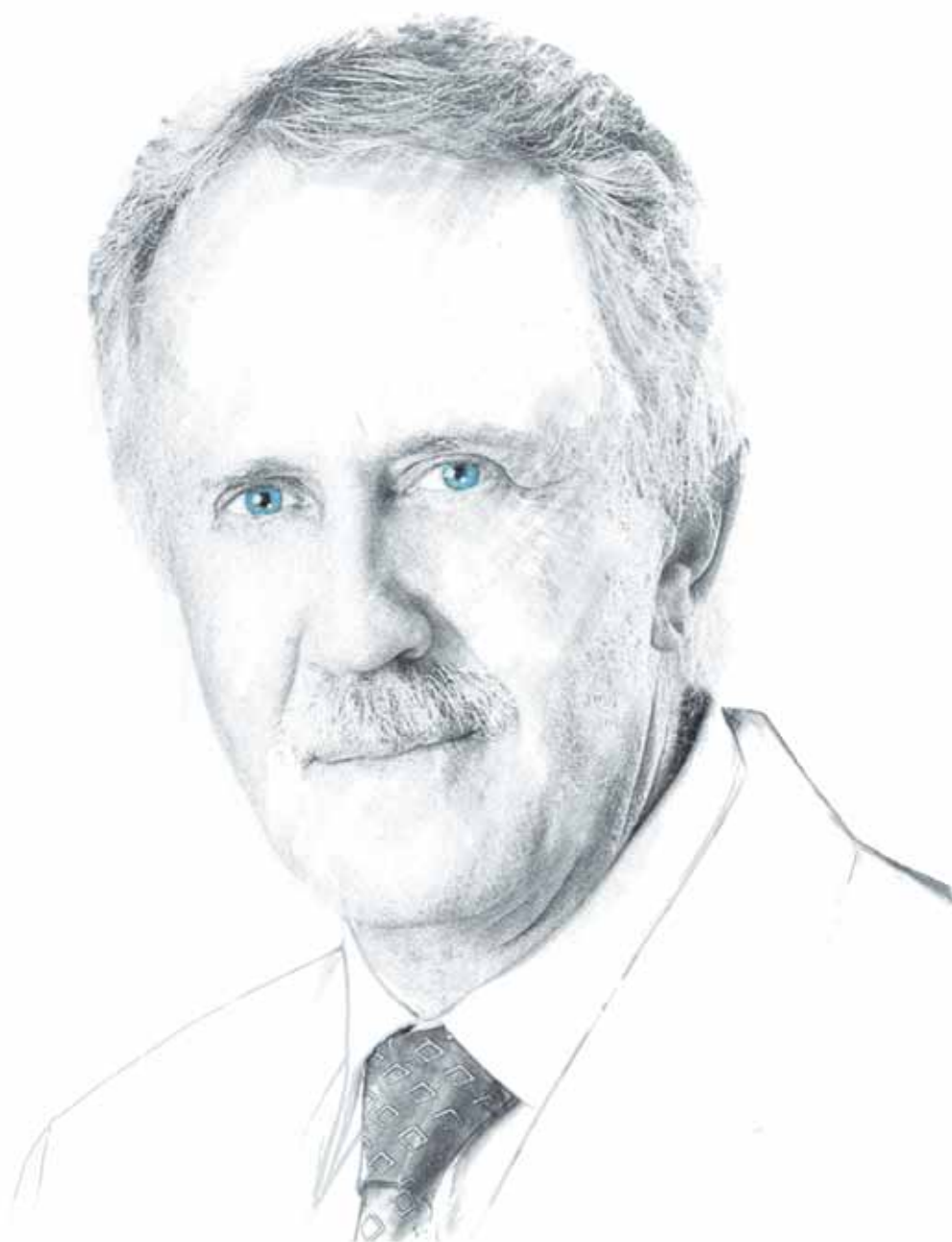


Dental Press Journal of
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Volume 15, Number 6, November / December 2010



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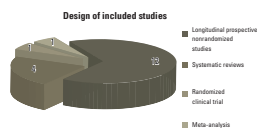


TABLE 4 - Test results used in comparison of groups with respect to orthodontic treatment.

QUESTIONS	TEST RESULT	P-VALUE
Cost of treatment	4020	p<0.5
Office's environment	1765	p<0.5
How do you feel during the consultations	31 750	p<0.005
How many patients are treated	1342	p<0.05
Who does care clinical	2388	p<0.1

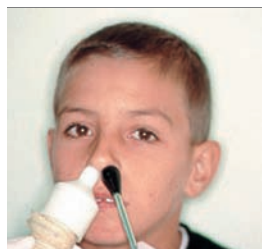
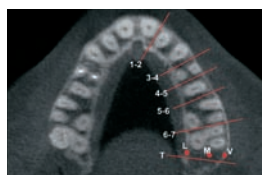
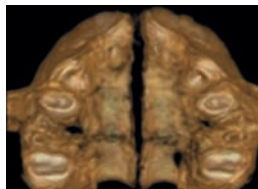
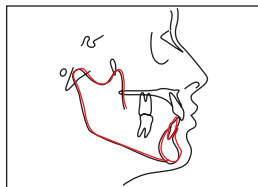
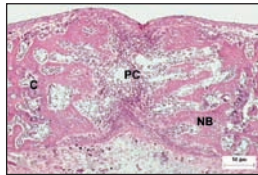


TABLE 3 - Results of Student's t-test for the comparison between Group 1 and Group 2 measurements, obtained from the study models.

Measures	Group 1 (n=42)		Group 2 (n=20)		t	P
	X	SD	X	SD		
TPI final	1.74	0.97	1.35	1.12	1.40	0.167
TPI initial	5.94	2.17	7.12	1.09	-2.30	0.025*
TPI I-I	-4.20	2.52	-5.77	1.40	2.59	0.011*

(*) Statistically significant difference (p < 0.05)



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The impact of orthodontics on society

What is the impact of orthodontics on society? This question is often addressed to specialties whose goals are, at least in part, aesthetic. We orthodontists are intuitively aware that orthodontic treatment reaches beyond the realm of beauty. A great many patients clearly understand the relevance and scope of orthodontic correction because they enjoy its benefits firsthand in their everyday life.

Cleft patients are among those people. And it is curious to note that Brazil has contributed immensely to the development of techniques and concepts used in the treatment of this pathology since one of the largest and most highly reputed centers in the world for treatment of cleft patients is called "Centrinho" (Little Center), and is located in the city of Bauru, São Paulo State (USP-HRAC). It was there that in the 1970s a team of researchers was challenged to expand their knowledge of orthodontic solutions for people who sought them with serious aesthetic and functional facial impairments. Perhaps as a result of this selection pressure, a classic case of 'professional Darwinism', several great professionals emerged. I'd like to highlight one such example because he is our interviewee in this edition of the Journal: Dr. Leopoldino Capelozza Filho, or simply, Dino, as he is fondly known to all. He was forged in an environment that gave him "relentless conditions to develop a critical spirit and the confidence to ignore dogmas and shift paradigms." These virtues are the hallmarks of his professional life both as a clinician and a professor. His greatest legacy undoubtedly lies in the latter, I mean his contribution to the academic universe. He is one of a handful of teachers who helped transition Brazilian orthodontics from a mere echoer of knowledge to a position of worldwide leadership. All this he accomplished without losing sight of the premise that patients "are my primary goal."

I mentioned above our intuition because it helps us realize the benefits that orthodontics brings to the population. And cleft patients provide us with an obvious touchstone to measure the extent of these benefits.

Moreover, the article by Feu and colleagues on indicators of quality of life and their importance in orthodontics further enhances this understanding. By describing and illustrating various dentistry-related indicators of quality of life the authors managed to conveniently sum up the knowledge available on the different ways in which our specialty can impact on people's lives. And the number of people who need orthodontic treatment is huge. To gain an insight into what I mean by that, just read the article by Machado Bittencourt, who evaluated 4776 Brazilian children during the campaign "Prevention is Easier to Handle," conducted in 18 Brazilian states by the Brazilian Association of Orthodontics and Dentofacial Orthopedics.

Finally, the broad scope of orthodontics can be experienced in a simple and direct manner by observing the figure generated with the words used in this issue of the Journal (Fig 1). The size of each word represents how frequently they appear in the articles. It is remarkable to note the myriad effects that orthodontic treatment can produce in patients.

Enjoy your reading!

Jorge Faber

Editor-in-chief (faber@dentalpress.com.br)

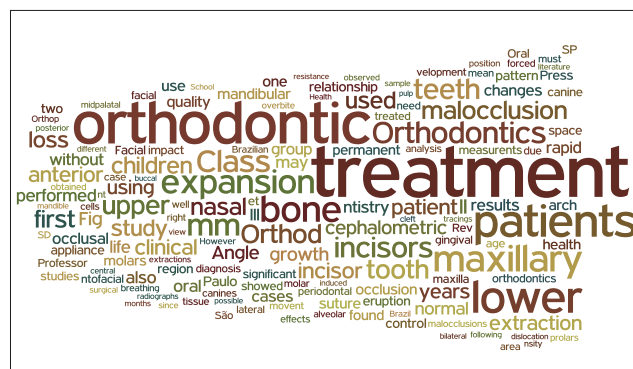


FIGURE 1 - The size of each word depicts the frequency with which each word appears in the articles published in this issue of the Journal. It is remarkable to note the myriad effects that orthodontic treatment can produce in patients.



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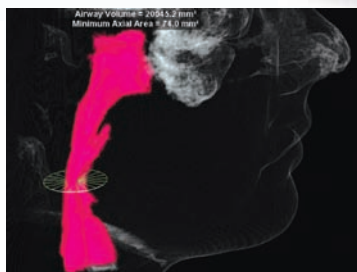
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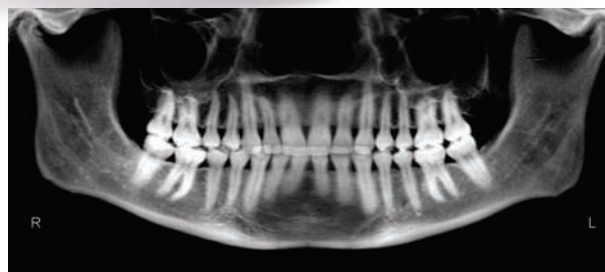
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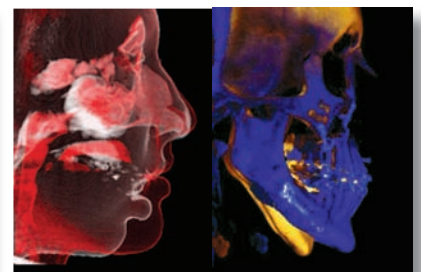
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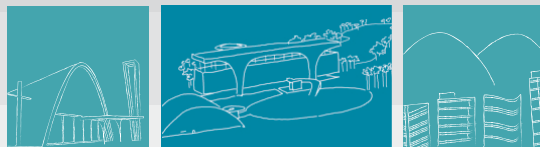


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The organizing committee of the 8th ABOR (Brazilian Orthodontic Association) INTERNATIONAL CONGRESS, October 2011 in Belo Horizonte, is working to offer a scientific program with national and international outstanding speakers on orthodontics and dentofacial orthopedics who will discuss relevant contemporary research and clinical topics.

In addition, a special program has been prepared for graduate students.

Among the international speakers we have confirmed Dr. James McNamara (USA), Dr. Rolf Behrents (USA), Dr. Juan Martim Palomo (USA), Dr. Marco Rosa (ITALY), Dr. Stephen Yen (USA), Dr. Albino Triaca (SWITZERLAND) and Dr. Giuseppe Scuzzo (ITALY).

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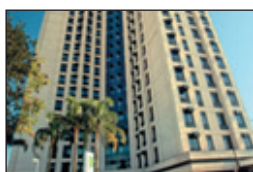


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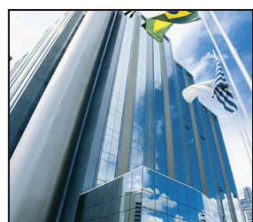


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LETTER TO THE EDITOR

Dear Editor,

There was a miscommunication during the writing of the article entitled Statement of the 1st Consensus on Temporomandibular Disorders and Orofacial Pain, published in 2010 May-June;15(3):114-20: it was mistakenly included the

name of Dr. José Tadeu de Siqueira Tesseroli as endorser. Thus, we authors want to clarify that this doctor was not one of the endorsers of the work. Sincerely, Simone Vieira Carrara, Paulo César Rodrigues Conti and Juliana Stuginski Barbosa.

SPO 2010

The 17th SPO Congress was held at the Anhembi Conventions Palace, in São Paulo, under the theme “Contemporary Orthodontics: Technology and Welfare”, with the presence of nationally and internationally leading names of Orthodontics.



Laurindo Furquim, Vanda Domingos, Nerio Pantaleoni, Vera T. C. Terra and Ertty Silva.



Alberto Consolaro and Jorge Faber.



Alisson Hernandes, Amanda Oliveira, Renata Romero, Maria Cláudia, Márcio Almeida and Manuela Morisco.



Bjorn Ludwig and Hugo de Clerck.



Weber Ursi, José Valladares and David Normando.



Laurindo Furquim and Carlos Cabrera.



Laura, Carlos and Marise Cabrera with Hugo José Trevisi.



Fabrizio Panti, Alessandro Rampello, Vanda, Leopoldino Capelozza and Enrico Massarotti.



Renato Almeida and David Normando.

Book release: “O ‘Ser’ Professor”

To celebrate the releasing of the 5th edition of the book “O ‘Ser’ Professor – Arte e Ciência no Ensinar e Aprender,” the professor Alberto Consolaro, with support from the Publisher Dental Press, received friends, students and teachers for an evening of autographs in Bauru-SP (Brazil).



Professor Alberto Consolaro, professor Maria Arminda do Nascimento Arruda and José Jobson de Andrade Arruda.

Portugal – OMD 2010

Santa Maria da Feira received, on 11, 12 and 13 November, the Nineteenth Annual Conference of the Annual Congress of the Order of Dentists (OMD, Portugal). The event offered multiple opportunities for interdisciplinary learning, and also had a group of world renowned speakers. One of the highlights, with the introduction of innovations, was the trade fair Expo-Dental.



The Presidente of the OMD 2010, Pedro Pires, and Eunice Carrilho.



Robert R. Edwab and Sherry Edwab.



Marco Rosa and Teresa Furquim.

AOA

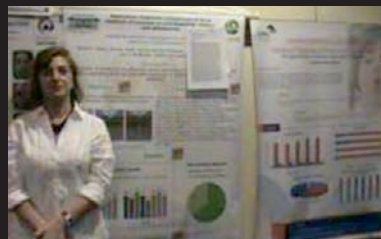
Curitiba received the 14th Scientific Meeting of the Association of Former Students of Orthodontics of Araraquara (AOA). The event, organized by Roberto Shimizu and Adriano Marotta Araujo, with support from Ilapeo met lecturers, teachers, alumni and colleagues from the region.



Adriano Marotta, Ulisses Coelho, Ana C. Melo, Hideo Shimizu, Adilson Ramos and Helio Terada.

Honorable Mention

Silvia Hitos received honors at the 39th Congress of the International Association of Orofacial Myology, with the work *Mastication diagnosis: comparison of three methods of Analysis oral breathing in children and adolescents*.



Silvia Hitos.

Defenses

David Norman defended his doctoral thesis entitled "Dentofacial morphology and occlusal characteristics of Arara Indians: revisiting the role of heredity and diet in the etiology of malocclusion," under the guidance of Professor Dr. Cátia Quintão.



Jorge Faber, João Guerreiro, Cátia Quintão, David Normando and Marco António Almeida.

Henry Victor Alves Marques defended his masters degree dissertation in Unopar in Londrina - PR.



Dr. Marcio Rodrigues de Almeida, Henry Victor Alves Marques, Dr. Renato Rodrigues de Almeida and Dr. Adilson Luiz Ramos.

Moving teeth faster, better and painless. Is it possible?

Jose A. Bosio*, Dawei Liu**

The history has shown attempts to correct crowded or protruding teeth since 3000 year ago. Egyptian mummies have been found with crude metal bands wrapped around individual teeth, and primitive and surprisingly well-designed orthodontic appliances have also been found with Greek and Etruscan artifacts.¹

From Pierre Fauchard, passing through Ben Kingsley, Calvin Case, and finally to Edward H. Angle, we have seen technology evolved. The modern era of orthodontics has initiated its history around 1900 and has gone from metal bands adjusted around the teeth to bonded braces on the buccal and the lingual sides, as well as clear aligners, mini-implants/mini-plates, self-ligating brackets, digital models, lasers and so on. Thus, the continuing quest for improvements on materials and techniques leads us to the desire to treat patients faster, better, and totally painless.

Today, many people receive orthodontic treatment which brings about better occlusion, improved oral function and harmonized facial appearance. However, two perplexing challenges have not been solved in clinical orthodontics, i.e. long treatment time (on average 2-3 years) and iatrogenic root resorption. Figuring out these challenges will dramatically improve the quality of orthodontic care.

By nature, orthodontic tooth movement (OTM) is a process of mechanically-induced bone modeling wherein new bone formed on the tension side and resorbed on the compression side of the periodontal ligament (PDL). Historically, it has been found that when forces are applied, three distinct phases of tooth movement can be observed, namely the 1st strain phase in which the PDL is squeezed (less than 5 seconds), the 2nd lag phase in which tooth movement pauses due to hyalinization formed in the PDL (as long as 7-14 days), and the 3rd move phase in which the tooth moves readily with significant undermining resorption of the adjacent alveolar bone.² Therefore, it is logical to assume that if the 2nd phase (hyalinization in the PDL) can be avoided or minimized, the tooth can move smoothly and faster.

From a clinical standpoint, force application owns features of magnitude, frequency and duration. For years, studies on the magnitude and duration of forces have been emphasized, resulting in most of the solid scientific findings in today's literature. In brief, if light forces are applied, it seems that the second phase is not present and the tooth moves much more atraumatically (no hyalinization) through the alveolar bone, which is obviously ideal. The problem with heavy force application is that although the tooth moves ultimately through the alveolar bone, the tooth root

Both authors have contributed equally to this work.

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surface will be resorbed due to the long duration of contacting the wall of the alveolar socket.³ Clinically, lighter forces are considered to be proper, however the hyalinization still cannot absolutely be prevented per se due to the irregular surfaces of the root and the wall of alveolar socket.⁴

With regard to the frequency of force application which has rarely been studied, all the currently available orthodontic appliances can only apply static forces. Therefore, it can be hypothesized that if a light alternating force is applied on teeth, the tooth movement will be faster and root resorption risks reduced due to the possible absence of hyalinization delay.

But, how can we achieve a light alternating (pulsating, cyclical) orthodontic force? One of the possible means is to impose mechanical vibration to the conventionally applied static orthodontic force. Are there any scientific evidences supporting our hypothesis? Yes. In recent years, whole body weight-bearing bones have been shown to be sensitive to low-level mechanical vibrations.^{5,6} With less than 50µm of displacement and as little as 5 minutes per day, the mechanical vibration signals can promote bone formation, enhance bone morphology, increase bone strength, and attenuate the negative effects associated with catabolic stimuli.⁶ In dentistry, Kusano et al⁷ found that both ultrasonic (1.6MHz) and vibratory (141Hz) toothbrush mechanisms increased the proliferation and collagen synthesis of gingival fibroblasts in dogs. More importantly, Nishimura et al⁸ reported that the resonance vibration could increase tooth movement rate in rats. In clinical orthodontics, Marie found vibration to be possible to reduce pain in orthodontic patients, but without looking at the vibratory stimulation effect on OTM.⁹ These findings strongly encourage the researchers to investigate the possibility of using mechanical vibration to enhance orthodontic tooth movement and reduce root resorption.

As one of the pioneers focusing on this issue, Liu has reported that when mechanical vibration (4Hz, 20µm displacement, 5 min/day) is applied

to help orthodontically move teeth for 4 weeks in mice, compared with the non-vibrated tooth movement group, the tooth movement rate under vibration is increased by about 50%.¹⁰ However, cautions should be taken when extrapolating the experimental findings and conclusions from animals to human being.

With the advancement of research, a new orthodontic company "OrthoAccel" founded in 2007 brought his brand generation of dental vibrator named "AcceleDent" (Fig 1B) into the market in 2009. To explore the clinical effects of this device, Kau et al¹¹ conducted a clinical trial in which 14 orthodontic patients were recruited and instructed to use the device for 20 minutes daily for a period of 6 consecutive months. As a result, it was found that the total rate of movement for the mandibular crowding was 2.1 mm per month and for the maxillary arch was 3.0 mm per month, which apparently is faster than the traditional finding as of about 1.0 mm per month.¹² The patient compliance was 67% with good patient perception. It was thus concluded that the AcceleDent device is a useful adjunct to orthodontic treatment. If used appropriately, it can accelerate routine orthodontic tooth movement.¹¹ Currently, the "AcceleDent" device is marketed in the European Union and Australia, while the opening to the US market will not take place until the outcome of an ongoing clinical trial being conducted at the University of Texas Health Science Center San Antonio gets approved by the US Food and Drug Administration (FDA).

According to the manufacturer, AcceleDent is a simple, removable dental device that patients need to use between the teeth for twenty minutes daily. The product is hands-free and allows the user flexibility to carry out most routine tasks during use like doing homework, watching television and reading. This device can be used with any type of appliance, such as fixed braces and/or clear aligners. If proven efficacious, we may face a revolution in the orthodontic arena.

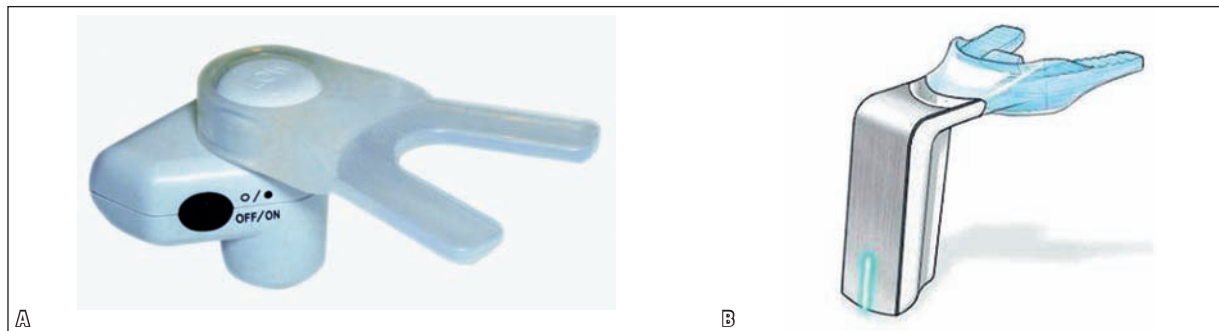


FIGURE 1 - Two models of dental vibrators. **A)** Is named dental masseuse developed by Dr. Powers and primarily used to relieve pain of orthodontic adjustment; and **B)** is named AcceleDent developed by OrthoAccel Inc.

Another “new” orthodontic system has also been present in the literature since 2002. It is called SureSmile®. In this system, the orthodontist needs to scan the teeth and associated structures 3-dimensionally and send the records over to the company through the internet, with the doctor’s prescriptions and preferences for brackets, for treatment planning and fabrication of the appliance. The orthodontist only has to follow the track set by the company to finish the case and possibly to retain as well.¹³

By looking back in our profession, we realize that traditionally, the orthodontists have relied heavily on a standard prescription designed into the bracket for the first half of the treatment cycle. In the second half, the doctor focuses on correcting errors resulting from improper diagnosis, limitations of the standard bracket prescription and placement. This stage of the treatment is considered a highly reactive phase. The frequency of patient visits increases substantially, and the demands on doctor time increase.¹⁴ SureSmile is designed to facilitate a proactive care delivery model. It enables the orthodontist to provide personalized and targeted therapeutics using robotically fabricated prescription archwires. The robot is driven by input from the doctor. In simple words, impressions are not taken anymore because teeth are

scanned with special intraoral scanner and a digital model is produced, the doctor then sees a malpositioned tooth, changes the position in the computer, the information is sent automatically to the company which activates the robot to produce a pre-adjusted wire. This, in turn, will be sent back to the participant orthodontist to be delivered to the patient mouth.

Dr. Saschdeva states that “the treatment-planning software has many functional components: 3D visualization, measurement, communication, decision making with simulation, bracket placement, setup and archwire design, quality and outcome assessment, and SureSmile patient management. Each of these utilities used either singularly or in combination enables the doctor to make better informed decisions and design the targeted prescription archwire”.¹⁴ According to his statements, it will take a motivated and experienced orthodontist a minimum of 2 years and the completion of at least 100 patients to develop competency in treating with SureSmile. However, we believe that the orthodontic community would be interested to see unbiased strong level of evidence studies showing that teeth can be moved faster, better, and more efficiently with SureSmile technology.

Difficulties with the SureSmile system are: 1) scanning time is still significantly long, about

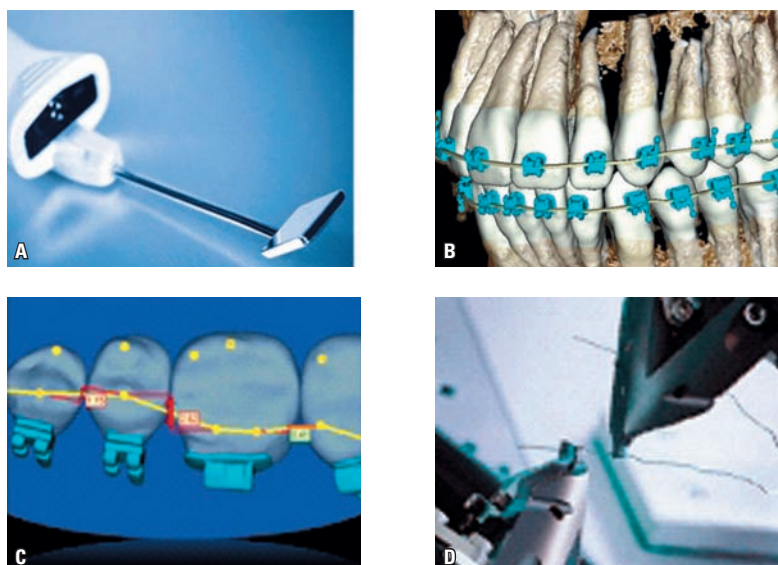


FIGURE 2 - **A)** Intraoral Scanner; **B)** 3-D individualized model; **C)** Robotic wire bending; **D)** Individualized tooth wire bending.

25 minutes to take a full mouth impression, 2) clinical chair time is reduced but computer organizing time is greater, 3) initial cost with

the equipment set up is still very high. A challenging technology will show to our orthodontic community its efficacy in the near future.

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Orthodontic forced eruption: Possible effects on maxillary canines and adjacent teeth

Part 3: Dentoalveolar ankylosis, replacement resorption, calcific metamorphosis of the pulp and aseptic pulp necrosis

Alberto Consolaro*, Renata Bianco Consolaro**, Leda A. Francischone***

Canine forced eruption comprises one among a number of procedures that can be used in orthodontic treatment to ensure that cuspids are positioned in the dental arch in normal esthetic and functional conditions. Canine forced eruption should be characterized as an orthodontic movement.

Unfortunately, in discussions of clinical orthodontic practice some professionals are reluctant to indicate orthodontic forced eruption, especially of maxillary canines. These professionals believe that orthodontic forced eruption can cause many clinical problems during and after surgery. Among the most widely cited reasons for restricting the indication of orthodontic forced eruption are:

- 1) Lateral root resorption in lateral incisors and premolars.
- 2) External cervical resorption of canines due to forced eruption.

- 3) Dentoalveolar ankylosis of the canine involved in the process.
- 4) Calcific metamorphosis of the pulp and aseptic pulp necrosis.

In two previous works, we reviewed the first two topics. In this last article in the series we address the biological foundation of dentoalveolar ankylosis, replacement resorption, calcific metamorphosis of the pulp and aseptic necrosis cases either directly or indirectly related to the orthodontic forced eruption of canines.

How to distinguish orthodontic forced eruption from other procedures

There are other ways to position unerupted, or erupted but poorly positioned canines in the dental arch using surgical procedures. Surgical displacement of canines is given such names as "fast-track canine forced eruption," or rapid canine extrusion,

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but in fact involves an autogenous intra-alveolar¹⁰ transplant and does not make use of induced tooth movements with the aid of periodontal tissues. There is no such thing as surgical canine "forced eruption" since this expression refers to a force applied to the tooth. A more appropriate denomination would be surgical displacement or intra-alveolar autogenous tooth transplant. Surgical displacement of canines can cause:

- a) disruption of the periodontal ligament.
- b) compromised vasculo-nervous bundle of the pulp.
- c) The need to partially or fully prepare a socket to receive the canine.

The rupture of the periodontal ligament can damage cementoblasts and the epithelial rests of Malassez, structures without which inflammatory resorption, dentoalveolar ankylosis and replacement resorption tend to occur. Moreover, disruption of or damage to the vascular pulp-periodontium bundle may induce aseptic pulp necrosis or calcific metamorphosis of the pulp.

Consequences of the surgical displacement of canines are similar to the possible effects of traumatic injuries as the affected structures are the same. In surgical displacement however, unlike in dental trauma, microbial contamination can be controlled while tissue damage can be minimized through adequate planning. In dental trauma the forces are unpredictable when applied to the tissues and injuries vary in scope and intensity. In a basic analogy, one can say that the consequences of the surgical displacement of an unerupted canine can resemble dental trauma.

Genuine canine forced eruption is an orthodontic movement, not a surgical displacement. This distinction becomes crucial as soon as one begins to analyze the possible consequences of canine orthodontic forced eruption.

Surgically induced dislocation is independent of orthodontic forced eruption

Surgical approach of the canine crown in-

volves handling the tissues of the dental follicle, exposing enamel, and sometimes improperly and inconveniently also exposing the cemento-enamel junction, which may result in external cervical resorption, among other consequences. These surgical issues regarding the dental follicle, exposure of the enamel and cemento-enamel junction and their impact on bracket bonding have been presented in previous papers.^{6,7,8}

When requesting surgeons to bond a bracket on the crown of an unerupted tooth, orthodontists are not requesting, nor expecting surgeons to complement the surgical procedure by dislocating the canine with the purpose of facilitating orthodontic movement. Strictly speaking, surgically induced dislocation in cases of canines that require forced eruption should be undertaken at the orthodontist's request. When performed without such request, for reasons identified during the surgical period, the orthodontist must necessarily be informed by the surgeon about such decision.

This idea of "facilitating" forced eruption through dislocation can only be understood in the world of physics without considering that tooth movement—of which orthodontic forced eruption is but one example—comprises a set of biological events. Forces delivered through orthodontic movement induce biological events, determine the intensity and sites where such forces should be applied, but do not replace these events.

Surgically induced dislocation of teeth necessarily involves the rupture of the periodontal ligament, rupture of periodontal vessels, nerves and fibers, and cellular fragmentation and disorganization of epithelial rests of Malassez. Three-dimensionally, the epithelial rests of Malassez appear as a network of well-organized basketball hoops around the tooth in the context of the periodontal ligament. These changes induced by periodontal dislocation can be controlled if surgical procedures are well planned

and accurately performed without overdoing forces and repetitive handling of instruments.

Surgically induced dislocation is a risky procedure to which teeth should be subjected only when potential benefits are significant, as in cases of well-established and accurately diagnosed dentoalveolar ankylosis. Among the risks of induced dislocation is dentoalveolar ankylosis. Should such condition not be present, consequences may involve replacement resorption, calcific metamorphosis of the pulp and aseptic pulp necrosis.

The procedure of surgically induced dislocation refers to increased tooth mobility in the alveoli attained through the agency of surgical instruments. Such mobility is higher than the one commonly observed as a function of the periodontal ligament. In ankylosed teeth, tooth mobility, even such as results from the presence of periodontal ligament, is not observed. Lever movements performed with surgical instruments can accomplish dislocation and this is perceived as discrete forces applied to the tooth with the instrument heads. However, professionals, in their eagerness to verify that mobility has occurred during dislocation, can—with their instruments or fingers—induce considerable movements in the alveoli. If the dislocation itself had not produced major periodontal injuries, these verification or checking maneuvers can now cause such injuries or even enlarge them.

Indications for surgically induced dislocation during orthodontic forced eruption

Surgically induced dislocation for therapeutic purposes is a valid alternative but only when clearly indicated after a clinical and/or definitive imaging diagnosis of dentoalveolar ankylosis, and not performed preemptively to mechanically "facilitate" orthodontic forced eruption. In the presence of an unerupted canine, an indication for induced dislocation can be reached by

following this diagnostic path or protocol to decide on the therapeutic approaches to be undertaken. This protocol can be divided into three necessarily sequential different times:

1. First step of diagnosis and therapeutic decision: evaluate and create adequate space for the canine in the dental arch.

When an unerupted canine is present, the first evaluation should ascertain space availability in the dental arch as well as normal dental follicle tissues.^{2,5,11} Should eruption be mostly attributed to the dental follicle, space availability in the dental arch should disclose not only the mesiodistal width of the crown but also the presence of follicular tissue in the follicular space.^{1,2,5}

The measurement to be added to the canine mesiodistal width, which must be considered to accommodate the uncompressed dental follicle in the eruptive path, with or without orthodontic forced eruption, can use as reference half of that width (1.5 times the mesiodistal canine width) although this is not always applicable in all clinical cases. In many cases, the potential space is much smaller and the canine erupts, but this increases the risk of resorption in neighboring teeth^{6,7}—although sometimes such risk is inevitable. It must be assumed that the dental follicle of maxillary canines, given their unique anatomy, tend to bulge and broaden laterally more than any other teeth.

In some cases, space is sufficient and natural eruption is just a matter of time. But depending on patient age, orthodontic assessment and clinical need, there is no time or reason to wait.

2. Second step of diagnosis and therapeutic decision: orthodontic forced eruption.

Even when the available and required space is orthodontically provided for natural eruption of the canine, the tooth does not move toward the arch. It may be impacted in an area of denser bone, hindered by a more pronounced root curvature, intercepted by the root of a neighboring tooth,

or else it just may not display eruptive force. After a two month period with no sign of the eruption, even with sufficient space available, one can opt for orthodontic forced eruption—which requires the bonding of a bracket, some specific orthodontic device, or even perforation of the enamel for anchoring the orthodontic wire and applying the necessary force in terms of intensity in the appropriate direction.

3. Third step of diagnosis and therapeutic decision: surgically induced dislocation, followed by orthodontic forced eruption.

Even when sufficient available space is orthodontically provided, sometimes the unerupted tooth will not move, and in some cases, even through forced eruption one fails to direct or "pull" the tooth into that arch space. In radiographic and/or CT images, dentoalveolar ankylosis may not appear owing to the early stage of the process or to image superimposition. Dentoalveolar ankylosis only appears in imaging diagnostic tools when over 20% of its root surface area has been affected.³ Prior to this degree of impairment, the images obtained will be normal and this can give rise to uncertainty in exclusively clinical diagnoses, where the support of diagnostic images is not available. However, one should not wait for biological phenomena to develop before generating diagnostic images. If a tooth had adequate space available and was subsequently subjected to orthodontic forced eruption and even so failed to move occlusally, the only remaining option is surgically induced dislocation.

Possible consequences of surgically induced dental dislocation

The consequences of surgically induced dislocations are directly related to the degree of injury sustained by the periodontal ligament, especially in the cementoblast layer and epithelial rests of Malassez. In the pulp, induced injury and its consequences are also dependent on the

shape, intensity and direction of forces delivered during the surgical procedures of surgically induced dislocation.

Inflammatory resorption would only indicate injury to the layer of cementoblasts and maintenance of the epithelial rests of Malassez and the periodontal space, but it is not usually observed in teeth subjected to forced eruption and surgical dislocation. If periodontal damage occurs due to surgically induced dislocation, typically this will also affect the epithelial rests of Malassez, induce dentoalveolar ankylosis and subsequent replacement resorption.

Ankylosis and replacement resorption after forced eruption usually manifest themselves months or years after the procedure has been performed when the tooth is in its appropriate position in the dental arch. In most cases they are detected by chance during routine examinations. The processes of ankylosis and replacement resorption are asymptomatic, with no evident clinical signs. Tooth darkening may be associated, but when this occurs it is not due to ankylosis or resorption but rather results from injuries to the pulp, such as *calcific metamorphosis of the pulp and/or aseptic pulp necrosis*,^{4,9} which may also have been induced by maneuvers during dislocation surgery, i.e., tooth darkening represents only a simultaneous occurrence.

If during dislocation there is partial damage to the neurovascular bundle and partial and/or temporary restriction of pulp oxygenation and nutrition, the cells undergo metaplasia and settle randomly and diffusely into a dysplastic dentin, i.e., poorly formed and deposited with the purpose of filling and reducing cellular metabolism at the site to ensure survival. This dentin partially or totally obliterates the pulp chamber (Figs 1 and 2) over a period of 3 months to 1 year after procedure.^{4,9} Consequently over time, the tooth will darken slowly, affecting the patient's aesthetics.



FIGURE 1 - Maxillary canine subjected to orthodontic forced eruption which after many months showed gradual crown darkening and radiographs showed obliteration of pulp chamber by calcific metamorphosis of the pulp. The most likely causes were surgically induced dislocation performed simultaneously with placement of bracket/orthodontic device, showing injury to neurovascular bundle of pulp and/or "fast-forced eruption."



FIGURE 2 - Maxillary canine with obliteration of pulp chamber by calcific metamorphosis of the pulp. It is noteworthy that after a few years chronic periapical lesion was detected. It is found in approximately a quarter of cases between 2 and 22 years of monitoring.

Although it is asymptomatic, within periods of up to 22 years later calcific metamorphosis of the pulp can produce chronic periapical lesions in 24% of affected teeth^{4,9} (Figs 1 and 2). Root canal therapy may be rendered impracticable due to canal obliteration, making it necessary to use a paraendodontic approach. In cases where endodontic treatment is no longer possible and chronic periapical lesions are not yet manifest, yearly external dental bleaching can improve esthetics, although not as a definitive solution because the deposit of dysplastic dentin in the

pulp chamber cannot be resolved. More lasting and satisfactory esthetic and functional results may be attained through facet installation.

In cases of aseptic pulp necrosis there was complete disruption of the pulpal neurovascular bundle during surgically induced dislocation. Pulp cells contain few lysosomes with their proteolytic enzymes and thus, when they undergo necrosis their proteins tend to coagulate, remaining in the site indefinitely. In other words, without vascularization the pulp undergoes anemic infarct, a necrosis due

to protein coagulation. Thus, one can spend months or years with no symptoms as one's interface and relationship with the rest of the body is conducted exclusively through the minute apical foramen. In general, the most common clinical consequence for the patient manifests as gradual darkening of the tooth depending on the gradual and slow decomposition of dead tissues and incorporation of pigments derived from the inner wall of the dentin. The pulp chamber is maintained and over the years one can detect the presence of chronic periapical lesions. Endodontic treatment is indicated as well as external and/or internal dental bleaching.

Surgically induced dental dislocation: When should it be indicated?

In the third step of diagnosis and therapeutic decision making, dislocation is an option. If the canine remains unerupted, and remains in place with ankylosis it will evolve over time towards replacement resorption and loss. If dislocation is well planned with precise and delicate maneuvers without aggressive verification chances are that it will get back to normal if it is followed by extrusion when the subsequent orthodontic forced eruption is performed. In cases where this procedure still results in ankylosis and replacement resorption after the canine tooth is properly positioned in the dental arch, planning may involve its replacement by an osseointegrated implant, or orthodontic space closure followed by re-anatomization of the premolars.

In cases of darkening by calcific metamorphosis of the pulp and aseptic necrosis endodontic procedures lead to esthetically and functionally adequate results with preservation of the natural canine tooth.

However, surgically induced dislocation should not be indicated without restrictions in all cases of forced eruption of unerupted canines, but only when dentoalveolar ankylosis is

accurately diagnosed. The risks involving ankylosis, replacement resorption, calcific metamorphosis of the pulp and pulp necrosis not only exist but are of considerable prevalence.

If orthodontic forced eruption is well planned and performed it is an orthodontic movement and as such is a safe procedure whose consequences are minor and clinically manageable. Even when conducted in association with surgically induced dislocation, also well planned and consciously performed, orthodontic forced eruption remains a safe procedure.

In short, orthodontic forced eruption, if performed as a tooth movement, does not promote ankylosis, replacement resorption, calcific metamorphosis of the pulp or aseptic pulp necrosis. These problems stem from technical procedures during surgically induced dislocation.

Speed of movement during orthodontic forced eruption

During surgically induced dislocation in cases where it was adopted as a therapy prior to orthodontic forced eruption, small movements induced during operative procedures, although intense, should not cause large displacements of the tooth in the socket as partial or total lesion of the neurovascular bundle may develop.

However, special care should also involve the intensity of the forces and the speed of tooth movement during orthodontic extrusion induced in canines whose forced eruption resulted from dislocation. Dislocation "loosens" the tooth, even when well accommodated in the tooth socket. Injuries to the neurovascular pulp bundle are commonly associated with cases of "fast-track orthodontic forced eruption," which actually consists of a therapeutically adopted tooth avulsion that causes surgically induced dislocation and tooth displacement to inflict a severe dental injury to the neurovascular bundle in addition to the other aforementioned periodontal damage. Orthodontic

forced eruption is a tooth movement and, as such, has its speed limits because movement is effected by the periodontal ligament cells.

Final considerations

Orthodontic forced eruption should be considered an induced tooth movement just like any other orthodontic movement. Its forces and direction induce tooth extrusion and are responsible for the specific features of this orthodontic procedure. In planning and implementing orthodontic forced eruption of canines, the anatomical and functional characteristics of the periodontal ligament should be considered.

The unintended consequences most often cited to restrict the indication of forced eruption are of a technical and procedural nature and can be explained biologically. They are: a) Lateral root resorption in the lateral incisors and premolars, b) External cervical resorption in the canine involved in the process, c) Dentoalveolar ankylosis of

the canine involved in the process, d) Calcific metamorphosis of the pulp, and aseptic pulp necrosis.

These possible outcomes do not arise primarily and specifically from orthodontic forced eruption. They can be avoided if certain technical precautions are adopted, especially the "four cardinal points for the prevention of problems during orthodontic forced eruption,"⁶ namely:

Assess the dental follicle and its relations with neighboring teeth.

Value the cervical region of the unerupted tooth to avoid exposure and surgical manipulation of the cemento-enamel junction.

Ensure that the dislocation performed prior to forced eruption does not become severe dental trauma caused by unnecessary surgical procedures.

Preserve the apical neurovascular bundle that enters the root canal during the procedure of verifying that dislocation has been attained, or by increasing the speed of forced eruption in the occlusal direction.

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An interview with

Leopoldino Capellozza Filho

- Dentistry Graduate, Bauru School of Dentistry, São Paulo University (1972).
- M.Sc. in Orthodontics, Bauru School of Dentistry, São Paulo University (1976).
- Ph.D. in Oral Rehabilitation, Area of Periodontics, Bauru School of Dentistry, São Paulo University (1979).
- Began his professional career as founder and head of the Orthodontics Department, aka “Centrinho” (Rehabilitation Hospital of Craniofacial Anomalies, São Paulo University (HRAC-USP).
- Faculty member of the postgraduate department, (HRAC-USP).
- In the early 80’s, started his private orthodontic practice gaining extensive experience in the orthodontic treatment of children and adults with dental and/or skeletal deformities, and dental follow-up.
- Former Assistant Professor and Ph.D., São Paulo University; Professor, Postgraduate (Masters) Program in Orofacial Clefts (HRAC-USP); Visiting Professor, Julio de Mesquita Filho São Paulo State University, Orthodontist, HRAC-USP, Advisor to the Foundation for Research Support, São Paulo. With many publications in national and international journals, and significant participation in orthodontic conferences, currently coordinates the Specialization Program in Orthodontics (Profis) encompassing the Specialization and Masters Programs in Orthodontics, Sacred Heart University (USC), and collaborates with several graduate courses in orthodontics.



I was invited to introduce Prof. Leopoldino Capellozza Filho's interview under a rather unfortunate circumstance. One of his greatest friends and scientific partners, Prof. Omar Gabriel da Silva Filho, was supposed to do so, but soon after receiving his questions, a health problem no longer allowed him to undertake this task. But with the grace of God he will soon resume his work and enjoy this historic participation.

As regards our illustrious respondent of this issue's interview, I am sure that many of his friends (and they are many) - had they been invited in my stead - would inevitably feel burdened by the responsibility of introducing “Dr. Dino,” as he is fondly nicknamed. And they would all ask if such introduction was indeed necessary.

It is estimated that over 3,000 copies of his book have been sold, including a best-seller published by Dental Press. Furthermore, this indefatigable master is poised to launch a new book with further innovations, focusing on his concept of an individualized orthodontics, which is at once realistic and minimalist, and according to which—were I to paraphrase him—“minimum can mean maximum.”

Early in my training I was privileged to have Prof. Capellozza as one of my key mentors in Orthodontics. So I feel I am in a position to attest to the character, personal and scientific honesty, and common sense of this undisputed master. I had the chance to learn and awaken to a more open-minded orthodontic approach given his vast experience and his scientific criteria. He spearheaded this approach, based on patients' morphology, and it has long been his unique diagnostic and treatment method.

During the years I spent in residency at the Department of Orthodontics of “Centrinho” (HRAC-USP, Bauru), I was also able to keep track of his influential and clear minded performance in his daily struggle to enhance the outcomes of cleft patient treatment with the support of the entire Centrinho team.

Countless lines would be needed to describe the impact of his views on the current behavior of Brazilian orthodontists, built over 30 years of orthodontic practice. Starting with his former students, like myself, who today closes ranks on the educational “front” and continues to convey my concepts in the training of new professionals, right down to the new orthodontists, who may have the golden opportunity to start a career very soon. Dino has benefitted us all.

Those who know him well also know that a lot more could be said of this ingenious friend.

In this interview one can grasp a bit of Prof. Leopoldino Capellozza Filho's lucid reasoning as he walks the reader through his treatment of cleft patients and his orthodontic practice, affording insights into compensatory treatment in all three planes (vertical, anteroposterior and transverse). Interviewers included the following distinguished colleagues: Dr. Omar Gabriel da Silva Filho, Prof. Terumi Okada, Prof. Laurindo Furquim, Prof. Suzana Rizzato and Prof. Dione Vale.

Readers can expect to be enthralled by this fertile and unmissable chat with Dino as if they were talking personally with this unique icon of the orthodontic world.

Good reading!
Adilson Luiz Ramos

Upon graduating from FOB-USP (Bauru School of Dentistry), you were invited to work at "Centrinho" (Rehabilitation Hospital of Craniofacial Anomalies, HRAC-USP), Bauru, São Paulo State, Brazil. As the first orthodontist to take part in their multidisciplinary team, you undertook the difficult task of giving back "smile and life" to the complex cases that confronted you there. What were the main challenges you faced in implementing your treatment philosophy? Tell us about your experience there. How worthwhile was it? Terumi Okada

In life, a good start can make a difference. As a student, I was asked to join the team of professionals of what was then known as "Centrinho" (Little Center) at the Bauru School of Dentistry. The invitation came from Professor José Alberto de Souza Freitas (Dr. Gastão), who would, from that moment on, be my mentor in academic life and an example in my private life. This informal invitation would determine to a great extent the sort of professional I would eventually become. For starters, I got used to hard work for it was sweetened by the gratitude I discerned in the eyes of my patients, their mothers and fathers. No doubt I was burdened with tremendous responsibilities. Too big, in fact, for such a young fellow, but impossible to turn down, in view of the expectations, trust and support provided by Dr. Gastão. I started working at Centrinho in early 1973 doing general practice and in August of that year I began to prepare to become their very first orthodontist. I started the postgraduate course in orthodontics, the first class of Bauru School of Dentistry, coordinated by Prof. Décio Rodrigues Martins, another very important person in my orthodontic life. He showed me the way, the importance of basic knowledge, of reading and understanding scientific articles and keeping records of my professional practice. He awakened in us (Jurandir Barbosa, Luis Garcia and Wanderlei Amorin) students of the first class, a huge affection for this specialty.

As I gained a practical knowledge of bands, brackets and Typodont archwires and started planning with cephalometric diagnosis the first cases of our postgraduate course, the difficulties began to pop up at Centrinho. Patients who needed orthodontic treatment were accumulating, and all were complex cases. The presence of clefts of various types created different diseases with skeletal involvement. They had very different ages, from the very young to mature adults. The orthodontics that I was learning reflected the period and was limited to corrective treatment of young patients. The literature was overall scarce, inaccessible and time consuming, and did not provide anything consistent about the treatment of cleft patients. Removable appliances, poor results... Very discouraging! Since I had no idea how to proceed I decided to just let time go by... But who could control Dr. Gastão's eagerness?

I had to put my shoulder to the wheel. When things get tough, there is no point in brooding over difficulties. You've got to find solutions. In the literature, Dr. Pruzansky²⁶ at least said what should not be done: using orthopedic appliances pre-and post surgery, which he condemned at the time based primarily on common sense. Time and scientific research have confirmed such devices are of little value. There were also the articles by Dr. Haas 'teaching' us how to perform rapid maxillary expansion. At the FOB Department of Orthodontics I learned to fabricate good bands and to produce tooth movement using leveling loops. All in all, it was still not enough because the concepts of normality defined and assessed by cephalometry and by Angle's molar key to occlusion did not apply, so we were unable to define therapeutic goals for patients at Centrinho.

It took courage. Is this the right word? I don't know. What I do know is that at that time I began to schedule patients who were admitted to the Hospital to have the orthodontic appliance set up. We were in the 70s, the era of bands, stainless steel wires with leveling and alignment loops, when a whole lot of time was spent in the procedures. I then started to do to them something similar to

what we did in patients without clefts, and that was setting up the orthodontic appliance. This contact, no longer with models and radiographs, but with patients and parents, made the difference. The confidence with which these people, often of humble origin, entrusted themselves to an institution that was intent on treating them, hoping to recover their "smile and life," left an indelible mark in me. Emotion and willingness. Driven by necessity, I found the courage to do things for the first time. Some had already been described, others not. We are talking

about absolutely individualized diagnosis. Seeing the patient's needs and defining what was needed to address them, whether or not it broke the rules of orthodontics. It was based on morphology, especially of the occlusion, since there were major limitations when dealing with the face. That is when I began to develop the new concept that I currently adopt for diagnosis.⁴

We began to finish treatments with satisfactory results, which greatly surprised people who worked in the area (Fig 1). But this was only the beginning,



FIGURE 1A - Young patient, 17 years and 3 months of age with unilateral cleft lip and palate operated on as a child, showing scars marking the lip and nasal deformity, but Pattern I face. Class II relationship on the right and Class I on the left side, with right posterior crossbite and retruded anterior teeth. Complicated occlusion due to missing teeth, poor hygiene and remaining teeth in bad condition. This picture clearly reflects the usual conditions faced by these patients at that time (1978).

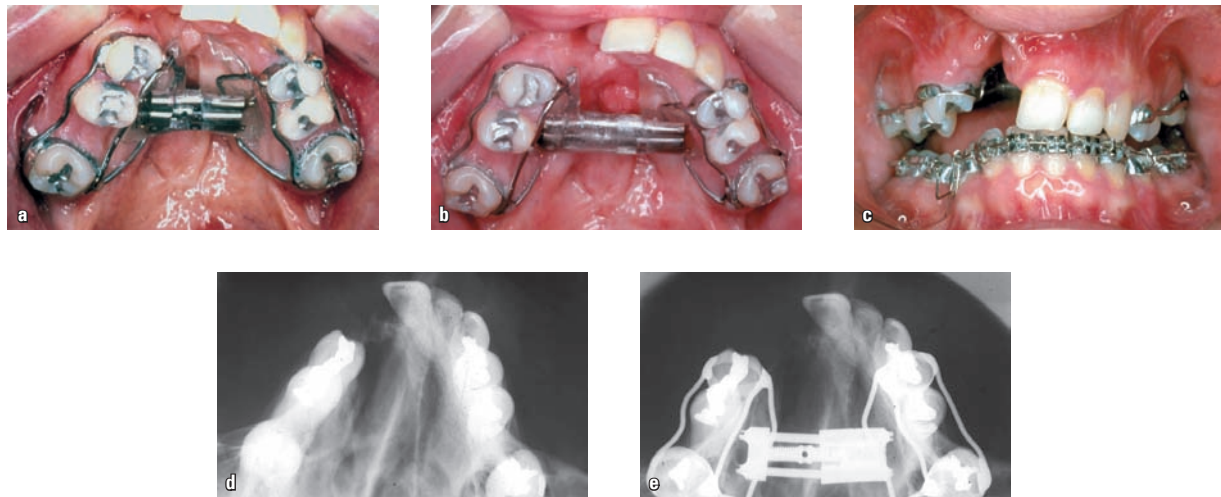


FIGURE 1B - Upper arch with expander in place, before activation (a), after activation (b), frontal occlusion (c), occlusal radiograph of maxilla before (d), and after expansion (e).

