the ratio of ions. In Group A, a decrease in iron and chromium ions, and in Group B, a reduction of chromium ions, after immersion (T5).

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Clinical trials are among the best evidence for clinical decision making. To be considered a clinical trial a research project must involve patients and be prospective. Such patients must be subjected to clinical or drug intervention with the purpose of comparing cause and effect between the groups under study and, potentially, the intervention should somehow exert an impact on the health of those involved.

According to the World Health Organization (WHO), clinical trials and randomized controlled clinical trials should be reported and registered in advance.

Registration of these trials has been proposed in order to (a) identify all clinical trials underway and their results since not all are published in scientific journals; (b) preserve the health of individuals who join the study as patients and (c) boost communication and cooperation between research institutions and with other stakeholders from society at large interested in a particular subject. Additionally, registration helps to expose the gaps in existing knowledge in different areas as well as disclose the trends and experts in a given field of study.

In acknowledging the importance of these initiatives and so that Latin American and Caribbean journals may comply with international recommendations and standards, BIREME recommends that the editors of scientific health journals indexed in the Scientific Electronic Library Online (SciELO) and LILACS (Latin American and Caribbean Center on Health Sciences) make public these requirements and their context. Similarly to MEDLINE, specific fields have been included in LILACS and SciELO for clinical trial registration numbers of articles published in health journals.

At the same time, the International Committee of Medical Journal Editors (ICMJE) has suggested that editors of scientific journals require authors to produce a registration number at the time of paper submission. Registration of clinical trials can be performed in one of the Clinical Trial Registers validated by WHO and ICMJE, whose addresses are available at the ICMJE website. To be validated, the Clinical Trial Registers must follow a set of criteria established by WHO.

2. Portal for promoting and registering clinical trials

With the purpose of providing greater visibility to validated Clinical Trial Registers, WHO launched its Clinical Trial Search Portal (<http://www.who.int/ictrp/network/en/index.html>), an interface that allows simultaneous searches in a number of databases. Searches on this portal can be carried out by entering words, clinical trial titles or identification number. The results show all the existing clinical trials at different stages of implementation with links to their full description in the respective Primary Clinical Trials Register.

The quality of the information available on this portal is guaranteed by the producers of the Clinical Trial Registers that form part of the network recently established by WHO, i.e., WHO Network of Collaborating Clinical Trial Registers. This network will enable interaction between the producers of the Clinical Trial Registers to define best practices and quality control. Primary registration of clinical

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WHO proposes that as a minimum requirement the following information be registered for each trial. A unique identification number, date of trial registration, secondary identities, sources of funding and material support, the main sponsor, other sponsors, contact for public queries, contact for scientific queries, public title of the study, scientific title, countries of recruitment, health problems studied, interventions, inclusion and exclusion criteria, study type, date of the first volunteer recruitment, sample size goal, recruitment status and primary and secondary result measurements.

Currently, the Network of Collaborating Registers is organized in three categories:

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Yours sincerely,

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