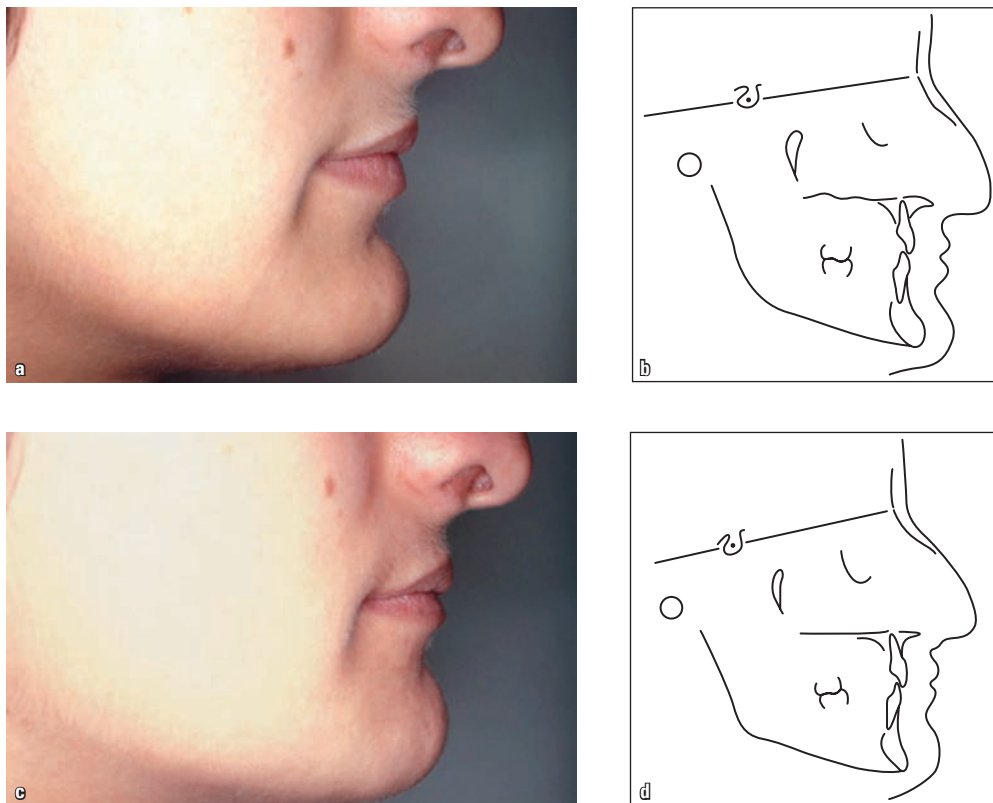


FIGURE 1C - Profile close-up and cephalometric tracings before (a, b) and after (c, d) chin reduction surgery performed by Dr. Reinaldo Mazzottini (Centrinho), with very positive impact on facial profile.



FIGURE 1D - Upper dental arch, before (a), immediately after placement of late bone graft (b), and alveolar area repaired (no cleft) after healing (c). Occlusal correction was complete and missing teeth replaced prosthetically. When critically analyzing these results, consider that they were obtained 30 years ago.



FIGURE 1E - Cosmetic surgeries were performed by Dr. Diogenes Laércio Rocha (Centrinho) to improve the contour of the upper lip and nose shape.



FIGURE 1F - Comparison between initial and final images (frontal and profile) demonstrates very significant aesthetic recovery, considering the complete cleft lip and palate. These results were influenced by an adequate facial growth pattern displayed by the patient. Speech rehabilitation complemented rehabilitation as a whole, attesting to the pioneering efforts of Centrinho in the treatment of cleft patients.

and far from over. Occlusion correction was effective but we still had to grapple with many patients' faces. Although we acknowledged how effective our approach had proven, we were confined to certain dentoalveolar limits.

Patients with deformities and unsightly faces required correction. The quest for surgical resources for these patients was in its infancy. It was the dawn of the history of orthognathic surgery in Brazil. This story is told in the introduction to my interview with Dr. Reinaldo Mazzottini, on the 30th anniversary of this event.⁶ We learned a lot from this experience, starting with facial analysis, the basis for diagnosis in contemporary orthodontics, which I learned from Dr. Larry Wolford. It was 1978 and the first patients were operated on in an unforgettable week for all those who had the privilege to experience yet one more step Centrinho was taking to attain its goal. The "smile and life" were returned to those who were most unlikely to regain them.

Those early days were the happiest. Perhaps because we were young, because everything was still waiting to be accomplished and, of course, because we were naive. We were a fledgling team, but a team nonetheless, sharing ideas in a brotherly atmosphere. Residency in orthodontics was now available. Teaching and research were growing. We investigated the influence of surgical procedures on the correction of cleft lip and palate, as the primary etiological agent in the sequelae of the face. We had to operate seldom, well and in a timely manner. We began to see relapse and instability in patients we had treated. All these aspects were investigated and led to publications. They served as a basis for further actions. I became coordinator of the Hospital's therapy management area, which established conduct protocols for the rehabilitation process, because this function is supposed to be performed by an orthodontist.

More and more orthodontists joined us. Special people the likes of Dr. Reinaldo Mazzottini, Dr. Arlette Cavassan, Dr. Silvia Graziadei, Dr. Omar Gabriel da Silva Filho and Dr. Terumi Okada Ozawa. This was the core of professionals that

surrounded me at a time of intense clinical practice. I learned to respect differences, to admire competence, to be part of a team, to always regard the patient as our primary target.

I think that answers your question. We humans are a result of genetics and whatever experience life allows us. Centrinho meant an opportunity for teamwork in dealing with complex patients, challenges and conditions to face them, early recognition of the limitations of orthodontics, dedication to clinical practice and study. All these were relentless requisites to develop a critical spirit and the confidence to ignore dogmas and shift paradigms. Was it worth it? Each and every day!... Mainly because all those actions took place in an environment of respect for the human being, which pervaded the entire Centrinho team, inspired by Dr. Gastão.

Although your orthodontic practice can sometimes be bold and challenging, it is always based on morphological, scientific and clinical concepts. Do you think this is partly due to your experience in treating those complex and borderline cleft lip and palate patients?

Terumi Okada

I agree that that was the main influence. For one thing, diagnosis is failure-prone if conducted using cephalometry in patients with skeletal deformities, and therefore not applicable to most patients with complete clefts. In these cases, prognosis can prove difficult if made with conventional tools since it is determined by factors beyond genetic inheritance, such as the cleft condition and the treatment it requires, as well as by the functional disorders it causes. This complexity you referred to limited therapy goals and required enough understanding not to transgress those limitations and risk instability. Individualizing and compensating were the keywords in those days. Those were times of dogmas, rigid targets, based on numerical data which I believe nowadays only orthodox orthodontists still pretend to abide by. Shifting those paradigms was quite a challenge, especially for the young man I was at the time.

But the commitment to patients in need of orthodontic treatment as part of an interdisciplinary approach began to dictate the procedures that I would begin to use and gradually organize and protocol.⁴

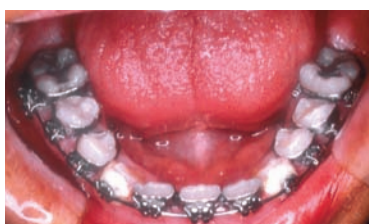
I believe you will get a clearer picture if I tell you how my first rapid maxillary expansion came about. I learned how to expand the maxilla using a W-shaped archwire. It was a limited resource if your purpose was to expand the basal bone. Rapid maxillary expansion was not routine yet and I had not learned how to perform it, but the potential results were exciting. Haas's articles were clear so I summoned enough courage to perform the first expansion, following his instructions. I told him when we brought him to Bauru in 2001 to teach a course and receive our respects that everyone here had been his students and I, the first and most grateful. It involved the use of elastic separators, banding, impression taking, making a model with the bands in place, and then going to a lab where it was also the technician's first experience fabricating an expander. Fabricating, cementing and activating.

The thrill of seeing the cleft segments moving away and the crossbite being corrected! Excitement and satisfaction. We began to make lots of expansions. In contrast to the prevalent concept at the time, we expanded the maxilla of children in early mixed dentition, youths and adults. This experience was enriched by each and every one of our professionals, who changed the expander design using rectangular wires instead of a buccal bar,¹⁰ used different anchorage teeth depending on patient age,⁹ and allowed continued expansion by replacing the screw^{7,8} (Fig 2C), besides devising specific expansion protocols for different ages.^{5,7,8,13}

That's what those magical days of discovery were always like. Different needs justifying different methods. We used brackets with reversed angulation on central incisors and canines and superangulation on canines near the cleft to respect bone limits. We would level the dental arches in segments and only then expand and perform a complete leveling⁸ (Fig 2B). Cases were finished with class II relations for canines and/or molars,



FIGURE 2A - As the incisors show a reduction in size in routine bilateral cleft lip and palate, one option to set the perimeters of the anterior upper and lower dental arches was to extract one lower central incisor.



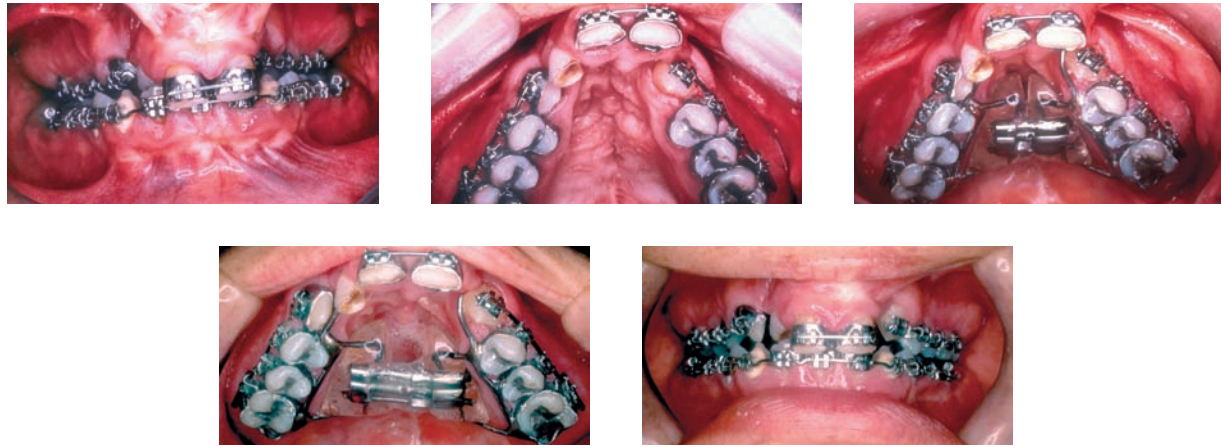


FIGURE 2B - Leveled and aligned dental arches, with the upper arch in segments, which was routine prior to expansion. Expansion was not enough to correct the crossbite, requiring a new appointment with patient for further expansion. This was a problem involving operating times and additional costs.



FIGURE 2C - When the expander was exhausted and occlusion not yet corrected, instead of fabricating a new appliance, acting on Prof. Dr. Reinaldo Mazzottini suggestion we would lock the acrylic base of the expansion appliance, remove the screw, close it and once again attach it to the base. The locks were removed and expansion continued. Then the crossbite was finally corrected.

not necessarily symmetrically. We would extract a mandibular incisor of patients with bilateral cleft lip and palate to compensate for the smaller size of maxillary central incisors (Fig 2A). We would compensate by tipping incisors in the opposite direction of the skeletal discrepancy, usually a Pattern III, but preferred to concentrate on compensating the lower arch.

This approach obviously reached beyond the care of cleft patients, and affected my entire universe of orthodontic clinical practice and teaching.

Competent and special individuals, who believed in me—like Dr. João Cardoso Neto, private practice partner for 31 years—allowed the exhaustive application of these concepts. I believe at this point you may have an insight into the root of the concepts that enabled me to develop a diagnosis based on facial growth patterns,⁴ the need to accept the limitations of orthodontic intervention, as a rule curtailed by dentoalveolar limits, and my individualized

brackets.¹² Nothing is by chance. Individualization and compensation are still keywords in my orthodontic philosophy and reflect the influence of having experienced complex and borderline orthodontic patients with cleft lip and palate.

The care of patients with cleft lip and palate is now almost 100% provided by public medical services (SUS), and they thought at first to concentrate it at the Centrinho, in Bauru. However, the current trend is the creation of several mini health centers scattered across different regions of Brazil, coordinated by different professionals with varying protocols. How do you view this policy of decentralization? Terumi Okada

I do not know if the centralization that occurred in the early days had been planned ahead. I rather think it was a consequence of the quality of the interdisciplinary treatment offered at Centrinho, which created opportunities and facilities that patients and their parents could not find elsewhere. As a result, many training centers in the medical field and some other areas now play a very minor role in terms of number of patients. Either that or they discontinued care delivery altogether. At this point, concentrating care delivery at Bauru's Centrinho became almost the only option. Though such centralization may be frowned upon from the perspective of staff training—which is necessary and has been accomplished by HRCA—it was not ideal for the provision of services. I think that decentralization is the best system, and it seems quite feasible with the service virtually supported by public health agencies (SUS). Centers located in strategic areas within our continental country do offer advantages, but provided that one single consistent protocol be applied.²⁹ This protocol, which tends in general to be universal must focus on cost-effectiveness analysis, with results commensurate with all sorts of investments made by the key stakeholders (professionals, patients and health agency). It is not reasonable to assume, however, that after all the experience that

has been documented and is available now, in the 21st century, the protocol—which though not a guarantee of fantastic results, does spare the patient long-term treatments—is deprecated on account of outdated, obsolete preferences or techniques touted with a new name. This is a risk that must be accepted and requires vigilance to avoid.

Based on your experience how do you envisage the rehabilitation of cleft lip and palate patients? Terumi Okada

In order to be achieved, excellence in the rehabilitation of cleft lip and palate patients requires many components. The first such component is an interdisciplinary team where each professional possesses in-depth knowledge of the resources available in their area for diagnosis, prognosis and treatment of these patients. Furthermore, each one should clearly recognize the relevance of their participation in the process while conforming to the hierarchy of established procedures. This should be determined in a protocol which, besides defining conducts, also sets the times at which they will be adopted, determining treatment strategies. The compliance of patients and their guardians seems to play a fundamental part here, and seems to be dependent on their socioeconomic and cultural level. Financial status is obviously required for all this to work satisfactorily, which may be a problem for a system totally dependent on the state.

From a technical standpoint, I think we can afford professional training, and the protocol²⁹ adopted by the HRAC is good. From the standpoint of treatment delivery, it is essential to comply with the strategies, especially regarding the age for adoption of the procedures. The patient's behavior—from simple actions such as performing preventive methods for dental caries to a dedication to the procedures recommended by therapists—also contributes to the quality of the rehabilitation process.

In private practice, where the constraints that influence the context for excellence are more easily controlled very interesting results can be obtained for facial growth and development of dental arches,



FIGURE 3A - Patient aged 10, presenting with right unilateral cleft lip and palate, had undergone lip and soft palate surgery (when 3 months old), hard palate, nasal septum and alveolar ridge surgery (at 5 years and 10 months), and alveolar bone grafting 6 months earlier (at age 9 years 6 months). This is a Pattern III face with moderate maxillary retrusion, whose etiology seems to have been determined by the cleft. Typical occlusal relationships, with canines and anterior teeth in Class III, bilateral posterior crossbite and anterior end-on bite.

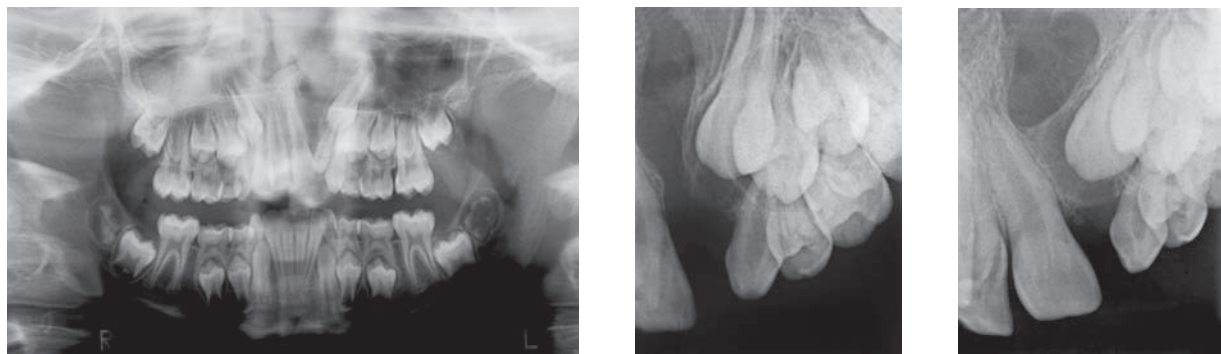


FIGURE 3B - Panoramic radiograph taken before alveolar bone grafting surgery shows the presence of a pre-canine in cleft area, which was removed before grafting surgery. Periapical radiographs enable assessment of outcome 3 months after grafting surgery. A bone tissue bridge was formed, and cleft is no longer present.

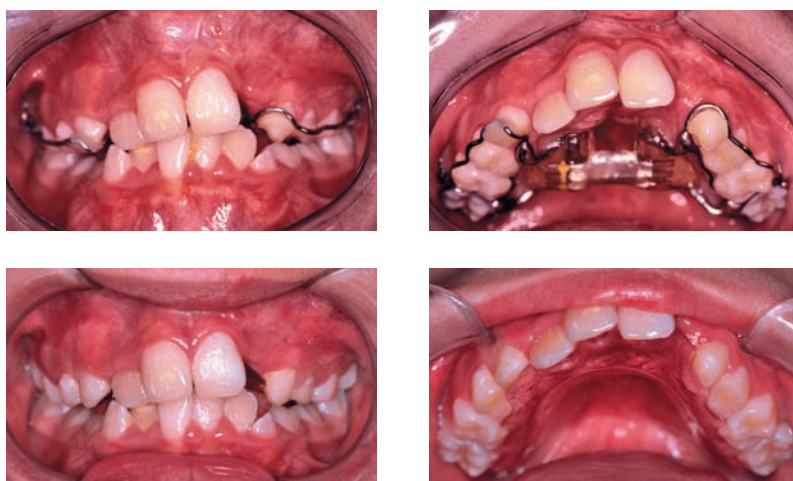


FIGURE 3C - Treatment with rapid maxillary expansion and maxillary traction performed 6 months after bone grafting, corrected the crossbite, but did not split the midpalatal suture.

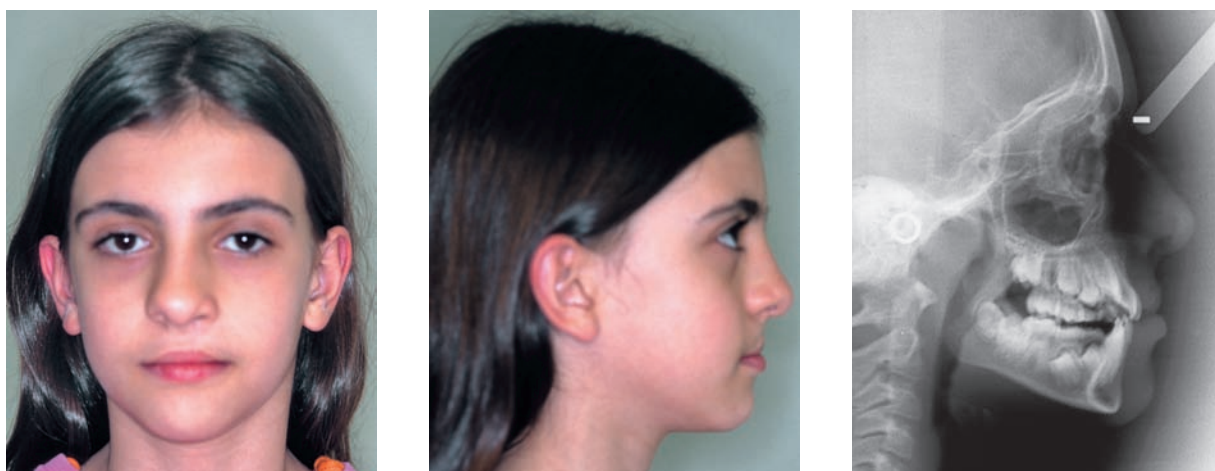


FIGURE 3D - Although the impact of rapid maxillary expansion and maxillary traction on the face was relative it was still able to improve the malocclusion.



FIGURE 3E - Patient 13 years and 9 months old at the end of growth spurt; Pattern III maintained; face acceptable.

occlusion and speech. The conditions for facial esthetics depend on the type of cleft, facial pattern of the patient and the patients' / guardians' willingness to invest. As a routine results are good, although more or less subtle signs of injury do remain.

The treatment progress of the patient depicted in Figure 3 clearly portrays what in my view can be defined as excellence in the rehabilitation of cleft lip and palate. In summary, the protocol provides: conservative primary surgeries performed with quality in the

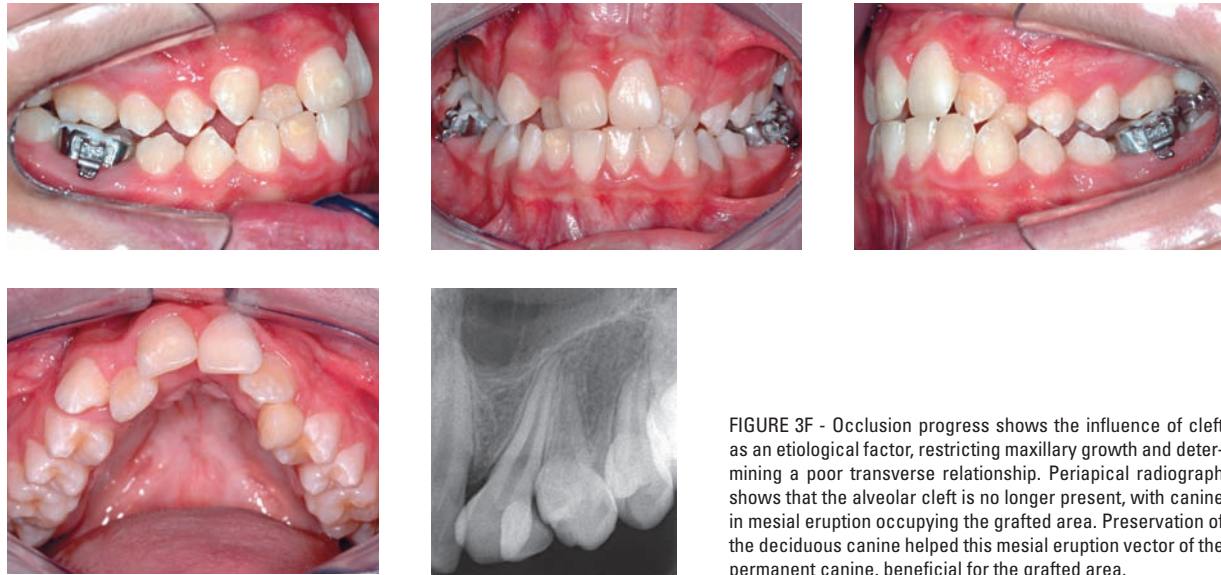


FIGURE 3F - Occlusion progress shows the influence of cleft as an etiological factor, restricting maxillary growth and determining a poor transverse relationship. Periapical radiograph shows that the alveolar cleft is no longer present, with canine in mesial eruption occupying the grafted area. Preservation of the deciduous canine helped this mesial eruption vector of the permanent canine, beneficial for the grafted area.



FIGURE 3G - Compensatory orthodontic treatment was performed according to the protocol for standard III malocclusions. Conventionally performed rapid maxillary expansion this time was able to split, albeit partially, the mdpalatal suture. This result is not frequent, but when it occurs, it favors final treatment outcome.



FIGURE 3H - Treatment was conducted according to protocol, beginning with the upper arch, using prescription III brackets, stripping the mesial side of the first premolars and distal side of lower canines, and the use of canine-supported Class III elastics since the beginning of lower arch leveling.

first year of life by an experienced surgeon, cosmetic revisions of the lip and nose, made increasingly early (which is not necessarily good); specific monitoring by a speech therapist, and a dental caries preventive program for monitoring eruption (looking out for dysgenesis) and growth until the pre-grafting phase

(9-11 years). At this point the maxilla is prepared, usually by expanding it. Retention is introduced to preserve the form obtained by the treatment, and bone grafting is made according to protocol.²⁹ Later, in the permanent dentition, orthodontic assessment and planning are performed—in cases for which

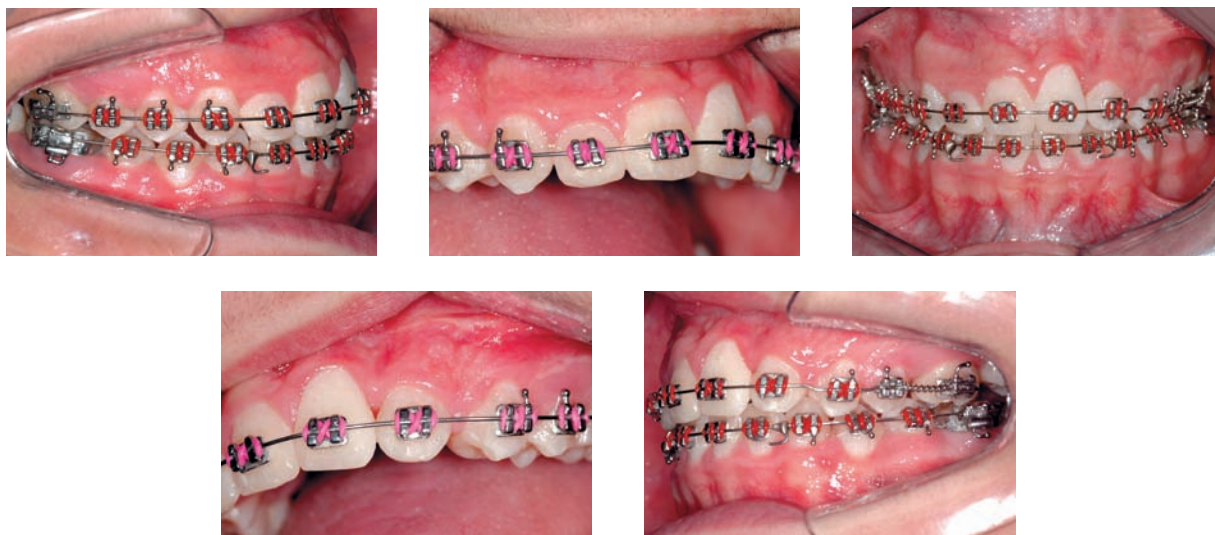


FIGURE 3I - At the end of leveling, occlusion was corrected with molar and canine in Class I relationship on the right side, and tooth 23 in the position of the lateral incisor (canine bracket placed upside down), tooth 24 in the position of the canine (with a canine bracket). Prescription I brackets were used in the upper arch to avoid closure of the nasolabial angle. Treatment protocol is compensatory for pattern III malocclusions in Caucasians. See how repair of the cleft in the alveolus is clinically optimal.

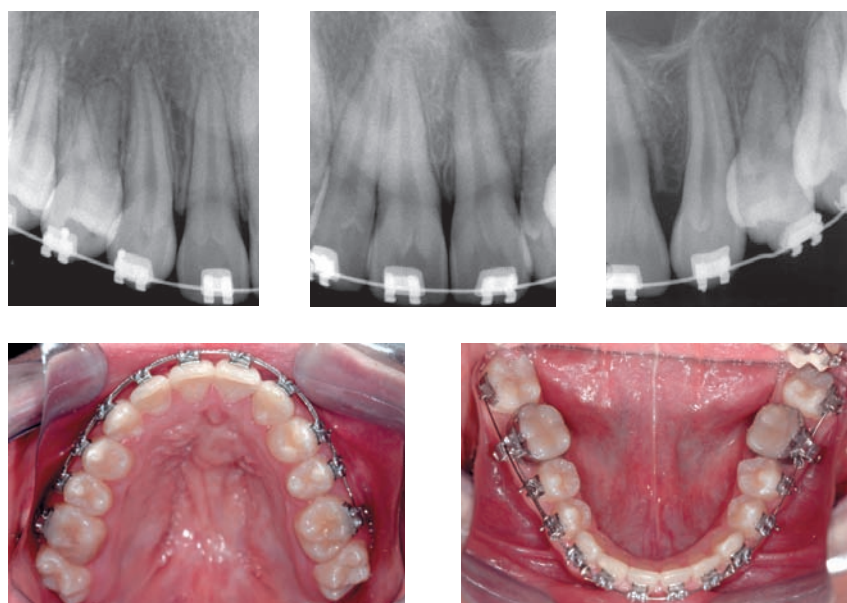


FIGURE 3J - Showing that the shape of the upper arch is similar to what can be achieved in a non-cleft maxilla, and teeth position in the anterior maxilla is symmetrical.



FIGURE 3K - At the end of treatment, adequate occlusion outcome. The face features pattern III characteristics due to maxillary deficiency, with greater soft tissue involvement, acceptable skeletal and dental relations (see lateral cephalogram). Esthetic deficit related to soft tissue can be greatly alleviated by refining surgery on the lip and nose, which is comprised in the final stage of the treatment protocol that the patient has to undergo.

treatment has been successful, orthodontic treatment is often found to be very similar to patients without cleft. Specifically in the case of the patient shown in Figure 3, rapid maxillary expansion was performed after bone grafting, and the mid-palatal suture was split (Fig 3G). This can happen¹⁵ and it adds value to treatment, leading to a final occlusion that resembles even more the one achieved in patients without cleft.

Orthognathic surgery may be used when the patient requires a greater closeness to normality, and serves as an effective and absolutely essential resource to resolve major discrepancies.

Your unorthodox position on the use of cephalometry as the main tool in the diagnosis of malocclusion has been much discussed and, for that matter, criticized. Could you make some comments about this position? Dione do Vale

Since the end of the last decade, convincing evidence has been produced to prove that the use

of cephalometric diagnosis is absolutely unjustified. Those who insist on using it are departing from the key diagnostic concepts that govern contemporary orthodontics. I think it is up to them to try and defend this anachronistic and meaningless position. Cephalometry remains a useful tool for the evaluation of orthodontic patients. Not for diagnostic purposes, but for studying growth, the effects of appliances on teeth or on the skeleton, and so on. From this perspective, cephalometric analysis should be taught within the scope of a subject like the history of orthodontics, and presented as orthodontic culture, but not as a viable method for treatment planning.

Acknowledging that growth pattern is the primary etiological factor in determining malocclusions, considering and investigating the set of changes that defines them beyond the limitations of Angle's classification, are all mandatory. In other words, personal preferences should yield to current

knowledge. Qualitative facial analysis, morphological analysis of radiographs or CT scans of the face and dental arch models are efficient methods in orthodontic diagnosis and prognosis.⁴

Pattern II and III cases treated with compensation may have their results compromised during the final phase of growth. In an attempt to minimize this problem, you individualize the type of retention to be used. To what extent do you feel that this individualization can minimize the negative effects of growth after treatment? Dione do Vale

I do not believe that the compensatory treatment of pattern II and pattern III malocclusions play out quite the same way during the final stage of growth. For pattern II malocclusions the clinical consensus that finds support in the literature is that, when caused by maxillary protrusion, they must be treated in mixed dentition, and when caused by mandibular deficiency, they should be treated in permanent dentition, preferably during pubertal growth spurt. In both circumstances, the best choice of “retention” to preserve results in the late growth phase and even later depends on establishing proper occlusal relationships and an adequate functional pattern (lip contact, nasal breathing, swallowing pattern compatible with patient age). Thus, the sort of retention used in these patients is conventional, with a Hawley retainer for 6 months of continuous use, then another 18 months of night use, and a 3/3 fixed lingual retainer until age 30, optionally for life.

As regards Pattern III malocclusions, the perspective is rather diverse and concerns about growth after treatment are greater. Given that this malocclusion develops on an ongoing basis throughout growth²⁸ it requires a different protocol. The classical treatment, as described in this interview, comprises rapid maxillary expansion and maxillary traction, which characterizes the first phase in early mixed dentition. The best retention for this procedure is no retention at

all, but rather an overcorrection. Then you have to wait until facial growth spurt is over, usually two years after menarche in girls and after full pubescence in boys, always checking with wrist (carpal) X-ray to detect the IJ stage of Hagg and Taranger,²⁰ which is the landmark indicating that compensatory orthodontic treatment should be started, or to determine the need for corrective treatment with orthognathic surgery.⁴ Any orthodontic treatment performed prior to that period, even with high quality occlusal correction, unlike what is allowed for the treatment of compensatory Pattern II malocclusions, does not ensure stability. If the choice falls on compensatory orthodontic treatment, then after performing it—starting from that point considered the initial landmark—the conventional retention program described above may be further reinforced by adding an Osamu¹⁴ dentoalveolar retainer, whose indication will depend on the amount of compensatory movement performed in the lower arch or, in other words, the amount of lingual tipping applied to the teeth of the lower arch (Fig 4). When indicated, and this is very common, this retainer is used at night for two years. Besides, in controlling the case after removal of the appliance, special attention should be given to the vertical and horizontal incisor relation in order to detect primary impingement in this region, which may result from relapse or instability caused by terminal growth of the mandible. When this happens, removal of the 3x3 retainer is indicated, sometimes associated with interproximal stripping of the lower incisors to allow a lingual movement to adjust these teeth.

To complete my answer to your question, I hope I made it perfectly clear that although these steps are taken in terms of retention, the actions that really matter in minimizing the negative effects of growth after treatment are related to the age at which treatment is performed (this is even more important for Pattern III), the quality of occlusal relations and of the functional pattern allowed to these patients, especially those of Pattern II.



FIGURE 4 - Final occlusion and modified Osamu retainer, without occlusal coverage, placed in order to give stability to the lingual tipping movement applied to the lower teeth during compensatory treatment of a pattern III malocclusion.

Assuming that “normal,” and esthetic occlusion can exhibit many possible angulations and inclinations given the huge morphological variability, do preadjusted brackets offer few prescriptions? Laurindo Furquim

Normal occlusion is not one, but many. We all know that and, increasingly, a greater number of professionals support the thesis behind this reality: the bracket individualization. Originally, from the perspective of the author of the Straight-Wire concept, L. Andrews, the ideal would be a different bracket for each tooth of each patient. This was not, and still is not viable, but I am sure that one day it will be. Because of this limitation, Straight-Wire began with much less than that, but at least with a bracket designed for each tooth. In other words, a bracket for the upper central incisor, another specific bracket for the lateral incisor, and so on. It has been a great evolution. Moreover, without raising widespread interest, brackets were also introduced in order to compensate upper and lower incisors in terms of inclination (torque). As time went by, the understanding of how frequent compensatory treatment² is was established and

other prescriptions have been proposed, including mine.¹² We therefore have many prescriptions available, but they still are not enough for an absolute individualization. What should be done to remedy this limitation is a combination of brackets of different prescriptions, which could provide, overall, the possibility of individualization that is required for each case. It is important that these combinations always be made with the same bracket model and brand so as to ensure standard manufacturing features while preserving other details such as inset and offset positioning. An example of this combination occurs frequently in the compensatory treatment of moderate long face pattern when the therapeutic goal is to keep teeth where they are. In this situation, non-protrusive brackets are used for the upper arch (prescription II plus) and lower arch (prescription III), which is a combination that helps to increase the protrusion typical of leveling and alignment. In addition to the prescriptions built into brackets, remember that in terms of angulations, without a doubt the most important factor in individualization, changes in bracket positioning can create

a wide range of variations. This is so important, and a feature so often used, that my prescription I and prescription II brackets for upper central and lateral incisors (they are the same) were designed without a curved base to allow for this variation in position during direct bonding, so that angulation can be individualized without losing the prescriptions built into the brackets.

Concerning inclination (torque), depending on the accuracy of the available bracket prescription being used in the patient, wires should be used on an individual basis, (a) not to express torque (round wire), (b) to express torque in part (rectangular wire with play, for example 0.019x0.025-in archwire in a 0.022x0.030-in slot), or (c) to express the full bracket torque (rectangular wire with minimal play, for example 0.021x0.025-in in a 0.022x0.030-in slot). Anyway, I am sure that the future will grace us with a wider array of prescriptions. We might even attain what today is still regarded as utopian: a specific bracket tailored for each tooth of each patient.

In my view, the best treatment for Class II patients with mandibular deficiency today is performed by Dr. Carlos Martins Coelho using the Mandibular Protraction Appliance (MPA). His treatment underscores the positioning of lower incisors. Torque control seems pretty consistent. When asked whether these results stem from the application of lingual torque in the lower incisors, Dr. Carlos denies it, saying that this procedure can be adopted in some specific cases, but not as a routine. Dr. Carlos uses incisor brackets with -1 degree torque and 2 degrees angulation, and lower canines with 7° angulation. Assuming that the incisors of patients with Class II mandibular deficiency have a buccal offset, the placement of a rectangular archwire with no torque will apply lingual torque to these teeth. In your view, do angulations and torques in lower brackets make a difference in the treatment

of Class II malocclusion in patients with Class II mandibular deficiency when MPA is being used? Laurindo Furquim

This question encompasses many issues. To address them, I think it is important to review certain concepts underlying the compensatory treatment of Pattern II malocclusions with mandibular deficiency. These should be the foundations for our clinical actions.

- a) Mandibular protraction appliances, including MPA, are clinically effective and accomplish the correction of malocclusion, notably through dentoalveolar changes. The repercussions on the skeleton, including mandibular growth, are of small magnitude and transient, similarly to other mandibular advancement procedures.^{1,16} Even when growth results are significant in terms of mandible management, as shown by the Herbst appliance, they are not maintained consistently by the end of growth.²⁵
- b) From this perspective, the conclusion—also found in the literature—for all appliances used for the treatment of Pattern II malocclusions with mandibular deficiency, is that the lower teeth are moved forward (incisors are buccally tipped). Whatever the anchoring system, incisor movement is difficult to control.²⁴ Lingual torque in the archwire or lingual torque in the base of incisors brackets cannot stop this tendency. Evidence to prove this assertion comes specifically from the sample of Dr. Carlos Martins Coelho, treated with MPA and which, as you mentioned, has great quality. When analyzed by cephalometry, the results show that the lower incisors are buccally tipped.²⁷ This happens despite the brackets with -1 degree of angulation that would be used by the author.
- c) The occlusal correction achieved with this sort of treatment is stable, provided that adequate dental intercuspation is obtained at the end of therapy, and as long as the patient has a good functional pattern,²⁵ allowing compensatory

adjustments in the posttreatment period. These adjustments mean more movement of the same nature (inclination) and direction as that which is performed during active treatment.

Now, to summarize and focus on the foundation of my answer, it seems that treatment of Pattern II malocclusions with mandibular deficiency is, in fact, compensatory and involves moving the lower arch forward, with inclination of the incisors. That does not seem possible to be controlled. This is the point that lends support to the strategy I use when setting the inclination of brackets in the lower arch of patients with an indication for this treatment: I either agree with or accept the inclination that these teeth already exhibit, and that will be increased.¹²

Thus, incisor brackets have a prescription of 8 degrees of torque, which we call II “plus”, although clinically speaking it is often “minus” because it is common for patients with this malocclusion to have much higher crown inclination during and after treatment.¹⁸ This torque should not be regarded as exaggerated since studies have shown that there are samples of occlusions that have undergone treatment and have been rated as excellent,³ which nevertheless exhibit very pronounced torque values in the lower incisors (maximum: +15 degrees). These values, which correlate with cephalometric values (Wits), suggest that the presence of a Pattern II maxillomandibular relationship is therefore expected and acceptable.

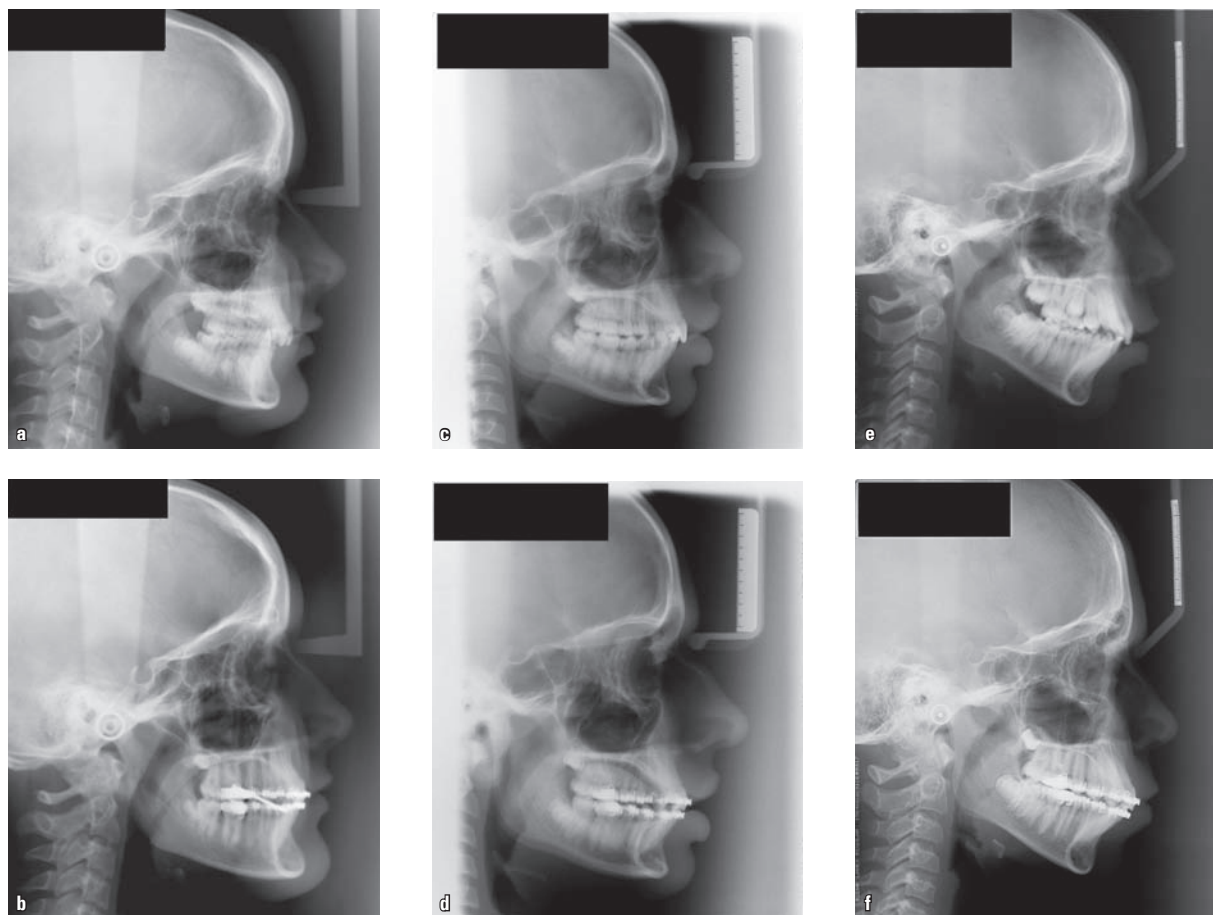


FIGURE 5 - Initial and final lateral radiographs of the face of several patients who made use of MPA and show what appears to be the unavoidable buccal tipping of lower incisors.

Well, +15 degrees is much higher than +8 degrees. How can I adjust this difference, when the lower incisor torque is greater than the torque built into bracket? Basically, I do what everybody does, namely, I use rectangular wires with smaller cross-sections, usually a 0.019x0.025-in wire in a 0.021x0.025-in slot. This creates the so-called clearance angle, which ranges from 7 to 10 degrees (in vitro) and allows a mean, conservative clearance of 7 degrees between the tooth inclination and the torque which was preadjusted in the bracket base.¹¹ Thus, for example, if a patient is using Prescription II Plus bracket (8 degrees) in lower incisors that show a 15° torque, theoretically no clinically significant torque is being delivered to these brackets if the rectangular wire is 0.019x0.025-in. There is evidence to prove that this is true, and here I base myself on results of a CT investigation we conducted in Pattern II patients.¹⁸ My approach therefore relies on a very comfortable safety margin. Supposing that in the same example just given the patient had on a bracket with -1 degree torque, this safety margin would drop to +6 degrees. In other words, if torque values are higher (as is often the case) the lower incisors would presumably undergo lingual torque, which is incompatible with the therapeutic goals and the basal bone conditions shown by the CT scan. Therefore, to give a straightforward answer to your question, any torque pre-built into a bracket can make a difference in the treatment of Pattern II malocclusion with mandibular deficiency. However, this may be masked in most cases by using a progressively smaller rectangular wire gauge as the difference between the torque prescription built into the bracket and the actual torque of the tooth in the basal bone increases.

Since I am searching for brackets that make a difference and allow individualization, which is the essence of the Straight-Wire technique, the idea is to conduct research to support the accurate understanding of this variation and lay

the groundwork for the manufacture of brackets with even greater buccal tipping. This explains why I think it is preposterous, from a logical and biological standpoint, to restrain the buccal tipping movement of mandibular incisors when mandibular advancement is performed in the compensatory treatment of Pattern II malocclusions. There is no support in the literature for any other thesis.

As for angulation, a primary factor in compensation, I think that the brackets you referred to, with +7 degrees angulation in canines and +2 degrees in incisors (which are protrusive brackets) are for the most part suitable for use with devices like the MPA. My prescription II¹² for the lower arch is similar, but with a lower canine angulation (+5). My restriction to the use of these brackets applies to cases where there is crowding in the lower anterior region. In that circumstance, I would use my prescription II brackets, bonding brackets with no angulation on the central and lateral incisors, and with a minimum +3° angulation in canines. The reason being that it doesn't make sense to use brackets that by introducing angulation will create demand for space in a crowded area, and will receive buccal tipping as a result of treatment with mandibular advancement. In so doing, less angulated brackets will require less protrusion for leveling and alignment, and the end-result should be decreased buccal tipping.

What is your opinion about the protocol for orthognathic surgery with anticipated benefit? Do you consider that possibility a reality or a regression? Under what circumstances would you recommend this protocol, considering the risk of instability it involves? Susana Rizzato

It is definitely not a regression. Surely, it is a real possibility in some cases, but seldom a routine approach. Not a regression because, as can be inferred from the article that introduces the

subject,¹⁷ it is only possible by the unrestricted adoption of available knowledge, starting with the adoption of an accurate diagnosis based on current concepts of growth pattern and morphological basis, with a special hierarchical role being played by the face. Moreover, the confidence generated by refinements in surgical technique, the possibility of predicting outcomes, assurance of stable surgical movements given by the use of rigid fixation, and the possibility of movement ensured by orthodontic miniplates, all reflect the evolution of orthodontics and surgery. It would be unreasonable to adopt this procedure in another context, where these technical and scientific developments were not available. Moreover, one should not forget that the main motivation behind this process is to mitigate the esthetic discomfort of the patient, which is commendable and can facilitate treatment for some individuals who would not agree to spend a period of time with their facial relations compromised. In my view, based on my experience with conventional procedures, using this protocol seems more attractive for surgery that targets either bone, maxilla or mandible, mainly for correction of Pattern III malocclusion with maxillary advancement or mandibular setback. I would certainly begin to develop my experience with this procedure through these indications.

In 1996, you published an article with samples of adult patients undergoing orthopedic maxillary expansion, without surgical assistance. In concluding the article about 80% of cases reached the desired therapeutic goals, although with little orthopedic response, and consequently with little opening of the central interincisal diastema. Today, considering the need for a more significant orthopedic response to resolve negative discrepancies of the upper arch; taking into account respiratory status in its relation to nasal resistance, and finally in view of the periodontal condi-

tion resulting from losses in the buccal bone plate of the anchorage teeth, would you still hold your position regarding orthopedic maxillary expansion in adults? Susana Rizzato

This question has the merit of allowing me to update my concepts about rapid maxillary expansion in patients who are out of the growth phase, without surgical assistance. The article to which you refer was published in 1996¹³ and later translated and published in the Dental Press Journal in 1999.⁵ In it, I present the results obtained with rapid maxillary expansion without surgical assistance, in patients no longer in the growth phase, for a period of about ten years. These patients were selected from my private practice, treated in sequence, and after having been advised about the limitations of the research process and the investigative nature of the procedure, all agreed to take part. I was particularly motivated to conduct this research because the literature was unsure about the age limits for rapid maxillary expansion. It was unwilling to conceive of this process after the end of growth. My experience prior to this research gave me grounds to diverge from this concept, since I had performed maxillary expansion in many adult patients. The need, initially for cleft patients and, later, with patients from the postgraduate and specialization programs, had driven the indication for this procedure in adult patients. The results were limited, but enough to treat the malocclusion. With this scenario, the attempt to perform rapid expansion in adults, regardless of age, was proposed and encouraged me to write the article you referred to. The results fully met all my goals, especially owing to the quality of material and methods. After all patients were treated in sequence, always cared for by the same professionals (Dr. João Cardoso Neto and myself), and always using the same type of appliance (Haas modified expander^{5,13}), manufactured by the same laboratory technique. In addition, a history of occurrences was recorded in the chart for further evaluation.

At the end of the experiment, when the sample appeared to be substantive, the results determined the possibilities and limitations of rapid maxillary expansion after the growth phase, and were presented in the article conclusions. Figure 3 shows the possibilities of the process. These possibilities and the experience of going through the treatment of the sample patients, which defies a full definition in so many words,

significantly influenced the protocol that we adopt for this procedure nowadays. After finishing this experiment, I changed my position considerably regarding the indication of rapid maxillary expansion without surgical assistance to patients no longer in the growth phase. In summary, I only indicate this procedure (always using a modified Haas expander) for patients below age twenty, who do not require a significant



FIGURE 6A - Young adult female patient (21y, 6m), Pattern I borderline to III, due to moderate maxillary deficiency. Half Class II molar relationship on the right, $\frac{1}{4}$ Class III on the left side, due to early loss of teeth 26, 36 and 46, and recent loss of tooth 16. A moderate expansion of the maxilla could be useful.



FIGURE 6B - With the patient's consent (limitations), an expansion appliance, adapted to the absence of tooth 16 was indicated, and an expansion that exemplifies the possibilities for patients out of the growth phase was obtained. Note that after activation, it was necessary to grind the acrylic on the right side to relieve pressed area and pain (routine problems in this process).

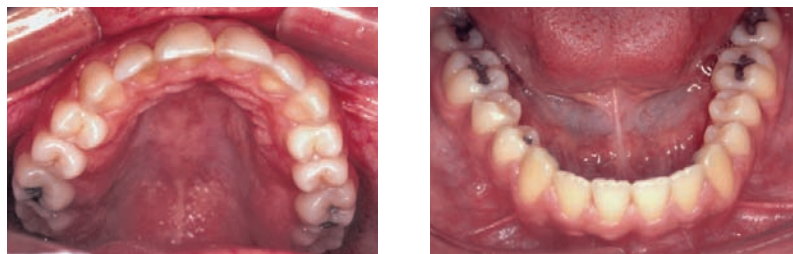
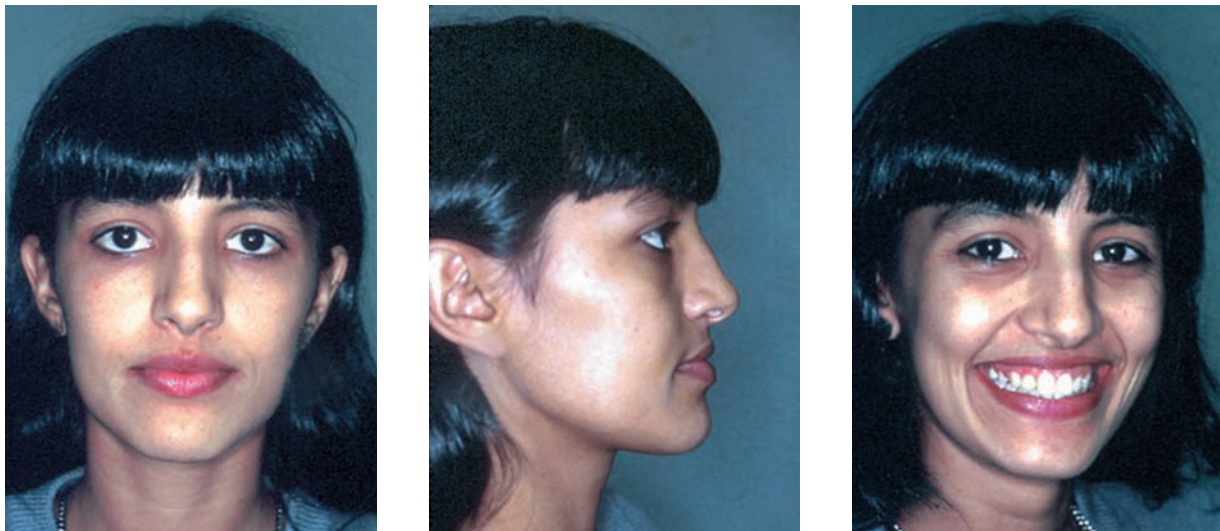


FIGURE 6C - The patient, in addition to expansion, had other benefits, such as replacement of tooth 16 by tooth 17 and improvement in the position of the other second molars, all replacing the first molars, and with all third molars replacing the second molars. This explains the smile that she is displaying, even more than the facial changes which, albeit subtle, were positive.

perimeter gain (maximum opening of the suture = 4 mm), who do not present with periodontal involvement in the teeth supporting the appliance, who are willing to cope with any complications that may arise from the procedure (pain, inflammation, injury), and who can be medicated. Awareness of all these limiting factors and of our ability to perform upper dentoalveolar expansions and lower dentoalveolar constrictions, provided they are supported by a morphological diagnosis, significantly restricts the indication for this procedure today.

Finally, and summarizing the answer to your question, the limitations for rapid maxillary expansion in patients who are no longer in the growth phase without surgical assistance are clear, and circumscribe the effects of the procedure to correction of minor dentoalveolar discrepancies, with no effect on breathing, but jeopardizing periodontal support. Conversely, it would be appropriate to consider that even with rapid maxillary expansion assisted by surgery there is no guarantee of any changes in the

breathing pattern,³⁰ and there are risks to the supporting teeth, including periodontal risks, which has justified the development of implant-supported expansion appliances.²¹

Eventually, orthodontists accepted the orthopedic treatment protocol suggested by Haas and modified by other orthodontists in the correction of Class III malocclusion with anterior crossbite. This approach includes expansion and reverse traction of the maxilla. Do you think transverse mechanics contributes to sagittal response in the early orthopedic correction of Pattern III patients? Omar Gabriel

I would add to your question “wisely”. Eventually, orthodontists wisely accepted the orthopedic treatment protocol suggested by Haas and modified by other orthodontists in the correction of Class III malocclusion with anterior crossbite. It is an absolutely effective protocol, particularly when we achieve the targets set for the treatment by Haas, which is not usual.¹⁹

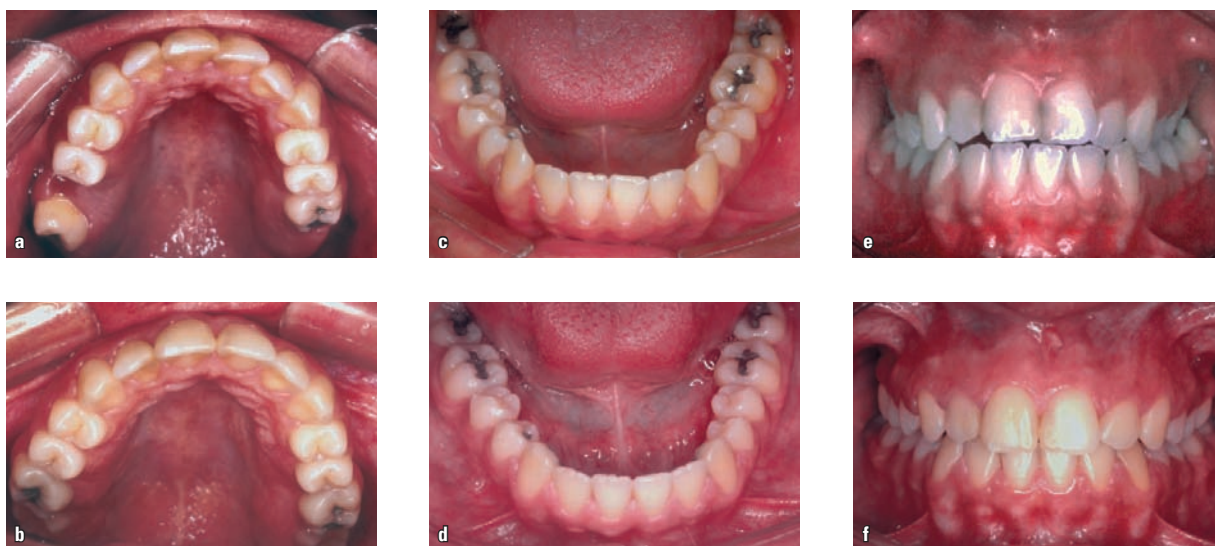


FIGURE 6D - After having been corrected, the arches show (a) expansion in the upper arch (canine = 2 mm, premolar = 4.5 mm, first molar = 4.5 mm), and (b) some constriction in the lower arch (canine = -1.5 mm, premolar = 0 mm, first-molar = 1 mm), sufficient to enable proper occlusion.



FIGURE 6E - Long-term assessment, eight years after treatment (patient is now 31 years old), seems to justify the treatment.

A large rapid maxillary expansion, and a traction with heavy orthopedic forces are the goals here, and generally good responses are obtained with this protocol. Transverse effects are significant for the sagittal response in the early orthopedic correction of Pattern III malocclusions because, as we already knew and was recently emphasized by the protocol of Liou,^{22,23} a large amplitude rapid maxillary expansion is a critical factor in accomplishing a more significant sagittal response through maxillary traction. Your question

also mentions anterior crossbite. An interesting resource to use under these circumstances is to add anterior bars to the expander passing through the palatal region of the upper incisors (Fig 5), which will prevent the palatal inclination that these teeth perform when filling the space created by the rapid expansion. With the use of these bars fabricated with 0.5mm wire the teeth may move toward the midline, without tipping palatally, which will favor the correction of the anterior crossbite.

The advent of cone-beam computed tomography (CBCT) enabled the viewing of the buccal and lingual bone plates of tooth roots. In what way or to what extent will this influence the freedom to use dental compensation in skeletal discrepancies? Omar Gabriel

The use of CT should be routine soon, allowing very consistent morphological evaluations. I do not think it will modify the classical concepts of compensation and much less change the therapeutic goals for patients who have

this indication. Treatment with these goals has long been made, and with good results. There is positive evidence in the literature, including for the long term, especially for pattern II malocclusions with mandibular deficiency, which are the most frequent malocclusions and are almost always treated compensatorily. We will be able to define the amount of tolerance that normality, expressed by the clinical condition, has with the amount of bone on the buccal and lingual sides of the tooth roots. Certainly once



FIGURE 7A - Patient indication for rapid maxillary expansion and risking possible palatal tipping in the central incisors, which could cause anterior crossbite.



FIGURE 7B - If one's intent is to prevent inclination in the upper incisors during mesial movement to occupy the bone area created by rapid expansion of the maxilla, passive bars, placed palatally against the upper incisors may be helpful.

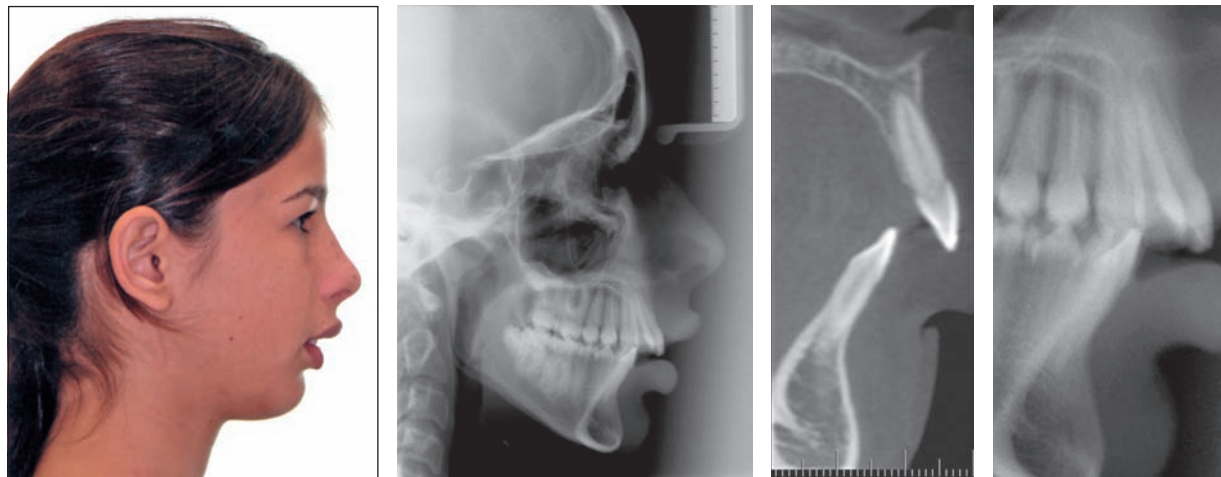


FIGURE 8A - Patient with Pattern II, Class II malocclusion, maxillary protrusion, moderate mandibular deficiency, and CT scan showing more clearly the relationship of the incisors (teeth 21 and 31, image taken by sectioning the center of the clinical crown) and their respective basal bones.

this tolerance is confronted with the tomographic image it will be greater than previously thought. In other words, clinical conditions common to the teeth, especially incisors, in compensatory treatment, are exhibited in CT images with surprisingly scant bone limits. This will underscore the value of clinically assessing the periodontium, especially the attached

gingiva in planning and controlling such movements in daily practice. A quality periodontium can support buccal tipping, either lingual or palatal. Thus, and this is very important, it will become clear that in performing compensatory treatment orthodontists should mimic what nature does when it naturally provides compensation, i.e., buccal, lingual or palatal tipping.



FIGURE 8B - Patient with pattern III, Class III malocclusion, prognathism with CT image clearly showing the limitations of bone support for all incisors (teeth 21 and 31, images obtained by sectioning the center of the clinical crown) and their respective basal bones.

The visualization of teeth in the basal bone, given the quality afforded by CT, lays bare how pretentious it is to try to perform bodily movements (translation) when carrying out compensatory treatment (Figs 8A and 8B). The

scant relationship of the roots on the buccal and lingual surfaces, and often of the root apex with the basal bone, indicates that exerting torque control while performing such movements would not be appropriate.^{10,18}

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Orthodontics as risk factor for temporomandibular disorders: a systematic review

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Abstract

Introduction: The interrelationship between Orthodontics and Temporomandibular Disorders (TMD) has attracted an increasing interest in Dentistry in the last years, becoming subject of discussion and controversy. In a recent past, occlusion was considered the main etiological factor of TMD and orthodontic treatment a primary therapeutical measure for a physiological reestablishment of the stomatognathic system. Thus, the role of Orthodontics in the prevention, development and treatment of TMD started to be investigated. With the accomplishment of scientific studies with more rigorous and precise methodology, the relationship between orthodontic treatment and TMD could be evaluated and questioned in a context based on scientific evidences. **Objective:** This study, through a systematic literature review had the purpose of analyzing the interrelationship between Orthodontics and TMD, verifying if the orthodontic treatment is a contributing factor for TMD development. **Methods:** Survey in research bases: MEDLINE, Cochrane, EMBASE, Pubmed, Lilacs and BBO, between the years of 1966 and 2009, with focus in randomized clinical trials, longitudinal prospective nonrandomized studies, systematic reviews and meta-analysis. **Results:** After application of the inclusion criteria 18 articles was used, 12 of which were longitudinal prospective nonrandomized studies, four systematic reviews, one randomized clinical trial and one meta-analysis, which evaluated the relationship between orthodontic treatment and TMD. **Conclusions:** According to the literature, the data concludes that orthodontic treatment cannot be considered a contributing factor for the development of Temporomandibular Disorders.

Keywords: Temporomandibular joint dysfunction syndrome. Temporomandibular joint disorders. Craniomandibular disorders. Temporomandibular joint. Orthodontics. Dental occlusion.

Editor's summary

Temporomandibular Disorders awakened the attention of Orthodontists due to the lawsuits showing orthodontic treatment as the development factor for pain in the temporomandibular

joint region. Furthermore, the literature has investigated in detail the influence of occlusal alterations in the etiology of TMD. Current studies, with rigorous methodological criteria and adequate designs, have more precise evidences

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of the interrelationship between Orthodontics and TMD.

This study presented a systematic review about the association between orthodontic treatment and temporomandibular disorders. The sample consisted of 18 studies that met the inclusion criteria adopted. The systematic literature review showed that the prevalence of TMD due to traditional orthodontic treatment is not increased, either with protocols for extractions or not. However, it is necessary to perform further longitudinal, randomized and

interventional studies, with standardized diagnostic criteria for TMD for more accurate causal associations.

It is important to perform, during the diagnostic phase of the pre-orthodontic patients, a full assessment of the presence or absence of signs and symptoms of TMD. Thus, an integration with the Temporomandibular Disorders and Orofacial Pain specialty becomes important for an appropriate treatment decision in the presence of TMD, due to the high prevalence of TMD in the general population.

Questions to the authors

1) Is there a relationship between malocclusion and Temporomandibular Disorders?

Increasingly inserted within a context of an evidence-based Dentistry, occlusion cannot be regarded as a primary etiological factor in the development of TMD. It is recognized that certain occlusal conditions can act as co-factors in the etiology of TMD, but their role cannot be overestimated. Thus, treatments that irreversibly change the occlusal pattern, such as occlusal adjustment and Orthodontics, do not have scientific support as initial treatment protocols for TMD.

2) What conduct must be established before beginning orthodontic treatment in a patient with TMD?

Clinical examination of the pre-orthodontic patient should include a complete assessment on signs and symptoms of TMD, making use of complementary examinations when necessary for the correct diagnosis. In the presence of TMD, a therapeutic option should be based on conservative and reversible treatments, and after controlling the signs and symptoms of TMD, proceeding to orthodontic treatment and prosthetic rehabilitation. The awareness of patients with TMD about

this condition is necessary, as well as the importance about the multifactorial nature of the etiology of TMD for adequate management and control of Temporomandibular Disorders.

3) Orthodontic treatment should not be indicated in order to alleviate the symptoms of TMD. What is your perception on the diffusion of these evidences among general dentists and Orthodontists?

The initial treatment protocol for TMD should be conservative, reversible, minimally invasive and based on significant scientific evidences. Currently, using evidence-based methods, clinical studies demonstrate that orthodontics does not consist in a form of treatment and prevention for TMD, and when it is properly performed it does not cause TMD development. This knowledge should be discussed and passed on to general dentists and Orthodontists, elucidating this relationship for professionals and patients, since, in some publications, this interface is not entirely clear for professionals.

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Evaluation of level of satisfaction in orthodontic patients considering professional performance

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Abstract

Objective: Considering the increasing professional concern in conquering new patients and maintaining them satisfied with treatment, this study aimed to evaluate the level of satisfaction of patients in orthodontic treatment, considering the orthodontist's performance. **Methods:** Sixty questionnaires were filled out by patients in orthodontic treatment with specialists in Orthodontics, from Curitiba. The patients were divided into two groups. Group I consisted of 30 patients which considered themselves unsatisfied and changed orthodontists in the last 12 months. Group II consisted of 30 patients which considered themselves satisfied, and were in treatment with the same professional for at least, 12 months. **Results and Conclusion:** after statistical analysis, using the chi-square test, it was concluded that the factors statistically associated to patient's level of satisfaction considering the orthodontist's performance were: professional degree, professional referral, motivation, technical classification, doctor-patient personal relationship and interaction. For orthodontic treatment evaluation, the factors that determined statistical differences for patients' level of satisfaction were: the number of simultaneously attended patients and the integration of the patients during the appointments.

Keywords: Patient satisfaction. Orthodontics. Professional-patient relationship.

Editor's summary

With the increasing number of professionals, the search for the orthodontic patient satisfaction gained attention. However, there is difficulty in quantifying these issues, due to the need in consulting patient's views and the long-term nature of orthodontic treatment. So, what patient's

perceptions would influence his/her satisfaction with orthodontic treatment and also with professional performance? This is an important issue towards discovering the patient's psychological universe, responsible for the integration or not with the clinical environment.

The study included 320 patients from 10

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private clinics of specialists in orthodontics. They grouped the patients reportedly unsatisfied with orthodontic treatment and who had changed professional, and a second group had patients satisfied with orthodontic treatment. These patients answered a questionnaire of 17 objective questions with three alternatives, in the waiting rooms of orthodontic clinics. The test used was the "Chi-square", to access differences between groups ($p < 0.05$).

Professional curriculum doesn't seem to influence the patient's level of satisfaction. Considering the nature of the information transmitted to the patient, there were no statistically significant differences between groups. The majority of the patients of both groups in this study reported having received educational information by the

orthodontist. Despite the absence of significant differences, the prevalence of patients who reported that the professional didn't recognize them by name, consisted a third of unsatisfied patients. Regarding the professional's acceptance of criticism and suggestions, there were statistically significant differences between groups. Among patients who considered themselves unsatisfied, 60% had no freedom to express opinions and suggestions. This suggests a lack of communication in more than half of the professionals who had transferred patients. In the study, almost 90% of patients who thought they were unsatisfied did not have a good personal relationship with the professional. These data suggest that patient's satisfaction is strongly related to a good personal relationship with the professional.

Questions to the authors

1) What is the importance of such studies?

These studies enable the understanding of the professional/patient relationship, besides the professional improvement, not just in the technical aspect, but to ensure the patient's welfare. From the moment the professional receives the patients, he ensures his stay in the clinic, winning their satisfaction.

2) In order to optimize the satisfaction of orthodontic patients, what advice would the authors give to the clinical orthodontists?

Clinical orthodontists should care more for the personal relationship with their patients. A good relationship makes patient integration with the clinical staff easier, improves the dialogue between orthodontist/patient, and ensures referral of the professional by the patient's relatives and friends.

3) Is there a special recommendation for orthodontic care of patients in the academic-university environment?

Within the university, it would be interesting to explore the integration capability between patient and professional, since it is a learning environment, where professionals can train this ability continuously during successive clinical appointments. Moreover, the psychological aspect of orthodontic treatment should be valued by the professionals, since the orthodontist doesn't rely only on a good technique and speed—he needs to learn the psychological context to improve his relationships with patients, guaranteeing, in this way, satisfaction for both sides.

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Bone density assessment for mini-implants position

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Abstract

Introduction: Cortical thickness, interradicular space width and bone density are key factors in the use of mini-implants as anchorage. This study assessed maxillary and mandibular alveolar and basal bone density in Hounsfield units (HU). **Methods:** Eleven files with CT images of adults were used to obtain 660 measurements of bone density: alveolar (buccal and lingual cortical) bone, cancellous bone and basal bone (maxilla and mandible). The Mimics software 10.0 (Materialise, Belgium) was used to estimate values. **Results:** In the maxilla, the density of buccal cortical bone in the alveolar region ranged from 438 to 948 HU, and the lingual, from 680 to 950 HU; cancellous bone ranged from 207 to 488 HU. The buccal basal bone ranged from 672 to 1380 HU, and cancellous bone, from 186 to 402 HU. In the mandible, the buccal cortical bone ranged from 782 to 1610 HU, the lingual cortical alveolar bone, from 610 to 1301 HU, and the cancellous bone, from 224 to 538 HU. In the basal area, density was 1145 to 1363 HU in the buccal cortical bone and 184 to 485 HU in the cancellous bone. **Conclusions:** In the maxilla, the greatest bone density was found between the premolars in the buccal cortical bone of the alveolar region. The maxillary tuberosity was the region with the lowest bone density. Bone density in the mandible was higher than in the maxilla, and there was a progressive increase from anterior to posterior and from alveolar to basal bone.

Keywords: Bone density. Orthodontic anchorage procedures. Orthodontics.

Editor's summary

Mini-implants have excelled in the preference of professionals due to their ease of insertion and removal, the possibility of immediate loading, their small size and low cost. The choice of a mini-implant insertion site should be made considering appropriate soft tissue regions, adequate amounts of cortical bone, mini-implant angulation and size and, foremost, the type of tooth movement.

Cone-beam computed tomography assesses bone density of mineralized tissues. This study evaluated bone density in interdental regions.

The study sample comprised 11 files of CT scans in DICOM format used to evaluate, in both maxilla and mandible, the density of buccal and lingual cortical bone and cancellous bone in the region of the alveolar bone, and the densities of buccal cortical and cancellous bone

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in the basal bone region. Bone densities were calculated using the Mimics 10.01 software and measured in Hounsfield units (HU). CT slices of alveolar bone were obtained at a height of 3 to 5 mm from the bone crest and, of basal bone, at a height of 5 to 7 mm from the root apex (Fig 1). In the alveolar bone and basal bone areas of mandibles and maxillae, the sites between the following teeth were evaluated: central and lateral incisors; canines and first premolars; first and second premolars; second premolar and first molar; first and second molars; and second molar and distal region to second molar. Measurements in the areas between the teeth were density of buccal cortical, lingual cortical and cancellous bone in the region of alveolar bone, and density of buccal cortical and cancellous bone in the region of basal bone (Fig 2).

In the maxilla, the area with lower density was the maxillary tuberosity, and the area with the greatest bone density in cortical bone was in the

area between the premolars. In the maxilla, cortical vestibular bone was denser in the region of basal bone than in the region of alveolar bone in all regions under analysis. The density of maxillary lingual alveolar cortical bone was slightly greater than that of cortical bone. In the mandible, in general, there was a progressive increase in bone density from the anterior mandible (lower density) to the posterior region (higher density). The density of buccal cortical basal bone was greater than that of the buccal alveolar cortical bone, except in the retromolar region. Bone density in the mandible was greater than in the maxilla in nearly all areas assessed, except between central and lateral incisors and between the second premolar and first molar. This study found that the bone density of cortical areas is greater than the density of the cancellous bone area. Therefore, mini-implants should be inserted at an angle of 10 to 20 degrees to the long axis of teeth to make the most of the low thickness but high density of lingual and buccal cortical bone.

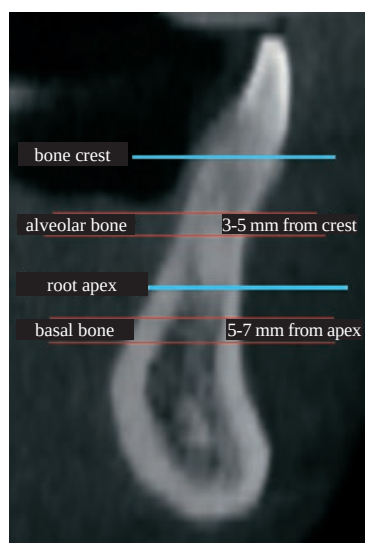


FIGURE 1 - Transversal section computerized tomography, illustrating the location of the crest, and root apices, as well as determining the areas measured, corresponding to the alveolar bone (3 to 5 mm of bone crest) and the basal bone (5 to 7 mm of root apices).

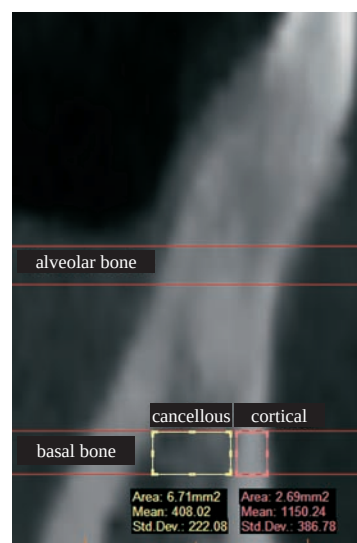


FIGURE 2 - Magnified view of CT scan of region between 1 and 2 in the mandible; basal bone density measurement in both buccal cortical and cancellous bone areas. The area of alveolar bone is defined by the upper red lines.

Questions to the authors

1) What are the clinical implications of this study?

With the advent of image interpretation using software for evaluation of cone beam CT (CBCT), there have been advances in studies in this field. Clinically, the results of bone density studies according to the mapping of regions in the maxilla and mandible give orthodontists a greater understanding of bone density differences and facilitate the selection, based on scientific evidence, of one or more maxillary and mandibular regions that are suitable for the installation of orthodontic mini-implants in adult patients.

2) Were there methodological difficulties in conducting this study?

The major difficulties resulted from the large number of regions on the CT images and, in a few cases, from image artifacts produced by metal restorations in some large teeth. However, as the areas measured were located near the bone crest (alveolar area) and the apical area (basal area), the artifacts did not prevent bone density readings in the study.

3) The thickness of cortical bone and bone density tend to coincide or differ for each particular region?

Yes. According to the tables and figures in the full manuscript, the cortical bone in the maxilla was denser in the area of basal bone than in the area of alveolar bone in all regions under analysis.

We also observed a progressive increase in bone density from the anterior mandible (lower density) to the posterior region (higher density). In the mandible, the buccal basal cortical bone had statistically higher density than the buccal alveolar cortical bone in all the regions under analysis, except in the retromolar region.

The alveolar bone density of mandibular cortical bone was statistically higher than in the maxilla, except as between central and lateral incisor and between the second premolar and first molar.

Comparing the cancellous bone of the alveolar region, the areas between canine and first premolar and between first and second premolars were statistically significant denser in the mandible compared to the maxilla.

In the alveolar bone, the values obtained for the lingual cortical were very similar with average values for vestibular cortical bone, for the maxilla as well as for the mandible.

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Quality of life instruments and their role in orthodontics

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Abstract

Objective: The purpose of this study was to survey reliable information about quality of life as it relates to oral health in the literature, allowing clinicians to access and understand its influence on the process of finding and treating their patients. **Methods:** The MEDLINE, LILACS, BBO and Cochrane Controlled Trials electronic databases were researched between 1980 and 2010 and 158 studies were found that discuss quality of life related to oral health. **Results:** Thirty studies were selected: two prospective longitudinal studies, two systematic reviews, five case-control studies, twelve epidemiological studies, five cross-sectional studies and three reviews of literature, in addition to the Statement of the World Health Organization (WHO). The selection was based on the goal of describing the indicators of quality of life and the methodology used in the studies. **Conclusions:** The use of quality of life indicators in dental research and clinical orthodontics are extremely important and helpful in diagnosis and planning but do not replace standard indexes and should be used in a strictly complementary manner.

Keywords: Quality of Life. Orthodontics. Malocclusions.

INTRODUCTION

Quality of life is characterized as a "sense of well-being derived from satisfaction or dissatisfaction with areas of life considered important for an individual".^{25,30} The focus of clinical studies has been on measuring the quality of life of patients with the purpose of evaluating health care. These measurements are gaining more importance as researchers realize that traditional studies bear little or no relevance to patients.²⁵ Therefore, to fully

evaluate any intervention in health care, including oral health care services such as orthodontics, only those measures that really matter to patients should be implemented, while clinicians continue to be provided with the usual pertinent information.^{19,23}

Typically, assessments of pre- and post-orthodontic treatment changes are based on traditional clinical or standard measurements, such as cephalometric data and occlusal indexes. More recently, some subjective indicators have

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been developed and adapted as new methods for measuring treatment need and comparing results. In this case, the individual's perception is the crucial link to all orthodontic treatment need and satisfaction, reflecting the impact that malocclusion exerts on their daily lives, whether by causing limitations and constraints or not. Clinical measurement is undeniably important, however, the dimensions of dental, social and functional impact are equally relevant,^{18,25} especially in orthodontics, where all treatment phases play a remarkable psychosocial part in patients' lives.²⁵

In Brazil, where provision of orthodontic treatment by governmental institutions is either circumscribed or non-existent, perceived need determines demand. In fact, perceived need generates action, which in turn leads to the use of private services for treatment. Worldwide, perceived need has emerged as an important predictor of the use of medical and dental services, underscoring the importance of learning about the desires of the patient.²²

The purpose of this study was to identify reliable information about quality of life as it relates to oral health in the literature, describing the most widely employed indexes in the literature^{28,29} while allowing clinicians to access and understand the influence of such information on the process of finding and treating their patients.

MATERIAL AND METHODS

In September 2010, a search was conducted in the MEDLINE, LILACS, BBO and Cochrane Controlled Trials electronic databases spanning the period from 1980 through 2010. Descriptors (keywords) were taken from the Medical Subject Headings (MeSH): "Oral health related quality of life", "quality of life" and the expression "life quality". Five hundred and sixty-nine articles were found, among which 158 were selected because they

addressed oral health related quality of life (the others were linked to medical areas, or were studies in the dental field that used general quality of life questionnaires). Based on the analysis of 158 articles, 30 were identified as being directly related, through development, evaluation, testing, translation or discussion, to the subjective quality of life indexes. Only those articles were selected which validated the original versions of the subjective indicators discussed, reviews conducted by their authors, as well as validations and tests conducted for the Portuguese language.

Articles published in Portuguese, Spanish, English, French and Italian were included and all studies published in other languages were excluded, even with summaries or abstracts written in English. Extraction of data from the selected articles was performed by a single reviewer using a pre-structured instrument. The following information was gleaned: Author names, location where the study was conducted, year of publication, study period, study design, age or age group of the population, type of subjective indicator used, main findings and relevant issues.

RESULTS

Thirty studies were selected: two prospective longitudinal studies, two systematic reviews, five case-control studies, twelve epidemiological studies, five cross-sectional studies and three literature reviews, in addition to the Statement of the World Health Organization (WHO). All were used to describe the seven quality of life indexes discussed in this article. No Randomized Clinical Trials (RCT) or systematic reviews of The Cochrane Collaboration were found on the subject.

According to the literature, the most widely used and most reliable questionnaires^{28,29} are: Oral Impacts on Daily Performance (OIDP),¹ Dental Impacts on Daily Living (DIDL),¹⁶

Geriatric Oral Health Assessment Index (GOHAI),³ Child Oral Health Quality of Life Questionnaires (COHQLQ),¹⁴ Early Childhood Oral Health Impact Scale (ECHOIS),²⁹ Oral Health Impact Profile (OHIP)^{24,27} and Orthognathic Quality of Life Questionnaire (OQLQ).⁸

Among these indexes, some are specific to children and some specific to the elderly, since the cognitive abilities of understanding and self-perception change with age.²⁸ Moreover, complaints and personal experiences also change considerably.^{8,20}

These instruments provide numerical scores that can be used to compare groups with or without disease in the oral cavity, with different diseases or different degrees of severity of such diseases. Score values can also be compared before and after treatment to determine the extent of change that can be attributed to the treatment in terms of patient well-being and quality of life.^{17,18}

Oral Impacts on Daily Performance - OIDP

The index “Oral Impacts on Daily Performance” (OIDP) is one of the shortest. It aims to assess what the authors call “the latest impacts.” The impact of oral conditions on the individual’s ability to perform eight daily activities is assessed: Eating and enjoying the food, speaking clearly, performing oral hygiene, sleeping and relaxing, smiling, laughing and showing teeth without embarrassment, maintaining a stable emotional condition, properly performing jobs at work or in social settings, enjoying contact with people.¹

The frequency with which the individual is affected or displays a negative impact on these functions is assessed by a time scale called “Frequency Scale,” stratified as follows: Never in the past six months, less than once a month, once or twice a month, once or twice a week, three to four times a week, every day or almost every day. This scale has a score ranging from zero (never in the past six months) to five (every day or almost every day). “Perceived Severity” is also rated. It is

a score used by respondents to grade how much trouble that specific function causes in the individual’s daily life, ranging from five (very severe) to zero (none).¹

The final score of each activity is obtained by multiplying the value on the frequency scale by the value in the perceived severity scale. The total OIDP score is obtained by adding up all the scores on the frequency and perceived severity scales and dividing the resulting value by the maximum possible score (8 performances x 5 in the frequency range, x 5 on the scale of perceived severity = 200) and subsequently multiplying it by 100 to reach a percentage value.²

This test was evaluated in a pilot study with 501 patients, 35-44 years of age. Internal consistency showed adequate reliability (Cronbach’s alpha=0.65), and test-retest reliability demonstrated that the index—applied in 47 individuals at three-week interval—was stable, resulting in a kappa coefficient that ranged from 0.95 to 1.0. The OIDP features good psychometric properties and a consistent theoretical basis, allowing the assessment of behavioral impacts on daily performance, unlike other questionnaires, which assess the perceived impact dimensions.²

The key advantages of the OIDP consist in the fact that it is easily understood by respondents and swiftly completed. Therefore, it has been translated into other languages and used in different cultures.²

In Brazil, the OIDP was employed to assess the impact of dental pain on 504 women during pregnancy and showed increasing negative impact on quality of life in pregnant women who had more carious lesions, fewer teeth, who visited the dentist less frequently, and who perceived the need for treatment.²⁴ The OIDP was also used to measure the impact on quality of life of 1,675 Brazilian adolescents relative to the standard measurement of their malocclusions and showed no difference between standard view and perceived impact, i.e., the psychosocial effects, as

measured by the OIDP, when the same malocclusion is assessed.²⁵

In a case-control study using OIDP with 279 cases and 558 controls, Bernabé et al⁴ showed that orthodontic treatment significantly improved OHRQoL in Brazilian adolescents. These patients were significantly less likely to have impacts on physical, psychological and social problems in their daily lives, related to the presence of malocclusions, than patients with no history of orthodontic treatment.

The CHILD-OIDP¹¹ was launched in 2004 by adapting the OIDP model for 11-12 year-old children. It evaluates the impact of oral health issues on the same eight daily activities using pictures to illustrate the questions.

The index was evaluated in 1,100 children aged 11-12 years old and proved reliable and valid, as the values it yielded highly correlated with the perceived need for dental treatment. Cronbach's alpha was 0.82. CHILD-OIDP (test-retest) stability was tested in 90 children and showed kappa = 0.91.¹¹

Dental Impacts on Daily Life - DIDL

The Dental Impacts on Daily Living (DIDL) index evaluates psychosocial problems and, consequently, quality of life according to oral health conditions using five quality of life dimensions: Comfort (related to gingival health and absence of food impaction), appearance (individual's self-image), pain, performance (ability to perform normal daily activities and social interactions), and dietary restrictions (in biting and chewing).¹⁶

The DIDL is a questionnaire with 36 items that aims to obtain scores for each dimension as well as an overall score that assesses the overall impact of all dimensions. The dimensions score is obtained by adding the values of each item (question) that make up a dimension, for example, the four items or questions that comprise the "Appearance" dimension. The result is then divided by the number of items comprising

the scale, which in this case is 4. The impacts are interpreted as positive if the final value is +1, and negative if it is -1, and not altogether negative when the final value is zero.¹⁶

The dimensions are given weights proportional to the impact perceived by the respondent using a visual scale graded 1-10 with dimensions positioned side by side. Spearman's correlation test was used to evaluate how the determination of weights for the dimensions contributes to the final result, comparing the DIDL scores with and without weights. The results suggested that some patients rated as dissatisfied (score below zero) in the version without weights were actually less severely impacted when they were assigned weights.¹⁶

The total score is obtained by calculating the score of each dimension (the sum of items divided by the number of items that make up the scale), and these scores are assigned weights by the interviewees. The dimensions are then added up, yielding a total score.¹⁶

The instrument was tested on a convenience sample of Brazilian individuals where their stability (test-retest) and internal consistency were assessed using the questionnaire (0.87 and 0.85, respectively) and the scale (0.78 and 0.59, respectively), yielding positive results.¹⁶ The major advantages of this index is its flexibility in producing or eliminating data (individual items, dimensions or total score) and the possibility of assigning weights to the dimensions, reflecting the true importance of each dimension in the life of the individual.

Geriatric Oral Health Assessment Index - GOHAI

The Geriatric Oral Health Assessment Index (GOHAI), developed through research with North American senior citizens, was specifically designed to evaluate oral functional problems in elderly populations and assess the degree of psychosocial impact associated with oral diseases.

It may also be used to evaluate the functional and psychosocial effectiveness of dental treatment.³

The GOHAI consists of 12 items that assess pain, discomfort and changes in function. Four of these items are geared towards psychosocial functions such as dissatisfaction with oral health and appearance. The questionnaire score is obtained with a Likert scale of six levels, always (5), very often (4), often (3), sometimes (2), rarely (1) never (0). Only the total score is calculated by adding the scores of the 12 items, ranging from zero to sixty.³

The index was tested in 1755 individuals aged at least 65 years who received health care, and showed adequate consistency, with a Cronbach's alpha of 0.79. This study also showed that individuals with a greater number of natural teeth achieved more positive results in the GOHAI.³

When it was applied in 280 Hispanics, with a mean age of 39 years, the GOHAI yielded excellent internal consistency results (Cronbach's alpha=0.83), demonstrating that it can be used reliably in young adults.⁹

The GOHAI was used to test a government program to foster oral health in Florida, evaluating 200 senior residents. Two years after completing dental treatment, 119 patients underwent a retest, which allowed researchers to note a 2.3-point mean improvement in the impact, starting from a baseline (set in pretreatment tests) of 52.3 (SD=9.0)⁹.

Currently the GOHAI is used reliably in elderly and young adults and has been translated and adapted into many languages and cultures.⁹

The Child Oral Health Quality of Life Questionnaire - COHQOL

The Child Oral Health Quality of Life Questionnaire (COHQOL) was designed to adapt to modern concepts of child health and be applicable to children between six and fourteen years of age with a wide variety of facial and

orofacial disorders.¹⁴ Its goal is to incorporate the perceptions of children and their parents, attuned to children's cognitive and emotional development. To this end, separate assessments are made.

The Parental/Caregiver Perception Questionnaire (PPQ) comprises 31 questions and aims to evaluate the impact of children's oral conditions seen from their parents' perspective. The PPQ was considered reliable in the evaluation of 231 caregivers (Cronbach's alpha = 0.94) and stable when retested at 79, with interclass correlation coefficient of 0.85.¹⁴

Due to a large variability in child perception across different ages three other questionnaires are available which are similar to the Child Perceptions Questionnaire (CPQ), with 36 questions each, and each specific to one age group only: between 6 and 7 years, between 8 and 10 years and between 11 and 14 years. The perception questionnaires were assessed in 123 children aged 11-14 years, divided into three clinical groups (pediatric, orthodontic and orofacial). All three constructs are divided into three main areas, i.e., social confidence and well-being, oral and social self-image, and concern for oral health.¹⁴ Positive correlation was found between the results, the perception of oral health ($p=0.013$) and overall well-being ($p<0.001$). The reliability and stability tests (test-retest) were performed on 65 children, with satisfactory results, Cronbach's alpha and interclass correlation coefficient were 0.91 and 0.90, respectively, showing that the COHQOL scale designed for children aged 11-14 was valid and reliable.¹⁴

The CPQ for children aged 8-10 years was based on the 11-14 years CPQ and had its validity and reliability tested in 68 children. The authors noted a positive correlation between the results and the perception of oral health and general well-being ($p<0.001$), with Cronbach's alpha and interclass correlation coefficient of

0.89 and 0.75, respectively, showing that this scale is also valid and reliable. The CPQ for children 6-7 years of age has not yet been tested for validity and reliability.¹⁴

The CPQ is ideal for measuring the quality of life of children as it is relatively short and features parallel measurements for caregivers and for children, thereby capturing the impact on quality of life from both perspectives.¹⁴

Early Childhood Oral Health Impact Scale - ECOHIS

The design of the Early Childhood Oral Health Impact Scale (ECOHIS) was based on the 36 items that comprise the COHQOL¹⁴ questionnaire. ECOHIS is focused on evaluating quality of life related to oral health in preschool children.²⁹ Of the 13 questions that compose the index, 9 are designed to measure the impact on children and 4 to measure the impact on the family.

The questionnaire was tested for validity and reliability in a sample of 167 American caregivers of children five years of age. Correlation was found between ECOHIS scores and overall health condition ($p < 0.05$) and oral health status ($p < 0.001$) of children evaluated according to the perception of interviewed parents. The authors also observed a correlation between the scores of the child and family subscores ($p < 0.001$), with Cronbach's alpha equal to 0.87, showing satisfactory reliability.²⁹

In 2006, a cross-cultural translation of ECOHIS into Portuguese²⁹ was performed. Internal consistency for the 13 items of the questionnaire, tested on a sample of 80 children and their families was high (Cronbach's alpha=0.80). A positive correlation was also noted between ECOHIS scores and general health ($p < 0.01$), and oral health status ($p < 0.01$) for children, as measured by the perception of respondents. The stability test (test-retest) was conducted with 50 female caregivers with a mean age of 32.1

years, and 50 children. Interclass correlation coefficient (ICC) for the ECOHIS questionnaire was 0.98. ICC child subscale was 0.98 and ICC respondent subscale (children's next of kin) was 0.97. Therefore, the Portuguese version of ECOHIS was considered reliable and stable.²⁹

The ECOHIS' most remarkable advantage is that it is a short and easy-to-apply questionnaire. Age groups, however, should be strictly observed since it is designed for children whose maturity and cognitive, emotional, social and linguistic development are at the preschool stage.²⁹

Oral Health Impact Profile – OHIP

Oral Health Impact Profile (OHIP) was developed and tested in Australia as an indicator of perceived need in order to enhance understanding of oral health-related behaviors by measuring the discomfort, dysfunction and self perceived impact of oral diseases on the daily activities of adults and seniors, thereby complementing traditional²⁷ epidemiological indicators. Its 49 items are divided into seven subgroups or dimensions: Functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability and handicap in performing daily activities that collectively indicate the "social impact" of each disease.²⁷ These sub-scales are in a hierarchical order of increasing impact on the individual's life, and are based on a concept suggested by Locker (1988),¹⁸ which is derived from the Classification of Impairments, Disabilities and Handicaps of the World Health Organization (WHO).³⁰ The questions are rated using the five-level Likert scale (always [4], often [3], sometimes [2], rarely [1], and never [0]).

The index was assessed in a sample of 122 individuals aged 60 years or older. The internal reliability of six subgroups was high (Cronbach's alpha coefficient = 0.70-0.83) and low only for the disability subscale (0.37) while test-retest reliability, performed on 46 of individuals sampled

for each dimension of the questionnaire (ICC of 0.42 to 0.77 for the dimensions), showed stability. There was also a positive correlation between OHIP scores and general health status and oral health ($p < 0.05$).¹⁹

The authors noted that the OHIP was able to detect an association previously observed between social impact and perceived need for treatment,^{22,27} besides being the most commonly used sociodental instrument in use, translated and adapted into many languages and cultures.^{18,20}

A systematic review of literature on the use and performance of OHIP concluded that the instrument is sensitive enough to capture changes in the impact of oral conditions. However, there is little scientific evidence to recommend the use of the OHIP instrument in isolation, be it in planning or assessing oral health services. Its use should be considered complementary to traditional objective indicators.²²

The short form of the OHIP-49 questionnaire (OHIP-14) was developed using epidemiological data from a sample of 1,217 South Australians with a mean age of 60 years.²⁸ The author concluded that fourteen questions were effective in determining the same patterns of variation in clinical and socio-demographic factors that were observed using the forty-nine questions, in addition to comprising the seven subgroups, neatly and hierarchically distributed every couple of questions, suggesting that the reduced version of the instrument is useful to quantify the levels of impact with good reliability, validity and accuracy.^{18,22} The internal reliability of the OHIP-14 was high according to Cronbach's alpha ($\alpha = 0.88$) and its variance was 94% compared to the OHIP-49.²⁸

To adapt the OHIP-14 to the cultural context of Brazil and the Portuguese language, a cross-cultural translation was performed. The validation showed psychometric properties similar to those measured in the original situation. The properties of the Brazilian version of OHIP-14 were evaluated in a

cross-sectional study, which concluded that this version has similar properties to the original version and is therefore a valid tool for international research.²⁴

Most studies on the impact of oral diseases on quality of life focused on adults. This may be due to the fact that the impact on this group is more evident owing to an accumulation of diseases and their effects on oral tissues. Broder et al⁵ spearheaded the use of the OHIP in adolescents aged 12 to 17 years. The authors concluded that OHIP-14 may be an important, sensitive screening tool to identify people with high levels of oral health impacts in a given community, even in younger individuals.

The impact of orthodontic treatment on the quality of life of adolescents between 15 and 16 years of age was evaluated in a Brazilian study that used OHIP and OIDP. The results showed that patients treated orthodontically showed significant improvement in quality of life compared to those never treated or undergoing orthodontic treatment.²⁵

Another Brazilian study used OHIP-14 to evaluate quality of life in 92 patients (mean age of 13.2 years) who sought orthodontic treatment, and in 102 patients who did not, and concluded that individuals seeking treatment experience a significantly more negative impact on their quality of life, regardless of the severity of their malocclusion and their esthetic condition, as assessed by an orthodontist.¹³

The OHIP-14 was also used to assess the impact of treatment on 117 ortho-surgical patients (mean age of 24 years), and demonstrated improvement in quality of life in terms of oral health, with significant reduction in OHIP values after treatment. Presurgical orthodontic treatment also led to significant improvement in patients' quality of life.¹⁰

A prospective study assessed the OHRQoL of 250 Chinese patients in periods of one week, one month, three months, six months and after the orthodontic treatment, using the OHIP-14.

The study showed significant worsening in OHRQoL during treatment periods, with the worst phase in the first week. The most significantly affected dimensions were: physical pain, psychological discomfort and psychological disability. Authors concluded that patients exhibited a significant gain in its OHRQoL after removing braces when compared with their pretreatment stage and also with their treatment stages.⁶

However, a systematic review¹⁷ showed that scientific evidence levels of available articles in literature about the effects of orthodontic treatment are relatively low since most studies are cross-sectional. Moreover, the issues discussed were primarily related to the relationship between malocclusions and OHRQoL, and there is still no controlled study that links the oral health-related quality of life and the orthodontic treatment prospectively, showing its effects and consequences.

To Bernabé et al⁴, Feu et al¹³ and Liu, McGrath and Hägg,¹⁷ there is a negative impact on OHRQoL in adolescents with malocclusion, but the role of psychological, physical and social impact in that is still not well understood, probably due to large individual variation with which it manifests itself.

Although OHIP was originally designed to assess impact on groups and populations it can likewise measure impact on individuals and be incorporated into daily care as an aid in individualizing treatment planning.²⁷

Orthognathic Quality of Life Questionnaire – OQLQ

Patients with severe dentofacial deformities may require a comprehensive ortho-surgical treatment, and providing better quality of life is an objective of this kind of intervention. Patients are often young, which limits the use of most existing tools, such as OHIP. Based on this, the instrument known as the Orthognathic Quality of Life Questionnaire - OQLQ was created in order to analyze the impacts and benefits of the

ortho-surgical treatment in patients' quality of life. The development and reliability of this instrument was described and validated by Cunningham, Garratt and Hunt⁸ in 2002.

The great importance of using more specific questionnaires is their sensitivity in capturing impacts related to the individuals condition and their smaller interaction with confounding factors, such as patients general health.^{4,17,20} Therefore, to evaluate ortho-surgical patients, it is better to use a questionnaire with adequate sensitivity and specificity as the Orthognathic Quality of Life Questionnaire.⁸

Choi et al⁷ prospectively evaluated 36 ortho-surgical Class III patients to measure changes in OHRQoL, measured by the OQLQ and the OHIP-14. Patients were evaluated at the initial period (before treatment begins), six weeks after surgery, six months after surgery and after orthodontic treatment. Authors observed a progressive reduction in OQLQ rates at all evaluated times when compared with baseline assessment. The OHIP-14, however, had a significant reduction only six weeks and six months after surgery. Ortho-surgical treatment has been considered effective, producing significant psychosocial and functional gains for the patients.

DISCUSSION

The literature is in general agreement that the use of indicators of quality of life is an essential component in dental research and clinical studies, especially those that evaluate prevention and treatment options that seek to improve the health of individuals.^{3,14,17,18,29} In Orthodontics, recent studies showed significant positive effects in the OHRQoL in treated patients.^{4,6}

Functional improvement is not the primary motivation of many individuals who receive treatment.^{4,6,17} From a sociological standpoint, the need and desire to convey a culturally acceptable image and the desire to achieve esthetic dentistry standards are the main reasons

for seeking orthodontic treatment, and it is precisely these kinds of motivation that subjective indexes, such as the OHIP, evaluate.

According to the literature, dissatisfaction and demand for orthodontic treatment are related to increasing age, the use of derogatory nicknames and embarrassment associated with malocclusions. Therefore, self-esteem is closely linked to demand for treatment.^{10,12,13,18,26} This demand can be construed, in the patient's view, as a quest to recover their self-esteem and satisfaction in living socially.

Although the desire to improve dental and/or facial appearance is the main reason for seeking orthodontic treatment,^{12,15} this quest is not usually related to malocclusion severity, as demonstrated in a study by Feu et al¹³ but to a general desire shared by individuals and families alike to improve their esthetics and self-esteem, often with unrealistic expectations. This fact once again underscores the importance of being aware of the actual motivation behind the search for orthodontic treatment in order to avoid future disappointment and misunderstandings as regards treatment outcome.

Today's society has changed its way of thinking and acting over the past few years driven by new patterns of behavior and esthetics, which are now part and parcel of the concept of quality of life for most of its members.²⁰ Therefore, how can orthodontists ignore the major demand generators of today? And how can they plan a treatment without being aware of the patients' view of their own problem?

In actuality, no scientific evidence exists to

recommend the use of subjective indicators alone in planning orthodontic treatment or assessing the quality of oral health services.²² The use of such indicators should be complementary to traditional objective indicators, which enable a broader view of diagnosis and treatment goals, involving standard and subjective perceptions, which are equally important to the patient's quality of life.

CONCLUSIONS

The study of quality of life in orthodontic patients is of paramount importance if one is to understand the impact of malocclusions on daily life, especially in terms of functional limitations and psychosocial well-being. The use of indicators of quality of life hand in hand with standard indicators for diagnosis of malocclusions allows orthodontists to identify which patients can benefit most from orthodontics. As a result, strategy and expenditure planning can be implemented with greater effectiveness.

In private settings, the in-depth diagnostic capabilities acquired through the introduction of quality of life indexes ensure invaluable gains for the professional-patient relationship by broadening the understanding of which factors lead patients to seek treatment. Planning has therefore become individualized and based not only on the characteristics of the patient's malocclusion but also on the factors that exert the worst impact on their everyday life. As a result, expectations regarding treatment outcome become perfectly clear to both patients and professionals.

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Evaluation of the effect of rapid maxillary expansion on the respiratory pattern using active anterior rhinomanometry: Case report and description of the technique

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Abstract

The aim of the present investigation is to evaluate the effect of rapid maxillary expansion (RME) on the respiratory pattern. A clinical case is presented to describe how patients with atresic maxilla and respiratory problems can benefit from rapid maxillary expansion. The article highlights that the health professional, mainly the Orthodontist and the Otorhinolaryngologist, may use complementary exams to diagnose a mouth breather patient.

Keywords: Active anterior rhinomanometry. Rapid maxillary expansion. Total nasal resistance. Respiratory pattern. Mouth breather. Upper airway.

INTRODUCTION

Nasal breathing is the only physiologically normal breathing pattern seen in humans. When for some reason, the individual has any difficulties of breathing through the nose, it complements or replaces the nasal breathing by mouth breathing.¹⁵

The diagnostic methods to determine the breathing pattern of an individual are controversial. However, the effects of nasal respiratory obstruction are not fully understood in the development of malocclusion and facial growth.

Although much has been researched about the relationship between respiration and craniofacial growth, many questions still remain unanswered, because of numerous variables including genetic predisposition and environmental influences, as each individual has its own way to adapt for the resulting impact of the alteration of normal breathing pattern.^{11,20,27}

The importance of studying the nasal breathing and its alterations is fundamental to the orthodontist, because the nasal breathing disorders may impact negatively on the development

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of occlusion^{19,20} and on facial growth.^{11,25}

For over a century, some researchers were interested in evaluating the effect of rapid maxillary expansion (RME) on nasal morphology and function. This procedure, introduced by Angell¹ changes the shape of the jaw, opening the palatal suture and other facial sutures. Numerous studies have shown that the outcome of this procedure causes changes in the transverse dimension of the maxilla and nasal cavity, providing an improvement in breathing.^{2,3,8,9}

There are reports of scientific studies that the breathing pattern of an individual with reduced naso-respiratory function may be improved by rapid maxillary expansion, since the increase in nasal cross-sectional area leads to a decrease in nasal resistance increasing the airflow.^{3,4,10,12,14} However, it is necessary to maintain a minimum level of nasal resistance in order to provide respiratory gas exchange occurring in the pulmonary alveoli.²⁹

Subtelny²⁶ associated oral breathing to unfavorable dentofacial development, and reported that, for normal breathing to exist the proper use of the nasal cavity and nasopharyngeal space was necessary. And that an abnormal increase of the structures within these anatomic areas, such as hypertrophy of the turbinates and / or hypertrophy of the adenoid tissue, could cause a blockage of air passage through the upper airway. Thus, if the obstruction was of sufficient size to prevent nasal breathing, the result could be a way of adapting to mouth breathing.

The reduction of naso-respiratory function may be caused by several etiologic factors, which may be located in the bucopharynx, nasal cavity or nasopharynx.^{15,16,21,23} However, the most commonly nasal obstructions encountered, that can cause an increase in nasal resistance are: pharyngeal tonsil hypertrophy, hypertrophy of palatine tonsils, hypertrophy of the turbinates, nasal septum deviation and allergic rhinitis.^{5,15,16,31}

For Watson Jr. et al,³¹ most patients with re-

spiratory nasal resistance above 4.5 cmH₂O/L/sec. are mouth breathers, although for Vig et al,²⁷ nasal respiratory resistance of 4.5 cmH₂O/L/sec., is a critical value to distinguish the nasal from the oral breathers. McCaffrey and Kern¹⁸ report that the symptom of nasal obstruction occurs when the value of total nasal resistance is greater than 3 cmH₂O/L/sec. Warren et al³⁰ described that when the total nasal resistance is high, around 4.5 cmH₂O/L/sec, the vast majority of individuals are regarded as mouth breathers. The values obtained through the active posterior rhinomanometry and nasal breathing in patients with nasal obstruction are different—on average 1.86 cm H₂O/l/sec. and 3.05 cmH₂O/L/sec., respectively.¹³

Another method used to quantify the respiratory pattern is by measuring the nasal cross-sectional area. However the limit of change of oral to nasal breathing is very close,²⁸ about 0.40 to 0.45 cm². About 97% of individuals with nasal cross-sectional area smaller than 0.4 cm² have some kind of mouth breathing,²⁸ or a nasal cross-sectional area equal to or less than 0.4 cm² gives a nasal respiratory resistance from 0.5 to 4.7 cmH₂O/L/sec.¹⁴ Thus, the extremely high breathing resistance requires the individual to open his mouth about 0.4 to 0.6 cm² to reduce it and achieve normal values compatible with breathing, from 1.9 to 2.2 cmH₂O/L/sec.³⁰

Recently, with technological advances and the increasing interest of orthodontists and otolaryngologists for this topic, new techniques try to quantify and evaluate more objectively the effect of rapid maxillary expansion on the respiratory pattern.^{22,24} To MacCaffrey and Kern;¹⁸ Kern;¹⁷ Clement,⁶ one of the more common and physiologic diagnostic methods used to study resistance and conductance of the nasal airway is the active anterior rhinomanometry, which was standardized in 1968 by Cottle,⁷ and consists of an aerodynamic test in which the pressure and nasal flow are quantified.

Therefore, the purpose of this article was to evaluate whether there was a change in the patient's breathing pattern which showed transverse deficiency of the upper arch and had indication for rapid maxillary expansion.

RAPID MAXILLARY EXPANSION APPLIANCE

The device used for rapid maxillary expansion was a tooth-mucosa supported appliance, called modified Haas⁸ appliance. The device was made of acrylic resin with an expansion screw of 11 mm placed on the center of the device. Orthodontic bands were used on the first premolars and first permanent molars, which were soldered onto a length of stainless steel wire of 1.2 mm that extended from the cervical portion of the lingual surface of the first molar to the lateral incisor.

Installation and activation of the rapid maxillary expansion device

A caucasian, male patient, aged 11 years and 6 months, sought the orthodontic clinic with the desire of improving his smile and teeth position. During clinical examination, it was found that the patient presented an Angle Class II, division 1, malocclusion, bilateral posterior crossbite in the region of the first pre-molars, atretic pre-maxillary, mild anterior upper and lower crowding with lack of space for the upper left canine and lower first premolars. In this first appointment, the patient reported that he was a mouth breather, thus, the same was referred to the otolaryngologist.

In the first phase of treatment a rapid maxillary expansion modified Haas appliance was planned. On the day of appliance installation all the recommendations were explained to the parents, regarding oral hygiene and the device's mode of activation. However, the activation only started the next day.

Concerning oral hygiene, it was explained to the patient that always after meals he should perform his dental hygiene, brushing his teeth

and the appliance. He was advised to use a 20 ml plastic syringe with water, to perform the removal of food remnants that remained between the palate and the appliance. In relation to the activation of the appliance, the patient's guardian was called, and requested to sit beside the patient so all necessary guidelines were passed, and also to observe how to activate the expander. First, it was explained that whenever he was performing the procedure, the activation key should be tied with dental floss, around one of the fingers of the person who would be performing the activation. This procedure is necessary in order to prevent accidental swallowing of the key. The parent was oriented that, for the activation of the device, the screw should be turned with the key from front to back, two quarters backwards in the morning and two quarters backwards in the evening, summing a full turn of the screw per day. After the initial explanation, we performed the activation of the screw, and then immediately asked his father to perform the same procedure in order to observe that he would have no doubts in carrying out the activation at home. After elucidation of all doubts, the patient was dismissed.

Consultations were scheduled every three days for periodic control of expansion and to observe whether activation was being conducted properly.

ACTIVE ANTERIOR RHINOMANOMETRY

Type of device and calibration

The appliance used for the patient's active anterior rhinomanometry was a rhinomanometer RM 302 Berger, composed of two channels, allowing simultaneous assessment of flow and pressure in each nasal cavity during breathing. This equipment has two transducers, two graphic recorders, a flow meter (pneumotachograph), a pressure gauge and two olives. The flow olive had an outlet diameter of 7 mm, while the pressure olive had an outlet diameter of 5 mm. The



FIGURE 1 - Extraoral photographs: **A)** profile view, **B)** front view, **C)** opening of diastema between upper central incisors.



FIGURE 2 - Intraoral photographs: **A)** right lateral view, **B)** front view, **C)** left lateral view.

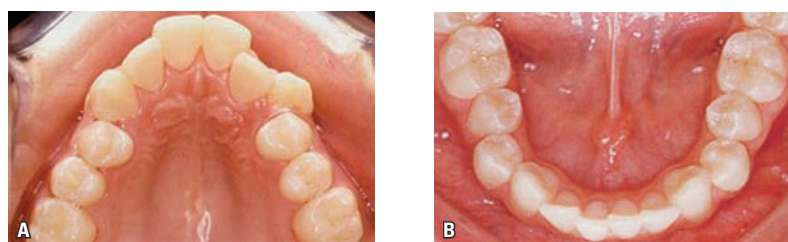


FIGURE 3 - Intraoral photographs: **A)** upper occlusal view, **B)** lower occlusal view.



FIGURE 4 - Intraoral photographs: **A)** front view, with opening of diastema between upper central incisors, **B)** upper occlusal view, with modified HAAS palatal expander in position and **C)** upper occlusal view, after opening of the midpalatal suture.

recordings were made with writing needles on common graph paper at a speed of 10 mm/sec.

Device calibration had the following standardization: the flow meter was calibrated so that each 5 mm of deviation from baseline on the paper matched the flow of 10 liters/minute, while the pressure gauge was calibrated so that each 5 mm of deviation on the tracing was equivalent to 20 mm H₂O.

Before conducting the patient examination the rhinomanometer was taken to a specialized company (Eletromedicina Berger Indústria e ComércioTM, Brazil), for review and calibration.

Examination

Before the examination, the patient was asked if he had a cold, otherwise the examination was not performed and another date would be scheduled.

The procedure was fully explained to the patient, who was instructed to sit comfortably on a chair, breathing quietly through the nose and keeping his mouth closed. The examination was performed at room temperature and after the patient had rested for 30 minutes.⁶

Initially, the exam was conducted under normal conditions, without the use of topical vasoconstrictor. It always started by the right nasal cavity. The olive that was connected to the pneumotachograph was placed in the right nostril and the olive connected to the pressure gauge was placed in the left nostril. Thus the flow (V) and

pressure (P) were obtained from the right nostril and then reversing the positions of the olives, the left nasal cavity was evaluated.

The olive connected to the flow meter as well as that connected to the pressure gauge were fitted perfectly to the nostrils, in order not to cause deformation of the lobe and nasal air escape. With this purpose, the examination was always performed by the examiner, who held the olives into the desired positions, during acquisition.

At the beginning, three respiratory cycles were recorded for the patient to become familiar with the exam and breathe normally, then ten respiratory cycles were done for each nasal cavity.

Later 3 drops of a topical vasoconstrictor solution (oxymetazoline hydrochloride 0,05%) were applied in each nostril of the patient, and after 15 minutes, the test was repeated as described above.

Thus the values of flows and pressures in each nasal cavity were obtained and recorded. From this data, we calculated the unilateral nasal resistance and total nasal resistance of the patient

CALCULATION OF UNILATERAL AND TOTAL NASAL RESISTANCE

Calculation of unilateral nasal resistance

To calculate the unilateral nasal resistance, the sensitivity of rhinomanometer RM - 302 was the following:

- » Pressure: each 5 mm variation of the baseline corresponded to 20 mm of water (mm/H₂O)
- » Flow: each 5 mm variation of the baseline was equal to 10 liters per minute (l/min.)

To obtain the actual values of pressure and flow from the tracings every millimeter of the tracing was multiplied by the following factors:

- » Pressure tracing, every millimeter was multiplied by 4
 $1 \text{ mm} \times 4 = 4 \text{ mm H}_2\text{O}$
- » Flow tracing: every millimeter was multiplied by 2
 $1 \text{ mm} \times 2 = 2 \text{ mm H}_2\text{O}$

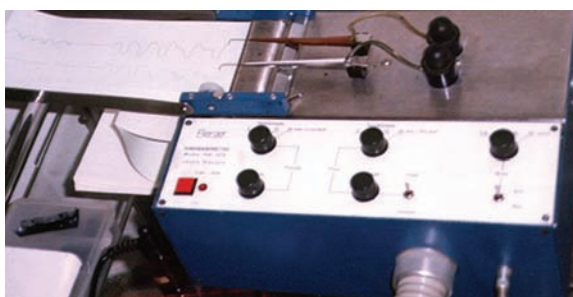


FIGURE 5 - Device used to perform the active anterior rhinomanometry exam. Rhinomanometer RM - 302 from BergerTM.

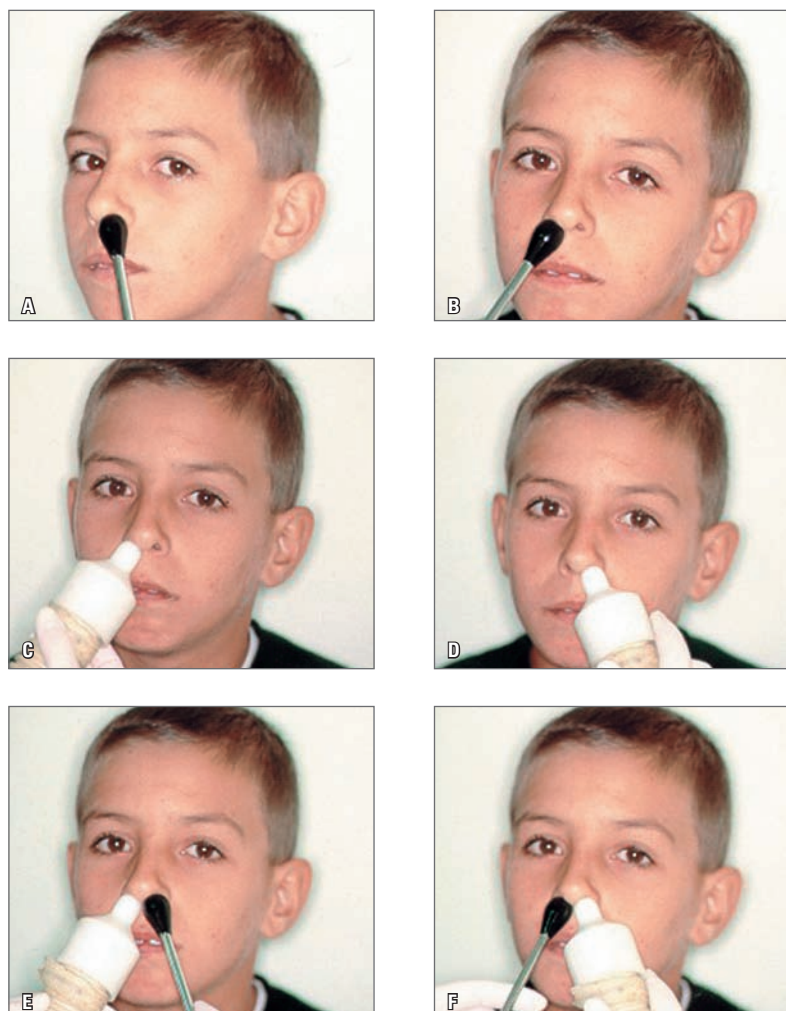


FIGURE 6 - Performing the active anterior rhinomanometry exam: **A)** Obtaining the right nasal pressure, **B)** Obtaining the left nasal pressure, **C)** Obtaining the right nasal flow, **D)** Obtaining the left nasal flow, **E)** Simultaneous obtainment of pressure and right nasal flow and **f)** Simultaneous obtainment of pressure and left nasal flow.

The formula used to calculate the unilateral nasal resistance was as follows:^{6,18}

$$R = \frac{\Delta P}{V}$$

In this manner the left and right nasal resistance were calculated without vasoconstrictor, and after with vasoconstrictor.

For Cottle,⁷ a tracing pattern characterized by regular rhythm, amplitude and frequency observed in normal subjects without complaints of nasal obstruction, the flow:pressure ratio (V/P) would be 20/20 or 24/18.

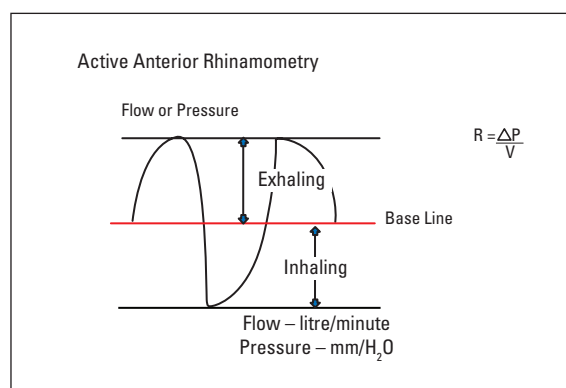
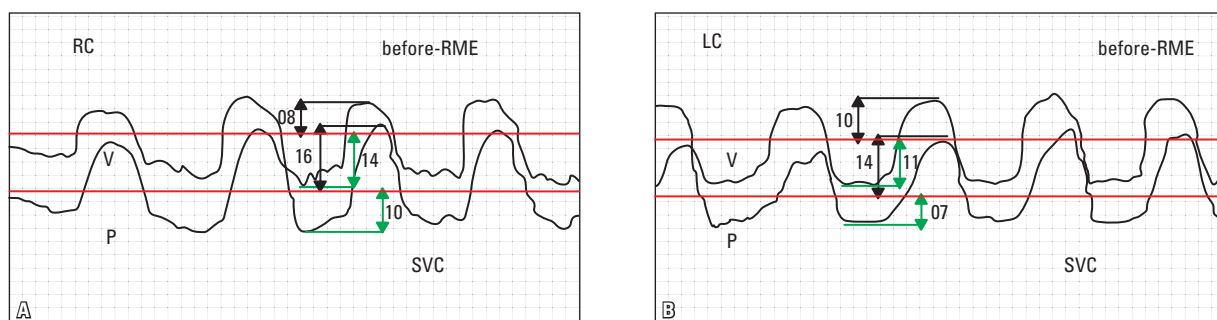
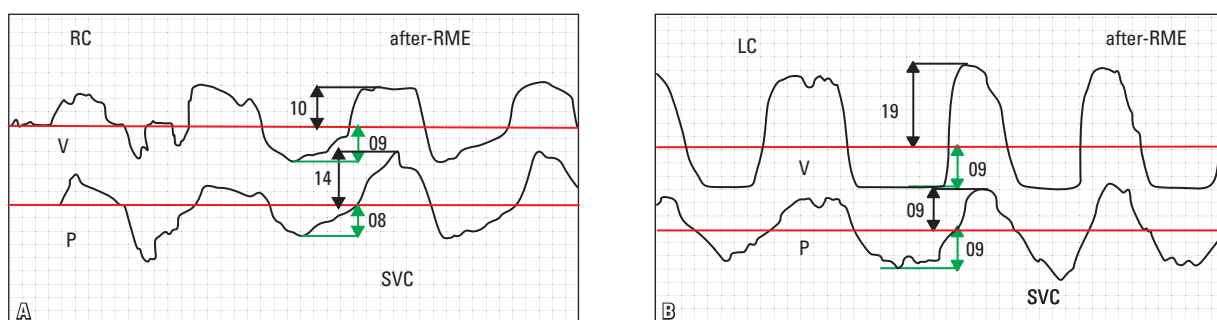


FIGURE 7 - Rhinomanometric trace showing expiratory and inspiratory curves.

FIGURE 8 - Rhinomanometric examination trace before the rapid maxillary expansion (RME): **A)** Right nasal cavity and **B)** Left nasal cavity.FIGURE 9 - Rhinomanometric examination trace after the rapid maxillary expansion (RME): **A)** Right nasal cavity and **B)** Left nasal cavity.

Thus, as our study was not concerned with the nasal conductance (V/P), but with the nasal resistance (P/V), the pressure: flow ratio would be 20/20 or 18/24. Therefore, normal individuals without complaints of nasal obstruction would have a unilateral nasal resistance ranging from 0.75 to 1.00 mm/H₂O/l/min.

Calculation of total nasal resistance

To calculate the total nasal resistance, the following formula was used:

$$TNR = \frac{RNR \times LNR}{RNR + LNR}$$

By this formula, the grid is equal to the right nasal resistance (RNR) multiplied by the left nasal resistance (LNR) and divided by the sum of them.^{17,18}

Thus, the total nasal resistance with and without vasoconstrictor was calculated.

Therefore, normal individuals without complaints of nasal obstruction would have a total nasal resistance ranging from 0.37 to 0.50 mm/H₂O/l/min.

FINAL COMMENTS

After (RME), a decrease in pressure (P) was observed in the right nasal cavity (RN), while the flow (F) remained constant. In the left nasal cavity (LN) a decrease in pressure (P) and an increase in the flow (F) were observed.

After the RME was completed the patient showed a reduction in nasal resistance, an event previously reported in studies in the literature.^{10,22,24,27,33} However, we must be aware that despite the benefit of the decrease in nasal resistance and thereby increase nasal patency of this orthopedic procedure, it should not be

done simply for the purpose of providing improvement in nasal function in patients with breathing difficulties, but only when it is associated to a correct indication for rapid maxillary expansion.^{10,32}

Thus, one of the purposes of this article is to emphasize that the expander, used to perform rapid maxillary expansion (RME), and correct

posterior unilateral or bilateral crossbites is its main function, but it also contributes to reduce total nasal resistance and increase nasal conductance. However, we must not forget that the examination of active anterior rhinomanometry is an important diagnostic method for evaluating the reduction of naso-respiratory function and determine the individual's breathing pattern.

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Non-neoplastic proliferative gingival processes in patients undergoing orthodontic treatment

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Abstract

Introduction: Orthodontic appliances render oral hygiene difficult and may contribute to the development of gingival lesions such as non-neoplastic proliferative gingival processes. These lesions, depending on such factors as development time, histopathological components and oral conditions may be reversible in some cases, through oral hygiene advice and basic periodontal therapy. In most cases, however, surgical treatment is required. **Objectives:** The purpose of this paper is to report the case of a patient using fixed orthodontic appliance who presented with two distinct gingival lesions diagnosed as pyogenic granuloma and inflammatory gingival hyperplasia. The clinical and histopathological features, incidence and frequency, treatment modalities and prevention of both lesions were discussed, highlighting the importance of submitting the material collected from the lesions to histopathological examination given the possibility of different diagnostic hypotheses. Surgical excision was performed on both lesions. The upper arch lesion, diagnosed as pyogenic granuloma, relapsed, which led us to provide basic periodontal therapy and repeat the surgical procedures. **Results:** The lesion in the lower arch, diagnosed as gingival hyperplasia, was surgically removed and followed up clinically, whereas the patient was instructed to perform proper oral hygiene.

Keywords: Pyogenic granuloma. Gingival hyperplasia. Periodontal diseases. Orthodontics. Gingiva.

INTRODUCTION

The effects of fixed and removable orthodontic appliances on the periodontium have been widely investigated. Orthodontic appliances usually hinder proper oral hygiene, contributing to the development of gingival inflammation,

more evident in children, adolescents and young adults. This situation is exacerbated when a patient already presents with periodontal changes and, especially, if they are not undergoing periodontal maintenance and, as a result, become a patient at risk.^{1,15}

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Gingival hyperplastic and inflammatory responses during orthodontic treatment are common and can lead to complications that require periodontal therapy.^{1,5,15}

Pyogenic granuloma and inflammatory gingival hyperplasia are tissue growths of inflammatory origin with varying degrees of granular and fibrous inflammatory tissues, possibly caused by low intensity chronic irritation.^{2,9,11,12}

Both occur frequently in clinical dentistry and are clinically characterized by exophytic, sessile or pedunculated tissue growths, of pale pink to erythematous color, which may manifest ulceration and spontaneous bleeding.^{3,6,7,11,12,17-20} They are most prevalent in the female gender during the second decade of life, possibly due to vascular effects exerted by feminine hormones.⁹ Treatment often consists of surgical excision associated with the removal of local irritating factors.²⁻⁷ However, recognition and identification of these factors are not always possible and the recurrence rate of lesions is relatively high.^{12,17}

The purpose of this study was to report the case of a patient using fixed orthodontic appliance who presented with two distinct lesions—pyogenic granuloma and inflammatory gingival hyperplasia. The development of these conditions

is related to chronic low intensity trauma. We encourage orthodontists and dentists to routinely submit any material collected from the lesions to histopathological examination after surgery.

CASE REPORT

Black female patient, aged 20 years, after 6 months of orthodontic treatment presented to our private clinic complaining of gingival changes.

On examination, a tumor-like lesion was observed, of erythematous color, irregularly shaped, with a smooth surface and pedunculated base, located in an edentulous region between teeth 23 and 25, under occlusion trauma. The condition had been developing for a week, starting with a node in the aforesaid region. The diagnostic hypotheses were pyogenic granuloma, gingival hyperplasia and peripheral giant cell lesion (Fig 1). Tooth 24 had been extracted 4 months earlier with no history of postoperative complication. The other lesion was observed between teeth 41 and 42. It was characterized by moderate gingival enlargement, pale pink in color, sessile base, smooth surface extending from the papilla to the brackets. The hypothetical diagnosis was inflammatory gingival hyperplasia (Fig 2). Radiographs of the lesions yielded no significant findings.



FIGURE 1 - Erythematous tumor mass with heavy bleeding to the touch, resembling pyogenic granuloma.



FIGURE 2 - Hyperplastic lesion between teeth 42 and 43 stemming from the keratinized gingiva and indicative of inflammatory gingival hyperplasia.

Under local anesthesia, excisional biopsy of the lesion was performed in tooth 24 region by incising it by the pedicle, from which a wedge was removed as a safety measure and tissue was removed from the edentulous area. The region was sutured and surgical cement added and maintained for 7 days, aided by the orthodontic appliance. The removed part was fixed in 10% formalin and submitted for laboratory analysis. Histopathological examination showed fragments of mucosa lined by parakeratinized stratified squamous epithelium exhibiting areas of spongiosis and acanthosis, and an ulceration area covered with fibrin-haemorrhagic exudate and bacterial colonies. In the lamina propria—permeating the dense connective tissue—we observed the proliferation of endothelial cells delimiting sometimes congested vascular spaces. There was exuberant hemorrhagic exudate and intense mononuclear and polymorphonuclear inflammatory infiltration in the ulceration areas. The histopathological diagnosis was pyogenic granuloma (Fig 3). In the same consultation excisional biopsy of the lesion in the region of teeth 41 and 42 was performed, and the removed piece was

also prepared and treated histologically. Light microscopy disclosed fragments of mucosa lined by parakeratinized stratified squamous epithelium, showing acanthosis, exocytosis and hyperparakeratosis. In surface areas there were fibrin-hemorrhagic exudate and bacterial colonies. In the lamina propria we observed intense deposition of collagen fibers forming a dense stroma that sustained intense chronic inflammatory infiltrate. Finally, there were also numerous vascular spaces and areas of hemorrhagic exudate. The histopathological diagnosis was inflammatory gingival hyperplasia (Fig 4).

After a postoperative period of 7 days the surgical cement and remaining sutures were removed. The patient was evaluated after 20 days, showing satisfactory repair of the region between teeth 41 and 42 (Fig 5). However, there was recurrence of pyogenic granuloma. Periodontal treatment was then performed and once again excision, submitting the lesion to the same laboratory, which confirmed the diagnosis of pyogenic granuloma. Repair was satisfactory with no signs of relapse (Fig 6). After four years of treatment, the patient is still being monitored and exhibits no signs of recurrence.

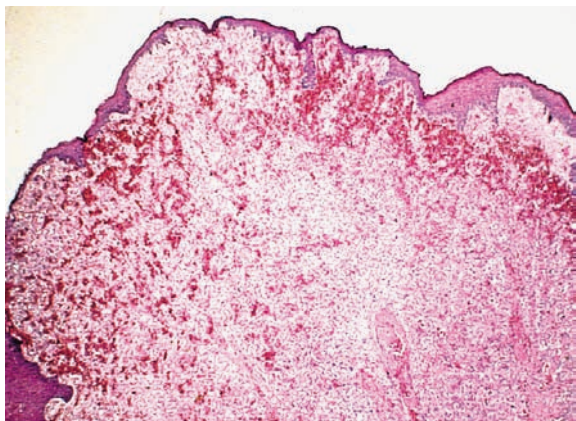


FIGURE 3 - Histological section of pyogenic granuloma (original color: HE; smaller magnification).

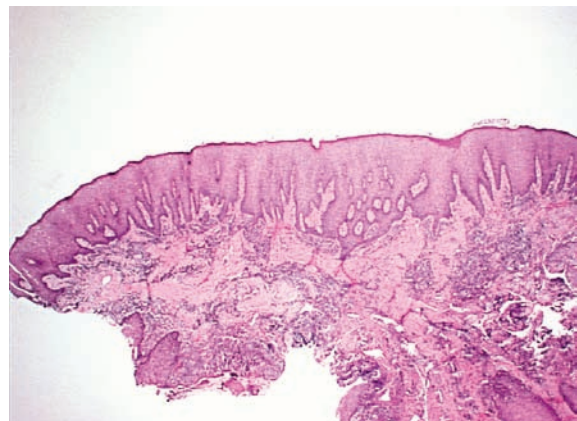


FIGURE 4 - Histological section of inflammatory gingival hyperplasia (original color: HE; smaller magnification).

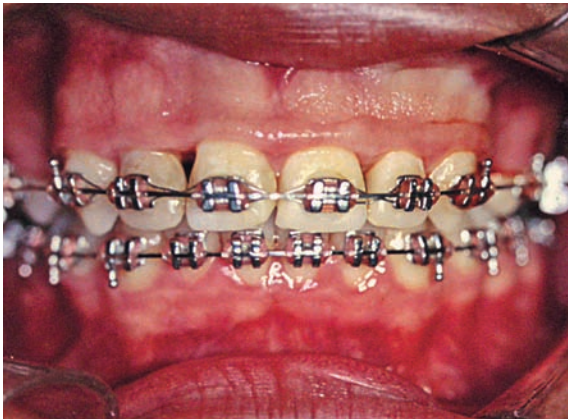


FIGURE 5 - Postsurgical view after 20 days showing satisfactory repair in the region between 41 and 42 teeth.

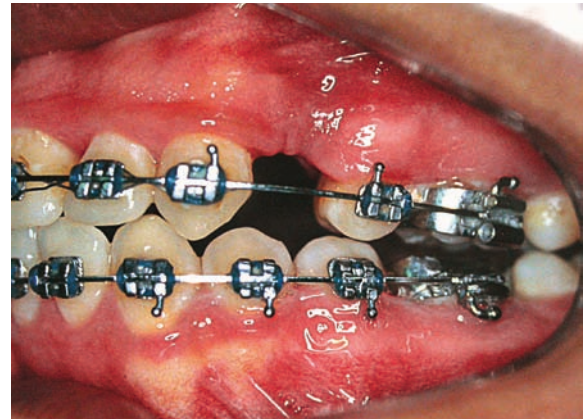


FIGURE 6 - Satisfactory repair with no signs of recurrence after periodontal treatment and second surgical procedure.

DISCUSSION

Among the most frequent gingival proliferative processes are inflammatory gingival hyperplasia and pyogenic granuloma. Peripheral fibroma, peripheral giant cell lesions and gingival hyperplasia are also part of this group, although not as common.⁴

In order to facilitate lesion exposure the discussion was divided into topics.

Etiopathogenesis

Etiopathogenesis of both lesions is usually related to chronic low intensity trauma, producing in most cases gingival inflammation and infection (periodontal diseases) caused by difficulty in removing biofilm in patients wearing an orthodontic appliance, which translate into traumatic injuries and hormonal factors.^{1,4,6,9} The physical set-up (brackets and bands that could invade the periodontium's biological space) and mechanical set-up (forces delivered by orthodontic and / or orthopedic movement), associated with biofilm, were reported as hypotheses to explain the etiopathogenesis of gingival hyperplasia.^{1,9} And so was trauma during placement of the orthodontic appliance, which

causes pressure areas that result in epithelium thickening, connective tissue proliferation and an increased amount of tissue. The possible allergic process triggered by the acrylic resin monomer placed on the base of the removable orthodontic appliances, when associated with the presence of fungi (*Candida albicans*) may also cause a slight increase in plaque and gingival indices. The possibility of an unusual host response against the local irritant (biofilm), exacerbated by the patients' hormonal changes (puberty and menstruation) was also reported.¹

Local irritants such as excessive restorations and neonatal teeth combined with poor oral hygiene, plaque and dental calculus were also considered in the etiopathogenesis.^{2,3,6,7,11,12,17,18,19} Hormonal changes such as menarche, use of oral contraceptives and pregnancy were also reported. During gestation, lesions usually arise in the 2nd or 3rd quarters, but tend to regress thereafter.^{2,6,11,13,19}

Increased levels of progesterone and estrogen produce dilatation and proliferation of gingival microvasculature and destruction of mast cells, which result in an increased release of vasoactive substances in the adjacent tissue, inducing

the formation of pyogenic granuloma.¹⁷ A decrease in keratinization of the epithelium of the attached gingiva, rendering it more vulnerable to trauma and triggering a tendency towards growth of vascular tumors in the gingiva and alveolar mucosa has also been reported. The development of pyogenic granuloma depends on factors such as sufficient amount of tissue, degree of gingival inflammation, degree of vulnerability to trauma, presence of teeth and dentures, and level of oral hygiene. Low intensity tissue trauma could facilitate the invasion of nonspecific low virulence saprophytic microorganisms, causing a tissue response characterized by excessive proliferation of vascular-type connective tissue.³

Clinical Features

Non-neoplastic proliferative processes are generally characterized by gingival tissue growth, either well defined, such as nodules, or diffuse, like tissue masses; fibrous or flaccid texture (resilient); variable symptoms and ranging from pink to erythematous color; sessile or pedunculated base; usually bleeding to touch; loss of the “orange peel” look on the surface.^{1,2,4,5} Gingival growth stems from the interdental papilla and expands to the marginal gingiva.^{1,2,4,5,13} Although they have a predilection for the gingiva, they can be found in extra-gingival regions with various clinical features that often mimic malignant lesions.¹⁰ Pyogenic granuloma, in particular, differs from inflammatory gingival hyperplasia because it is characterized by well circumscribed papular, nodular or tumoral exophytic soft tissue; erythematous to brownish in color, depending on the maturity of the lesion; hemorrhagic aspect and a bleeding tendency; smooth or lobulated surface; soft and resilient texture when young, and more fibrous when mature due to obliteration of the capillaries; rapid growth; may cause bone resorption. It may be covered with a pus-filled membrane

due to trauma, hence the name of the lesion, despite the absence of a relationship between suppuration and pathological entity. It varies in size from a few millimeters to a few centimeters and as it grows increasingly larger it can interfere with physiological activities in the oral cavity.^{2,3,6-8,11,12,17-22}

Both lesions may present with an ulcerated surface under occlusion trauma.^{1,2,4,5,13}

There was no incidence of inflammatory gingival hyperplasia. Pyogenic granuloma is more common in the gingiva, in the anterior maxilla. It affects adolescents and young adults, with 60% incidence at ages 11-40 years and no race predilection. Women are two to four times more affected than men.^{2,3,6,7,11,12,17-20} Studies have confirmed the incidence of pyogenic granulomas in young adults.^{19,21,22}

Histopathological Features

The histological picture of inflammatory gingival hyperplasia is characterized by parakeratinized stratified squamous epithelium issuing long, thin projections towards the connective tissue. The lamina propria is made up of dense, well cellularized and collagenized connective tissue permeated by an intense mononuclear inflammatory infiltrate,¹ as shown in Figure 4.

Regarded as an inflammatory reaction process with exuberant proliferation of fibrovascular tissue, the histopathological pattern of pyogenic granuloma is composed of ulcerated stratified squamous epithelium similar to granulation tissue with numerous capillaries, lined by endotheliocytes. Other features include fibrinous exudate, inflammatory infiltrate cells (lymphocytes, plasma cells, histiocytes, and neutrophils) and fibroblasts.^{2,3,6,7,11,12,17,18} The possibility of invasion by non-specific microorganisms has been reported.^{3,7} There is no histopathological distinction between pyogenic granuloma and granuloma gravidarum, except for certain inherent etiopathogenetic conditions.^{17,18}

Differential Diagnosis

Among the lesions that make up the differential diagnosis are peripheral ossifying fibroma, peripheral giant cell lesions and inflammatory gingival hyperplasia.^{2,4}

Particularly in the case of pyogenic granuloma, given its clinical aspects and marked vascularization, the differential diagnosis comprises hemangioma, lymphoma, nevus flammeus, Kaposi's sarcoma, metastatic tumor, parulis, hemangioendothelioma, hemangiopericytoma, leiomyoma, cytomegalovirus infection and gingival lesions by bacilli.^{3,11,19}

Hemangioma is an important differential diagnosis since some smaller lesions may be indistinguishable⁹. Dyscopia tests are used in case of suspected vascular lesions. Inflammatory fibrous hyperplasia should also be considered as a differential diagnosis of pyogenic granuloma.

Given the breadth of the differential diagnosis, a histopathological examination was suggested as a means to verify and clarify the diagnosis of gingival lesions.^{7,8}

Treatment

Surgical excision has usually been the treatment of choice for both lesions.^{1-3,12,16-19}. However, some changes have been suggested, such as curettage,^{1,2,7} gingivectomy or gingivoplasty techniques.^{2,3,7} The latter is determined by the amount of attached gingiva.⁶ Barack et al¹ cited the need for flap procedure (modified Widman technique) in the presence of periodontal pocket with attachment loss. Other modalities have been recommended. Surgical removal using laser (CO₂ or Nd:YAG) has been proposed.^{3,4,12,14} The advantages of laser use in these procedures are: Enhanced hemostasis with better visualization of the surgical field, less discomfort or pain, reducing the need for postoperative medication; satisfactory tissue healing, improved patient acceptance, fewer anesthetics, and reduction of postoperative bacteremia in the surgical site.⁴

Cryosurgery was cited in the treatment of pyogenic granuloma.⁶ Silverstein et al¹³ performed free gingival graft for root coverage and keratinized gingiva loss resulting from surgical excision of pyogenic granuloma. The use of chlorhexidine mouthwashes pre and post-surgically have prevented potential post-surgical infection and inflammation.^{11,17} The removal of the base of the lesion in order to avoid recurrence has been recommended.^{1,7,16} For cases of pyogenic granuloma, the clinical follow-up and supervision of oral hygiene during pregnancy is recommended if the lesion is small, asymptomatic and not bleeding.^{17,18}

The need for removal of causative factors through basic periodontal treatment (scraping sessions, coronoradicular smoothing and polishing and oral hygiene advice) has been advocated.^{1-4,6,7,17,18} It is suggested that periodontal treatment be performed prior to surgery in view of a milder inflammatory process and surgery procedure, reducing heavy bleeding and decreasing the chance of recurrence.

Prognosis

It would be timely to make some considerations regarding the monitoring of gingival lesions in orthodontic patients. Orthodontists should use appropriate orthodontic components that do not put the periodontium at risk. Periodontal changes should be diagnosed and treated as early as possible in order to control periodontal disease (periodontal treatment and reinforcement of basic oral hygiene).¹

The monitoring of pyogenic granuloma has been cited as showing no relapse within a 6-24 month period.^{17,18} Recurrence was related to the non-removal of local irritating factors and the partial removal of the lesion^{12,17} and was estimated at around 14-16%.⁷ In this study, recurrence was possibly related to a pre-existing periodontal disease. There are reports of increasing recurrence during pregnancy.²

CONCLUSIONS

In view of the foregoing, we may conclude that:

1. Pyogenic granuloma and inflammatory gingival hyperplasia usually exhibit typical clinical and histopathological features.

2. Periodontal disease, usually present due to the difficulty in performing adequate oral hygiene because of the orthodontic appliance, must be treated before surgical removal of the proliferative processes so as to avoid heavy transoperative bleeding and postoperative compli-

cations, such as lesion recurrence itself.

3. Surgical excision is the most widely employed technique today. Regardless of treatment modality, submitting the collected material to histopathological examination is not only enlightening but a sine qua non measure to avoid the underestimation of these lesions and possible errors in the final diagnosis since different diagnostic hypotheses are possible.

4. In following up on these cases, supportive periodontal therapy and oral hygiene control are necessary.

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Occlusal characteristics of Class II division 1 patients treated with and without extraction of two upper premolars*

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Abstract

Introduction: The purpose of this study was to identify initial occlusal characteristics of Class II, division 1 patients treated with and without extraction of two upper premolars. **Methods:** For this purpose, 62 patients presenting with Class II, division 1 malocclusion were selected and divided into two groups according to treatment type. Group 1 consisted of 42 patients (23 females and 19 males) with a mean age of 12.7 years, who were treated without extractions, with fixed appliance and headgear. Group 2 was composed of 20 patients (6 females and 14 males) with a mean age of 13.5 years, also treated with fixed appliance combined with the use of headgear, but Group 2 treatment plan indicated the extraction of two premolars. In order to observe initial and final occlusal characteristics as well as changes throughout treatment the Treatment Priority Index (TPI) was used. TPI values were subjected to statistical analysis by the independent t-test to compare variables between groups. **Results and Conclusions:** The results showed that the degree of initial malocclusion was different in the two groups when assessed by the TPI, which was higher in the group treated with extraction of two upper premolars.

Keywords: Extraction of premolars. Class II, Division 1. Orthodontics.

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INTRODUCTION

The treatment of Class II malocclusion is widely discussed in the literature. Such interest is justified by the fact that most orthodontic patients present with Class II malocclusion.¹² A broad array of resources is therefore available for Class II treatment. Indication depends on the particular characteristics of each case, orthodontists' preference and patient acceptance.

One form of Class II, division 1 treatment is the use of fixed appliances associated with the use of extraoral appliances, combined or not with extractions. Should an orthodontist opt for a treatment without extractions, he will be confronted with mechanical difficulties in anteroposterior correction due to the influence of craniofacial growth and development.

Observation shows that Class II, in patients whose growth is nearing its end or who have stopped growing, a significant distal movement is required for molar correction. In these cases, patient compliance can prove essential for a successful treatment. Another treatment option involves the extraction of two upper premolars. It has been speculated that the success of non-extraction Class II treatments is associated with the severity of the anteroposterior discrepancy in the malocclusion.

Therefore, in order to investigate this speculation, the following null hypothesis will be tested: there is no difference between the initial occlusal characteristics of Class II, division 1 patients treated with and without extraction of two upper premolars.

MATERIAL AND METHODS

Material

Sample description

To evaluate both the initial characteristics and the occlusal improvements achieved by patients with Class II division 1 malocclusion, a sample was drawn from a total of two hundred and thirty patients, from the files of the Department of

Orthodontics, School of Dentistry of Bauru, University of São Paulo. All subjects had been referred for orthodontic treatment to the students attending the Specialization Course in Orthodontics and Facial Orthopedics, starting in the years 1995 and 1997.

The sample consisted of a total of 62 patients divided into two groups according to their treatment modalities.

Group 1 consisted of 42 patients with Class II, division 1—19 males and 23 females, mean baseline age of 12.7 years—who were treated without extractions.

Group 2 was comprised of 20 patients—6 females and 14 males, mean baseline age of 13.5 years—also presenting with Class II, division 1 malocclusion, treated with the extraction of two upper premolars.

The additional criterion for inclusion in the sample was the requirement that their treatment be considered successful according to an analysis of the final models.

Methods

Data from the plaster study models

To evaluate the initial and final occlusal characteristics and their changes the Treatment Priority Index (TPI) developed by Grainger⁶ was used, which is based on a sum of weights assigned to each type and degree of malocclusion severity.

Statistical Analysis

Method error

To assess the reliability of the results we repeated the measurements in 20 randomly selected patients. We used the paired t-test, introduced by Houston,⁸ to detect systematic errors. The formula ($Se^2 = \sum d^2 / 2n$), proposed by Dahlberg,³ was applied for the assessment of random errors.

Statistical Analysis

We used Student's t-test to compare the indices found for each group. The groups' final indices were compared to assess their compatibility.

RESULTS

The results are presented in Tables 1, 2 and 3.

TABLE 1 - Mean ages of groups 1 and 2.

Groups	Mean age (years)	N
1	12.7	42
2	13.5	20
Total	13.8	62

TABLE 2 - Gender distribution in Groups 1 and 2.

Groups	Female	Male	N
1	23 (54.76%)	19 (45.24%)	42
2	6 (30.0%)	14 (70.0%)	20
Total	29	33	62

TABLE 3 - Results of Student's t-test for the comparison between Group 1 and Group 2 measurements, obtained from the study models.

Measures TPI	Group 1 (n=42)		Group 2 (n=20)		t	P
	$\bar{X}$	SD	$\bar{X}$	SD		
TPI final	1.74	0.97	1.35	1.13	1.40	0.167
TPI initial	5.94	2.17	7.12	1.09	-2.30	0.025*
TPI f-i	-4.20	2.52	-5.77	1.40	2.59	0.011*

(*) Statistically significant difference ($p < 0.05$)

DISCUSSION

Sample description

In order to minimize any bias that might arise in terms of treatment plan orientation and also to ensure that our sample was as recent as possible, the subjects were selected from patients referred for orthodontic treatment to students attending two consecutive specialization courses in orthodontics at the Department of Orthodontics, School of Dentistry of Bauru, which began in 1995 and 1997 and consisted of two hundred and thirty patients. Of this total, seventy-eight cases were classified as Angle Class I malocclusion cases, one hundred and forty-four, Class II and eight, Class III. Therefore, 62.6% of the total

sample were Class II malocclusions, which confirms the high demand for treatment of this patient population.^{7,4,5}

Among the Class II cases there were ten Class II, division 2 cases and thirty-four Class II, division 1 cases, who had a choice of several different treatment approaches. Fifty-eight cases were initially treated without extractions. Four subjects dropped out of treatment and some changes were made to the initial planning. Two cases were treated with extraction of one upper premolar, seven cases with extraction of two upper premolars and three cases with extraction of four premolars. Thus, only forty-two patients had their treatment completed without extractions. The extractions were introduced in the initial planning of the cases. In six cases, one premolar was extracted, in thirteen cases, two premolars, in eight cases combinations of three premolars were extracted, in thirty-one cases combinations of four premolars and in six cases combinations in which one or more first permanent molars were extracted. There was also one case involving the extraction of an upper right canine and in another case the upper lateral incisors were extracted. Among Class II, division 1 patients, we found four cases with agenesis, two with dental absence and four patients who did not use fixed appliances and underwent interceptive treatment only.

The patients our study focused on were those who had extractions indicated in their treatment plans or had had only the first two upper premolars extracted, as described below: (a) Patients treated without extractions, who were accepted because they produced comprehensive orthodontic documentation consisting of records, models and radiographs; (b) patients whom we initially planned to treat without extractions using the standard and pre-adjusted edgewise technique; (c) patients who had used headgear and who may or may not have used a functional appliance; (d) patients without

agenesis or loss of permanent teeth, who had completed the treatment. After applying the criteria above, we were left with forty-two patients (Group 1). Group 2 comprised twenty patients: (a) patients treated with extraction of the first upper premolars, who were also evaluated according to the same criteria; (b) patients whose treatment plans included the extraction of the first upper premolars and were treated using the standard or pre-adjusted edgewise technique, who may or may not have used headgear or a functional appliance; (c) patients who did not present with agenesis or loss of permanent teeth and had completed the treatment.

It was noted therefore that in the course of treatment without extractions a few patients had their treatment plans changed mainly due to the fact that treatment without extractions requires considerable patient compliance^{1,2,9,10,11}. Extraction of the first upper premolars was the most prevalent treatment modality, accounting for 12.0% of all cases.

Group compatibility

The groups were compatible by the end of treatment, demonstrating that all were completed successfully. This is attested by the absence of statistically significant difference between the final TPI values of the two groups.

Discussion of occlusal results

The plaster models provided both baseline and final TPI values. The mean baseline TPI value for Group 1 was 5.94, indicating “definite malocclusion requiring elective orthodontic treatment”.⁶ The mean value for Group 2 reveals severe malocclusion “requiring highly desirable treatment” (Table 3).

A comparison of the baseline TPI values yields a statistically significant difference, which shows that the severity of Group 2 was greater than that of Group 1 and points to an increased difficulty in correcting severe Class II cases without

extractions. From a practical point of view, the results suggest that orthodontists should not expect to correct severe Class II discrepancies without extractions. In order to achieve greater planning efficiency, professionals should only correct mild discrepancies without extractions and opt for the extraction of two upper premolars when discrepancies are moderate to severe. It might be added, in support of this argument that treatments involving the extraction of two premolars have been shown to provide greater change in indices (TPI values) between the beginning and end of treatment.

CONCLUSIONS

The null hypothesis was rejected because the degree of initial malocclusion assessed by the TPI in the group treated with the extraction of two upper premolars was higher than in the group treated without extractions.

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The expression of TGFβ1 mRNA in the early stage of the midpalatal suture cartilage expansion

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Abstract

Introduction: The application of orthodontic expansion force induces bone formation at the midpalatal suture because of cell proliferation and differentiation. Expansion forces may stimulate the production of osteoinductive cytokines, such as transforming growth factor β1 (TGFβ1), in the progenitor cells. **Objectives:** This study determined the role of TGFβ1 in the early stage of midpalatal suture cartilage expansion. **Methods:** A orthodontic appliance was placed between the right and left upper molars of 4-week-old rats. The initial expansion force was 50 g. Animals in the control and experimental groups were sacrificed on days 0, 2, and 5 and 6 μmm thick sections were prepared for an in situ hybridization technique. **Results:** Two days after the application of force, prechondroblastic and undifferentiated mesenchymal cells distributed along the inner side of the cartilaginous tissue had high levels of TGFβ1 transcription. On day 5, the TGFβ1 transcription was found in osteocytes and osteoblastic cells on the surface of newly formed bone. Immunohistochemistry using Osteocalcin-Pro (OC-Pro) confirmed osteoblastic activity. **Conclusions:** Results suggest that the expansion of midpalatal suture cartilage induces differentiation of osteochondroprogenitor cells into osteoblasts after stimulation by cytokine production.

Keywords: Transforming growth factor β1. Proliferation. Differentiation. Osteoblasts. "In-situ" Hybridization.

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INTRODUCTION

The midpalatal suture cartilage of growing rats is composed of layers of precartilaginous cells located in the central part of the suture, and of mature cartilaginous cells layers on both sides of the precartilaginous layers. The precartilaginous cells layers are filled with prechondroblastic and undifferentiated mesenchymal cells with a high capacity to proliferate and differentiate into chondrocytes and osteoblasts.

Bone formation at the midpalatal suture cartilage initiates from the outer side of the cartilaginous tissue by means of endochondral ossification. However, when an orthodontic expansion force is applied to the suture, new bone formation is initiated on the inner side of the cartilaginous tissue by means of intramembranous ossification.^{7,18} This process involves the proliferation of undifferentiated mesenchymal cells and their differentiation into osteoblasts.

Kobayashi et al⁷ described the early cell response caused by the induction of orthodontic forces, which increase the expression of proliferating cell nuclear antigen (PCNA), a specific cell proliferation marker, and many other proteins of the bone matrix in the inner side of the cartilaginous tissue. Their results showed that mechanical stress is an important mediator of proliferation and differentiation of osteochondroprogenitor cells into osteoblasts.

However, no studies have definitively explained the molecular mechanism of cell response mediated by orthodontic expansion forces that leads to proliferation and differentiation of the progenitor cells into osteoblasts.

Both *in vivo*^{11,12,14} and *in vitro*^{4,8,9} studies have demonstrated the participation of transforming growth factor β 1 (TGF β 1), a cytokine that belongs to the TGF β superfamily, in bone formation.

This study was performed using an *in situ* hybridization technique to evaluate the transcription level of TGF β 1, a cytokine with high

osteogenic capacity, after an orthodontic expansion force was applied to the midpalatal suture cartilage of growing rats.

MATERIALS AND METHODS

Expansion of the midpalatal suture

Four-week-old male Wistar rats (Charles River Corporation, Kanagawa, Japan) weighing 67-83g were housed at the animal laboratory and fed a standard pellet chow (Oriental Yeast, Tokyo, Japan) and water *ad libitum*. All experimental procedures were approved by the Animal Welfare Committee of Nagasaki University, Japan.

An orthodontic expansion appliance (0.014 inch Co-Cr wire, green Elgiloy Semi-Resilient wire; Rocky Mountain Morita Corporation, Denver, CO, USA) was placed between the maxillary right and left molars, as described by Kobayashi et al.⁷

A strain gauge (Tomy International Co., Tokyo, Japan) was used to adjust the initial expansion force to 50 g. The animals in the control and experimental groups were sacrificed on days 0, 2, and 5. Each group was composed of 3 animals.

Tissue preparation for immunohistochemistry

The maxillary bone was surgically removed and fixed by immersion in 4% paraformaldehyde overnight at 4°C. After fixation, the maxilla was demineralized in 10% ethylenediaminetetraacetic acid (EDTA) for 10 days at 4°C, and then dehydrated using an increasing ethanol series. The specimens were embedded in paraffin, cut into 6 μ m thick serial frontal sections at the mesial root of the maxillary first molar, and mounted on 3-aminopropyltriethoxysilane coated slides.

Tissue preparation for *in situ* hybridization

Sections for *in situ* hybridization were prepared in the same way as for immunohisto-

chemical staining. All solutions were free of RNase due to the addition of 0.1% diethyl pyrocarbonate (DEPC) to H₂O.

Preparation of cRNA digoxigenin-labeled probes for in situ hybridization

The plasmid containing TGFβ1 cDNA was transferred into *Escherichia coli* to amplify cDNA. TGFβ1 cDNA was cut at the BamHI/HindIII site, subcloned into Bluescript KS+ vector, and then used as a model for cRNA production. Single strand RNA antisense (complementary) and sense (non complementary) digoxigenin-labeled probes were prepared according to the instructions supplied with the DIG-RNA labeling kit (Boehringer Mannheim, Germany). Transcriptions were performed using T3 or T7 RNA polymerase. Labeling with digoxigenin was confirmed using a hybridization filter. Each probe reacted only with a corresponding RNA reverse strand.

In situ hybridization

In situ hybridization was performed according to the method described by Nakase et al.¹³ After blocking the alkaline phosphatase activity with acid, the sections were incubated with RNA DIG-UTP (1.5 mg/ml) label probes at 55°C overnight, and then washed extensively and treated for RNase. The DIG-labeled probes were detected using an anti-DIG antibody conjugated with alkaline phosphatase and 5-bromo-4-chloro-3-indolyl phosphate as a substrate and developed using a DIG nucleic acid detection kit (Boehringer Mannheim).

Controls were: (a) hybridization with sense (mRNA) probe; (b) hybridization with non probe.

Immunohistochemical and histochemical staining

Immunohistochemistry was performed using the peroxidase-anti-peroxidase method as described by Sakai et al.¹⁶ Briefly, the sections were pretreated with first antibody. Rabbit an-

tiser against rat Cathepsin K (CK)³ and rat Osteocalcin-Pro peptide (OC-pro)² were diluted at 1:200 and 1:100 and kept in blocking buffer overnight at 4°C.

On the following day, the sections were washed and incubated with the second antibody (goat anti-rabbit IgG).

The immunoreactivity sites were visualized using peroxidase-anti-peroxidase and reacted with 3,3 diaminobenzidine to produce a brown benzidine staining precipitation.¹⁷ For Proliferating Cell Nuclear Antigen (PCNA) detection, specimens were kept overnight at 4°C in mouse monoclonal antibody (clone PC10, DAKO, Tokyo, Japan) at 1:50 dilution as the first antibody.

The sections were stained with streptavidin-biotin peroxidase (Histofine ABC kit-Nichirei Co. Ltd., Tokyo) according to the manufacturer's instructions. Negative control immunoreactivity was evaluated using normal rabbit serum (1:100 dilution) or normal mouse IgG (100 mg/ml). The histochemical tests for hematoxylin and eosin were performed using the method described by Lyon.¹⁰

RESULTS

Histological changes during midpalatal suture cartilage expansion

On day 0, the central area of the suture cartilage was filled with a cartilaginous cell layer composed of undifferentiated mesenchymal at the center, and prechondroblastic cells. Around this area, the cells exhibited features of mature chondroblasts and/or chondrocytes (Fig 1A).

On day 2, the mature cartilaginous cell layers were displaced laterally, and the central part of the suture still had immature prechondroblastic and mesenchymal cells. In addition, a cell cluster was observed at the border of prechondroblastic and chondroblastic cells (Fig 1B).

New trabecular bone formation was first seen 5 days after the application of an expansion force (Fig 1C).

In situ hybridization and immunohistochemistry

In this study, *in situ* hybridization technique was carried out using cRNA-DIG-labeled probes to evaluate the expression of TGFβ1 mRNA localized in the midpalatal suture cartilage. On day 0 (Fig 2A), a positive TGFβ1 mRNA (a) transcription level was detected in the mature osteoblasts located in the periphery of trabecular bone, laterally to the layer of cells compatible with chondroblasts, as shown by arrows in Figure 2A.

Positive PCNA immunoreactivity (Fig 2B) was found in the prechondroblastic cells in the central part of the suture and in the mature and hypertrophying cartilage cells located in the periphery of the suture. Intense cathepsin (CK) (Fig 2C) immunoreactivity was observed in the outer side of the cartilaginous cell layers, in the

transition to bone tissue.

On day 2 (Fig 3A), an intense positive TGFβ1 mRNA (a) transcription was seen at the border of prechondroblastic and chondroblastic cells.

Strong PCNA (Fig 3B) immunoreactivity was seen in the same area. The positive immunoreactivity pattern for CK found in the control group (day 0) was also seen in the outer side of cartilaginous tissue, which was indicative of osteoclastic activity.

During the following days (Fig 4A), an intense specific signal for TGFβ1 mRNA (a) was observed in osteocytes (open arrowheads) and osteoblasts (filled arrowheads) inside and on the surface of newly formed bone (day 5).

Osteoblastic activity was confirmed by immunohistochemistry using Osteocalcin-Pro (OC-Pro) (Fig 4B). The pattern of osteoclastic activity (Fig 4C) was the same found on day 0 (control group).



FIGURE 1 - Sequence of histological changes in midpalatal suture after application of expansion force. Con: control; PC: precartilaginous cells; c: cartilaginous cells; B: bone; NB: newly formed bone. Bars A, B and C = 50 μm.

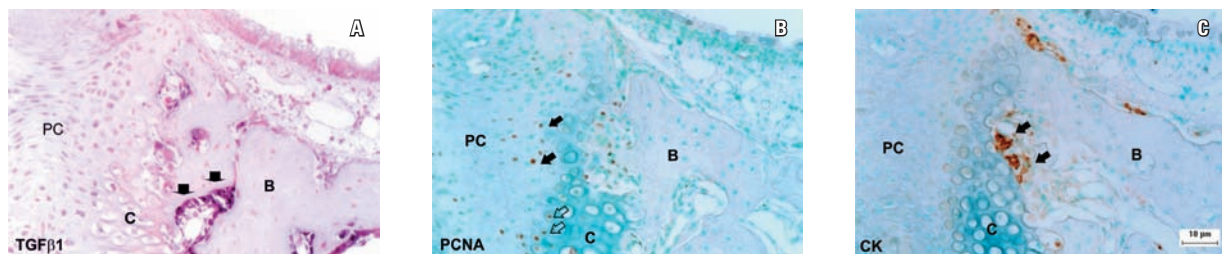


FIGURE 2 - Expression of TGFβ1 mRNA (A), PCNA (B) and CK (C) on day 0. TGFβ1: transforming growth factor B1; PCNA: proliferating cell nuclear antigen; CK: cathepsin K. Bars A, B and C = 10 μm.

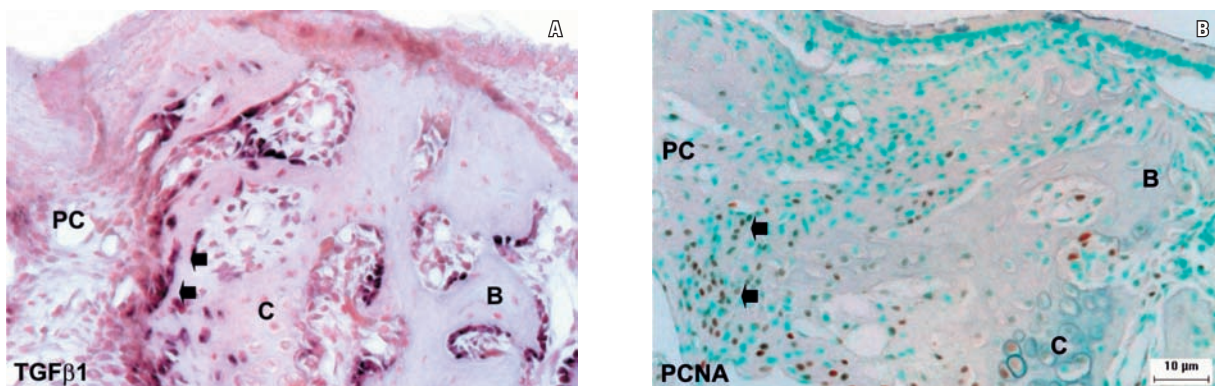


FIGURE 3 - Expression of TGFβ1 mRNA (A) and PCNA (B) on day 2. Bars A and B = 10 μm.

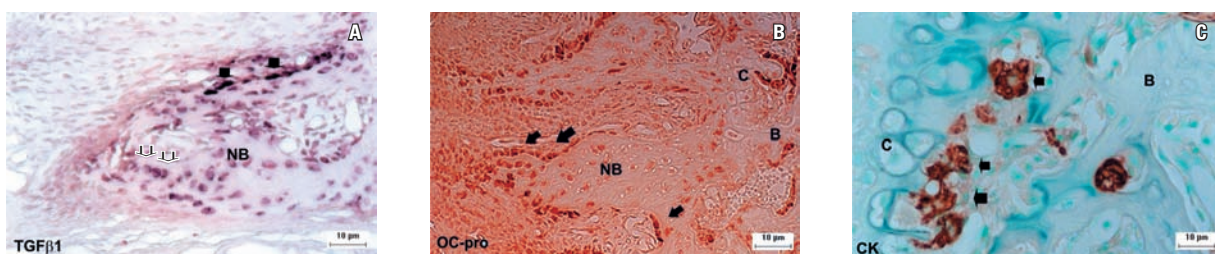


FIGURE 4 - Expression of TGFβ1 mRNA (A), OC-Pro (B) and CK (C) on day 5. OC-Pro: Osteocalcin-Pro. Bars A, B, and C = 10 μm.

DISCUSSION

On day 0, positive PCNA immunoreactivity was expressed in the prechondroblastic cells located in the central area of the midpalatal suture cartilage and in some mature and hypertrophying cartilage cells, which was indicative of their proliferative activity. PCNA is a protein found in the cell nucleus that acts as a DNA polymerase delta cofactor during the DNA synthesis stage.¹ It is used to determine the level of proliferative activity. At this stage, proliferative activity may be associated with normal cross-sectional development of the palate.⁷

On day 2, the expression of PCNA immunoreactivity increased substantially in the border of the prechondroblastic and chondroblastic layers after the orthodontic expansion force was applied.

Previously to our study⁷, positive immu-

noreactivity for osteocalcin (OCN), a specific marker for osteoblasts, and alkaline phosphatase (ALPase) activity were found in the same stage and area, which suggests that osteochondroprogenitor cells differentiate into osteoblasts in response to the expansion force. Accordingly, high TGFβ1 mRNA transcription levels were expressed in the same region on day 2, as well as in mature osteoblasts on day 0.

TGFβ1 expression associated with newly formed bone has been investigated by many authors. Noda et al¹⁴ reported the occurrence of bone formation after TGFβ1 injection in the calvarium of newborn rats.

In addition, the role of TGFβ1 in osteoblastic differentiation from undifferentiated mesenchymal cells was been investigated by Joyce et al,⁵ who reported that TGFβ1 induces differentiation of mesenchymal-like cells into osteoblasts

by stimulating proliferation and extracellular matrix protein production.

TGFβ1 may mediate osteogenesis because of its chemotactic effect on the osteoblastic precursor cells as it recruits those cells to the region to start the process of bone formation.¹⁵

In the late stage of the treatment (day 5), new bone formation continued and developed a columnar bone structure that grew from the center of the suture.

Positive immunoreactivity for Osteocalcin-Pro (OC-Pro), a specific osteoblastic marker, confirmed osteoblastic activity on the surface of the newly formed bone in this region.

TGF1 transcription was detected in osteocytes and osteoblasts on the surface of newly formed bone, which suggests that those cytokines participate in the regulation of the differentiation of mesenchymal cells into osteoblasts.

At all experimental time points (day 0, 2, 5), CK immunoreactivity was expressed exclusively in the outer side of the cartilaginous cell layers, following the normal pathway of calcified cartilage matrix absorption by osteoclastic cells. This protease is involved in the degradation of type I and type II collagen and osteonectin by osteoclasts.³

However, there was no osteoclastic activity in the inner side of the cartilaginous tissue, although there were blood vessels that promoted the migration of precursor osteoclasts to this region. Osteoclastic activity may change due to the

high TGFβ1 expression, which can inhibit the differentiation of precursor osteoclasts and also the absorptive activity of mature osteoclasts.⁶

CONCLUSIONS

The results of this study suggest that:

The expansion of the midpalatal suture increases TGFβ1 transcription in the cells in the border of precartilaginous and cartilaginous cell layers and in osteocytes and osteoblasts on the surface of newly formed bone.

The expression of TGFβ1, osteocalcin (OCN), and alkaline phosphatase (ALPase) in the border of the precartilaginous and cartilaginous cell layers on day 2, was an indicative of the beginning of osteochondroprogenitor cells differentiation into osteoblasts.

New bone formation by means of intramembranous ossification was induced in the inner side of the cartilaginous layers.

The absence of osteoclastic activity in the inner side of the expanded cartilaginous tissue may be associated with the high level of TGFβ1 transcription.

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The influence of bilateral lower first permanent molar loss on dentofacial morphology – a cephalometric study

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Abstract

Objective: To evaluate cephalometric changes in patients with bilateral loss of lower first permanent molar teeth. **Methods:** Sixty-eight lateral radiographs of patients from private practices were analyzed. The sample was divided into two groups matched for age and gender: 34 individuals without loss (control group) and 34 presenting with bilateral loss of lower first permanent molar teeth (loss group). Patients who had lost teeth other than lower first molars, cases of agenesis and patients under 16 years of age were excluded from the sample. Only individuals who reported losing teeth at least 5 years earlier were evaluated. **Results:** It was found that bilateral loss of lower first permanent molars leads to smooth closure of GnSN angle ($P = 0.05$), counterclockwise rotation of the occlusal plane ($P = 0.0001$), mild decrease in lower anterior face height ($P = 0.05$), pronounced lingual tipping ($P = 0.04$) and retrusion of mandibular incisors ($P = 0.03$). Moreover, bilateral loss of lower first permanent molars did not affect the maxillomandibular relationship in the anteroposterior direction ($P = 0.21$), amount of chin ($P = 0.45$), inclination of upper incisors ($P = 0.12$) and anteroposterior position of maxillary incisors ($P = 0.46$). **Conclusion:** Bilateral loss of lower first molars can produce marked changes in lower incisor positioning and in the occlusal plane as well as a mild vertical reduction of the face.

Keywords: First permanent molar. Cephalometry.

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INTRODUCTION

Despite the vast scientific knowledge available concerning effective methods to prevent dental caries disease, epidemiological data on tooth loss show alarming rates in Brazil, especially in the low-income population.^{2,8,9,15} Loss of lower first permanent molars not only contributes to these statistical data but has been identified as the most prevalent.^{8,9}

Over the years literature has highlighted the importance of first permanent molars in occlusion. Their loss can lead to serious problems with remarkable clinical changes in the position of neighboring and antagonist teeth,^{5,10,11} which may require orthodontic and rehabilitation treatment due to the complexity of the resulting malocclusion.

Several occlusal changes caused by missing first molars have been described in the literature. Second molars have been shown to migrate mesially into the posterior region of the dental arch,^{5,11} while second premolars^{5,6,11} and canines^{10,11} drift distally. However, it is clear that the effects of lower first molar loss are not restricted to the posterior region as they seem to significantly influence anterior teeth, increasing the occurrence of diastemas¹⁰ and midline shifts.^{10,11} Few studies have sought to examine the effects of missing first permanent molars on the cephalometric pattern. These studies^{1,12} showed spontaneous cephalometric changes in overbite and overjet and in incisor inclination after extraction of lower first permanent molars. A tendency was observed toward increased overjet and overbite in association with retroclination of lower incisors and protrusion of upper incisors, with relatively significant variation in these changes.¹² In most cases where overjet and overbite were normal, the overbite remained stable after extraction.¹² However, no evidence has been found to support the occurrence of changes in the vertical relationships of the face.¹

MATERIAL AND METHODS

This study was developed through the analysis of 68 lateral cephalometric X-rays from routine orthodontic records. The sample was divided into two groups matched for gender and age: a control group (no loss), consisting of 34 radiographs, 8 men and 26 women, whose mean age was 19.5 years (16-26.2), and another group with bilateral loss of first permanent molars, consisting of 34 radiographs, 8 men and 26 women with a mean age of 24.6 years (16-36). Patients who had lost teeth other than the first molar, cases of agenesis and patients under 16 years of age were excluded from the sample.

Information regarding age and gender was collected directly from the patients' dental records. Despite the authors' efforts, it was not possible to accurately determine the time at which the molars were lost. The patients who were able to determine it reported having lost them at least 5 years earlier. Patients who reported a recent loss were excluded from the sample.

The radiographs were traced manually by one investigator and checked by another. The cephalometric measurements were made using the program Measurement and Cephalometric Tracing System (SMTC). Cephalometric landmarks and linear and angular measures were performed as outlined by Silva Filho et al.¹³

Random error was defined by Dahlberg's formula and systematic error was examined by the intraclass correlation test, duplicating measures in 20 randomly selected radiographs, 10 from each group. Student's t-test at 95% confidence was employed for statistical analysis of differences between groups.

RESULTS

Error analysis revealed a random error between 0.18 (I-NA) to 1.34 (Co-A) and systematic error (intraclass correlation) revealed an excellent correlation ($r=0.75-0.98$, $p<0.001$) for all measures except Co-A, which exhibited a fair degree of correlation ($r=0.68$, $p<0.01$).

Direction of facial growth and facial height

A comparative analysis of the GnSN angle, which defines the resultant vector of the antero-inferior growth of the mandible, showed a more smoothly closed GnSN angle ($P=0.05$) in the loss group (mean= 65.2° , $SD=5.5^\circ$) compared to the control group (mean = 67.2° , $SD = 3.8^\circ$).

The OclSN angle, which defines the occlusal plane from the cranial base, showed a mean of 12.6° ($SD=6.6$) in the control group, and 5.6° ($SD=5.7^\circ$) in the loss group, demonstrating that bilateral loss of first molars causes a nearly 6° ($P=0.0001$) counterclockwise rotation of the occlusal plane.

The GoGnSN angle, which provides insight into the behavior of the mandibular base relative to the cranial base, showed a mean of 32.3° ($SD=5.0^\circ$) in the control group and 31.2° in the loss group ($SD= 6.3$), with no statistically significant difference ($P = 0.21$). However, LAFH, which is the linear expression of lower face height, where the mean value obtained for the control group was 70.8 mm ($SD = 5.6$ mm), and for the loss group, 68.6 mm ($SD = 5.7$ mm), revealed that bilateral loss of first molars causes a mild, statistically significant ($P = 0.048$) decrease in LAFH.

Anteroposterior maxillomandibular relationship

Comparative analysis between the control group and the group with bilateral loss of first molars revealed that the anteroposterior maxillomandibular relationship did not undergo significant change due to the loss.

Regarding NAP measure, which aids in qualifying maxillary protrusion in relation to total facial profile, its mean value in the control group was 5.1° ($SD= 3.8^\circ$), and in the loss group, 4.4° ($SD= 7.1^\circ$). This difference was not statistically significant ($P = 0.39$).

The SNA angle, which defines the position of the maxilla in relation to the cranial base, yielded a value of 83.6° ($SD= 4.1^\circ$) in the control group,

and 83.5° ($SD= 4.2$) in the loss group, with no significant difference ($P = 0.49$). A similar behavior was noted in analyzing the anteroposterior position of the mandible in relation to the skull base, which is obtained by means of the SNB angle. The mean value obtained in the control group was 79.8° ($SD= 3.9^\circ$), and in the loss group, 80.2° ($SD= 4.5^\circ$). This difference was not statistically significant ($P= 0.34$). As a result, there was no significant difference ($P = 0.27$) in ANB angle. Control group mean was 3.7° ($SD = 3.0^\circ$) and loss group mean, 3.3° ($SD = 3.0^\circ$).

When linear distances were analyzed for the A-N Perp line, which relates the maxilla to the cranial base, the control group achieved a mean value of 1.1 mm ($SD= 4.3$ mm), and the loss group, 0.53 mm ($SD = 4.1$ mm), this difference was not statistically significant ($P = 0.28$).

As regards the numerical expression of the size of the maxilla, obtained through the Co-A distance, the control group's mean value was 93.2 mm ($SD = 5.1$ mm) and the loss group's, 92.7 mm ($SD = 5.8$ mm), $P = 0.34$. The size of the mandible given by the Co-Gn line was found to be 120.9 mm ($SD = 6.5$ mm) in the control group, and 119.9 mm ($SD = 6.8$ mm) in the loss group, with no statistically significant difference ($P = 0.13$). Consequently, the maxillomandibular differential (Mm Diff), which is the difference between the CoGn and CoA measures, was statistically similar ($P = 0.13$) between the control group (mean = 27.6 mm, $SD = 5.0$ mm) and the group with bilateral loss of lower first molars (mean = 26.4 mm, $SD= 4$ mm).

Dental pattern

Dental pattern results showed that the AIs angle, which reflects upper incisor inclination in the basal bone, exhibited no statistically significant difference between the control group (mean= 115.3° , $SD= 13.3^\circ$) and the loss group (mean= 118.3° , $D.P = 9.2^\circ$).

When comparing the axial inclination of up-

per incisors in the alveolar bone with the aid of 1.NA angle, the mean found in the control group was 24.4° (SD= 10.1), and in the loss group, 27.9° (SD= 9.8°), once again, this difference was not statistically significant ($P = 0.12$).

As regards the anteroposterior position of maxillary incisors in relation to their apical base, obtained by measuring 1-NA, the control group's mean was 7.3 mm (SD= 2.8 mm), and the loss group's, 7.2 mm (SD= 3.3 mm), indicating no statistically significant difference ($P = 0.46$).

Concerning the axial inclination of lower incisors in the alveolar bone, obtained with the 1.NB angle, the average found in the control group was 28.4° (SD = 7.9°), and the loss group, 23.2° (SD = 7.4°). This result indicates that the lower incisors are tipped lingually due to bilateral loss of lower first permanent molars ($P = 0.004$). This finding is confirmed by IMPA, where there was a marked lingual inclination of lower incisors in patients with missing first molars ($P = 0.003$), with control group mean equal to 94.6° (SD = 8.3°) and loss group mean of 89.4° (SD = 7.1°).

Regarding the anteroposterior position of lower incisors in relation to their apical base, measured by 1-NB, the control group's mean was 7.6 mm (SD= 2.3 mm) and the loss group's, 6.4 mm (SD= 2.6 mm). Moreover, a mild retrusion was found in the mandibular incisors of patients with missing first molars ($P = 0.03$).

Chin

Analysis of amount of chin through P-NB highlights a similarity between the control group (mean = 2.1 mm, SD = 2.8 mm) and the group with bilateral loss of first molars (mean = 2.0 mm, SD = 2.1 mm).

DISCUSSION

The literature has long discussed the key role played by first permanent molars in maintaining the morphology of the dental arches. The 50's and 60's saw the emergence of two orthodontic

schools of thought. One of these argued that first molars were instrumental in determining a normal occlusion and therefore of paramount importance in maintaining incisal relationships. For this group of researchers^{4,16} the loss of first permanent molars would lead to lingual collapse of lower incisors and increased overjet and overbite, as was indeed later confirmed by cephalometric studies.¹² Conversely, the other group contended that the loss of first molars produced no detrimental effect on incisal relationships.^{3,7,14}

While little has been assessed regarding morphological changes in the dental arches arising from missing lower first permanent molars, almost nothing seems to have been reported regarding dentoskeletal changes resulting from these losses in facial morphology. Studies^{1,12} have reported a tendency toward increased overjet and overbite associated with retroclination of the lower incisors

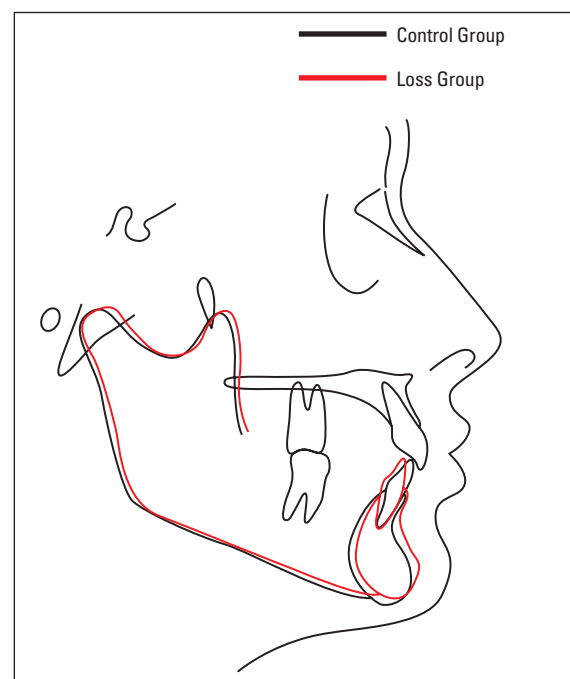


FIGURE 1 - Mean differences observed between the control group (black tracing) and the group with bilateral loss of lower first molar (red tracing).

TABLE 1 - Mean, standard deviation (SD), mean differences “t” and “P” values used to analyze differences between the control group and the group with bilateral loss of lower first molars.

	Control group (n = 34)		Bilateral loss group = 34)		Difference Mean	t-value	p-value
	Mean	SD	Mean	SD			
Facial growth direction							
GnSN	67.2°	3.8°	65.2°	5.5°	2.0°	1.64	0.05 *
Ocl SN	12.6°	6.6°	6.9°	5.6°	5.7°	3.83	0.0001 **
GoGnSN	32.3°	5.0°	31.2°	6.3°	1.1°	0.80	0.21 (ns)
LAFH	70.8 mm	5.6 mm	68.6 mm	5.7 mm	2.2 mm	1.60	0.048 *
NAP	5.1°	6.9°	4.4°	7.1°	0.7°	0.39	0.39 (ns)
Max-mand rel. A-P							
SNA	83.6°	4.1°	83.5°	4.2°	0.1°	0.02	0.49 (ns)
SNB	79.8°	3.9°	80.2°	4.5°	-0.4°	-0.39	0.34 (ns)
ANB	3.7°	3.0°	3.3°	3.0°	0.4°	0.58	0.27 (ns)
A-N perp	1.1 mm	4.3 mm	0.53 mm	4.1 mm	0.57 mm	0.56	0.28 (ns)
CoA	93.2 mm	5.1 mm	92.7 mm	5.8 mm	0.5 mm	0.38	0.34 (ns)
CoGn	120.9 mm	6.5 mm	119.9 mm	6.8 mm	1.0 mm	1.09	0.13 (ns)
Mm Diff.	27.6 mm	5.0 mm	26.4 mm	4.0 mm	1.2 mm	1.10	0.13 (ns)
Dental Positioning							
Ais	115.3°	13.3°	118.3°	9.2°	-3.0°	-1.07	0.14 (ns)
1.NA	24.4°	10.1°	27.9°	9.8°	-3.5°	-1.18	0.12 (ns)
1-NA	7.3 mm	2.8 mm	7.2 mm	3.3 mm	0.1 mm	0.09	0.46 (ns)
1.NB	28.4°	7.9°	23.2°	7.4°	5.2°	2.74	0.004**
1-NB	7.6 mm	2.3 mm	6.4 mm	2.6 mm	1.2 mm	1.90	0.03 *
IMPA	94.6°	8.3°	89.4°	7.1°	5.2°	2.75	0.003**
Chin							
P-NB	2.1 mm	2.8 mm	2.0 mm	2.1 mm	0.1 mm	0.10	0.45 (ns)

ns = non-significant.

* P<0.05.

** P<0.01.

12 to 18 months after the loss of lower first permanent molars.

The findings of this study corroborate the results of previous studies,^{1,11,12} which showed a marked influence of bilateral loss of lower first permanent molars on the positioning of lower incisors (Table 1, Fig 1). Cephalometric evaluation comparing the two groups—control and loss—shows that the bilateral loss of lower first permanent molars causes an approximate 5° retroclination of lower incisors both in terms of 1.NB, which assesses the angulation of lower incisors through a

craniomandibular reference, and IMPA, which assesses the positioning of mandibular incisors relative to the mandibular plane. However, the group cross-sectional analysis used in this study did not disclose any changes in the positioning of the upper incisors, which confirms the clinical data of Normando et al¹⁰ and diverges from the longitudinal cephalometric data¹² that point to an increase in the protrusion of upper incisors one year after the loss of lower first permanent molars.

It seems reasonable to believe, however, that the influence of bilateral loss of lower first

permanent molars, although on a smaller scale, is not confined only to the anteroposterior position of lower incisors (Fig 1). The group with bilateral loss also displayed changes in several measures that make up the vertical analysis of the face. Table 1 portrays a slightly decreased lower anterior face height (LAFH) in the loss group, substantiated by a decrease in the GnSN angle and a counterclockwise rotation of the occlusal plane. Although these cephalometric data do not lend support to previous studies,¹ they reinforce the common clinical evidence regarding the loss of vertical dimension that results from bilateral loss of first permanent molars.

Evidently, from a scientific point of view, a confident study of the influence of tooth loss on dentoskeletal development should be conducted by means of a longitudinal evaluation. However, ethical requirements render the adoption of this methodology impossible, leaving to investigators only those evaluations of a cross-sectional nature, along with the obvious disadvantages of working with two samples composed of different individuals. In the present investigation several measures were adopted in order to make it as reliable as possible, among which one should highlight the use of patients with no potential for growth and matched for age and gender.

Another point to be discussed focuses on the fact that cephalometric studies generally use as

control group subjects with normal occlusion. In this study, the sample that comprised the group with missing first permanent molars was not obtained through an epidemiological survey in a random population, but rather from a dental office sample. It is reasonable to believe that if a patient seeks orthodontic treatment, they probably present with an occlusal problem. Therefore, in order to obtain a control group that could be different from the experimental group in terms of the variable of interest, i.e., bilateral loss of lower first permanent molars, a control sample was used which consisted of individuals who sought orthodontic treatment without, however, having lost any teeth.

CONCLUSIONS

The following conclusions can be drawn based on the results of this study:

1. Bilateral loss of lower first permanent molars did not affect the anteroposterior maxillo-mandibular relationship, the dental pattern of the upper dental arch or the chin.
2. Bilateral loss of lower first permanent molars can interfere with the direction of growth, leading to a counterclockwise rotation of the occlusal plane, and a mild decrease in lower face height, and with the dental pattern of the lower arch, resulting in a steep lingual inclination and a mild re-trusion of lower anterior teeth.

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Analysis of rapid maxillary expansion using Cone-Beam Computed Tomography

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Abstract

Whenever a maxillary arch is diagnosed as skeletally atresic the treatment of choice is usually maxillary orthopedic expansion, involving separation of the midpalatal suture. Basically, this suture used to be assessed with the aid of a maxillary occlusal radiograph, which limited its posteroanterior evaluation. Similarly, quantifying this atresia in cephalometric x-rays always posed an obstacle for clinicians owing to considerable superimposition of facial structures. With the advent of computed tomography, this technology has revolutionized diagnostic methods in dentistry because it provides high dimensional accuracy of the facial structures and a reliable method for quantifying the behavior of the maxillary halves, tooth inclination, bone formation at the suture in the three planes of space, as well as alveolar bone resorption and other consequences of palatal expansion.

Keywords: Diagnosis. Radiographic images. Rapid maxillary expansion. Cone-Beam Computed Tomography.

INTRODUCTION

Recovery of transverse maxillary discrepancy seems to be essential for the proper treatment of various types of malocclusion. Several authors have investigated possible methods to expand the maxillary arch through different means. Proponents of rapid maxillary expansion (RME) argue that this method causes minimum tooth movement and maximum skeletal displacement. Conversely, advocates of slow expansion believe that this method produces less tissue resistance in neighboring maxillary structures while enhancing

bone formation in the intermaxillary suture, and that these two factors help to minimize postexpansion relapse.^{12,13}

Some authors have advocated the separation of the midpalatal suture to expand narrow maxillary arches.^{11,15,20} Moreover, Graber,⁷ in 1972, asserted that this technique is in decline as it develops open bite, relapse and improves nasal breathing only temporarily (REF). Furthermore, conventional orthodontic appliances have proved successful in accomplishing intermolar and intercanine maxillary expansion.

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Given the diversity of structures comprised in the craniofacial complex various therapeutic resources have emerged which are capable of modifying the position or morphology of these components. Lateral maxillary atresia is a very common condition in different malocclusions. This transverse deficiency, caused by genetic and/or functional⁴ factors, may involve only the posterior dental segments, imparting excessive lingual tipping to these segments,⁶ but it may also be associated with a skeletally compromised maxilla, which gives it a *sicatréo* appearance.^{6,14} When this happens, the maxilla presents with a narrow⁶ and gothic palate.¹⁴ To remedy this situation, an expansion is required which is capable of effecting maximum orthopedic movement of the maxillary bones while maintaining the integrity of the tissues and reducing the resulting tooth inclination.^{1,4,12,13,15,17,25} Rapid maxillary expansion (RME) meets these requirements, restoring the transverse dimensions of this bone structure and corresponding dental arch^{14,25} by opening the midpalatal suture in conjunction with orthopedic reactions in other facial sutures and slight movements in the posterosuperior segments.⁸

Numerous studies have been conducted to investigate the changes caused in the maxillary bones and midpalatal suture as a result of rapid maxillary expansion. Histological experiments on animals showed new bone formation in the suture zone after palate splitting.^{5,10,28} Radiographic studies in humans showed ossification in the region after expansion. However, the length of time that the palatal suture takes to restore its normal structure in humans is still the subject of considerable controversy. The vast majority of authors recommend that retention be performed with the appliance itself, after palate splitting, for a period of three months.^{2,8,10,16,18,19,22}

The ability to measure these changes allows orthodontists to predict the effects of orthopedic treatment. Invasive techniques such as metal implants provide accurate information but are too aggressive for routine use. Histological control of

tissue reactions is possible only in animal studies or autopsy material.²⁷

Several authors have studied the skeletal and dental changes resulting from opening the midpalatal suture but the literature is still inconclusive regarding dimensional changes in dental arches and maxillary displacement as a whole, and whether or not these changes are transient.^{4,11,12,30}

According to Sato et al,²³ posteroanterior cephalometric radiography provides an assessment of the transverse dimensions of the face by broadening the scope and thus facilitating the diagnosis of crossbites and orthopedic changes inherent in the rapid opening of the midpalatal suture. Because it is an image in two dimensions, radiographic overlays of anatomical structures hamper the precise location of cephalometric landmarks, which are instrumental for diagnosing and assessing the maxilla before or after any intervention, notably in the maxillary middle third.⁹

Assessment of frontal radiographs shows that the maxillary bones are displaced laterally with the fulcrum located close to the frontomaxillary suture while lower skeletal expansion progresses. The maxillary central incisors usually move mesially and, in general, undergo uprighting after appliance stabilization. Such movement aids in closing the wide median diastema produced by the orthopedic effects of the appliance. As these teeth are uprighted, part of the arch length benefits obtained with the expansion is lost. The occlusal radiograph shows that the intermaxillary suture experiences a non-parallel opening accompanied by a further, V-shaped expansion, greater in the anterior than in the posterior region.³⁰

In frontal view, a pyramid appears in the region of this suture, whose base is turned inferiorly. Thus, real bone mass gain occurs with a consequent increase in arch perimeter.^{4,10,11}

Occlusal radiographs have been widely used for monitoring the recovery of the suture after palatal separation. However, standardizing how x-rays are performed is not a simple matter.

The occlusal view showed that in the antero-posterior direction the opening of the suture would be twice as large in the incisor than in the molar region, allowing the visualization of a new triangle with the base facing the anterior region. Apparently, the amount of opening varies with each individual. By comparing the opening of the intermaxillary suture with the dental effects it was found that the amount of suture separation would be equal to or less than the amount of expansion in the dental arch.¹⁰

The advent of Cone-Beam Computed Tomography (CBCT) has made possible three-dimensional assessment. Today, it is increasingly applied in dentistry mainly because it is more affordable and entails lower radiation exposure.⁹

To compare the biological effects of radiation on various parts of the body, effective equivalent dose is used, which yields a comparison of the biological effects of different types of ionizing radiation and allows adjustments to be made in the volume and radiosensitivity of irradiated tissue. The unit of measure used is the sievert (Sv).^{9,24}

The effective equivalent dose in conventional radiographic examinations, comprising 3 maxillary periapical radiographs (5 μ Sv), 3 mandibular periapical radiographs to assess the bone tissue available in the mandibular symphysis (5 μ Sv), 1 upper occlusal radiograph (4 μ Sv), 1 panoramic radiograph (7 μ Sv), 1 posteroanterior cephalometric radiograph (7 μ Sv), 1 lateral cephalometric radiograph (7 μ Sv), results in a total of 42 μ Sv.^{9,24} Using a Cone-Beam CT scanner such as the i-CAT, radiation exposure is approximately 30-100 μ Sv for examining both the maxilla and mandible, which represents a reduction of 1/6 in patient radiation exposure compared to a conventional medical CT scanner (helical). Cone-Beam CT radiation dose is similar to the radiation dose used in the periapical examination of the entire mouth, equivalent to approximately 4-15 times the dose of a panoramic X-ray.⁹

Moreover, compared to conventional radiography, the potential of CT to provide additional information is much higher. Additionally, with Cone-Beam CT, professionals can obtain reconstructions of all conventional dental radiographs in addition to the unique information provided by multiplanar and 3D reconstructions.⁹

As new knowledge is generated by three-dimensional views of the skull and face, Cone-Beam CT is expected to change concepts and shift paradigms, redefining goals and treatment plans in orthodontics. This would facilitate the diagnosis of maxillary atresia and maxillary behavior in terms of expansion procedures, thus allowing for quantification of the actual skeletal gains in dealing with two different activation protocols. CT will therefore contribute to diagnosis to the extent that it will be decisive in establishing the best protocol expansion to be used in treatment planning.⁹

DISCUSSION

The increase noted in upper arch transverse dimensions after rapid maxillary expansion (RME) is due mainly to orthopedic effects, implying a real gain in bone mass and dental arch perimeter, as illustrated in Figures 1 and 2. Besides providing an expected increase in dental arch width, the Haas expansion appliance provides high palatal expansion, which translates into a significant transverse increase in the deep region of the palate. Clear clinical evidence of separation of the maxillary processes is given through a gradual opening of the diastema between the maxillary central incisors, observed in Figure 3. After the third complete turn of the screw, the incisors are affected by rapid maxillary expansion. From this stage on, a direct relationship takes place between the magnitude of the open diastema and the amount of orthopedic effect induced by the expansion. It is therefore possible to perform a clinical interpretation of skeletal involvement during RME: The larger the diastema, the greater the induced orthopedic effect. After expansion screw stabilization the

central incisors returned spontaneously to their original position. Control over this now purely orthodontic movement is linked to the memory of stretched gingival fibers, which rapidly move, first the crowns, then the roots, closer to each other.

Total maxillary occlusal x-rays are the routine diagnostic tool used in orthodontic practice to verify and document suture separation. Cone-Beam computed tomography enables more accurate result evaluation and improved quantification. One can observe a triangular, radiolucent area with its base facing the anterior nasal spine, a region where bone strength is reduced (Figs 2 and 3). At the same time that CT confirms the orthopedic splitting of the maxilla, it subsequently records midpalatal suture reorganization, which occurs during the retention phase, when the appliance is kept in the mouth (Fig 4). The fixed expander should only be replaced by a removable retention plate after complete tomographic restructuring, which takes on average 3-4 months.²⁹

It seems indisputable that, even though the predominant effect is of an orthopedic nature,

orthodontic effect, represented by the flaring of the posterior teeth and alveolar process, is an integral part of rapid maxillary expansion. It is known to practitioners who deal with orthopedic expansion that hand in hand with the gradual opening of the midpalatal suture, the force delivered by the expander causes periodontal ligament compression, lateral tipping of the alveolar process and subsequent flaring of the posterior teeth. These changes represent the orthodontic effect of RME. But before these forces induce classical orthodontic movement with osteoclastic histological changes in the periodontium, the maxillary bones are split due to orthopedic effects (Figs 2 and 3).

The ratio between orthopedic and orthodontic effects derived from rapid maxillary expansion depends mainly on bone strength, which increases with age. As a general rule, effects on the basal bone tend to be significant in children and minimal, or even non-existent, after the growth phase. As patient age increases, orthodontic effects will be increasingly more prevalent than orthopedic effects.²¹

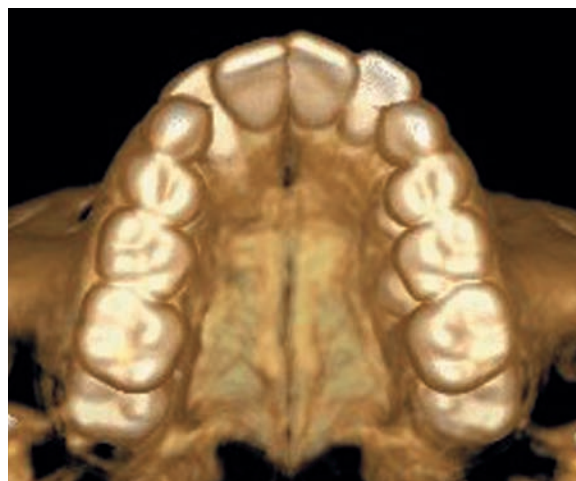


FIGURE 1 - Three-dimensional occlusal reconstruction of the maxilla from a CT scan, showing the closed midpalatal suture.

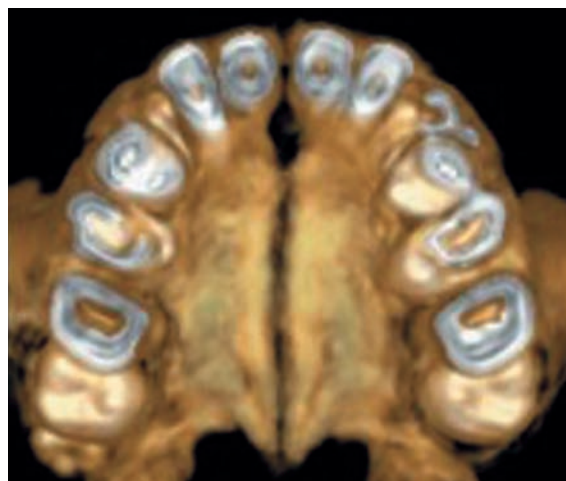


FIGURE 2 - Three-dimensional occlusal reconstruction of the maxilla from a CT scan, showing the open midpalatal suture.



FIGURE 3 - Three-dimensional occlusal reconstruction of the maxilla from a CT scan, showing the open midpalatal suture: (A) posteroanterior view; (B) occlusal view.



FIGURE 4 - Three-dimensional occlusal reconstruction of the maxilla from a CT scan, showing the suture reorganization process: (A) posteroanterior view; (B) occlusal view.

CONCLUSIONS

It could be argued that nowadays orthopedic maxillary expansion is part and parcel of a coherent therapeutic approach in orthodontic practice, provided that maxillary atresia is present. The lateral repositioning of the maxilla and increased basal bone, which can be accurately observed in Cone-Beam computed

tomography confirms the marked morphological changes that occur in the upper arch and nasomaxillary structure.

In general, the decision to provide orthodontic treatment using palate-splitting mechanics will depend on the clinical experience of each orthodontist, the need for such procedure and the individual characteristics of each patient,

such as age. These variables will establish the orthodontic planning and treatment best suited for each case.

Cone-Beam Computed Tomography is a groundbreaking diagnostic method in dentistry as it provides high dimensional accuracy of the

facial structures and a reliable method for quantifying the behavior of the maxillary halves, dental tipping, bone formation at the suture in the three planes of space, as well as alveolar bone resorption and other consequences of palatal expansion.

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An overview of the prevalence of malocclusion in 6 to 10-year-old children in Brazil

Marcos Alan Vieira Bittencourt*, André Wilson Machado**

Abstract

Objective: To provide an overview of the malocclusions present in Brazilian children aged 6 to 10 years, and present two clinical situations often associated with these malocclusions, i.e., caries and premature loss of deciduous teeth. **Methods:** A sample comprised of 4,776 randomly and intentionally selected children was evaluated. Data collection was performed by clinical examination and anamnesis as part of the campaign “Preventing is better than treating” conducted in 18 Brazilian states and the Federal District involving orthodontists affiliated with the Brazilian Association of Orthodontics and Facial Orthopedics (ABOR). **Results and Conclusions:** It was noted that only 14.83% of the children had normal occlusion while 85.17% had some sort of altered occlusion, with 57.24% presenting with Class I malocclusion, 21.73%, Class II, and 6.2%, Class III. Crossbite was also found in 19.58% of the children, with 10.41% in the anterior and 9.17% in the posterior region. Deep overbite was found in 18.09% and open bite, in 15.85% of the sample. Caries and/or tooth loss were present in 52.97% of the children. Moreover, the need for preventive orthodontics was observed in 72.34% of the children, and for interceptive orthodontics, in 60.86%. It should therefore be emphasized that the presence of specialists in orthodontics—duly qualified to meet the standards established by ABOR and the World Federation of Orthodontists (WFO)—in attendance at public health clinics, can greatly benefit underprivileged Brazilian children.

Keywords: Prevalence. Epidemiology. Malocclusion.

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INTRODUCTION

As of 1899 with the malocclusion classification proposed by Angle⁴ and the acknowledgement of orthodontics as a dental specialty much has been published on the incidence and prevalence of malocclusion in the population. Data from the World Health Organization (WHO)¹⁷ show that malocclusion is the third most important condition in the ranking of oral health problems, outranked only by caries and periodontal disease. The situation in Brazil is identical, which renders malocclusion worthy of special attention. It is worrying to note, however, that financially underprivileged layers of the population must overcome serious hurdles when trying to access public oral health services since few government agencies offer a sector or implement programs to address this particular issue. Thus, the overwhelming need for orthodontic treatment is compounded by the fact that the most basic preventive resources are unavailable, let alone those required for more complex treatments.

Studies on the prevalence of malocclusion in public health provide important epidemiological data to assess the type and distribution of occlusal characteristics of a given population, its treatment need and priority and the resources required to offer treatment in terms of work capacity, skills, agility and materials to be employed.⁹ It is essential to identify and localize the wide range of deviations from occlusal development that may arise and that must be intercepted before the end of the active growth stage. As well as problems of a functional nature that arise from these morphological changes, which may become more complex skeletal problems in the future, aesthetic impairment often occurs, with serious psychosocial consequences for the developing individual.

Malocclusions have a multifactorial origin and can hardly ever be attributed to a single specific cause. Causes include general factors, such as genetic and hereditary components, nutritional deficiencies and abnormal pressure habits, or local

factors, located directly in the dental arch such as supernumerary teeth, tooth decay and premature loss of primary teeth.^{2,11,18} This realization underscores the need for a clear definition of diagnostic criteria in order to facilitate prevention and assistance planning.¹⁹

The WHO recommends that health authorities conduct epidemiological surveys of the major oral diseases at ages 5, 12 and 15 years and in age groups 35 to 44 and 65 to 74 years every five to ten years. In the last survey on oral health conducted by the Brazilian Ministry of Health³¹ in 2003 one objective was to identify the prevalence of malocclusion based on the criteria of the Dental Aesthetic Index (DAI). An incidence of 36.46% was found at age 5, 58.14% in 12 years-old, and 53.23% at 15 years of age. Although this is not the most suitable index as it does not consider problems such as crossbite, posterior open bite, midline deviations or deep overbite,²⁵ these findings indicate that knowledge of the characteristics of a population is crucial for developing proposals that respond to the needs and risks present in the population. Field work in this area is both extensive and underserved. Malocclusion assessment has not progressed toward a public health perspective, with most studies focusing on specific themes or on morphological or biomechanical issues.

Thus, the diagnosis of oral health status of populations is an asset of paramount importance to the planning and evaluation of health promotion actions.¹⁶ Assessment of malocclusion and treatment needs for public health purposes are instrumental in determining the priorities for treatment in publicly subsidized dental services and to properly estimate the number of professionals to be recruited as well as the financial resources necessary to provide this treatment. Although much research has been conducted in recent years, from an epidemiological standpoint the number of nationwide or even international studies is still rather scarce. In view of these considerations, the purpose of this study was to provide an overview

of the malocclusions present in Brazilian children aged 6 to 10 years, and present two clinical situations often associated with these malocclusions, i.e., caries and premature loss of deciduous teeth.

MATERIAL AND METHODS

This has been characterized as quantitative study, of a descriptive, exploratory and transversal nature. The sample was random and intentional: 4,776 Brazilian children aged between 6 and 10 years were evaluated without distinction of race or gender. None had received any previous orthodontic treatment. Prior to data collection, the examiners fully explained to the children's parents and/or legal guardians the purpose and importance of the study, highlighting its many benefits. Moreover, they were instructed on practices that can prevent or minimize future orthodontic problems in children.

Data collection was performed by clinical examination and anamnesis as part of the campaign "Preventing is better than treating" conducted in 18 Brazilian states and the Federal District involving orthodontists affiliated with the Brazilian Association of Orthodontics and Facial Orthopedics (ABOR). The campaign was part of a 2009 Global Action Project implemented by the Social Service for Industry (SESI) in partnership with Brazilian television network Rede Globo. ABOR—by means of its 19 regional branches—provided nearly 300 professionals, viz. member orthodontists or students of Orthodontics Specialization programs recognized by the Federal Council of Dentistry (CFO), who volunteered to participate. The evaluation was conducted in the states of Amapá, Alagoas, Bahia, Ceará, Espírito Santo, Goiás, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Paraíba, Paraná, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Norte, Rio Grande do Sul, Santa Catarina, São Paulo, and in the Federal District.

A partnership was also forged with Colgate®, which donated five thousand sets of toothbrush, toothpaste and explanatory leaflets for

distribution to all children. This action was geared toward providing guidance to children and their parents/legal guardians about the proper way to clean their teeth with instructions on brushing and flossing, among others.

Data collection was performed under an artificial light source with the child sitting in a chair and facing the examiner. Gloves, masks and disposable wooden spatulas were utilized.

Initially, an attempt was made to determine whether or not the individual had a normal occlusion. If not, the examiners checked whether the alteration was significant or whether there were only small changes that would not jeopardize the establishment of an appropriate occlusal relationship in the future, both in terms of function and aesthetics. Children with normal occlusion and those that had minor changes were categorized as favorable occlusion. In all others, the occlusion was considered unfavorable and therefore the malocclusion features present in anteroposterior, transverse and vertical directions were identified.

First permanent molar relationship was preferentially observed, or else canine relationship, on the right and left sides, to determine the type of malocclusion according to Angle's classification.⁴ The following groups were established: Class I, Class II division 1, Class II division 2 and Class III.

The presence of crossbite was then observed in the anterior region, when one or more anterior teeth were involved, or in the posterior region, when the crossbite involved teeth in this region. In this case, it was subdivided into bilateral when present in the right and left sides, or unilateral when involving only one side.

Regarding vertical changes, each child's anterior overbite was evaluated. Considering that most children would be in mixed dentition, a parameter of 50% overbite was set as normal, i.e., an overlap of up to half the clinical crown of lower incisors by the upper incisors. Any overlap greater than 50% was categorized as deep overbite while

the absence of overbite was defined as open bite. If the child was in primary dentition the measure of normality was an overbite of 10%, and if they were in permanent dentition, 20% to 30%.

The examiners also assessed the presence of clinically visible carious lesions and the loss of permanent teeth or premature loss of deciduous teeth. Early loss was defined as loss due to tooth extractions motivated by diseases or injuries outside the period considered as ideal for their exfoliation.

In the following step the examiners sought to determine whether the child required orthodontic care through either prevention or interception. Preventive orthodontic care was defined as guidance on the need for proper hygiene and occlusal development, space supervision and guidance on abnormal pressure habits and on proper breathing pattern. Interceptive care was defined as the need for space maintainers or regainers, serial extractions and orthodontic mechanics for the correction of crossbites and open bites, and orthopedic procedures for the correction of Class II or III malocclusions.

RESULTS

Regarding gender, 2,270 (47.53%) of the 4,776 children were males and 2,506 (52.47%) females.

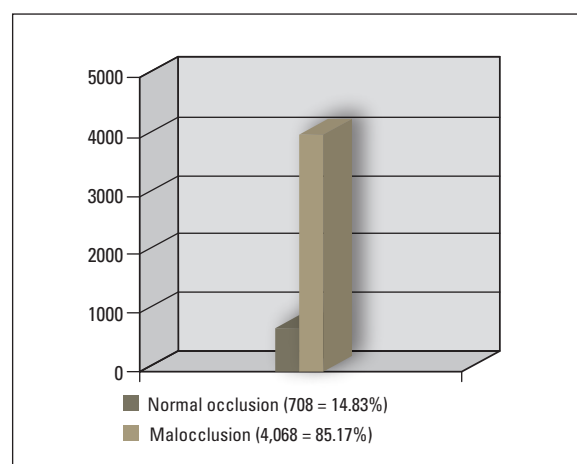


FIGURE 1 - Distribution of normal occlusion and malocclusion in children of the sample.

As described initially the examiners sought to analyze whether the children had normal occlusion. It was found that only 14.83% of the children fit this category while 85.17% had some kind of altered occlusion, as can be seen in Figure 1.

Subsequently, when reviewing occlusal characteristics in an attempt to determine whether the occlusion was favorable or not it was found that aside from children with normal occlusion some minor changes were present in 16.77%, although these alterations would not jeopardize the establishment of an appropriate occlusal relationship. Thus, the total number of children with favorable occlusion was 31.6% (Fig 2).

In children who had no occlusal characteristics supportive of establishing an adequate future relationship the malocclusion was examined in the anteroposterior, transverse and vertical directions. The results are depicted in Figures 3 to 5.

As can be seen in Figure 6, the presence of caries and/or tooth loss was observed in most of the children (52.97%).

As stated above, the examiners sought to determine whether each child required orthodontic care, be it preventive or interceptive. The former was required by 72.34%, and the latter, by 60.86% of the children (Figs 7 and 8).

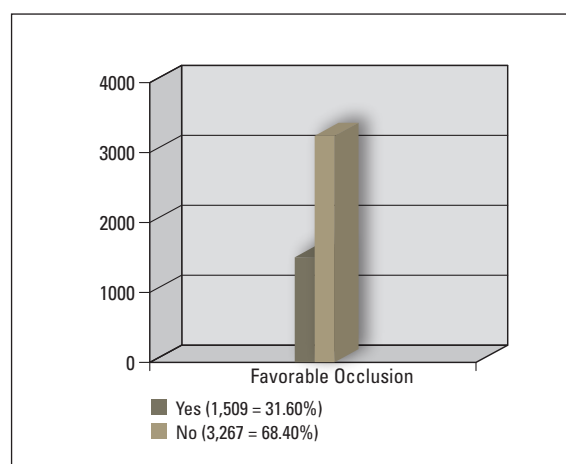


FIGURE 2 - Distribution of occlusions, in the examined children, that seemed favorable and unfavorable to the establishment of an appropriate occlusal relationship in the future.

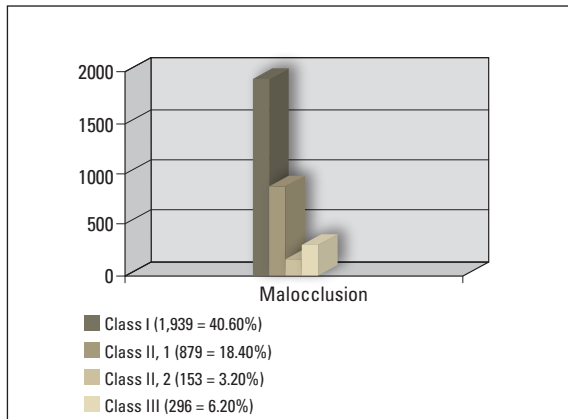


FIGURE 3 - Distribution of malocclusion type according to Angle's classification in children with unfavorable occlusion.

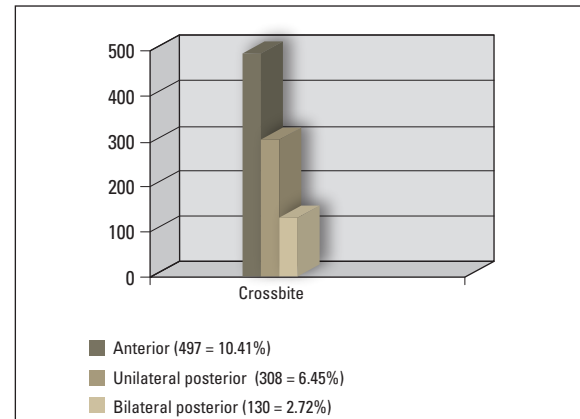


FIGURE 4 - Distribution of the presence of crossbite in children with unfavorable occlusion.

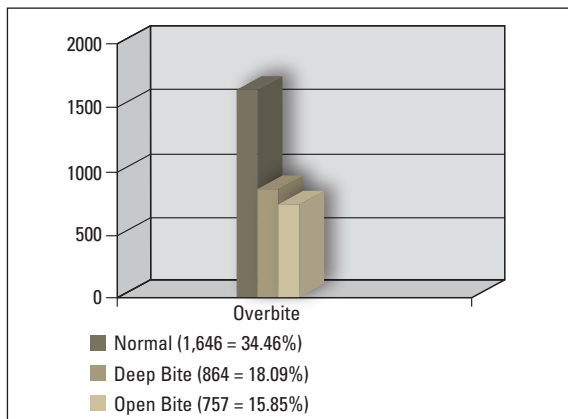


FIGURE 5 - Distribution of the presence of crossbite in children with unfavorable occlusion.

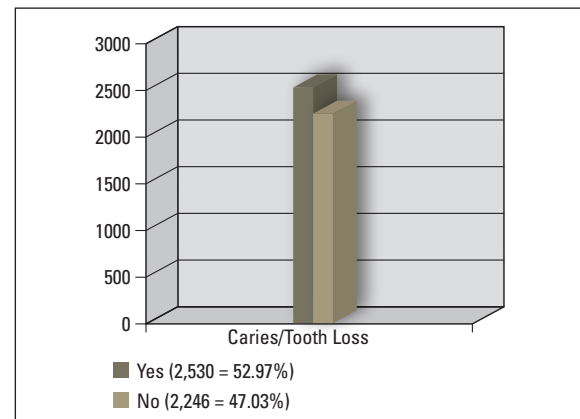


FIGURE 6 - Distribution of tooth decay and/or loss in the children of the sample.

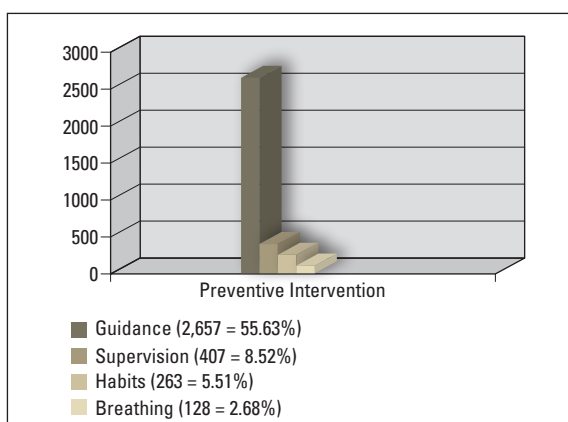


FIGURE 7 - Distribution of the type of preventive care that should be given to children involving guidance, space supervision and approaches related to abnormal pressure habits and mouth breathing.

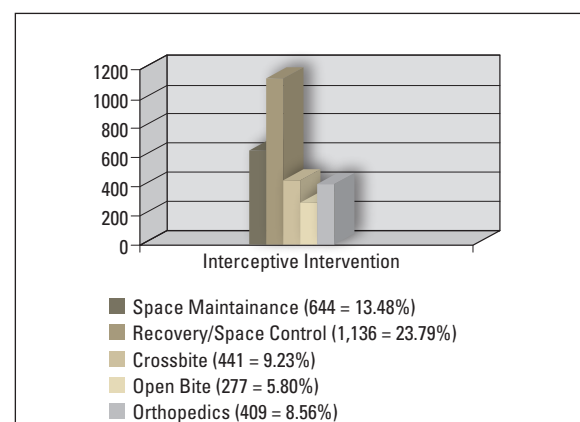


FIGURE 8 - Distribution of the type of interceptive care that should be delivered, involving the need for space maintenance, space recovery and/or control, crossbite and open bite correction, and orthopedic intervention for correction of Angle Class II or Class III malocclusion.

DISCUSSION

Although less prevalent than caries or periodontal disease malocclusion is endemic and widespread throughout the world. A study of the population of New York (USA) found that only 4.8% had normal occlusion, demonstrating the magnitude of the challenge that dentistry in general and orthodontics, in particular, has had to confront.⁵ Although the literature still discusses the concept of ideal occlusion,^{15,27} and perhaps for this reason its incidence varies considerably when different population groups are evaluated, its occurrence is known to be relatively rare. Therefore, the challenge remains. As can be seen in Figure 1, this research found that 85.17% of the children had some type of alteration, i.e., 57.24% had Angle Class I malocclusion, 21.73% Angle Class II malocclusion, and 6.2% Angle Class III malocclusion. Thus, only 14.83% of the children were considered to have normal occlusion. This high prevalence coincides with the study by Brito et al,⁷ who found a prevalence of 80.84% of malocclusion in children aged 9-12 years. On the other hand, Albuquerque et al¹ observed much lower prevalence (40.7%), which can be explained by the fact that their sample was comprised of children 1-3 years of age, suggesting a lower number of occlusal deviations in deciduous dentition vs. mixed or permanent dentition.

As already mentioned, the concept of normal occlusion is debatable. Thus, the examiners determined that 31.6% of the children showed favorable conditions to develop a normal occlusion. The reason for this was that in some of them the occlusal changes responsible for categorizing their malocclusion as Angle Class I were minimal and in no way compromised the establishment of an appropriate occlusal relationship in the future, both functionally and aesthetically. Therefore, the number of children who had abnormalities likely to compromise normal occlusal development fell to 68.4% (Fig 2).

In all others the occlusion was considered

unfavorable and the malocclusion features present in the anteroposterior, transverse and vertical directions were identified. In the anteroposterior direction it was found that the most prevalent malocclusion remained the Angle Class I, now affecting 40.6% of the children. As can also be observed, Class II appears as the second most prevalent with 21.6% but with a much higher prevalence of Class II Division 1 (18.4%) than Division 2 (3.2%). In agreement with the literature,^{7,21} Class III malocclusion was the least prevalent.

Also in the anteroposterior direction, it was noted that anterior crossbite was present in 10.41% of the children (Fig 4). This result is similar to investigations conducted on children in the states of Rio de Janeiro⁷ and Paraíba,⁸ and in Canada,¹² although much higher than the 3.2% observed by Tausche et al.²⁸

Regarding transverse issues, it is also possible to note in Figure 4 that posterior crossbite occurred in 9.17% of the children, with 6.45% unilateral and 2.72% bilateral. This result is somewhat lower than the finding reported by Brito et al⁷ and Cavalcanti et al,⁸ who found this alteration in 19.2% and 20.18% of the children, respectively, a higher percentage than the 5.31% reported by Karaiskos et al.¹²

It was observed that 33.94% of all children in the sample had problems in the overbite of the upper incisors in relation to the lower incisors. Deep overbite was present in 18.09%, and open bite, 15.85% (Fig 5) of the children. Cavalcanti et al⁸ found a similar value for deep overbite (20.5%), but a much higher prevalence of open bite (22.3%). Moreover, the value found in this study for the prevalence of open bite (18.5%) was close to the finding reported by Silva Filho et al²⁶ in the city of Bauru (SP), and higher than the 9.3% found by Alves et al³ in the city of Feira de Santana (BA), the 7.8% found by Brito et al⁷ in the city of Nova Friburgo (RJ) and the 8.3% recorded by Karaiskos et al¹² in Canada.

This study also intended to assess oral con-

ditions involving lesions caused by extensive tooth decay, and premature loss of primary teeth. Brazilian children have one of the highest rates of premature extractions with no maintenance of the remaining space, and their leading cause of premature loss is tooth decay.^{10,12} It has long been common knowledge that this is a factor often associated with malocclusions,^{13,24} since primary teeth should be kept healthy to provide support and preserve the integrity of the dental arch, thereby allowing the eruption of the succeeding permanent teeth.⁶ Untimely loss, depending on the region, occlusal relationship, individual skeletal features and periodontal conditions may cause overeruption of antagonist teeth.²² In this research, as shown in Figure 6, it was found that tooth decay and/or loss were present in 52.97% of the children. This result is much higher than that reported by Ribas et al,²² who found a prevalence of 16.58% of decay and/or premature loss in children between 6 and 8 years of age in Curitiba (PR).

The premature loss of deciduous teeth or the loss of permanent teeth with no immediate replacement are potential causes of malocclusion.^{2,11} Thus, loss avoidance can help to prevent orthodontic problems and ensure normal development of the dentition and occlusion. In this regard, as shown in Figure 7, this study showed that appropriate guidance—not only on the need for proper cleaning or restoration of compromised teeth—but also on the development of dentition, when provided by a qualified professional, had a positive impact on 55.63% of the children. Furthermore, 8.52% of the children exhibited an altered sequence when replacing primary by permanent teeth and therefore required professional monitoring (space supervision) with the purpose of attaining a more favorable sequence of eruption of permanent teeth from a physiological standpoint. Abnormal pressure habits were observed in 5.51% of the children and, although difficult to assess clinically, an abnormal respiration pattern

(mouth breathing) was observed in 2.68% of the total sample. Given that the literature establishes an unequivocal link between malocclusion and improper function of oral muscles,^{2,23,29,30} providing guidance to the children and/or their legal guardians was considered an essential preventive procedure to decrease the probability of future occlusal changes related to these problems in 8.19% of the children.

As depicted in Figure 8, tooth loss had occurred in 13.48% of the children, which required interceptive orthodontic intervention in order to maintain the remaining space until the eruption of the permanent successors. Moreover, 23.79% of the children already displayed problems related to a slight lack of space, either by migration of adjacent teeth to a region of early loss, or by a transient negative difference between the volume of deciduous and permanent teeth. In both cases, orthodontic appliances are indicated to minimize or correct these alterations, and space regainers could be used in the former case, as well as appliances which enable the use of leeway space, especially at the time of exfoliation of the second primary molars.

Although obvious, it should be stressed that only qualified professionals should be allowed to handle this stage since it is an extremely important phase in ensuring normal dentition development and establishing an appropriate occlusal relationship. In this sense, it is of paramount importance to distinguish patients who will benefit from interceptive treatment from those for whom corrective treatment is essential. Thus, it was determined that 441 (47.17%) of 935 children with crossbite could benefit from interceptive treatment. This represents 9.23% of all children examined in this study. Likewise, 277 (36.59%) of the 757 children who had open bite would have to be treated at this stage, i.e., 5.8% of the total. Additionally, 409 (30.80%) of the 1,328 children who had Angle Class II or Class III malocclusion also had skeletal disharmonies that

could be properly corrected at this stage, which translated into functional and aesthetic benefits to 8.56% of the children.

Given some difficulties in implementing a more specific and more detailed standardization, this study sought to provide only an overview of the occlusal situation of Brazilian children. However, with its participation in the project, ABOR has promoted an innovative activity, of great importance for public oral health services as the target audience comprised needy children aged between 6 and 10 years, who had no access to orthodontic guidance and assistance. It was felt that the lack of guidance and public policies aimed at this segment of the population are the key contributing factors to many of the occlusal problems encountered, especially those related to caries and/or tooth loss.

Needless to say, the planning of public health

policies should be grounded in knowledge about the needs of the population, by correlating causes, effects and solutions to the problems. With all the data presented here the authors hope to contribute to such planning by allowing the necessary material and human resources to be properly estimated. Regarding the latter, and taking into account the work published by Michael et al,¹⁴ which found that only 10.1% of undergraduate students from ten dental schools in the state of Rio de Janeiro could identify the characteristics of normal occlusal development, ABOR is aware of the fact that measures undertaken at this level require professionals to demonstrate their ability to perform diagnosis and an accurate treatment based on a solid training provided by a course that meets the requirements recommended by ABOR in Brazil, and by the World Federation of Orthodontists (WFO), in the international arena.

CONCLUSIONS

In light of the results of this research it is possible to conclude that:

» There was an 85.17% prevalence of malocclusion in the children, although it was verified that in 16.77% the occlusal alterations were minor, causing the rate of occlusions that are not conducive to normal development to be reduced to 68.4%.

» Among the children who had unfavorable occlusions, 40.6% had Class I malocclusion, 21.6%, Class II and 6.2%, Class III. Crossbite was present in 19.58%, with 10.41% in the anterior and 9.17% in the posterior region. Moreover, 34.46% had normal overbite, 18.09%, deep overbite and 15.85%, open bite.

» Considering the entire sample, the presence of caries and/or tooth loss was found in 52.97% of the children.

» The possibility of preventive orthodontic intervention was observed in a large portion of the children, including guidance (55.63%), space supervision (8.52%) and approaches related to abnormal pressure habits (5.51%) and to mouth breathing (2.68%).

» Likewise, the need for interceptive orthodontic intervention was detected, involving space maintenance (13.48%), space recovery and/or control (23.79%), crossbite correction (9.23%), open bite correction (5.8%), and orthopedic intervention for correction of Angle Class II or Class III malocclusion (8.56%).

» It became clear that the presence of specialists in orthodontics—duly qualified to meet the standards established by ABOR and the World Federation of Orthodontists (WFO)—in attendance at public health clinics, can greatly benefit underprivileged Brazilian children.

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Comparative study between manual and digital cephalometric tracing using Dolphin Imaging software with lateral radiographs

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Abstract

Objective: The purpose of this study was to compare angular and linear cephalometric measurements obtained through manual and digital cephalometric tracings using Dolphin Imaging® 11.0 software with lateral cephalometric radiographs. **Methods:** The sample consisted of 50 lateral cephalometric radiographs. One properly calibrated examiner performed 50 manual and 50 digital cephalometric tracings using eight angular measurements (FMA, IMPA, SNA, SNB, ANB, I.NA, I.NB, Y-Axis) and six linear measurements (I-NA, I-NB, Co-Gn, Co-A, E Line-Lower lip and LAFH). Results were assessed using Student's t-test. **Results:** The results showed no statistically significant differences in any of the assessed measurements ($p > 0.05$). **Conclusions:** Conventional and computerized methods showed consistency in all angular and linear measurements. The computer program Dolphin Imaging® 11.0 can be used reliably as an aid in diagnosing, planning, monitoring and evaluating orthodontic treatment both in clinical and research settings.

Keywords: Cephalometry. Orthodontics. Computerized diagnosis.

INTRODUCTION

In 1931, Orthodontics ushered in the age of radiographic cephalometry grounded in the historical work of Broadbent in the United States and Hofrath in Germany, who simultaneously developed techniques for obtaining standardized radiographs of the head. Cephalometric radiography is a valuable tool in diagnosis, prognosis,

treatment planning and evaluation, as well as in studies on the growth and development of the dental and craniofacial complex.^{1,7}

Cephalometric tracings can be performed by manual and/or computerized methods. The manual method was, for a long time, the only method used for implementing and obtaining cephalometric tracings, and angular and linear

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measurements required for their interpretation. The main disadvantage of this method lies in the fact that it is relatively time-consuming, particularly for orthodontists.^{5,27}

Continuous technological advances in computing combined with scientific advances in dental radiology resulted in the development of computer programs designed to perform cephalometric tracings and measurements, and different types of analysis. Therefore, in the late '60s and early '70s cephalograms began to take center stage as computers played an increasingly key role in the search for quantitative information regarding orthodontic diagnosis and events associated with craniofacial growth and development.²⁷ A substantial number of programs are available in the domestic and international market offering a wide array of features and variable prices.¹⁵ They have been widely used in orthodontics, especially for storing documentation and facilitating cephalometric tracings.¹⁸ It is undeniable that Orthodontics has benefitted more than any other dental specialty from computerization in structuring and developing its activities while incorporating computer resources to acquire and use information quickly and efficiently.²¹ But given the constant refinement of both software and hardware, it is important for professionals to update their knowledge on an ongoing basis, since computer updates and upgrades are incontestable.

In 1994, during the 2nd Symposium on Computers in Orthodontics, held during the 9th Brazilian SPO Orthodontic Conference, Dolphin Imaging software was first introduced in Brazil. This computer program features high technology and works with cutting-edge graphics software. It provided an alternative way to perform cephalometric tracings without using conventional cephalometric radiographs and therefore paved the way for the use of 3D Cephalometry.¹⁹ It can perform more than 120 different linear and angular cephalometric analyses, all

widely used in Orthodontics and Surgery. Dolphin Imaging software and the emergence of cone beam CT (CBCT) were pioneers in the processing of DICOM files (CT scans) and corresponding 3D cephalometric volumetric and cephalometric measurements in Dentistry.¹⁴ Today, images acquired through CT scans provide 100% reliably accurate measurements. This diagnostic and planning technology is available in major centers worldwide. In the United States this program is widely used by orthodontists and surgeons, attesting to its quality and credibility. In Brazil there are approximately 129 users. This limitation is due to the high cost of the program in view of the country's current socioeconomic reality.

Computer technology has brought to dental practice easier archiving while facilitating the search of administrative and financial information. It has also strengthened the communication channels between professionals and patients by providing information, guidance, documentation images and photographs. The manipulation of these images made it possible to develop computer presentations in programs like Microsoft PowerPoint and others, broadening their use in courses and conferences.^{12,19}

There is no escaping modernization and the great benefits this digital evolution has to offer. Since the cephalometric analysis method is frequently used by orthodontists and researchers and due to continuous advances in Cephalometric software, the need was felt to assess and compare the accuracy of cephalograms by manual methods and digital imaging using Dolphin® 11.0 software (Dolphin Imaging and Management Solutions, Chatsworth, Calif.).

MATERIAL AND METHODS

This cross-sectional study used a random sample of 50 cephalograms of 23 male and 27 female subjects with permanent dentition (up to second molars) with a mean age of 18 years and

four months. These tests were requested prior to treatment as part of the diagnostic elements from the archives of the Professor José Édimo Soares Martins Specialization Program in Orthodontics and Dentofacial Orthopedics, School of Dentistry, Federal University of Bahia (FOUFBA).

These lateral radiographs were obtained in the same radiological clinic and were performed with the patient's head immobilized by a cephalostat guided by the Frankfort Horizontal plane, parallel to the ground and perpendicular to the mid-sagittal plane.

Manual method

After sample selection, a single examiner performed the cephalometric tracings manually. The radiographs were divided into five groups of ten to avoid examiner fatigue during the course of anatomical tracing and landmark marking needed for the study. These were performed over a period of ten days and then the cephalometric measurements were taken. A sheet of Ultraphan transparent tracing paper (3M Unitek,® Campinas, São Paulo, Brazil) measuring 8X10-in and 0.003-in thickness was placed over each tooth, and the tracings were performed using a mechanical pencil (Pentel,® São Paulo, Brazil) with 0.5 mm thick lead. Despite the existence of a large amount of detail that could be traced, only those structures that proved important to this study were reproduced. Left-side anatomical structures were drawn as they exhibit less distortion and also because the computer program (Dolphin Imaging® 11, Management Solutions, Chatsworth, CA) does not trace bilateral structures.

The cephalogram determined the contours of the following structures: Anterior limit of the frontal bone, frontonasal suture, nasal bones, orbit (with its posterior and inferior contours), mechanical porion, sella turcica, clivus, bony palate (traced from the anterior nasal spine to the posterior nasal spine), anterior contour of the maxilla, mandibular condyle, posterior border of

mandibular ramus, lower border of mandibular body, anterior and posterior contours of the symphysis, upper and lower central incisors (which were more proclined), all drawn with the aid of a template (3M Unitek®, Campinas, Sao Paulo, Brazil), and soft tissue profile (Fig 1).

After completion of the cephalograms using the manual and digital methods the following cephalometric landmarks were traced as described by Araújo² and Ferreira¹⁰ and illustrated in Figure 1.

- Point S (Sella); point N (Nasion); point ANS (Anterior Nasal Spine); point Po (Porion); point Or (Orbitale); point A (Subspinale); point B (Supramentale); point Pog (Pogonion); Point Me (Menton); point Go (Gonion); point Gn (Gnathion); point Co (Condylion); point Pn (Nose tip), Li (Lower lip); point Pog' (Soft Tissue Pogonion).

Once the landmarks had been traced, the lines and planes, depicted in Figure 1, could be obtained.

For this evaluation 14 measurements were selected, eight angles derived from the Tweed²⁶

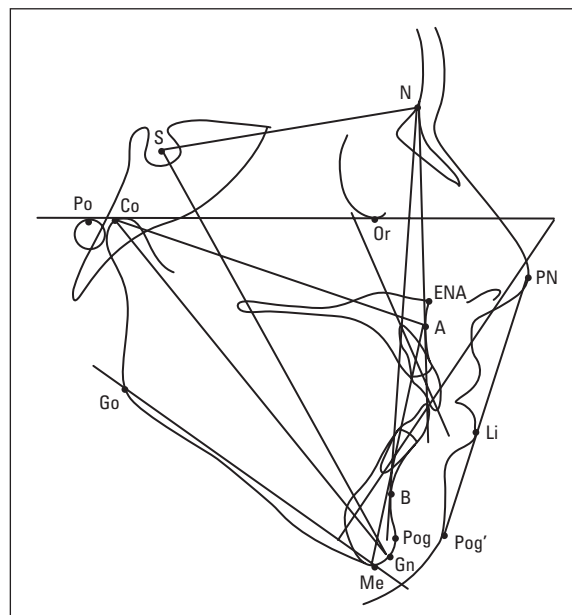


FIGURE 1 - Points and lines used in the study.

(FMA and IMPA); Steiner²³ (SNA, SNB, ANB, 1.NA, 1.NB) and Downs⁹ (Y axis) analyses, and six linear measurements taken from the Steiner,²³ (1-NA, 1-NB); McNamara,¹⁷ (Co-Gn, Co-A, LAFH) and Ricketts²⁰ (LE-Li) analysis.

After performing the tracings, the angular and linear measurements were obtained with the aid of a protractor (ref. 701-401) (3M Unitek®, Campinas, São Paulo, Brazil). The data were then tabulated for subsequent statistical analysis.

Digital methodology (Dolphin)

The 50 cephalometric radiographs were scanned into digital format using an HP Scanjet G4050 and exported to the Dolphin Imaging® 11.0 software (Dolphin Imaging and Management Solutions, Chatsworth, Calif.). An indicator was used (Dolphin® Radiographic Film Calibration Ruler) during image scanning to determine the amount of expansion and establish a proportion for the scanned images. The images were converted to JPEG format and saved with maximum quality with the Dolphin Imaging® 11.0 program. The file size of the final image was about 200Kb, with 200 dpi resolution. A 19" LCD 1550V flat screen monitor (Samsung®, São Paulo, Brazil) was used for viewing the images. When necessary, images were enhanced with brightness, contrast and magnification to identify areas with greater accuracy. The program illustrates all points and their tracing sequence, and allows users to magnify any specific areas.

In a first step, the researcher was properly calibrated by performing five sequential tracings until the technique was mastered. After calibration, 50 cephalometric tracings were performed using Dolphin Imaging® 11.0.

After scanning the radiographs and registering the patients a specific analysis, called MB analysis, was developed especially for use in this study. This analysis encompasses the following steps: 1) Selecting the cephalometric radiograph,

2) Clicking on the command "digitize", 3) Running the custom analysis editor, 4) Selecting the option "Single Analysis" to create a custom analysis (Fig 2) based on the linear and angular measures proposed by Tweed, Steiner, Downs, McNamara, Ricketts, as mentioned above.

The 42 cephalometric landmarks required by MB analysis were traced and digitized using Dolphin Imaging® 11.0 software.

Before implementing the digital tracings it was essential to determine the start and end points of the ruler (100 mm) with the purpose of rendering the actual size of each radiographic image (Fig 3).

The program illustrates all points and their tracing sequence, and allows users to magnify any specific areas (Fig 4).

By joining the above points the digital tracings were performed and linear and angular values obtained (Fig 5), which were accessed automatically by selecting the "Meas" (measures) button. Subsequently these values were treated statistically.

Statistical analysis

Data analysis

Evaluation of statistical differences between angular and linear measurements by the manual and digital methods was performed using Minitab software, version 14, and applying Student's t-test. Intraexaminer error was assessed by means of ten new, randomly selected tracings (five manual and five digital) after 20 days. The data obtained at T1 and T2 were compared using Student's t-test.

RESULTS

Intraexaminer error results showed no statistically significant difference at T1 and T2, as depicted in Tables 1 and 2.

Comparison of angular and linear measurements between the digital and manual groups is described in Tables 3 and 4.

TABLE 1 - Comparison between the means and standard-deviations of linear and angular measurements obtained from manual tracings at T1 and T2.

Variables	Manual tracings (T1)	SD	Manual tracings (T2)	SD	p value
FMA	26.80	5.11	27.20	5.40	0.908
IMPA	95.40	4.67	95.20	4.21	0.945
SNA	83.00	5.29	83.00	4.69	1.000
SNB	77.50	3.87	77.90	3.29	0.865
ANB	5.50	2.69	5.10	2.92	0.828
1.NA	21.8	11.2	22.2	12.6	0.959
1.NB	28.20	7.92	29.60	8.73	0.798
Y Axis	59.70	2.39	60.60	1.52	0.503
1.NA	5.40	2.88	5.40	3.85	1.000
1.NB	6.80	3.47	6.60	3.21	0.927
Co-Gn	129.90	9.09	131.10	9.26	0.842
Co-A	102.10	1.67	102.40	2.07	0.808
LE-Li	1.50	3.64	1.30	3.75	0.934
LAFH	79.30	8.25	78.80	8.56	0.928

LE-Li = E Line-Lower lip.

TABLE 3 - Comparison between the means and standard-deviations of angular measurements obtained from manual and computerized tracings.

Variables	Manual mean (SD)	Dolphin mean (SD)	p value
FMA	27.46 (5.33)	27.59 (5.11)	0.90 n.s.
IMPA	96.27 (7.35)	95.50 (7.73)	0.61 n.s.
SNA	82.75 (3.63)	82.56 (3.61)	0.78 n.s.
SNB	78.75 (3.49)	78.55 (3.43)	0.77 n.s.
ANB	3.99 (2.86)	4.00 (2.84)	0.98 n.s.
1.NA	27.73 (8.91)	26.95 (8.90)	0.66 n.s.
1.NB	30.96 (7.20)	30.06 (7.66)	0.54 n.s.
Y Axis	59.57 (4.02)	60.15 (3.98)	0.47 n.s.

(n.s.=non-significant, p>0.05).

mandibular incisors,¹ or both.^{3,16} Brangeli et al³ and Martins et al¹⁶ argued that dental structures are difficult to locate and measurements of such structures have low reliability in both methods (manual and digital). In this study, the smallest p values were found in the Y-axis (p=0.47) and in incisor-related angular measurements

TABLE 2 - Comparison between the means and standard-deviations of linear and angular measurements obtained from digital tracings at T1 and T2.

Variables	Digital tracings (T1)	SD	Digital tracings (T2)	SD	p value
FMA	27.3	5.17	26.88	5.61	0.88
IMPA	94.04	4.10	93.46	2.7	0.80
SNA	82.14	5.78	82.02	4.6	0.97
SNB	77.52	3.67	77.54	3.5	0.99
ANB	5.22	2.82	4.46	3.25	0.71
1.NA	20.76	11.12	21.34	13.4	0.94
1.NB	27.94	7.81	26.76	6.75	0.80
Y Axis	60.28	8.09	60.4	2.72	0.95
1-NA	5.82	3.27	6.72	4.6	0.73
1-NB	6.92	3.52	6.8	3.13	0.96
Co-Gn	130.38	8.91	130.66	9.72	0.96
Co-A	101.62	3.07	100.22	1.87	0.44
LE-Li	1.96	2.65	1.98	3.17	0.99
LAFH	80.04	8.09	60.4	7.96	0.92

(n.s.=non-significant, p>0.05).

TABLE 4 - Comparison between the means and standard-deviations of linear measurements obtained from manual and computerized tracings.

Variables	Manual mean (SD)	Dolphin mean (SD)	p value
1.NA	8.23 (3.20)	8.02 (3.22)	0.74 n.s.
1.NB	7.97 (3.44)	7.91 (3.41)	0.92 n.s.
Co-Gn	125.37 (7.55)	125.09 (7.81)	0.85 n.s.
Co-A	96.29 (5.22)	95.68 (5.71)	0.57 n.s.
LAFH	74.11 (7.37)	74.45 (7.41)	0.81 n.s.
LE-Li	2.12 (3.76)	2.53 (3.56)	0.57 n.s.

(n.s.=non-significant, p>0.05).

(1.NB p=0.54, IMPA p=0.61; and 1.NA p=0.61), as shown in Table 3, but can still be considered reliable in both evaluation methods.

The lower reliability observed in the Y-axis angle was also found in a similar investigation conducted by Chen et al,⁴ who encountered considerable difficulty in locating the point Gnathion.

It is a known fact that locating points on the apexes of incisors poses some serious difficulty in both radiographic film and scanned images. The latter can be even more challenging due to the presence of gray shades that merge in this region. Even when software features such as filtering and zooming are used, the task of locating these points is even more difficult than in X-ray films.²⁷ On the other hand, Albuquerque-Júnior and Almeida¹ and Chen et al⁵ argue that the computerized method is reliable as it exhibits lower error variance than the conventional method. Forsyth et al,¹¹ however, in 1996, asserted that errors in the identification of points, angular and linear measurements tend to occur more often in digital images than in conventional radiography. Nonetheless, since no significant differences were found in this study, the authors consider the digital method sufficiently reliable for use in Orthodontics.

Assessment of the linear values obtained in digital and manual tracings (Table 4) showed that this comparison did not yield any significant differences. Lower p values can be observed in the Co-A ($p=0.57$) and LE-Li ($p=0.57$) measures. Collins et al⁷ found statistically significant differences in linear measurements but these authors compared the Dolphin measurements of scanned and photographed images and found linear distortions in the latter.

This study found that the digital method is reliable, corroborating most authors^{1,3,8,24,25,27} who compared different cephalometric tracing

methods and programs and indicated its use in orthodontic practice.

Nowadays, digitizing X-rays has become the preferred method to perform cephalometric measurements. As technology evolves it becomes increasingly easier for professionals to adapt to the many routine tasks of clinical practice. This scientific investigation supports other studies published in the literature,^{5,8,25,27} which confirm the enhanced effectiveness provided by today's technological resources.

This study evaluated the reliability of angular and linear measurements in manual and computerized cephalometric tracings performed with the aid of Dolphin Imaging® 11.0 software. However, further studies should be performed using this computer program since it features other tools for cephalometric tracing, such as overlays, predictive tracings for orthognathic surgery and profile manipulation, in addition to the options provided by the 3D program itself, which involves three dimensions.

CONCLUSIONS

According to the methods used in this study and the results achieved by comparing angular and linear measurements of manual and digital tracings it is reasonable to conclude that the cephalometric program Dolphin Imaging® 11.0 can be used reliably as an aid in diagnosing, planning, monitoring and evaluating orthodontic treatment both in clinical and research settings.

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Angle Class III malocclusion, subdivision right, treated without extractions and with growth control*

Sérgio Henrique Casarim Fernandes**

Abstract

Angle Class III malocclusion is characterized by anteroposterior dental and facial discrepancies usually accompanied by skeletal changes associated with a genetic component. Early, accurate diagnosis and appropriate treatment are of paramount importance to promote growth control and prevent relapse. This article reports the two-phase treatment of a female patient, aged 12 years, with an Angle Class III, subdivision right malocclusion with anterior crossbite in maximum intercuspation (MIC) and end-on bite in centric relation, further presenting with lack of maxillary space. The case was treated without extractions and with growth control. This case was presented to the Brazilian Board of Orthodontics and Facial Orthopedics (BBO) as representative of Category 1, i.e., Angle Class III malocclusion treated without tooth extractions, as part of the requirements for obtaining the BBO Diploma.

Keywords: Angle Class III. Maxillary protraction. Interceptive orthodontics.

* Case report, Category 1 - approved by the Brazilian Board of Orthodontics and Facial Orthopedics (BBO).

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HISTORY AND ETIOLOGY

The female Caucasian patient presented for orthodontic consultation at age 12, with good general health, reporting no history of serious illness and/or trauma. She had no sucking or postural habit and had normal swallowing and speech.

She was in the permanent dentition phase with second maxillary molars still missing. Menarche had occurred five months earlier, suggesting that the patient was in the deceleration phase of pubertal growth spurt. She

had no relevant carious lesions and no periodontal problems. In centric relation (CR) she presented with an end-on bite in the anterior region, and maximum intercuspation (MIC), severe anterior crossbite (Figs 1, 2 and 3). In researching the family history it was found that the mother had an end-on dental relation in the anterior region. The patient's chief complaint was esthetics-related. According to her, she was greatly disturbed by the protrusion of her lower teeth.



FIGURE 1 - Initial facial and intraoral photographs in centric relation (CR).

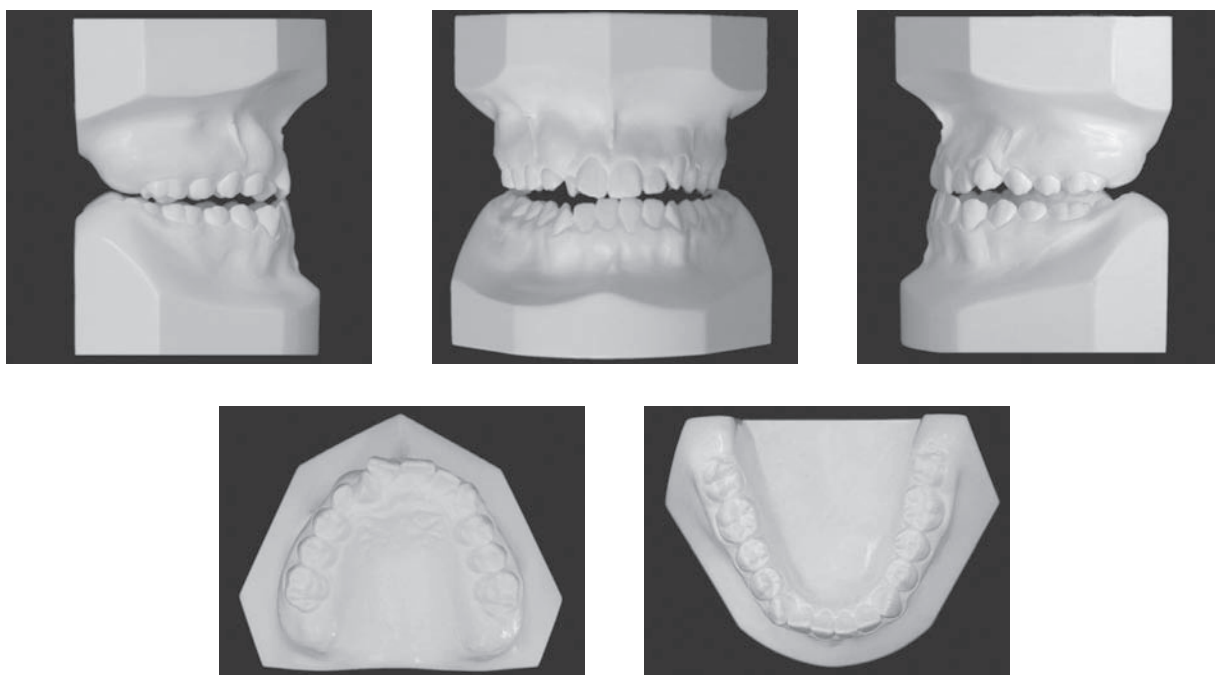


FIGURE 2 - Initial models in CR.

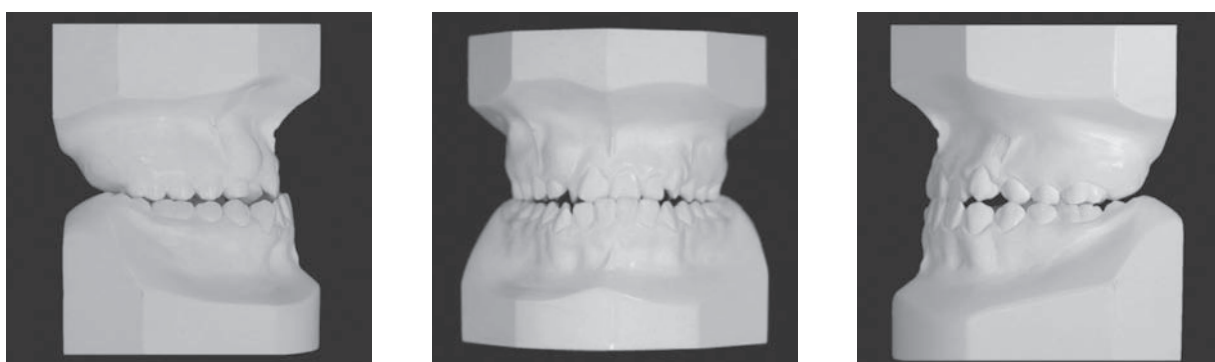


FIGURE 3 - Initial models in maximum intercuspation (MIC).

DIAGNOSIS

The patient showed facial symmetry, a straight profile, proportional vertical thirds, lip competence and a predominantly nasal breathing pattern (Fig 1).

From a dental perspective, she presented, in CR, an Angle Class III malocclusion, right subdivision, end-on incisor relationship and, on the right side, bilateral posterior open bite, maxillary and mandibular crowding with rotations, lack of space for tooth 13 with slight impingement, permanence of tooth 53 and midline shift greater than

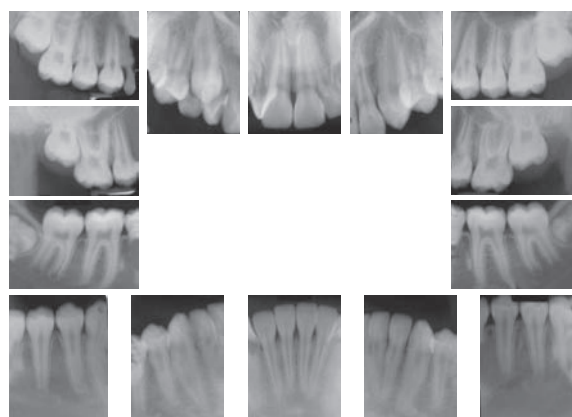


FIGURE 4 - Initial periapical radiographs.

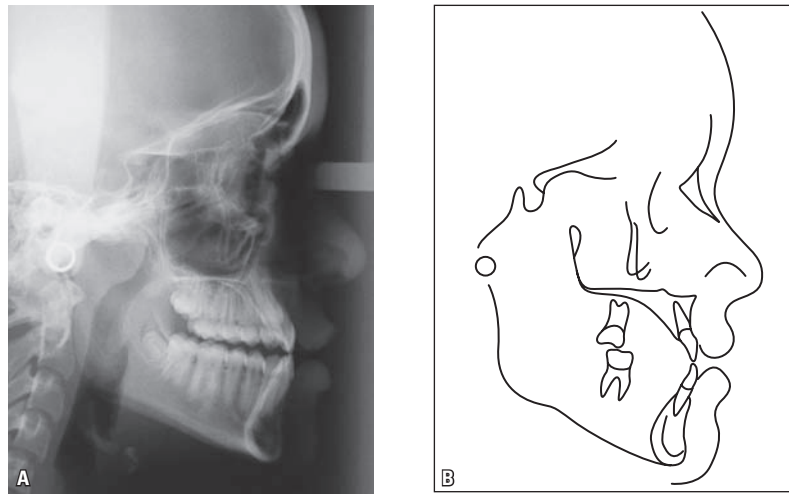


FIGURE 5 - Initial lateral cephalogram in CR (A), and cephalometric tracing (B).

3.5 mm to the right (Figs 1, 2). When in MIC, the Angle Class III malocclusion worsened with severe anterior and right lateral crossbite, as well as deep overbite (Fig 3).

The analysis of periapical radiographs revealed the presence of all permanent teeth, in addition to tooth 53, and the early formation of third molars. No changes capable of compromising orthodontic treatment were found (Fig 4).

The dental pattern featured retroclined lower incisors ($1-NB = 15.5^\circ$ and $IMPA = 84^\circ$), slightly protruding and inclined maxillary incisors ($1-NA = 6.5$ mm and $1-NB = 24$), which was consistent with her Class III malocclusion (Table 1).

Cephalograms in CR (Fig 5) exhibited a Class III skeletal pattern, especially due to maxillary retrusion ($WITS = -7$ mm; $ANB = -2^\circ$, with $SNA = 75^\circ$ and $SNB = 77^\circ$), with an increased lower facial third ($SN-GoGn = 34.5^\circ$; $FMA = 32^\circ$ and Y Axis = 67). It is noteworthy that these values were influenced by the end-on relation of the incisors during projection in CR. The cephalometric measurements can be evaluated in Table 1.

TREATMENT GOALS

Since this patient was still growing, the key

objective was to redirect mandibular growth, improving the relationship between the upper and lower lips. As regards the dental aspects, space was required for the correction of crowding, rotations and midline. The purpose was to maintain the inclination of maxillary incisors and enhance lower incisor inclination buccally, as well as achieve appropriate canine and molar relationships. From a skeletal standpoint, the aim was to reduce the anteroposterior discrepancy by maxillary protraction and redirection of mandibular growth with the purpose of enabling a more harmonious growth, expanding the upper arch and controlling the vertical direction of growth.

TREATMENT PLANNING

To attain the desired results, the patient and her parents were informed of the importance of compliance in wearing the appliances and the need to perform the treatment in two phases.

In the first phase, a removable "Skyhook" type appliance (600 g) would be used in conjunction with a Hyrax-type palatal expansion appliance with two daily activations to correct the crossbite. In addition to the expander, brackets would be

bonded to the upper incisors (Roth prescription, 0.022x 0.028-in slot) to start the alignment and leveling phase, and if necessary, slightly protrude these teeth.

In the second phase, the expander would be removed and a chin cup prescribed for night use. The complete fixed orthodontic appliance would be set up to proceed with alignment and leveling using 0.012-in nickel-titanium (NiTi) and 0.014-in to 0.020-in stainless steel archwires. If necessary, from the moment archwire progression reached 0.018-in archwires, Class III intermaxillary elastics would be used on the right side. Rectangular 0.019x0.025-in stainless steel archwires would then be used in both arches to finish the case. After the end of active treatment, a 0.8 mm lower fixed canine-to-canine lingual retainer would be bonded and in the upper arch a removable wraparound type appliance to be worn 24/7 for six months, and then nights only for six months. The patient and her parents were also informed in writing of the need for careful hygiene and proper care of the appliances to ensure the normal development of treatment and retention.

TREATMENT PROGRESS

Initially, bands were contoured for the first molars and an impression of the upper arch and chin were taken for fabrication of the appliances planned for the case. The Hyrax-type appliance was installed with two buccal extensions in the canine region for attachment of the protraction elastics, with a recommendation of two daily activations (0.5 mm per day). The Skyhook was also set up (to be used at least 16 hours per day), with a maxillary traction force of 300 g on each side (heavy 3/16-in elastics). The elastics were placed at an angle of 30° to the occlusal plane so as to offset a counterclockwise rotation likely to occur in the maxilla. Expansion proceeded as expected and after ten days of activation the screw was stabilized. After 21 days, Roth prescription straight wire metal brackets were bonded to the maxillary

incisors for leveling and alignment while creating space for tooth 13. Six months later, the expander and protraction appliance were removed. The patient's anterior and posterior crossbites were corrected, along with the dental Class III. At this point, the remaining upper and lower appliances were installed and the first NiTi 0.012-in archwire inserted for alignment and leveling. This was followed by a sequence of 0.014-in, 0.016-in, 0.018-in and 0.020-in stainless steel archwires. From this point on, Class III elastics began to be used (5/16-in with 200 g force) to control the Angle Class III malocclusion. In the lower arch interproximal stripping was performed on the incisors to correct the crowding. Next, rectangular 0.018x0.025-in archwires were used to correct the torque of tooth 12 and adjust its root position, which was palatally tipped. After the final correction of the torques with an ideal 0.019x0.025-in archwire and the assurance that the intended goals had been achieved, the brackets were removed and the retainer bonded. A lower bonded canine-to-canine retainer was made with 0.8 mm stainless steel wire and was used, along with an upper wraparound-type removable appliance, and the patient was instructed to wear the removable retainer 24 hours a day during the first six months and then nights only for another six months.

TREATMENT RESULTS

In evaluating the results (Figs 6 to 10) on completion of treatment and six years after removal of the appliance (Figs 11 to 15), one can observe that both the intended goals and the stability of treatment were rather successfully achieved. The posterior crossbite was corrected and the redirection of growth in the anteroposterior direction was also successful. In the mandible there was an increase of 1.5° in SNB, from 77° to 78.5° during treatment while the maxilla showed an increase of 2.5° in SNA, from 75° to 77.5°. Thus, there was an increase of 1° in the ANB, which rose from -2° to -1° (Fig 10, Table 1).



FIGURE 6 - Final facial and intraoral photographs.

The vertical dimension was controlled, maxillary position maintained and mandibular plane angle (SN-GoGn) decreased from 34.5° to 31° . Although it may seem a considerable decrease, it is important to remember that the first cephalometric radiograph was performed in CR, and in this position the incisors had an end-on relationship, which led to further opening of the mandibular plane. Regarding dental positions, appropriate alignment and leveling were attained as well as correction of the Angle Class III, crossbite, midline, overbite and overjet, in ad-

dition to establishing correct disocclusion guidance. Unfortunately, the upper incisors had to be tipped labially by 15° , from 24° to 39° . The upper molars however were moved mesially, providing normal occlusion according to Andrews' six keys. A slight intrusion of the maxillary incisors and small 4° lower incisor tipping toward labial, from 15.5° to 19° (Fig 10, Table 1) were also performed. Despite these changes, the intermolar and intercanine widths remained stable except for a slight 1 mm decrease in mandibular intermolar width (Table 1). The face exhib-

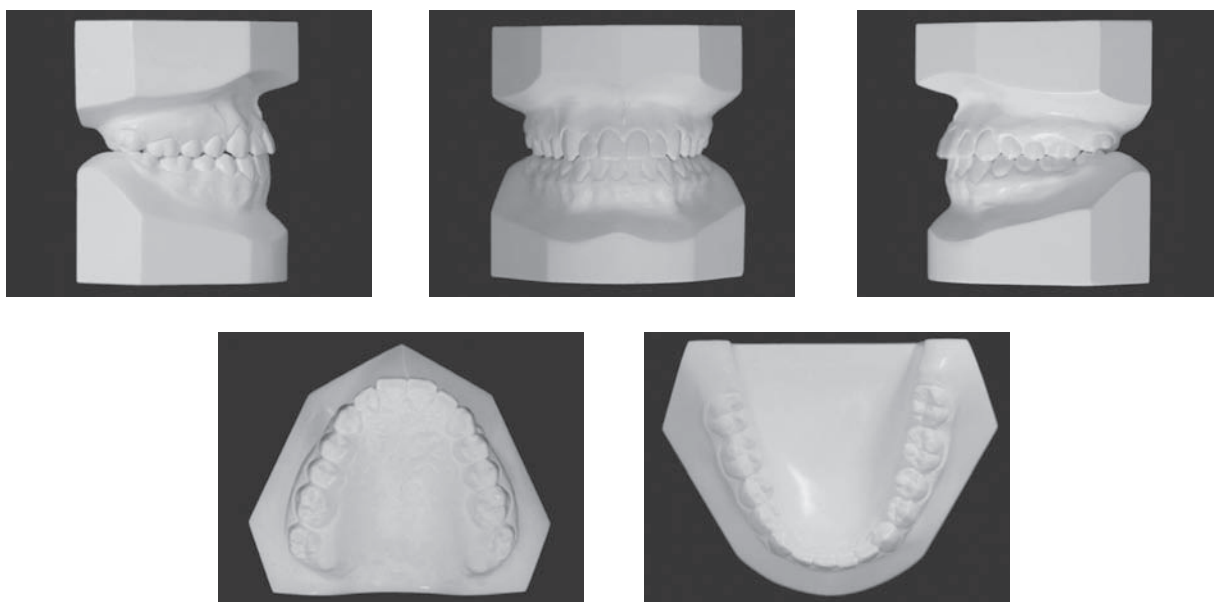


FIGURE 7 - Final models.

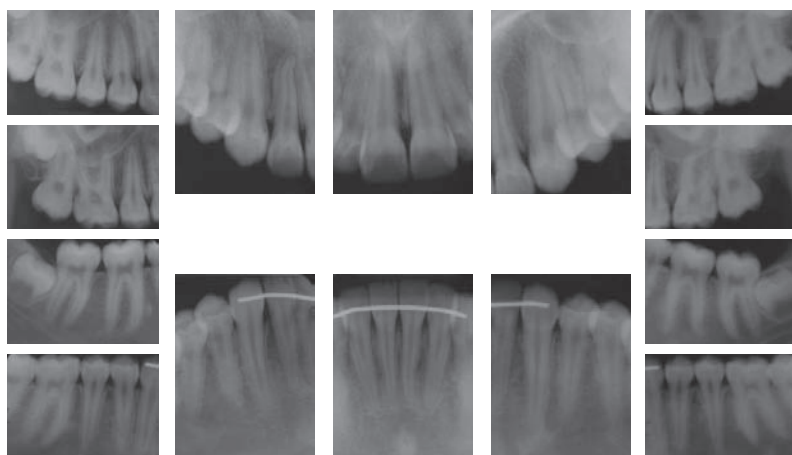


FIGURE 8 - Final periapical radiographs.

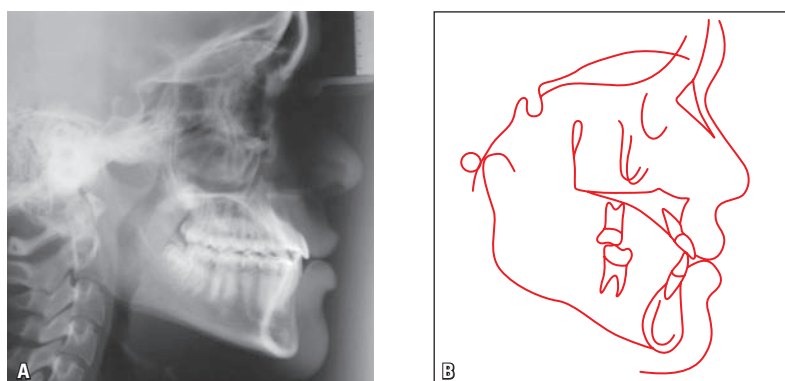


FIGURE 9 - Final lateral cephalogram (A) and cephalometric tracing (B).

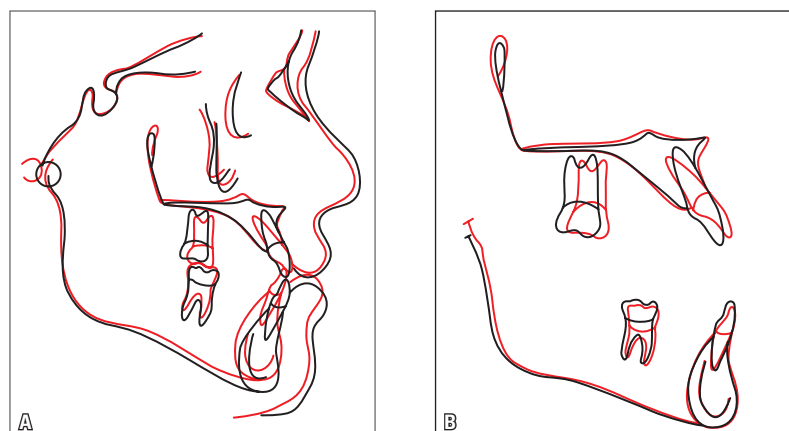


FIGURE 10 - Total (A) and partial (B) superimposition of initial (black) and final (red) cephalometric tracings.



FIGURE 11 - Facial and intraoral follow-up photographs taken six years after treatment.

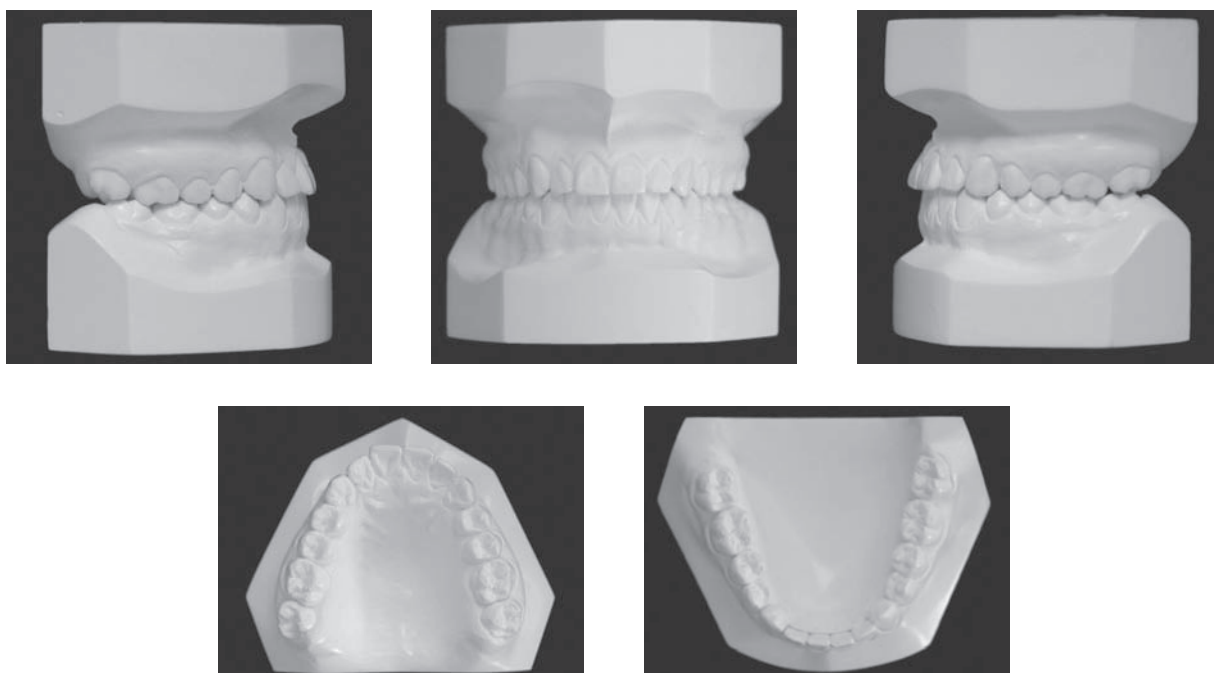


FIGURE 12 - Follow-up models six years after treatment.

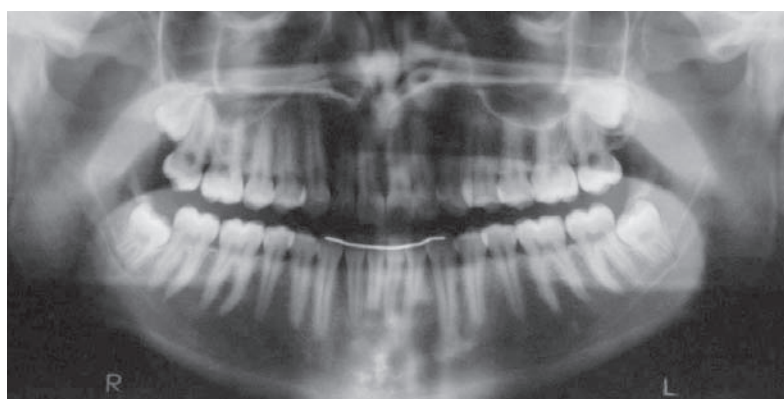


FIGURE 13 - Panoramic radiograph six years after treatment.

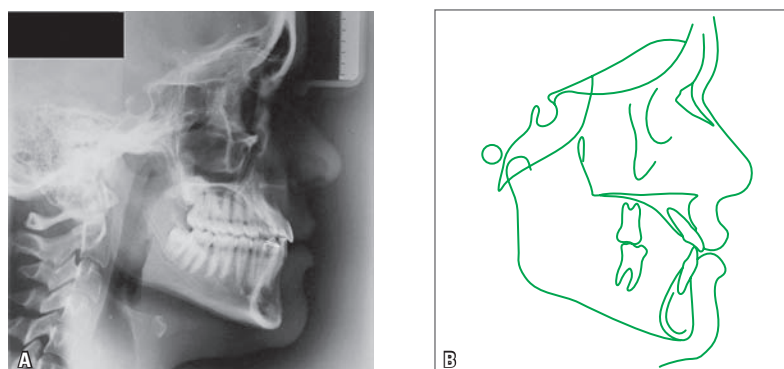


FIGURE 14 - Follow-up profile cephalometric radiograph (A) and cephalometric tracing (B) six years after treatment.

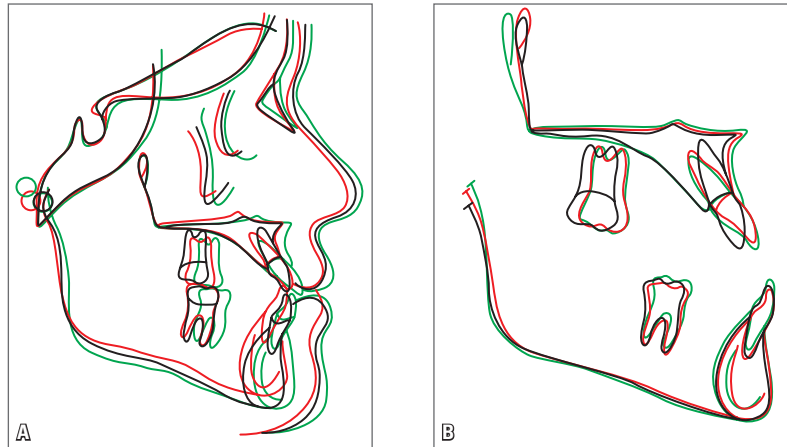


FIGURE 15 - Total (A) and partial (B) superimposition of initial (black), final (red) and follow-up (green) cephalometric tracings six years after treatment.

TABLE 1 - Summary of cephalometric measurements.

	MEASUREMENTS	Normal	A	B	Difference A/B	C
Skeletal Pattern	SNA (Steiner)	82°	75°	77.5°	2.5	77°
	SNB (Steiner)	80°	77°	78.5°	1.5	78°
	ANB (Steiner)	2°	-2°	-1°	1	-1°
	Convexity Angle (Downs)	0°	-4°	-4°	0	-3°
	Y-Axis (Downs)	59°	67°	62°	5	62°
	Facial Angle (Downs)	87°	80°	89°	9	84°
	SN-GoGn (Steiner)	32°	34.5°	31°	3.5	32.5°
	FMA (Tweed)	25°	32°	27°	5	26.5°
	IMPA (Tweed)	90°	84°	89°	5	88°
Dental Pattern	$\underline{1}$ - NA (degrees) (Steiner)	22°	24°	39°	15	40°
	$\underline{1}$ - NA (mm) (Steiner)	4 mm	6.5 mm	8 mm	1.5	7.5 mm
	$\bar{1}$ - NB (degrees) (Steiner)	25°	15.5°	19°	3.5	17.5°
	$\bar{1}$ - NB (mm) (Steiner)	4 mm	4 mm	3 mm	1	3.5 mm
	$\frac{1}{\bar{1}}$ - Interincisal Angle (Downs)	130°	143°	126°	17	124°
	$\bar{1}$ - APo (mm) (Ricketts)	1 mm	2 mm	2 mm	17	1.5 mm
Profile	Upper Lip – S Line (Steiner)	0 mm	0 mm	0 mm	0	-1 mm
	Lower Lip – S Line (Steiner)	0 mm	1 mm	0.5 mm	3	0 mm
	WITS	0 mm	-7 mm	-4 mm	3	-3 mm
	Inter canine Width	Upper Lower	NE 27 mm	34 mm 27 mm	— 0	34 mm 26.5 mm
	Inter molar Width	Upper Lower	53 mm 46 mm	53 mm 45 mm	0 1	54 mm 46 mm

ited a slight improvement in profile with a slight protrusion of the upper lip while chin position and vertical dimension were preserved. Regarding stability, it was noted that six years after completion of treatment the patient's occlusion was well established with well preserved molar and canine relationships, disocclusion guidance, adequate overbite and overjet, and facial aesthetics (Figs 11 and 12). From a cephalometric standpoint one can note that the measurements relating to the position of the maxilla and mandible underwent minor changes, consistent with the pattern of growth, while the dental measurements remained fairly stable (Fig 15, Table 1).

FINAL CONSIDERATIONS

Angle Class III malocclusion is difficult to plan and control as it may have a powerful genetic component.¹⁻¹⁰ Moreover, there are several other etiological factors to consider, such as poor individual tooth positions, mandibular overgrowth, inadequate maxillary growth, vertical problems or a combination of several of these factors.^{2,3,4,6} Planning should consider all these factors in addition to patient age to try to predict treatment outcome and stability.^{1,8,9} In this particular case, it is important to remember that cephalometric radiographs, photographs and initial models were performed in CR, which may have diminished

mandibular cephalometric measurements in an anteroposterior direction, and augmented them in terms of vertical relations, masking a more severe Class III. In MIC, the patient had a fully functional crossbite with the upper incisors being covered by their lower counterparts. The reason why all records were taken in CR was to show that even in CR the patient had indeed a genuine Angle Class III malocclusion relationship. Therefore, the goals were achieved, i.e. the molar relationship, anterior and posterior crossbites and midline shift were all corrected. The skeletal pattern also improved with greater maxillary growth in relation to the mandible, and although the cephalometric results showed only minor changes, one must remember again that the initial radiograph was performed in CR, which may have minimized the problem presented by the patient. However, in order to establish a correct relationship in the anterior region, the maxillary incisors had to be excessively tipped, in line with the compensatory treatment used for Class III malocclusion, which was intended in this case. Treatment stability, both esthetic and functional, was verified during a six-year follow-up period. There was slight extrusion of incisors and molars but the growth pattern remained fairly stable. It is thus possible to confirm that the mechanics used in this case was effective and well indicated.

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Lower incisor extraction: An orthodontic treatment option

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Abstract

Lower incisor extraction can be regarded as a valuable option in the pursuit of excellence in orthodontic results in terms of function, aesthetics and stability. The aim of this study was to gather information about the indications, contraindications, advantages, disadvantages and stability of the results achieved in treatments performed with lower incisor extraction. This treatment option may be indicated in malocclusions with anterior tooth size discrepancy due to narrow maxillary incisors and/or large mandibular incisors. It is contraindicated in malocclusions without anterior discrepancy or with discrepancies caused by large maxillary incisors and/or narrow mandibular incisors. The literature suggests this method affords improved posttreatment stability compared with premolar extraction. As well as a careful diagnosis, established with the aid of a diagnostic setup, professional skills and clinical experience are instrumental in achieving successful orthodontic results with this treatment option.

Keywords: Orthodontics. Corrective Orthodontics. Tooth extraction.

INTRODUCTION

The development of orthodontics through scientific research and clinical observations has brought with it the realization that in order to achieve a normal occlusion tooth extraction is often required, be the extracted teeth premolars—as is predominantly the case—or other teeth.

Extractions for orthodontic purposes were made as early as the eighteenth century by Hunter, whose reports were published in his book: “The Natural History of Human Teeth.” Edward Hartley Angle condemned this practice in the belief that “...better balance, more harmony and the best possible proportions of the mouth in its multiple

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relationships require the presence of all teeth and each tooth should occupy a normal position.”³

This assertion was disputed by Calvin Case, who argued that the basal bones could not be induced by mechanical means to grow beyond its inherent size. Therefore, without extractions it would not be possible to resolve severe skeletal-dental discrepancies, and it would not justify compromising normal occlusion and producing severe protrusion by keeping all teeth in the mouth.³ Case warned, though, that patients should not be treated according to a single model since malocclusions can have either hereditary and environmental origins, or even a combination of the two.³ Therefore, extraction of permanent teeth should be considered in the treatment of certain malocclusions.³ Eventually, tooth removal became common practice in orthodontic treatment and the first premolars were almost always selected due to their proximity to the incisors, which enabled correction and retraction of these teeth.

If, on the one hand, extractions facilitated orthodontic mechanics, on the other, they brought to light a range of treatment options, and in order for better planning to be established and practiced it is crucial that diagnosis be thorough and well executed. Besides periapical, panoramic and occlusal X-rays, cephalograms, photographs and models, it is essential to produce a diagnostic setup.⁴

Prior to choosing the most favorable treatment option it is important to analyze treatment goals, stability, the final occlusion to be achieved and the esthetic conditions that constitute a case. In view of this fact, lower incisor extraction becomes an alternative treatment for malocclusions that do not fit the conventional forms of extraction since they are more stable in the long term.²¹

The aim of this study was to compile available information in the literature, emphasizing indications, contraindications, advantages and disadvantages, stability of results, limitations, clinical considerations and case reports on the extraction

of mandibular incisors as an additional option in the correction of malocclusion.

INDICATIONS

» Angle Class I malocclusion with severe anterior tooth size discrepancy (greater than 4.5 mm) due to agenesis of incisors or a deficient mesiodistal diameter of the upper incisors (narrow) or, conversely, excessive mesiodistal diameter of the mandibular incisors.^{1,10,17,20,28}

» Dental Class I malocclusions with normal maxillary dentition, adequate posterior intercuspation and lower anterior crowding with lack of space for approximately one mandibular incisor.^{1,24,28}

» Dental Class I malocclusions with anterior crossbite due to crowding and protrusion of the lower incisors; adequate posterior intercuspation, acceptable facial esthetics and absence of skeletal-dental discrepancy in the upper arch.²²

» Cleft lip and palate cases where, after mandibular surgery, it was not possible to establish proper overbite and overjet, rendering necessary the extraction of a mandibular incisor to foster stable surgical results.²³

» Cases in which one wishes to avoid increasing intercanine width in certain malocclusions.^{6,12,20,27}

» Malocclusions that tend towards a Class III malocclusion.^{8,9}

» As a non-surgical alternative in Class III treatments.^{7,8}

» As a compromise solution in adult treatment or in relapse situations.³⁰

» Adult patients with mild to moderate Class III malocclusion with relatively small crowding and incisors with a non-triangular form.⁸

» Moderate Class III malocclusions with anterior crossbite, or incisors with edge-to-edge relationship, showing a tendency towards anterior open bite.⁷

» Class II Division 1 skeletal and dental malocclusions with maxillary protrusion and crowding

or protrusion of the lower incisors. Typically, lower incisor extraction should be associated with the extraction of maxillary premolars while keeping the Class II molar relationship but establishing normal canine occlusion.^{11,12,13,18,29}

» Malocclusions with a malformed or periodontally compromised mandibular incisor, whose maintenance would not provide any benefit whatsoever in view of the stability of the dentition as a whole.^{6,7,21,28}

It is noteworthy that the main indication to extract a lower incisor is the presence of tooth size discrepancy equal to or greater than 4.5 mm due to lower anterior excess or upper anterior deficiency.^{1,15,21,28}

CONTRAINDICATIONS

» All cases requiring extractions in both arches with severe overbite and horizontal growth pattern, bimaxillary crowding, no tooth size discrepancy in the anterior teeth, anterior tooth size discrepancy due to narrow mandibular incisors and/or broad maxillary incisors, pronounced overjet.^{1,28}

» Cases with “triangular” lower incisors and minimum crowding with less than 3 mm lack of space, which should preferably be treated without extractions by stripping the incisors to prevent the reopening of spaces and loss of interdental gingival papilla between the remaining incisors, which might compromise esthetics.^{2,8,20,28}

» Cases where the diagnostic setup demonstrates that lower incisor extraction can result in excessive overbite.²⁹

» Cases in which a high insertion of the lower labial frenum may cause gingival recession in the remaining incisor to be moved to the frenum area.²⁹

ADVANTAGES

Lower incisor extraction apparently includes the following advantages:

» Maintains or reduces intercanine width.¹⁰

» Maintains the overall arch form, minimizing or preventing its expansion, preserving supporting structures¹¹ and increasing the potential for greater stability.^{6,28}

» Reduces retention time as the likelihood of relapse is decreased.^{6,28}

» Quickly retracts anterior segments, if necessary.^{6,28}

» Diminishes the risk of anchorage loss since there is a solid anchorage unit in the posterior segments.^{6,28}

» Reduces the need for elastic use. This is especially important for children or patients with behavioral disorders or non-compliant individuals.^{6,28}

» Provides space in the area of greater crowding in the pretreatment stage.^{8,10,24}

» Improves parallelism between lower anterior tooth roots and reduces root proximity.¹⁰

Mandibular incisor extraction allows a reduction in tooth volume, minimizing changes in profile while reducing treatment time.^{11,22} It allows orthodontists to improve dental occlusion and esthetics through minimum orthodontic action.¹¹

Levin¹⁴ argues that lower incisor extraction:

» Improves facial profile by reducing the appearance of “mandibular protrusion.”

» Enables easy alignment of the lower anterior teeth.

» Establishes an esthetically pleasing and functionally effective overbite.

» Properly positions upper anterior teeth with acceptable axial inclinations instead of having to procline them to enable the positioning of all lower anterior teeth.

DISADVANTAGES

According to Brandt and Safirstein.⁶

» There is a tendency for space to reopen in the extraction site, especially when a lower central incisor is extracted. Irrespective of the parallelism between the roots adjacent to the extraction area the incidence of space reopening is common.

» It can create a tooth size discrepancy, especially if lower incisor extraction is associated with premolar extraction.

» There may be differences in color between lateral incisors and canines, which are often darker. This complication can and should influence the treatment plan, particularly in female patients.

Other undesirable effects include: increased overbite and overjet beyond acceptable limits, partially inadequate occlusion, crowding relapse in three incisors as well as esthetic loss of interdental gingival papilla in the extraction area.^{8,22,28,30}

Removal of a lower incisor also affects the inter-occlusal relationship of anterior teeth. If the upper anterior teeth are not sufficiently reduced through stripping, a more pronounced overjet may remain.^{11,25}

According to Canut⁷, in certain cases, especially in adults, space cannot be completely closed or can easily reopen, resulting in a visible diastema in an area of considerable periodontal and esthetic importance. Moreover, an inadequate dental midline relationship compromises dental esthetics.

Sheridan and Hastings²⁵ argue that a remaining triangular space may appear in the extraction area, especially in older patients.

DIAGNOSTIC SETUP

Setup is a diagnostic tool that shows orthodontic treatment outcome in study models to aid in determining the best treatment option. One can simulate various treatment options such as: without extractions, with stripping, with increased axial inclination, with premolar extraction or associated procedures.¹⁶

Kokich, Shapiro¹¹ and Tuverson²⁹ summarize the importance of the setup as one of the most valuable orthodontic records to determine if a lower incisor requires extraction. Setup is the most accurate method to predict potential interocclusal relations to be accomplished through orthodontic treatment, and it would be reckless to start treatment without first reviewing the overjet and overbite that would result from such procedure. It should be emphasized

that if overbite is excessive or buccal occlusion is unacceptable in the setup, stripping the upper arch should be considered, within acceptable limits. If the occlusal outcome remains dissatisfactory then probably the extraction of an incisor should not be the treatment of choice.²⁹

SELECTION OF THE INCISOR TO BE EXTRACTED

Following the decision to extract one lower incisor, professionals must define which one to remove. Indication depends on a combination of the following factors: type of malocclusion, amount of anterior tooth size discrepancy, arch length deficiency in the anterior region, dental and health conditions of the supporting tissue and upper and lower dental midline relationship.¹

Type of malocclusion and periodontal tissue health may influence the choice of the tooth to be extracted since if the tooth is diagnosed with ankylosis, tooth rotation or severe ectopic eruption far away from its normal position, it becomes the best option. Extraction of the worst positioned incisor is a means to prevent relapse by limiting the unnecessary movement of many teeth.⁷

Bolton's tooth size analysis may assist in determining the discrepancies and asymmetries in both arches, thereby establishing whether the best indication would be the removal of the wider lateral incisor or the narrower central incisor.^{5,30} Some professionals still prefer to remove the narrower central incisor, arguing that it promotes stability, especially in cases with less crowding.^{22,26}

Neff⁹ reported that he prefers to extract the lateral incisor in the belief that the distal face of a central incisor has better contact with the mesial surface of the canine. He further explains that when extracting a central incisor, contact occurs between the mesial surface of the remaining central incisor and the mesial surface of the lateral incisor, and even if the teeth are perfectly upright and parallel, sometimes an undesirable black triangle remains between the middle third of the tooth and the gingiva.

PERIODONTAL PROBLEMS

Proper alignment between remaining incisors should be established after a lower incisor extraction to avert periodontal issues with esthetic involvement.²²

Tuverson²⁹ warned that gingival recession could occur in the extraction space in patients at risk for periodontal disease, especially if the roots of the teeth adjacent to the space are not positioned correctly. Even in a simple space closure procedure it is essential to overcorrect root parallelism.

In cases with preexisting periodontal problems, Valinoti³⁰ considered that the decision to remove an incisor on account of buccal gingival recession or the presence of bone defects in the lower anterior area is contraindicated since the problem may persist. One should resort to periodontal treatment before deciding on the best treatment option. If the case does not present with any anterior tooth size discrepancy lower incisor extraction is contraindicated given the preexisting periodontal problem.

CANINE GUIDANCE

As in all orthodontic treatments, in cases of lower incisor extraction one should also establish canine guidance or group function in the working side, and no interference in the balancing side. Protrusive excursion should result in adequate posterior protrusive disocclusion. As seen in the literature, canine guidance may be lost due to the more mesial positioning of the mandibular canines.⁷ However, this could be avoided if an accurate diagnosis is established before deciding to extract a lower incisor.

To Kokich and Shapiro,¹¹ a more mesial positioning of the lower canines may be compensated by adjusting the non-functional portion of the cusp tips of the lower canines, or by extruding the lower incisors to ensure that the functional contacts are maintained in centric occlusion. If the upper anterior dental excess is properly corrected disocclusion can be established by means

of canine guidance. However, where this is not possible, group disocclusion can be accomplished orthodontically by performing occlusal adjustment and eliminating all balancing interference.^{11,12,25}

Valinoti,³⁰ however, warns that in the occlusion of six maxillary anterior teeth with five lower teeth, canines end up in normal occlusion, or else the upper canines will disocclude with the first premolars, i.e., the distal ridge of the maxillary canines will occlude with the mesio-occlusal ridge of the first mandibular premolars.

One can choose to introduce dental compensations to restore contact between the canines and restore the disocclusion function of these teeth:

- To position the lower canines, either completely upright or with a slight distal crown inclination in relation to their basal bone.
- Incorporate a mild offset on the distal side of the lower canines, making them more prominent.
- If possible, to incorporate artistic bends in the lower incisors in the non-extraction quadrant in order to consume space and distalize the lower canines.
- Strip the upper incisors to move the maxillary canines mesially.
- Position the upper canines with a mesial crown inclination.
- Reduce or remove the offset on the mesial side of the upper canines, making them less prominent.
- Perform a careful occlusal adjustment.

These options for compensatory orthodontic movements should be tested in advance by means of the diagnostic setup.

STABILITY OF RESULTS

One of the major challenges in orthodontic practice refers to the stability of treatment results. Valinoti³⁰ suggested in 1994 that the extraction of a lower incisor is less likely to exhibit crowding relapse after retention because the incisor is located closest to the area where the

problem is located, requiring less movement and effort to be exerted on the original conditions of the other teeth. However, there are still limitations that make it difficult to ensure greater stability after retention. Riedel et al²¹ suggested that the extraction of a lower incisor can provide greater stability in the anterior area in the absence of permanent retention.

In the long-term, cases with extraction of a lower incisor show less crowding relapse after retention than cases treated with premolar extraction by virtue of the following factors: original position of teeth is in large part preserved so that muscular pressures are less likely to introduce instability, and minimal effort exerted on the adjacent anchorage during space closure, using most of such space to correct the anterior region.³⁰

CASE REPORTS

Clinical Case 1

Diagnosis and etiology

Caucasian male patient, 23 years and 8 months of age. His chief complaint was: "Please straighten out my teeth." The clinical examination showed a mesofacial pattern, no apparent facial asymmetry, straight profile, normal lower face, prominent nose, normal nasolabial angle, nasal breathing, normal speech and swallowing, deviation to the right when opening mandible, presence of TMJ clicking, but with no pain (Fig 1).

The intraoral evaluation revealed low risk of developing caries, healthy gums, Angle Class I molar relationship, canines in Class I, severe lower anterior crowding but mild in the upper arch, reduced overbite, satisfactory posterior occlusion in both the vertical and horizontal direction. Lower midline deviation of less than 1mm to the left side and upper midline coinciding with the mid-palatine raphe (Fig 1).

The model analysis disclosed Bolton's discrepancy with 2.3 mm lower anterior excess.

Panoramic radiograph showed all permanent teeth (Fig 2). Cephalometric analysis was performed to check for protrusion in the maxilla and mandible in relation to the cranial base, skeletal Class II malocclusion, brachyfacial pattern, protruding upper and lower incisors and increased axial inclination. Straight skeletal and facial profiles (Fig 3, Tab 1).

Treatment goals

The treatment aimed to eliminate the lower anterior discrepancy, correct the lower incisor crowding, align and level the teeth, and establish adequate overjet and overbite using an orthodontic appliance.

Treatment planning and mechanics

A corrective standard Edgewise appliance (0.022x 0.028-in slot) was set up and the patient underwent extraction of the lower left central incisor and stripping in the upper arch. During correction mechanics the following was performed: alignment, leveling and repairing of dental rotations with 0.014-in to 0.020-in stainless steel wire, maintaining the posterior occlusion with passive bends, space closure through tie-back in the archwires, elastic chain and buccal (root) torque in the incisors. In the next step, 0.019x0.025-in archwires were used in the upper and lower arches in a coordinated manner using forms and torques that were ideal for intercuspatation and finishing. The planned retention consisted of upper and lower removable wraparound retainers, and a 3x3 lingual retainer on lower incisors and canines.

Treatment results

At the end of treatment there was improvement in facial esthetics, molar and canine in Class I occlusion, normal overjet and overbite (Fig 4).

The main treatment goals were achieved. The lower anterior crowding was corrected after extraction of a lower central incisor.

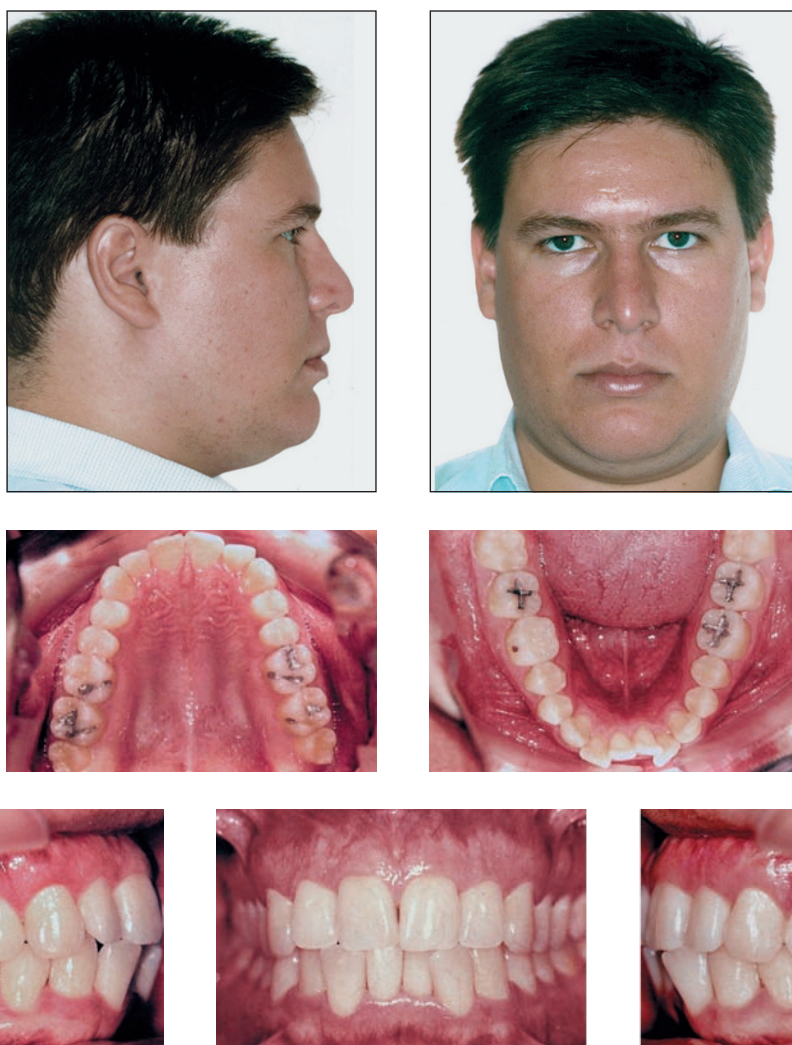


FIGURE 1 - Clinical case 1: initial extraoral and intraoral photographs.

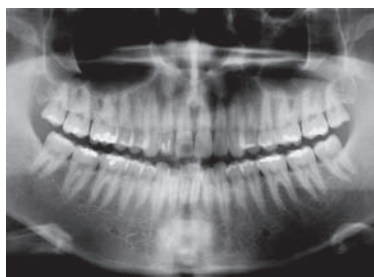


FIGURE 2 - Initial panoramic radiograph.



FIGURE 3 - Initial cephalogram and cephalometric tracing.

TABLE 1 - Cephalometric evaluation: pretreatment and posttreatment.

Cephalometric Measures	Pretreatment	Posttreatment
SNA	90°	91°
SNB	85°	85°
ANB	5°	6°
NAPg	8°	10°
SNGoGn	24°	22°
NSGn	60°	61°
Facial Axis	94°	94°
1.NA	25°	20°
1-NA	5 mm	5 mm
1.NB	31°	32°
1-NB	8 mm	10 mm
S-Ls	-3	-0,5
S-Li	-1	+1

The occlusion of the molars and premolars, which was very favorable, was maintained by carefully setting up the Standard Edgewise orthodontic appliance. In addition, normal overjet and overbite were attained, and the appropriate mandibular functions were established during lateral and protrusion movements.

Maxilla and mandible were unchanged in the anteroposterior vertical and lateral directions (Fig 5).

In the upper dentition there was no decrease in the axial inclination of the incisors (Fig 5), intercanine width was maintained and intermolar width slightly increased.

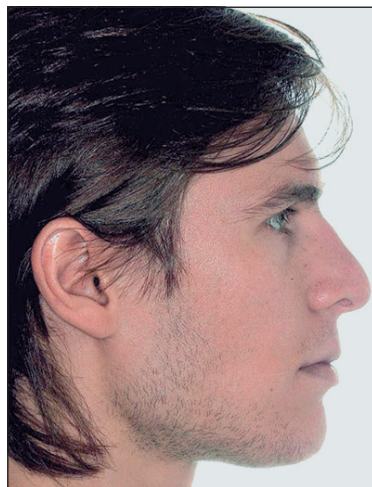


FIGURE 4 - Final extraoral and intraoral photographs.



FIGURE 5 - Final cephalogram and cephalometric tracing.

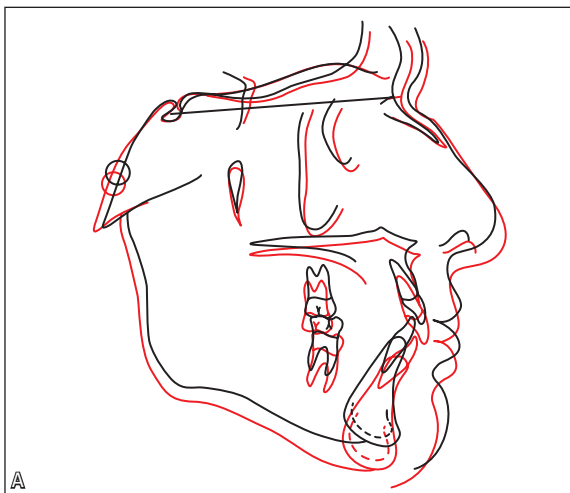
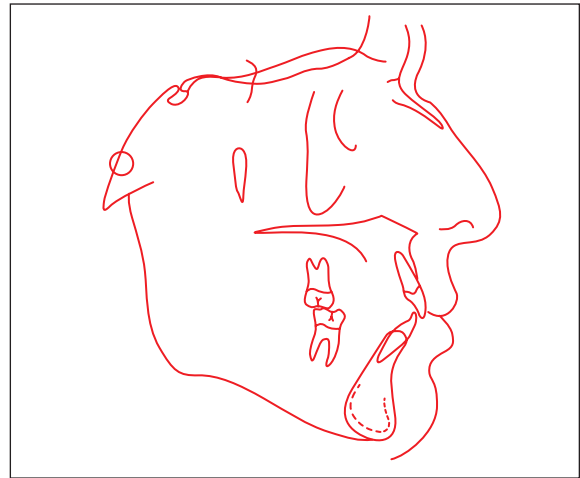


FIGURE 6 - Cephalometric superimpositions.

The lower dentition showed an increase in axial inclination and a slight protrusion of lower incisors (Fig 5), intercanine width was maintained and intermolar width slightly increased.

The complete superimposition illustrates minor facial and dental changes between the beginning and end of treatment, and the partial superimposition of the maxilla and mandible confirmed the decrease in axial inclination of upper incisors and increased protrusion of the lower incisors (Fig 6).

Clinical Case 2

Diagnosis and etiology

Caucasian female patient, aged 12 years, with a chief complaint of “anterior crowding.” The clinical examination revealed a mesofacial pattern, symmetrical face, straight profile, normal lower face, average nose, normal nasolabial angle, nasal breathing, normal speech and swallowing, deviation to the right in closing the mandible, and the presence of painless clicking in the TMJ (Fig 7).

The intraoral evaluation disclosed low risk of

caries, healthy gums, occlusal trauma in tooth 21, molar Angle Class I relationship, Class I canines, 0.5 mm overjet and edge-to-edge overbite, crowding of upper and lower incisors. Lower midline deviation of less than 1 mm to the left side and upper midline coinciding with the mid-palatine raphe (Fig 7), nail biting, and enlarged palatine tonsils.

The model analysis indicated negative skeletal-dental discrepancy in the maxilla (-3.0 mm) and mandible (-3.5 mm), Bolton's tooth size discrepancy with 2.7 mm lower anterior excess. Panoramic radiograph showed all permanent teeth, second

premolar with open apex (Nolla stage 9), upper and lower second molars erupted (Nolla stage 8). The germs of the third molars were in the early crown formation phase (Nolla stage 4), except the upper left 3rd molar, which had not yet begun to calcify (Nolla stage 1). The trabecular bone and lamina dura were normal, with no images indicative of pathologies (Fig 8). The cephalometric analysis showed protrusion in the maxilla and mandible in relation to the cranial base, skeletal Class I malocclusion, dolichofacial pattern, protruding upper and lower incisors with increased axial inclination.

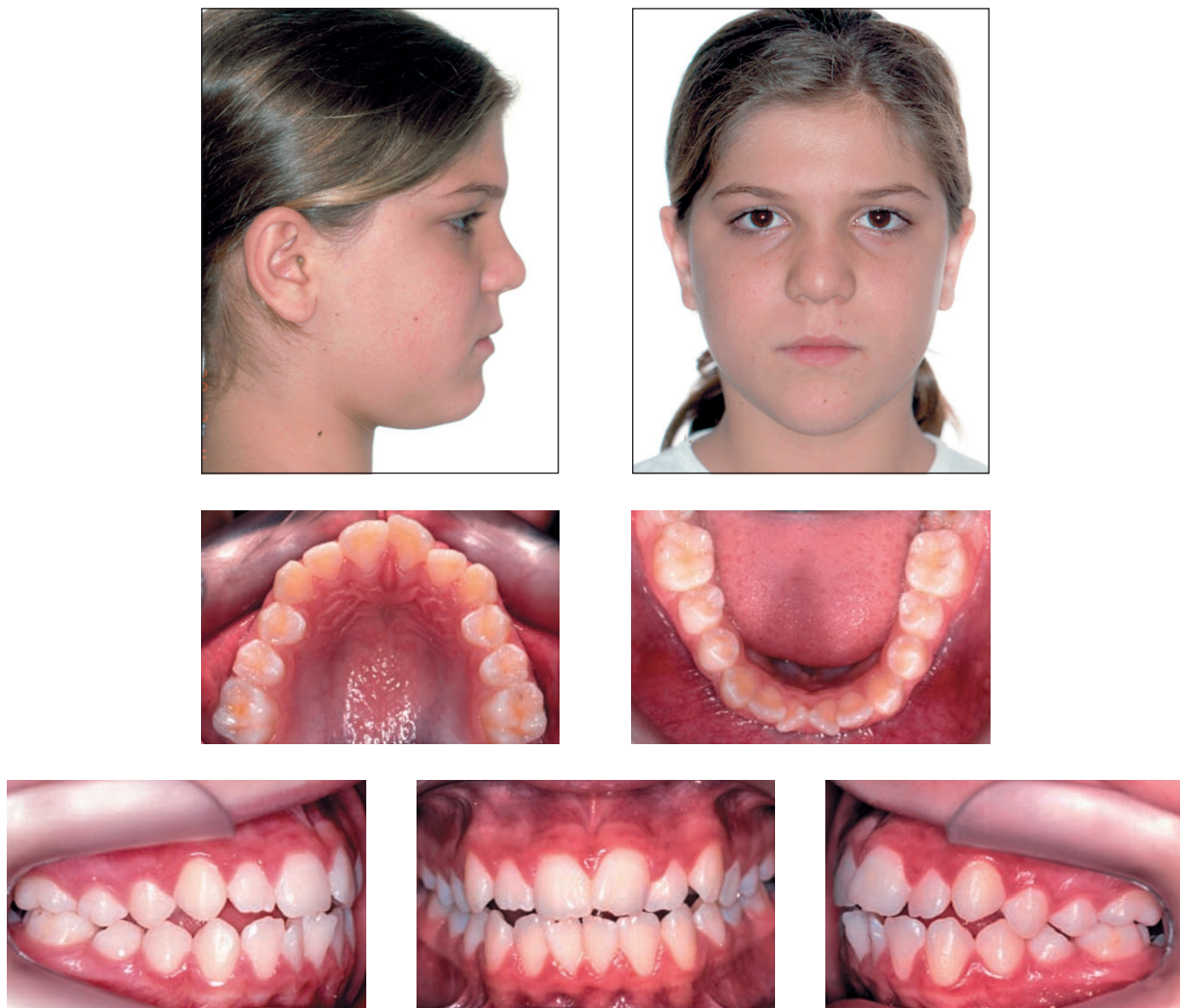


FIGURE 7 - Clinical case 2: initial extraoral and intraoral photographs.

Normal bone profile, straight facial profile and vertical facial growth (Fig 9, Table 2).

Treatment goals

The objective was to maintain a Class I molar occlusion, eliminate the lower anterior discrepancy, establish appropriate overjet and overbite, align and level the teeth and correct the midline with a fixed orthodontic appliance.

Treatment planning and mechanics

A corrective standard Edgewise appliance (0.022x 0.028-in slot) was set up and the patient underwent extraction of the lower right central incisor and stripping of the upper canines. During mechanical correction, the fol-

TABLE 2 - Cephalometric evaluation: pretreatment and posttreatment.

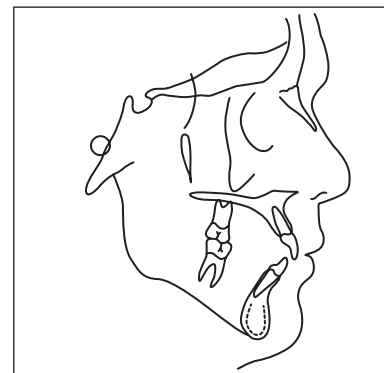
Cephalometric Measures	Pretreatment	Posttreatment
SNA	78°	76.5°
SNB	76°	77.5°
ANB	2°	-1°
NAPg	0°	3°
SNGoGn	36°	30.5°
NSGn	69°	69°
Facial Axis	85°	87°
1.NA	30°	34.5°
1-NA	8.5 mm	11.5 mm
1.NB	32°	25°
1-NB	6 mm	7 mm
S-Ls	0	-0.5
S-Li	-2	-1



FIGURE 8 - Initial panoramic radiograph.



FIGURE 9 - Initial cephalogram and cephalometric tracing.



lowing was performed: alignment and leveling of the upper arch, allowing incisor proclination; retraction of the lower incisors using 0.014-in to 0.020-in stainless steel archwires; mesial migration of the lower left central incisor until the upper midline coincided with half of this tooth; mesial migration of the right mandibular lateral incisor and lower right canine, tooth after tooth, until a Class I canine relationship was achieved. In the next step, rectangular 0.019x 0.025-in archwires were used in the upper and lower arches, in a coordinated manner, with ide-

al forms and torques for intercuspatation and finishing. The planned retention consisted of upper removable wraparound retainer and a 3x3 lingual retainer on lower incisors and canines. The patient was referred for evaluation by an otolaryngologist and an audiologist.

Treatment results

At the end of treatment, the profile became slightly concave, occlusion displayed molar and canine Class I relationship, and adequate overjet and overbite (Fig 10).

The main treatment goals were achieved with the extraction of tooth 41 and lower incisor alignment. The molar and canine Class I relationship was maintained throughout the treatment. There was little change in facial profile, but esthetics was not compromised. From a functional standpoint results were satisfactory as incisor and canine guidances were restored.

The maxilla showed normal growth in the anteroposterior and transverse direction while in the vertical direction it was controlled. The mandible showed increased horizontal growth (Fig 11).

In the upper dentition there was a slight increase in intermolar width and a slight reduction in intercanine width, increased axial inclination and protrusion of the incisors (Fig 11, Table 2).



FIGURE 10 - Final extraoral and intraoral photographs.



FIGURE 11 - Final cephalogram and cephalometric tracing.

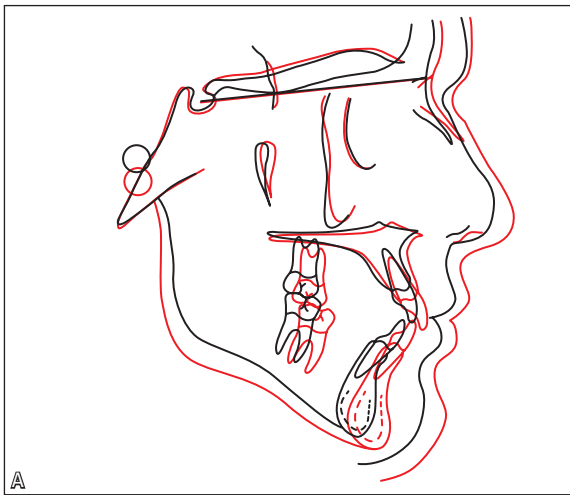
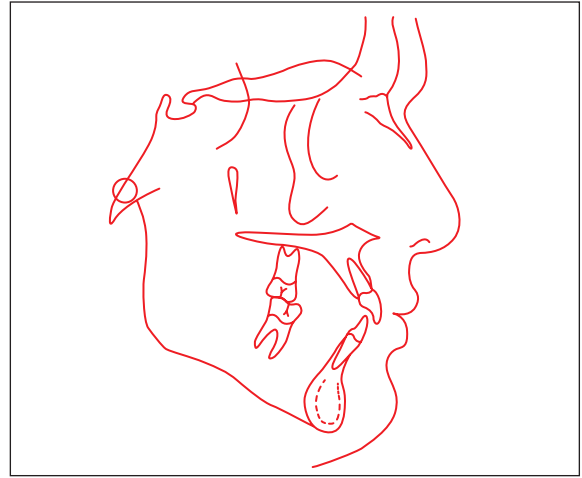


FIGURE 12 - Cephalometric superimpositions.

In the lower dentition there was improvement in incisor inclination, leveling of the curve of Spee and a slight reduction in intermolar and intercanine widths (Fig 11, Table 2).

The superimposition of cephalometric trac-

ings showed increased horizontal growth of the mandible, with counterclockwise rotation (Fig 12A). Partial superimpositions indicate vertical control of the mandible and decreased axial inclination of lower incisors (Fig 12B).

Clinical Case 3

Diagnosis and etiology

Caucasian male patient aged 16 years and 11 months. His chief complaint was: "My lower teeth are crooked." The clinical examination revealed a mesofacial pattern, a slightly asymmetrical face, concave profile, normal lower face, average nose, normal nasolabial angle (Fig 13), nasal breathing, normal speech and swallowing, normal mandibular closing pattern, and normal TMJ.

The intraoral evaluation disclosed low risk of caries, healthy gums, Angle Class I molar

relationship, canines in Class I, crowding of upper and lower incisors, mild overjet and overbite. Lower midline deviation of less than 2mm to the left side and upper midline coinciding with the mid-palatine raphe (Fig 13).

The model analysis indicated no osseodental discrepancy in the upper arch, and negative in the lower arch (-2.5 mm), Bolton's tooth size discrepancy with 4.0 mm excess in the lower arch, and 2.6 mm in the lower anterior region. Panoramic radiograph showed all permanent teeth, with the third molars in formation.

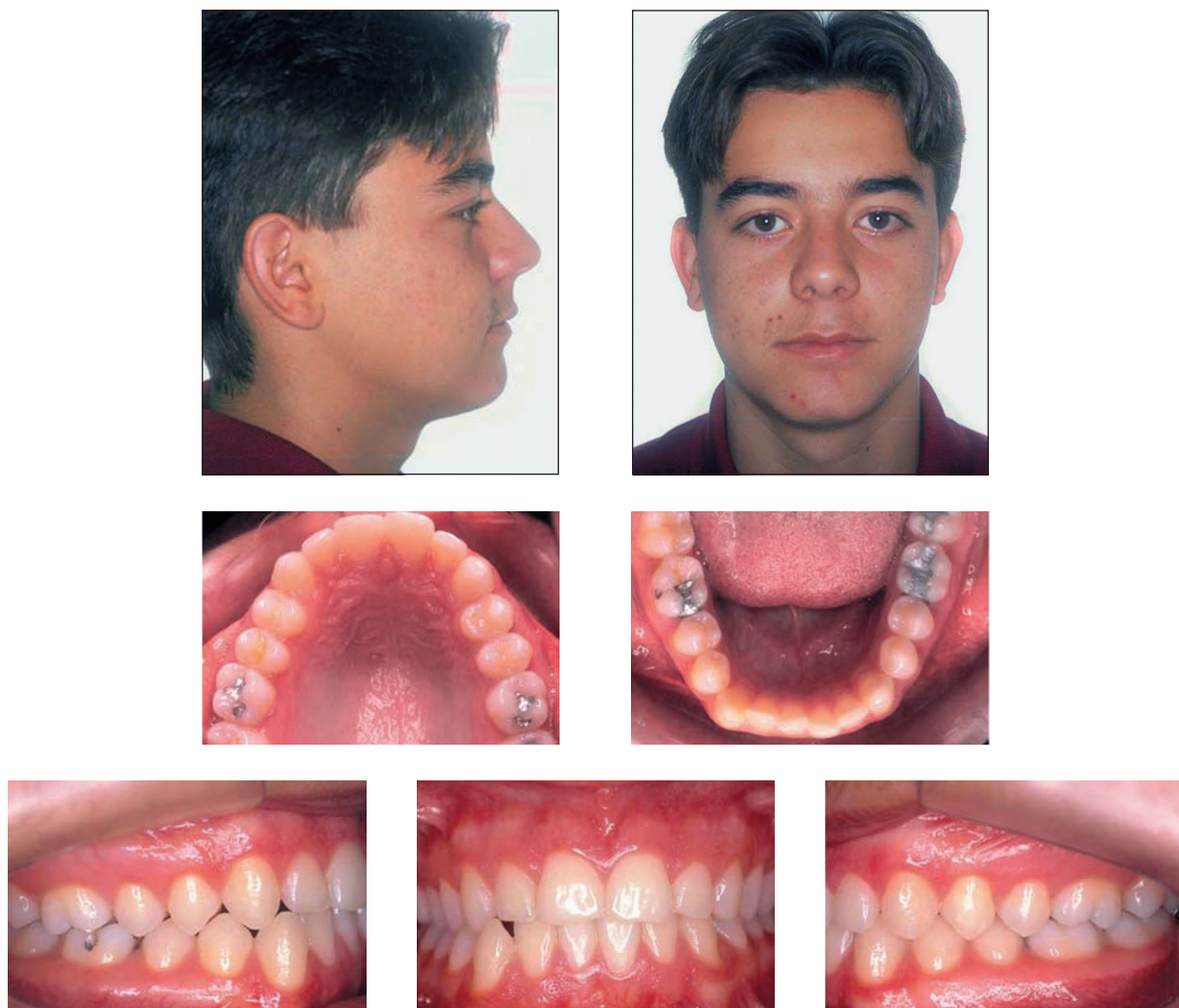


FIGURE 13 - Clinical case 3: initial extraoral and intraoral photographs.

The trabecular bone and bone crests were normal, as well as the lamina dura, with no images indicative of pathology (Fig 14). Cephalometric analysis was performed to verify that both maxilla and mandible were well positioned relative to the skull base and each other, in the anteroposterior direction (skeletal Class I), upper and lower incisors with increased and reduced axial inclination, respectively, with protruding upper incisors and lower incisors well positioned in their basal bones. Normal bone and facial profile slightly concave, normal vertical measures, and meso-facial pattern (Fig 15, Table 3).

TABLE 3 - Cephalometric evaluation: pretreatment and posttreatment.

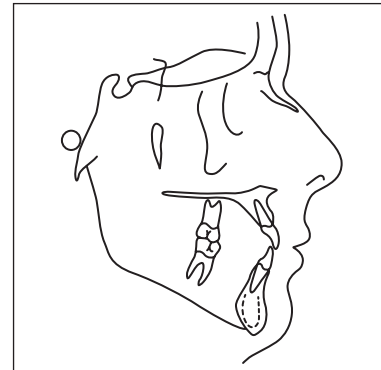
Cephalometric Measures	Pretreatment	Posttreatment
SNA	83°	84°
SNB	82.5°	82.5°
ANB	0.5°	1.5°
NAPg	1°	1°
SNGoGn	32°	31°
NSGn	66°	66°
Facial Axis	88°	88°
1.NA	25°	24°
1-NA	5.5 mm	5 mm
1.NB	21°	18°
1-NB	4 mm	3 mm
S-Ls	-1	-1.5
S-Li	-2	-2.5



FIGURE 14 - Initial panoramic radiograph.



FIGURE 15 - Initial cephalogram and cephalometric tracing.



Treatment goals

The objective was to maintain a Class I molar occlusion, eliminate the lower anterior discrepancy, establish adequate overjet and overbite, align and level the teeth and correct the midline with a fixed orthodontic appliance.

Treatment planning and mechanics

A standard Edgewise corrective appliance was set up (slot 0.022x 0.028-in), whereby the upper arch continued to undergo leveling in the posterior teeth and lateral incisors, with no artistic bends. The patient underwent extraction of the

lower right central incisor and during treatment it was assessed whether there would be the need for stripping of the upper incisors and teeth 34 and 44. In the alignment and leveling phase twist-flex and 0.014-in to 0.020-in stainless steel wires were used. As of the moment 0.020-in archwires began to be used, tooth 42 began to be moved mesially with elastic chain to close the extraction space. A 0.019x0.025-in archwire was placed in the upper arch with ideal form and torque for the case, as well as a coordinated 0.016x 0.022-in lower retraction archwire with tear drop loop. Subsequently, a lower 0.019x0.025-in finishing archwire was fabricated

with ideal form and torques, in coordination with the upper archwire. The planned retention consisted of upper and lower removable wraparound retainers, and a 3x3 lingual retainer bonded to the lower incisors and canines.

Treatment results

The final occlusion showed molar and canine Class I relationship with normal overjet and overbite. Lower incisor alignment was accomplished (Fig 16).

The main treatment goals were achieved. The

lower anterior crowding was corrected after extraction of the lower central incisor.

Occlusion of molars and premolars seemed very favorable and was therefore maintained by carefully setting up the standard Edgewise orthodontic appliance. In addition, normal overjet and overbite were attained, and the appropriate mandibular functions were established during lateral and protrusion movements.

Maxilla and mandible showed normal growth in the anteroposterior, lateral and vertical directions (Fig 17).

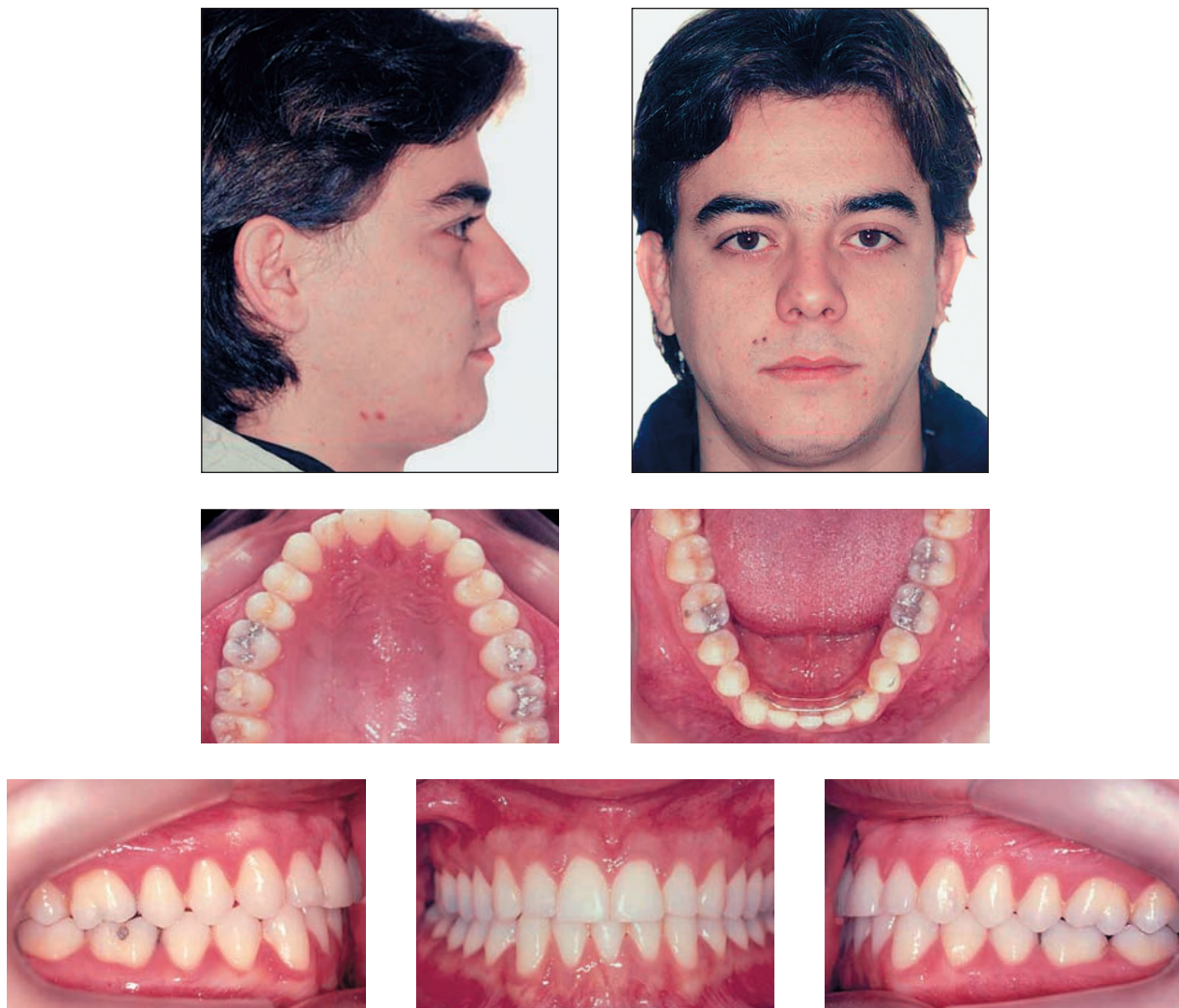


FIGURE 16 - Final extraoral and intraoral photographs.



FIGURE 17 - Final cephalogram and cephalometric tracing.

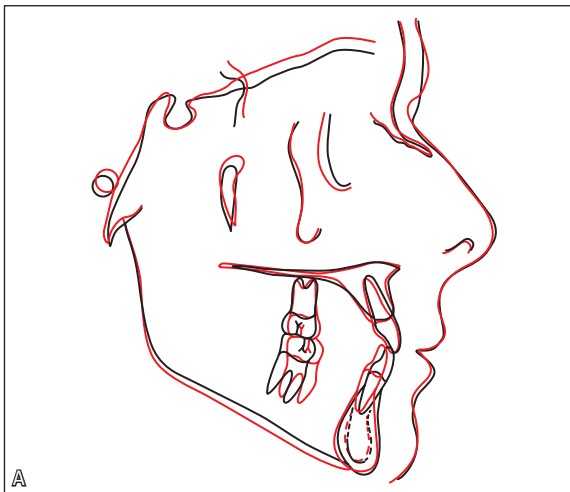
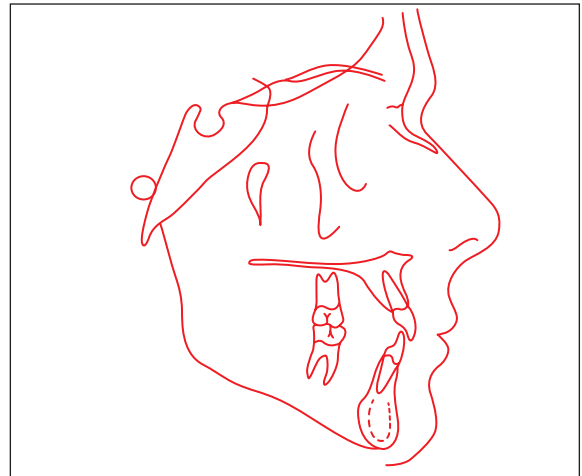


FIGURE 18 - Cephalometric superimpositions.

In the upper dentition, it was observed that the axial inclination and protrusion of upper incisors were slightly reduced (Fig 17, Table 3).

In the lower dentition, a slight retraction occurred (Fig 17, Table 3) with no concurrent changes on intermolar width and decreased intercanine width due to the extraction of tooth 41.

Since this case involved an adult patient, max-

illomandibular positions were maintained, as shown in Figure 18A. Figure 18B indicates that the upper incisors were maintained and the lower incisors were slightly retruded, with loss of anchorage in the upper and lower molars. There was also slight mandibular growth. Adequate incisal relationship was achieved while maintaining a favorable profile (Fig 18).

FINAL CONSIDERATIONS

It is noteworthy that the main indication to extract a lower incisor is the presence of tooth size discrepancy equal to or greater than 4.5 mm due to lower anterior excess or upper anterior deficiency.^{1,15,21,28} One should perform a careful diagnosis using a diagnostic setup to analyze treatment goals and occlusal outcome.

This treatment option may cause some of the following difficulties or limitations in orthodontic treatment: obtaining canine guidance, possibility

of spaces reopening, esthetic loss of gingival papilla, impact on the midline, overjet and overbite.

Crowding relapse after retention appears to be lower than in cases subjected to premolar extraction.

If properly indicated and carefully and appropriately conducted, lower incisor extraction can significantly contribute to the treatment of certain malocclusions and the pursuit of excellence in orthodontic treatment results, reflected in maximum function, esthetics and stability.

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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.

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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.

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Yours sincerely,

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Bone density assessment for mini-implants position

Marlon Sampaio Borges*, José Nelson Mucha**

Abstract

Introduction: The cortical thickness the interradicular spaces width and bone density are the key factor for the efficiency of mini-implants as anchor of resources. The objective was to assess the alveolar and basal bone density in maxilla and mandible in Hounsfield units (HU). **Method:** Eleven files from adults computed tomography images, were obtained 660 measurements of bone density: alveolar(buccal and lingual cortical),cancellous bone and basal(maxilla and mandible). Values were obtained through the Mimics software version 10.0(Materialise, Belgium). **Results:** Maxilla: The density of buccal cortical alveolar ranged from 438 to 948 HU, and the lingual from 680 to 950 HU, and the cancellous bone ranged from 207 to 488 HU. The basal bone in buccal showed a variation from 672 to 1380 HU and cancellous bone from 186 to 402 HU. In the mandible: a variation in alveolar bone in the buccal cortical was 782 to 1610 HU, in the lingual cortical alveolar from 610 to 1301 HU, and cancellous bone from 224 to 538. The density in the basal area was from 1145 to 1363 in the buccal cortical and 184 to 485 in the cancellous bone. **Conclusions:** The greater bone density in the maxilla in the area was observed between the pre-molars in the buccal alveolar cortical. The maxillary tuberosity is the region with lower bone density. The bone density in the mandible was higher than in the maxilla and there was a progressive increase from anterior to posterior and from alveolar to basal bone.

Keywords: Bone Density. Orthodontic Anchorage Procedures. Orthodontics.

INTRODUCTION

The mini-implants have been objects of study today, and have achieved great popularity in the community orthodontic.^{1,2,6} The reasons are due to these devices promote adequate anchorage in orthodontic mechanics.

All appliances or intraoral devices show some loss anchorage and headgear depend on the cooperation of patients about the proper use of orthodontic appliances. When using an

endosseous anchorage by means of temporary anchorage devices, as is the case for mini plates, mini-implants or dental implants, can be an anchorage without the need of cooperation from patients.

Compared with other anchoring devices, the mini-implants have excelled in the preference of professionals, the ease of insertion and removal, the possibility of immediate loading, small size and low cost.^{8,11,16,20}

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Regarding the location for its implementation, several sites have been proposed for the installation of mini-implants, which can be inserted in different regions of the basal bone and alveolar maxillary and mandibular. In the maxilla, between second premolar and first molar and mandible between the first and second molars are commonly used as a resource for anchoring in cases of retraction of anterior teeth after extractions of premolars.^{7,12,19}

The choice of the insertion site of mini-implant should be based on appropriate regions of soft tissues such as the presence of attached gingiva, adequate amounts of cortical bone, the angulation and the size of mini-implant and foremost, the type of tooth movement that is claiming, intrusion, extrusion, or space closure with both drive for mesial to distal.^{10,17}

Consequently, for that mini-implants are effective as anchorage, there must be adequate thickness of cortical bone, enough spaces between the roots for their deployment, without damaging the dental roots, and also the quality of this bone should be such that favors the retention of mechanical device in a predetermined location. It is considered that bone density is a key factor for the efficiency of mini-implants as an anchorage. This aspect of the assessment or mapping of characteristics related to bone density is still a subject little discussed and emphasized in the literature.

It was intended, therefore, with this study to evaluate the maxillary and mandibular bone density in various sites, both in the alveolar bone and basal bone by computed tomography (cone beam), quantitatively in Hounsfield units (HU).

MATERIAL AND METHODS

The study sample consisted of 11 files of computerized tomography (CT) in DICOM format (Digital Imaging and Communication in Medicine), obtained from two men and nine women, Brazilians, aged between 20 and

30 years, holders of Class I malocclusion with biprotrusion and all permanent teeth present except third molars, from the database of tomographic images of the post graduate course in orthodontics, Universidade Federal Fluminense - UFF (Niterói, RJ, Brazil).

The same measurements were performed for the left and right sides of the dental arches and do not present statistically significant differences between them, were grouped, the total sample consists of measurements of the study.

660 measurements were performed, evaluating the region of the alveolar bone, the density of buccal cortical, lingual cortical, cancellous bone and in the basal bone region, the densities of buccal cortical and cancellous bone in both maxilla and mandible.

The bone densities were calculated using the Mimics software version 10.01 (<http://www.materialise.com/materialise/view/en/65854> - Materialise, Begic) from images obtained from CT scans. The densities were measured in Hounsfield units (HU).

With help of the software Mimics 10.01, CT cuts were made in the alveolar bone height in the range of 3 to 5mm from the bone crest and to the basal bone height in the range of 5 to 7 mm from the apex of the teeth, as illustrated in Figure 1.

In certain areas of alveolar bone and basal bone sites evaluated between teeth were among the central and lateral incisors (1 and 2) between cuspids and first premolars (3 and 4) between the first and second premolars (4 and 5), between the second premolar and first molar (5 and 6), between first and second molars (6 and 7) and the region distal to second molars (7D) for both the jaw and to the mandible (Fig 2).

In areas between the teeth was measured the alveolar bone density of buccal cortical, lingual cortical and cancellous bone. In the section of basal bone was measured using the density of buccal cortical and cancellous bone.

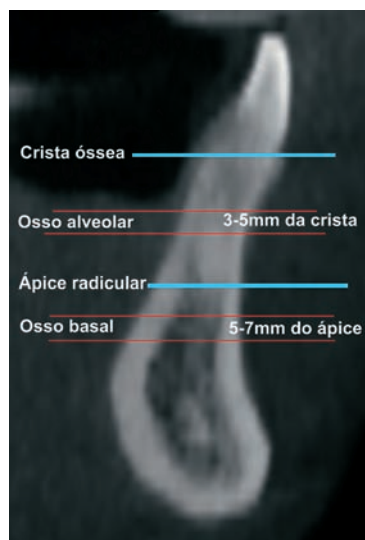


FIGURE 1 - Transversal section computerized tomography, illustrating the location of the crest, and root apices, as well as determining the areas measured, corresponding to the alveolar bone (3 to 5 mm of bone crest) and the basal bone (5 to 7 mm of root apices).



FIGURE 3 - Magnified view of CT section in the region between 1 and 2 in the mandible with the illustration of the measurement of bone density in the section of basal bone, both buccal cortical vestibular and cancellous bone area. The section shows the area represented the alveolar bone.

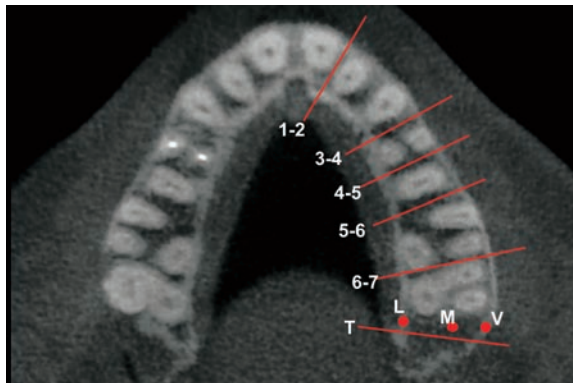


FIGURE 2 - Sites reviewed: 1 and 2, between the central incisor and lateral incisor, 3 and 4, between cuspid and first premolar, 4 and 5, between first and second premolar, 5 and 6, between the second premolar and first molar; 6 and 7, between first and second molar; T, tuberosity; V buccal cortical; M, cancellous bone; L, lingual cortical.

Measurements of the thickness of cortical bone met the limits of the buccal and lingual cortical and cancellous bone was measured in the section between cortical, corresponding to the cancellous bone with trabecular aspect, as illustrated in Figure 3.

Data were organized in tables and proceeded to obtain measures of central tendency and statistical tests.

Analise Estatística Statistical Analysis

The analysis of differences between the sites was evaluated through analysis of variance (ANOVA), complemented with subsequent examination (Tukey test) for multiple comparisons of differences between sample means.

For this purpose, multiple comparisons, we used the BioStat 5.0 software, which is distributed free (freeware), by site (http://www.mamiraua.org.br/download/download.php?fname=../BioEstat5_Portugues/BioEstat5_Portugues.zip).

RESULTS

The means, standard deviations and statistical significance between the areas assessed values for bone density, and basal alveolar jaw are shown in Table 1.

The values obtained for the averages, standard deviations and statistical significance between the areas assessed, bone density, and basal alveolar jaw are shown in Table 2.

The maxillary alveolar bone density, measured from the buccal aspect showed a variation 438-

948 HU, and the lingual side ranging 680-950 HU, and cancellous bone in this region has varied between 207-488 HU.

When observed values without the data obtained for the maxillary tuberosity, the density of cortical alveolar bone of the jaw, both in evaluating the buccal and lingual ranged between 802 and 950 Hounsfield units (HU). The maxillary tuberosity shows, therefore, one with poor bone density when compared to other sites analyzed in this study. A média da densidade óssea para a tuberosidade maxilar foi de 438 HU para a cortical vestibular e 680 HU para a cortical lingual. The average bone density for the maxillary tuberosity

was 438 HU for buccal cortical and 680 HU for lingual cortical.

The area with greater bone density in the buccal cortical, was found in the region between the premolars, with 948 HU (± 220), as shown in Table 1.

The maxillary basal bone showed a variation in buccal cortical vestibular 672-1380 HU, and cancellous bone 186-402 HU. The values of standard deviations were also high for all areas assessed. In the basal bone, again, the exception was the maxillary tuberosity, which presented as average of the lowest bone density, with 672 HU for cortical vestibular and 186 HU for the can-

TABLE 1 - Means, Standard Deviations and Statistical Significance of maxillary bone densities in Hounsfield units (HU) in regions evaluated between teeth, lateral incisor and central incisor (1 and 2) between cuspid and first premolar (3 and 4); first and second premolars (4 and 5), second premolar and first molar (5 and 6) first and second molars (6 and 7), and the maxillary tuberosity (7D).

		Region (between teeth)												Valor de P
		1 and 2		3 and 4		4 and 5		5 and 6		6 and 7		7D		
		Mean	SD	Mean	SD	Mean	SD	Mean	DP	Mean	SD	Mean	SD	
Alveolar Bone	Buccal cortical	802.67 ^A	170.95	876.67 ^B	190.15	948.40 ^B	220.42	840.33 ^C	100.54	886.00 ^C	185.14	438.76 ^F	211.08	<.0001
	Cancellous bone	488.30 ^A	168.54	365.82 ^C	190.15	281.67 ^A	167.94	207.51 ^B	159.03	230.93 ^F	212.92	207.89 ^E	158.04	<.0001
	Lingual cortical	802.46 ^A	130.45	912.88 ^A	196.61	930.18 ^A	175.35	873.35 ^C	177.33	950.24 ^A	210.05	680.05 ^D	281.10	<.0001
Basal bone	Buccal cortical	832.44 ^A	230.79	1043.68 ^D	211.78	1181.45 ^D	256.90	951.00 ^A	168.01	1380.90 ^E	236.32	672.20 ^F	208.65	<.0001
	Cancellous bone	370.84 ^A	170.60	290.80 ^C	121.08	301.16 ^A	174.42	247.76 ^E	68.94	402.79 ^A	244.61	186.42 ^D	168.09	.0005

Means followed by the same letter do not differ statistically significant ($P > 0.05$) by Tukey test.

cellous bone region, indicating low density, statistically significant.

According to the analysis of Table 1 and Figure 4, it can be seen in the maxilla, the buccal cortical was more dense in the section of basal bone than in the section of alveolar bone in all regions analyzed.

In the evaluation of mandibular bone density, there was a variation of the alveolar bone in the buccal cortical (782-1610 HU), and lingual cortical (610-1301 HU), and in the alveolar cancellous bone area was 224-538 HU. The density in the basal area of the buccal cortical ranged from 1145 to 1363 HU and 184-485 in cancellous bone.

Was observed, in general, a progressive increase in bone density in the anterior mandible (lower density) to the posterior region (higher density). In the mandible the buccal cortical basal compared to buccal alveolar cortical, showed statistically significant higher density evaluated areas, except in the retromolar region (Table 2 and Fig 5).

The alveolar bone density of buccal cortical region of the mandible was statistically higher than in the maxilla, except as between central and lateral incisor (1 and 2) and between second premolar and first molar (5 and 6) as illustrated in Figure 6.

TABLE 2 - Means, Standard Deviations and Statistical Significance of mandible bone densities in Hounsfield units (HU) in regions evaluated between teeth, lateral incisor and central incisor (1 and 2) between cuspid and first premolar (3 and 4); first and second premolars (4 and 5), second premolar and first molar (5 and 6) first and second molars (6 and 7), and retromolar mandibular (7D)

		Region (between teeth)											
		1 and 2		3 and 4		4 and 5		5 and 6		6 and 7		7D	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Alveolar Bone	Buccal cortical	782.75 ^A	172.73	1010.34 ^D	105.98	1098.33 ^E	164.39	801.76 ^A	221.60	1320.08 ^E	139.17	1610.42 ^{B^C}	145.25
	Cancellous bone	505.70 ^A	210.80	538.63 ^F	178.87	474.58 ^A	124.51	224.31 ^F	220.38	358.00 ^B	130.54	324.78 ^F	81.81
	Lingual cortical	707.18 ^A	198.00	1108.55 ^D	135.14	1250.20 ^D	188.95	610.27 ^F	109.72	1290.71 ^E	139.11	1301.20 ^B	203.68
Basal bone	Buccal cortical	1285.12 ^A	230.50	1145.57 ^D	312.99	1339.06 ^B	80.99	1363.44 ^B	244.14	1299.70 ^E	108.94	1166.70 ^B	149.06
	Cancellous bone	435.50 ^B	262.40	485.78 ^A	320.24	274.97 ^F	201.48	413.38 ^C	305.16	223.76 ^B	180.04	184.52 ^F	105.74

Means followed by the same letter do not differ statistically significant ($P > 0.05$) by Tukey test.

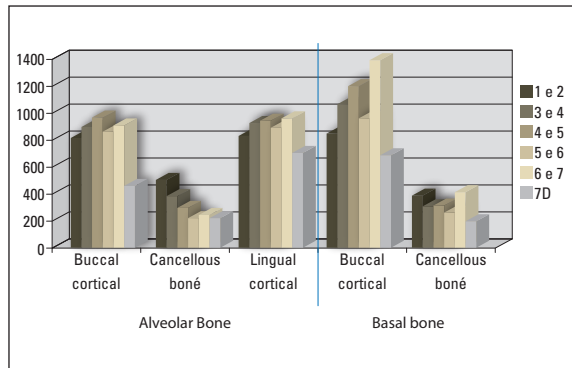


FIGURE 4 - Averages of the maxilla bone densities in Hounsfield units (HU) between the regions: central incisor and lateral incisor (1 and 2), cuspid and first premolar (3 and 4); first and second premolars (4 and 5), second premolar and first molar (5 and 6) first and second molars (6 and 7), and the region of the maxillary tuberosity (7D).

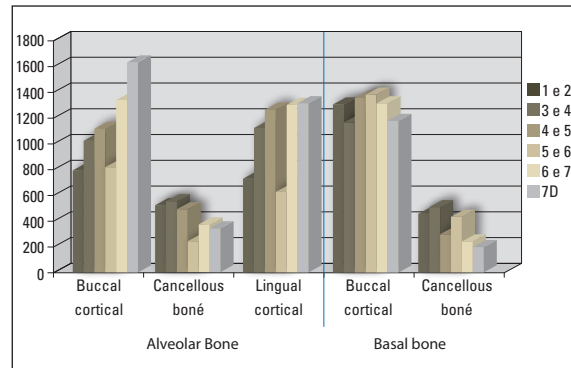


FIGURE 5 - Averages of mandible bone densities in Hounsfield units (HU) between regions: central incisor and lateral incisor (1 and 2), cuspid and first premolar (3 and 4); first and second premolars (4 and 5), second premolar and first molar (5 and 6) first and second molars (6 and 7), and retromolar mandibular (7D).

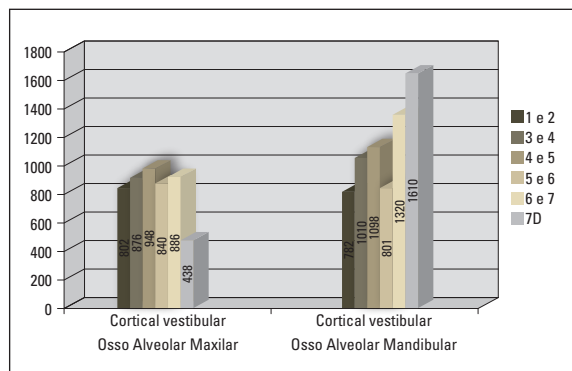


FIGURE 6 - Comparison between the mean bone density measurements (HU) areas of alveolar bone, the buccal cortical maxillary and mandibular.

Comparing the cancellous bone of the alveolar region, the locations between cuspid and first premolar (3 and 4) and between first and second premolars (4 and 5) were most dense in the mandible compared to the maxilla, which is statistically significant.

In the alveolar bone, the values obtained for the lingual cortical were very similar with average values for the vestibular cortical, as both the maxilla to the mandible.

DISCUSSION

The study of bone density in the maxilla and mandible, using images obtained from CT (Cone Beam), and using the software Mimics, to read images in DICOM format, allowing the section of the slices in the regions between the teeth, and evaluating the sections on both alveolar bone in certain areas such as basal 3-5 mm of bone crest and from 5 to 7 mm of root apices, as possible locations for the installation of mini-implants, was appropriate to this study.

The results may be used as additional information when selecting and electing the most suitable places to receive the anchoring devices, such as mini-implants.

The sample consisted of digital images obtained from adults, generating a total of 330 measurements on each side of the dental arches, and do not present statistically significant differences were grouped, resulting on 22 representative measures of each area evaluated, in a grand total of 660 measures. The sampling strategy adopted, with many measures and in several sites, generating results as averages in millimeters of cortical thickness, can be considered a point of emphasis of work in comparison with other studies.^{4,9,10,16,17,18}

It was found that specific areas of the maxil-

la, as the buccal cortical alveolar bone between the premolars, as one of the sites with greater bone density and the maxillary tuberosity area as lower bone density.

There are many reasons for the failure of mini-implants as an anchorage, and among these may be cited as the loss or unscrew. This fact is not only bone density, but the knowledge of the values of bone density, both alveolar and basal constitutes yet another important factor for selection of suitable sites for deployment.

The uppermost in the maxilla, the basal bone in this study represented by the regions located 5 to 7 mm of root apices showed higher density in comparison with those located in the alveolar bone. The application of forces supported by mini-implants should be based on the type of tooth movement desired,^{7,14,20} but when intrusion movements are expected and there is no impairment of efficacy of mechanical placement of mini-implants more superiorly interradicular a little space, can be considered uppermost, since they have greater bone density.^{16,18}

Another factor that provides the stability of mini-implants is the thickness of cortical bone.^{9,10,16} This study verified that the values of cortical bone density of the area are larger, generally in the same region, to double or up to 3-4 times the density of the cancellous bone area. This observation reinforces the need to insert mini-implants with an angled 10-20 degrees to the long axis of the teeth, to make the most of small thickness and higher density of cortical, either by buccal lingual as per.¹⁰

With the aesthetic concerns of the appliances, and for greater control mechanical anchorage devices can be installed by the lingual side.^{9,10} There was this study that bone density in maxillary alveolar region is similar to the density at the buccal side, with even slightly higher.

The placement of mini-implants in the mandible, considering only the highest bone density

as a factor for success will be more interesting in the more posterior and inferior. But this fact does not always occur, because other factors may contribute to loss or unscrew of the mini-implants. In some situations in areas of basal bone, and without attached gingiva alveolar mucosa may be one of the causes of failures, coupled with the difficulty of hygiene at.^{3,11}

However, despite the greater mandibular bone density, the heating caused by the drilling process of the cortical thick through drills, could cause bone necrosis at temperatures above 47 °C, causing the loss of the anchoring device.¹¹

Stand out as most interesting places of election to receive the mini-implants in clinical cases of retraction of anterior teeth for space closure after extraction of premolars, the region between second premolar and first molar in the maxilla and between first and second molars in the mandible. These sites appear to be interesting, because together with the good quality of bone density, there is a safe space for mini-implants between the roots of the teeth.^{12,15}

In the range of basal bone was not analyzed the density of lingual cortical, difficulty and even impossibility of clinical application of mini-implants in this anatomical region. Also, was not evaluated bone density in this region to be extremely thin and usually not be enough space for its placement.

The data will serve as guides for procedures for choosing the most suitable places for the placement of mini implants. It should be emphasized that in all measurements, the standard deviations found were very high, representing a wide variation of behavior of bone densities, requiring special consideration by the clinician for each case specifically.

Studies with larger samples and more specific, involving the resources of digital images, must be performed to qualify and quantify the characteristics most suitable sites for installation of mini-implants.

CONCLUSIONS

In the buccal cortical vestibular maxillary alveolar bone, the greater bone density was observed in the area between the premolars.

Higher density was observed in the buccal cortical basal of the maxilla between the premolars and molars between.

The density of lingual alveolar cortical maxillary showed slightly higher than in the buccal cortical.

The maxillary tuberosity was the region with lower bone density.

Bone density in the mandible was higher than in the maxilla in practically all areas assessed.

We observed in the mandible a gradual trend of increase in bone density from anterior to posterior and superior to inferior.

The mandibular alveolar cortical density was higher in the retromolar region, both by the buccal and lingual.

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Orthodontics as risk factor for temporomandibular disorders: a systematic review

Eduardo Machado*, Patricia Machado**, Paulo Afonso Cunali***, Renésio Armindo Grehs****

Abstract

Aim: The interrelationship between Orthodontics and Temporomandibular Disorders (TMD) has attracted an increasing interest in Dentistry in the last years, becoming subject of discussion and controversy. In a recent past, occlusion was considered the main etiological factor of TMD and orthodontic treatment a primary therapeutical measure for a physiological reestablishment of the stomatognathic system. Thus, the role of Orthodontics in the prevention, development and treatment of TMD started to be investigated. With the accomplishment of scientific studies with more rigorous and precise methodology, the relationship between orthodontic treatment and TMD could be evaluated and questioned in a context based on scientific evidences. This study, through a systematic literature review had the purpose of analyzing the interrelationship between Orthodontics and TMD, verifying if the orthodontic treatment is a contributing factor for TMD development. **Methods:** Survey in research bases: MEDLINE, Cochrane, EMBASE, Pubmed, Lilacs and BBO, between the years of 1966 and 2009, with focus in randomized clinical trials, longitudinal prospective nonrandomized studies, systematic reviews and meta-analysis. **Results:** After application of the inclusion criteria 18 articles was used, 12 of which were longitudinal prospective nonrandomized studies, four systematic reviews, one randomized clinical trial and one meta-analysis, which evaluated the relationship between orthodontic treatment and TMD. **Conclusions:** According to the literature, the data concludes that orthodontic treatment cannot be considered a contributing factor for the development of Temporomandibular Disorders.

Keywords: Temporomandibular Joint Dysfunction Syndrome. Temporomandibular Joint Disorders. Craniomandibular Disorders. Temporomandibular Joint. Orthodontics. Dental Occlusion.

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INTRODUCTION

Recent years have seen a considerable increase in the prevalence of signs and symptoms of Temporomandibular Disorders (TMD).⁴⁴ Several theories have been proposed to determine the etiology of TMD, but a single and specific factor was not detected.^{44,47} The etiology of TMD has a multifactorial nature and is associated with muscle hyperactivity, trauma, emotional stress, malocclusion and other predisposing, precipitating or perpetuating factors of this condition.⁴⁷ Due to the etiological complexity and variety of signs and symptoms that may, generally, also represent other conditions, recognition and differentiation of Temporomandibular Disorders can present in a not very clear way to the professional.⁵

Epidemiological studies show that the signs and symptoms of TMD are commonly found in children and adults,^{9,32} may reaching up to 31% of the population⁴² and affects more than 10 million people in the U.S.A.⁴¹. Usually the signs and symptoms are milder in childhood and increases in adolescence both in prevalence and severity.⁴⁹

Some studies have attempted to evaluate the possible effect of occlusal factors on the development of TMD. The results of these studies indicate that occlusal factors have small etiological importance in relation to pain and to the functional alterations of the stomatognathic system, but the role of occlusion in the etiology of TMD is still a subject of discussion.¹⁷

Thus, the role of Orthodontics in the development, prevention and treatment of TMD remains controversial. This study aimed, through a systematic review of literature, to analyze the inter-relationship between orthodontic treatment and TMD and specifically verify if orthodontic treatment is a contributing factor to the development of TMD.

MATERIAL AND METHODS

We performed a computerized search in

MEDLINE, Cochrane, EMBASE, PubMed, Lilacs and BBO in the period from 1966 through January 2009. The research descriptors used were “orthodontics”, “orthodontic treatment”, “temporomandibular disorder”, “temporomandibular joint”, “craniomandibular disorder”, “TMD”, “TMJ”, “malocclusion” and “dental occlusion”, which were crossed in search engines. The initial list of articles was submitted to review by two reviewers, who applied inclusion criteria to determine the final sample of articles, which were assessed by their title and abstract. If there was any disagreement between the results of the reviewers, a third reviewer would be consulted by reading the full version of the article.

Inclusion criteria for the selecting articles were:

- Studies that evaluated Orthodontics in relation to its role in the development of TMD and in which orthodontic treatment is already finished in the samples;

- Randomized clinical trials (RCTs), longitudinal prospective nonrandomized studies, systematic reviews and meta-analysis. Clinical trials should present control group;

- Clinical trials in which was performed clinical examination in patients and at least one clinical evaluation was realized after the final of orthodontic treatment. Studies based only on nuclear magnetic resonance imaging (MRI), computed tomography (CT), electromyography, cephalometry and conventional radiographs were excluded;

- Studies written in English, Spanish and Portuguese and published between 1966 and January 2009.

Thus, we excluded cross-sectional studies, clinical case reports, case series, simple reviews and opinions papers, as well as studies in which orthodontic treatment has not yet been completed and studies based only on imaging tests.

RESULTS

After applying the inclusion criteria was reached 18 articles: 12 longitudinal prospective nonrandomized studies, 4 systematic reviews, 1 randomized clinical trial and 1 meta-analysis, as shown in Figure 1.

The final sample of selected articles was divided into two groups: 1) clinical trials, in which were performed clinical evaluations and 2) sys-

tematic reviews and meta-analysis, and is presented in Tables 1, 2 e 3.

FIGURE 1 - Design of included studies

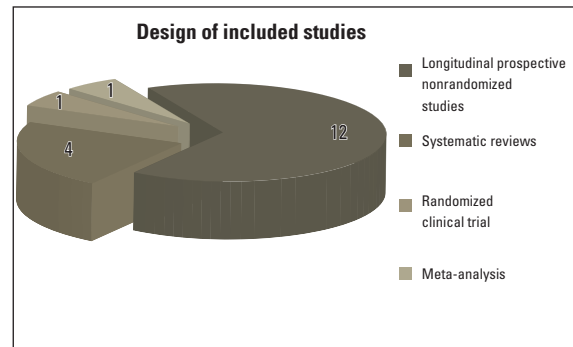


TABLE 1 - Design of clinical trials.

Authors	Year of publication	Design	Sample size	Orthodontic appliances used
Sadowsky et al ⁵²	1991	P, L	160 tt 90 no tt	F
Hirata et al ²⁴	1992	P, L	102 tt 41 no tt	F
Egermark e Thilander ¹³	1992	P, L	402 mixed	F, AF
O'Reilly et al ⁴⁶	1993	P, L	60 tt 60 no tt	F
Egermark e Ronnerman ¹²	1995	P, L	50 tt 135 no tt	F, AF
Keeling et al ²⁶	1995	RCT	60 tt Bionator 71 tt headgear 60 não tt	AF
Henrikson e Nilner ²¹	2000	P, L	65 tt 58 no tt (class II) 60 no tt (normal)	F
Henrikson et al ²²	2000	P, L	65 tt 58 no tt (class II) 60 no tt (normal)	F
Imai et al ²⁵	2000	P, L	18 tt (after splint) 27 tt (without splint) 13 no tt (after splint)	F
Egermark et al ¹¹	2003	P, L	320 mixed	F, AF
Henrikson e Nilner ²³	2003	P, L	65 tt 58 no tt (class II) 60 no tt (normal)	F
Mohlin et al ⁴⁰	2004	P, L, CC	72 without DTM 62 with DTM	F, AF
Egermark et al ¹⁰	2005	P, L	40 tt 135 no tt	F, AF

P: prospective, L: longitudinal RCT: randomized clinical trial; CC: case-control; tt: treatment, F: fixed appliances; FA: functional appliances.

TABLE 2 - Results of clinical trials.

Authors	Time of assessment	Diagnostic criteria for TMD	Relationship between extractions and TMD	Relationship between Orthodontics and TMD
Sadowsky et al ⁵²	After tt	TMJ sounds	No	No
Hirata et al ²⁴	1.2 years during tt	Questionnaire, mmO, TMJ sounds, deviations	NA	No
Egermark e Thilander ¹³	10 years	Questionnaire, Helkimo index	NA	Improvement
O'Reilly et al ⁴⁶	During, just after tt	Lateral movement, TMJ sounds, tenderness	No	No
Egermark e Ronnerman ¹²	Before, during and after tt	Questionnaire, Helkimo index	No	Improvement
Keeling et al ²⁶	Follow-up of 2 years	TMJ sound, TMJ pain, muscle pain	NA	No
Henrikson e Nilner ²¹	2 years after 1st evaluation	Symptoms (headache, TMJ sounds, pain)	NA	Improvement
Henrikson et al ²²	2 years after 1st evaluation	Signs (MM, pain, TMJ sounds)	NA	Improvement
Imai et al. ²⁵	Initial, after splint, after tt, 1 year after tt	TMJ sounds, pain, restriction	NA	No
Egermark et al ¹¹	20 years after 1st evaluation	Questionnaire, Helkimo index	NA	No
Henrikson e Nilner ²³	Beginning, after 1 and 2 years of tt and 1 year after the end of tt	Signs and symptoms	No	No
Mohlin et al ⁴⁰	Performed at 19 and 30 years old	Questionnaire, clinical assessment, psychological status	No	No
Egermark et al ¹⁰	Before, during, after tt and 15-18 years after the end of tt	Questionnaire, Helkimo index	NA	No

tt: treatment; mmO: maximum mouth opening; mm: mandibular movement; NA: not analyzed.

TABLE 3 - Systematic reviews and meta-analysis.

Authors	Year of publication	Design	Number of included studies	Orthodontic appliances used	Relationship between Orthodontics and TMD
Mcnamara & Turp ³⁷	1997	RS	21	F, AF	No
Kim et al ²⁷	2002	MA	31	F, AF	No
Popowich et al ⁵⁰	2003	RS	5	Aparelho de Herbst	Insufficient evidences
Mohlin et al ³⁹	2007	RS	30	F, AF	No
Abrahamsson et al ¹	2007	RS	3	CO	Insufficient evidences

SR: systematic review; MA: meta-analysis; F: fixed appliances; FA: functional appliances; OS: orthognathic surgery.

DISCUSSION

Considerations about the subject should always be performed through a critical reading of the methodology used by different authors. The use of the basic research principles allows to the researchers to try to control as best as possible the biases of the study generating higher levels of evidence. Thus, becomes important the sample size calculation, so that the sample presents representativity and the results can be extrapolated to the studied population. Moreover, the calibration intra and inter-examiners should be performed to assure the reliability of diagnostic criteria, as well as adoption of randomization and blinding criteria. Likewise, careful matching for age and sex between the test and control groups should also be observed.⁵³

Within this context of an evidence-based Dentistry, it appears that the most common types of studies published in Brazilian journals correspond to studies of low potential for direct clinical applications: *in vitro* studies (25%), narrative reviews (24%) and case reports (20%). The low number of studies with greater strength of evidence shows the necessity to expand the knowledge of evidence-based methods among Brazilian researchers.⁴⁵

The supposed relationship between Orthodontics and Temporomandibular Disorders has attracted the interest of orthodontic class in last years. Despite significant advances in diagnostic capability due to advanced techniques such as nuclear magnetic resonance imaging, 3D computed tomography, volumetric cone-beam tomography and application of more sophisticated clinical procedures, this possible relationship remains unclear. A reflection of this controversy is the way that orthodontic treatment is considered in several publications. If for some authors, orthodontic correction may be the cure for TMJ dysfunction, for others it may predispose patients to pain and dysfunction of the stomatognathic system.⁵

For the establishment of a risk factor, it must perform several methodological criteria to qualify as a true risk factor. Thus, the factor should be identified with the outcome in longitudinal studies, must be present before the establishment of the disease and shows a biological plausibility with the disease. Moreover, the factor remains associated after controlled for other risk factors, there must be a dose-response relationship, that is, higher the factor, higher the outcome and this factor must be identified in different populations.²

Cross-sectional or retrospective studies allow the study of associations that identify risk indicators and generate hypotheses. Subsequently, these hypotheses need to be tested in longitudinal studies to identify true risk factors, because only longitudinal studies can be used as generators of cause and effect evidence due to its temporal component.⁵⁴ Therefore, the clinical trials included in this systematic review show longitudinal design, whereas in this point of view is that must consider the interrelationship Orthodontics and TMD.

There is a difference in the quality of the designs of clinical studies before and during the 80s decade, and the most recent.³⁵ Studies of cross sectional and observational nature, methodological errors - such as lack of information about randomization, blinding, sample size calculation, calibration and control of factors - and inadequate quality of study designs compromised the power generation of scientific evidence. Furthermore, the heterogeneity of results in published studies difficult realization of an adequate meta-analysis. Added to this the lack of a standardized classification system for TMD diagnosis. Thus, you can always find a scientific article to prove a point of view.²⁷

Another important factor, as previously mentioned, when evaluating studies involving the interrelation of Orthodontics and TMD, are the diagnostic criteria adopted by the authors. Due

to the lack of a universal classification system and validated for TMD, can be found in this systematic review various diagnostic methods used by the authors of the included studies: Helkimo index,^{18,19} Craniomandibular index,^{15,16} as well as adaptations of these or other questionnaires. This fact complicates the comparison and analysis of results obtained in the studies evaluated in this systematic review.

In order to standardize the diagnostic criteria and facilitate future clinical trials, was formulated the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), which examined jointly the physical and psychosocial aspects of TMD, in the axis I and II, respectively.⁸ This diagnostic method has been translated, culturally adapted and validated in Brazil.^{31,48} Thus, future clinical studies may use a standardized and universal index, which will facilitate comparison of study results. It is important to be noted that none of the studies evaluated in this systematic review used the RDC/TMD as a diagnostic criteria.

Studies also analyzed the relationship between TMJ sounds and its morphology. Sounds can be associated with various pathologies and the presence of clicks and crackles does not necessarily indicate a TMJ with abnormal morphology¹⁴. It becomes important the knowledge in situations of disk displacement with and without reduction, as well as the presence of crackles as indicative of osteoarthritis. It is important accentuate that the absence of TMJ sounds, not necessarily characterized a situation of normality.^{14,52}

There are many factors that may cause or aggravate TMD. A review of the literature did not find a positive association between orthodontic treatment in children and adolescents and future risk of TMD developing. In addition, orthodontic mechanotherapy performs gradual changes in a system that has a great capacity of adaptation.⁵¹ Similar results were obtained in

other studies, and that there was not observed worsening of signs and symptoms of TMD pre-treatment.²⁰

In a critical review of the literature, there was noted a low association between occlusal factors that characterize TMD. Moreover, orthodontic treatment performed during adolescence usually do not increases or decreases the probability of developing TMD in the future. Some occlusal factors, such as skeletal anterior open bite, overjet greater than 6-7 mm, retruded cuspal position/intercuspal position slides greater than 4 mm, unilateral posterior crossbite and absence of 5 or more posterior teeth may be associated with specific diagnosis of TMD.³⁶

In another critical review, it was found that the signs and symptoms of TMD can occur in healthy individuals, increasing with age, particularly during adolescence, until menopause, and that the TMD that begin during orthodontic treatment may not be related to the treatment. Moreover, there is no risk for TMD associated with any type of orthodontic mechanics and there is no evidence that a stable occlusion, as ideal objective of orthodontic treatment, prevents signs and symptoms of TMD. Still, the extraction of teeth as part of orthodontic treatment plan does not increase the risk for development of TMD.³⁵

Current studies, within a context of an evidence-based Dentistry, such as randomized clinical trials, longitudinal prospective nonrandomized studies, systematic reviews and meta-analysis, through the use of more rigorous methodological criteria and adequate designs, evaluated more precisely the interaction between orthodontic treatment and Temporomandibular Disorders.

Significant current scientific evidences, such as longitudinal and experimental-interventionist studies, point to a tendency of not association of the relationship between orthodontic treatment and TMD,^{10,11,21,22,23,25,26,40} and the presence or

absence of extractions during orthodontic treatment did not increase the prevalence or worsened signs and symptoms related to TMD.^{11,23} Randomized clinical trials²⁶ and longitudinal prospective nonrandomized studies,^{10,11,21,23,25} well as meta-analysis²⁷ and systematic review,³⁹ besides present more rigorous methodologies, generate a greater power of scientific evidence. Moreover, the correct occlusal relationship between the teeth did not cause a change in the physiological position of the condyles and articular discs in TMJ when examined MRIs and CT.^{3,28,29}

Reviewing the literature in search of randomized clinical trials - studies that generate a high level of scientific evidence - about the interrelation of orthodontic treatment and TMD, there is only one study in the evaluated period in this systematic review.²⁶ This fact occurs due to difficulties in the accomplishment of randomized clinical trials evaluating orthodontic treatment and TMD, due to ethical and practices reasons.²⁷ Difficulties those are also present when assessing other forms of irreversible therapies such as TMD treatment protocols. An example of this situation is the occlusal adjustment, where from 1966 to 2002, only 6 RCTs evaluating the occlusal adjustment as treatment and prevention option for TMD in a systematic review published in Cochrane Library.³⁰

Regarding to the role of orthognathic surgery and orthodontic treatment with the Herbst appliance in relation to TMD, the literature analysis shows that there is a necessity for a higher number of longitudinal studies, controlled and randomized, to obtain more precise conclusions about the role of those therapeutics in relation to TMD. Systematic reviews that attempted to assess both therapeutics and their relationship with signs and symptoms of TMD were inconclusive, due to small number of significant scientific evidences.^{1,50} In relation to the role of therapy with Bionator²⁶ and headgear,²⁶ it ap-

pears that they have no association with the development of TMD. It is important to be noted that the use of chin cup^{4,6,7} and facial mask⁴³ shows weak or nonexistent associations in relation to TMD, but studies with this conclusions were not included by the methodological criteria of this systematic review.

Before the beginning of orthodontic treatment should be performed by the Orthodontist, in asymptomatic patients, a full history and physical examination on signs and symptoms of TMD.³⁴ Studies evaluating the attitude of Orthodontists front to the TMD show that this interrelationship is viewed differently as the possibility of orthodontic treatment increase the probability of developing of TMD.^{33,34}

Assessing the attitudes and beliefs of Orthodontists regarding to TMD, in a cross-sectional study, the authors obtained results as the majority of respondents did not feel secure about the diagnosis, therapeutic decision and assessment of treatment outcomes of TMD. The vast majority of respondents reported believing that orthodontic treatment does not carry to a higher incidence of TMD and Orofacial Pain (OP), but believe that it can be a form of prevention and treatment of these disorders. It is important to be noted that most participants reported obtained knowledge at a basic level or no knowledge about TMD and Orofacial Pain during their postgraduate course in Orthodontics.³⁸

Already the results of a research examining the attitudes of Chinese Orthodontists, regarding orthodontic treatment and TMD, through a questionnaire, showed that most Orthodontists think that an inadequate orthodontic treatment could increase the development of TMD and an adequate orthodontic treatment that could prevent it.³³

In the presence of signs and symptoms of TMD, the primary treatment protocol should be minimally invasive and with reversible nature. Therapies that change the occlusal pattern

irreversibly, such as orthodontic treatment and occlusal adjustment, should be indicated in a conscious and precise way. Furthermore, this decision should be based on significant scientific evidences.

CONCLUSIONS

- Many of the available studies in literature have limitations in their designs and methodologies, as well as heterogeneity of results, which reduces the power of evidence generated. Current studies, with rigorous methodological criteria and adequate designs, present more precise evidences of the interrelationship of the orthodontic treatment and TMD.

- The systematic review of literature shows that there is not an increased in prevalence of TMD due to traditional orthodontic treatment, either with protocols for extractions or not, with

significant scientific evidences, such as longitudinal controlled randomized and nonrandomized trials, systematic reviews and meta-analysis, concluding for a tendency to not association. However, it is necessary to perform further randomized clinical trials, with standardized diagnostic criteria for TMD to the determination of more accurate causal associations.

- It is important to perform, during the diagnostic phase of the pre-orthodontic patients, a full assessment of the presence or absence of signs and symptoms of TMD and Orofacial Pain, making use of complementary examinations for a correct diagnosis. In the presence of TMD, becomes important an integration with the Temporomandibular Disorders and Orofacial Pain specialty to an appropriate treatment decision, due to the high prevalence of TMD in the general population.

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Evaluation of level of satisfaction in orthodontic patients considering professional performance

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Abstract

Objective: Considering the increasing professional concern in conquering new patients and maintaining them satisfied with treatment, this study aimed to evaluate the level of satisfaction of patients in orthodontic treatment, considering the orthodontist's performance. **Methodology:** Sixty questionnaires were filled out by patients in orthodontic treatment with specialists in Orthodontics, from Curitiba. The patients were divided into two groups. Group I consisted of 30 patients which considered themselves unsatisfied and changed orthodontists in the last 12 months. Group II consisted of 30 patients which considered themselves satisfied, and were in treatment with the same professional for at least, 12 months. **Results and Conclusion:** after statistical analysis, using the chi-square test, it was concluded that the factors statistically associated to patient's level of satisfaction considering the orthodontist's performance were: professional degree, professional referral, motivation, technical classification, doctor-patient personal relationship and interaction. For orthodontic treatment evaluation, the factors that determined statistical differences for patients' level of satisfaction were: the number of simultaneously attended patients and the integration of the patients during the appointments.

Keywords: Patient Satisfaction. Orthodontics. Professional-Patient Relationship

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INTRODUCTION

Considering the growing concern of professionals in acquiring new patients and keep them satisfied with orthodontic treatment carried out this study is to identify the main factors responsible for the satisfaction of patients in treatment in relation to professional performance.

In Orthodontics, there is emerging interest in the study of expectations and patient satisfaction.²⁵ However, it is difficult to quantify them, the need to consult patients and the review by the protracted nature of orthodontic treatment, the results of which involve complex functional and aesthetic components. What, then, that would influence perceptions of patient satisfaction with orthodontic treatment and also with the professional's performance? This is an important issue to unravel the psychological universe of the patient, responsible for integration or not the clinical environment.

According to Bos et al^{6,7} professionals agree on the importance of gaining and maintaining the patient's cooperation to ensure the success of treatment. When the patient's expectations are not understood, there may be dissatisfaction, demotivation and even withdrawal of orthodontic treatment.¹⁴ Was the relationship professional / patient the most important motivating factor to ensure patient satisfaction?

For Sinha et al,^{29,30} the lack of professional efficiency in exposing the problems inherent in the case could lead to a mismatch of information. Professionals should focus more on the quality of care, their personalities, their attitudes and professional competence, so that the end of orthodontic treatment, the objectives are achieved personal satisfaction and professional satisfaction of the patient's orthodontist.^{2,3}

When a professional acts calmly, assuring safety to the patient, that will rely on the professional choice. You must provide adequate

information about treatment, show interest in helping the patient to gain her satisfaction.

Orthodontics and Quality of Life

The Orthodontic treatment, more than improving the quality of life, can bring to physical, psychological and social changes.^{5,12,17} Few studies explore such issues or, as the pain and discomfort that may occur during treatment, affect quality of life of patients. A better understanding of the impact of orthodontic treatment on quality of life is important for many reasons.²³

According to Zhang et al,^{33,34} when patients are aware of the treatment's consequences, such as discomfort, develop more realistic expectations, which may help them to encourage cooperation during treatment. In addition, the patient can do a more detailed analysis of the benefits and effectiveness of orthodontic treatment.⁸

Professional Relations / Patient

The dialogue with the patient favors the understanding of their reactions during orthodontic treatment. To this end, the professional should try a variety of strategies to achieve the desired level of patient cooperation (Fiillingim and Sinha; Maltagliati and Montes.^{13,18,19-22} To Turbill et al,³¹ the treatment goals should be detailed to motivate patients and to avoid patient dissatisfaction. The professional should use a vocabulary that can be understood by patients and their caregivers.

Thus, in this study through a questionnaire, we sought to determine the factors related to satisfaction level of patients in orthodontic treatment, given in relation to the orthodontist and the treatment itself.

MATERIAL AND METHODS

There were few professionals who have allowed the use of the questionnaire to their patients in Curitiba-PR; average 35 patients were

interviewed in each professional. Other professionals were interviewed, but did not allow access to their patients. In this way, we analyzed three hundred and twenty sheets of questionnaires filled by patients in orthodontic treatment, from 16 years of age, in Curitiba-PR. This age limit subtends the presence of capacity to formulate questions and the establishment of the maturity of the patients in the study. The maximum age of sample participants was 43 years and the mean age of patients was 28 years.

The choice of patients to answer to the questionnaires was random, in the office of ten professional specialists in orthodontics, which allowed access to their patients. Within professional s, participants were six male and four female. To a better understanding of the results, the questionnaire was divided into two parts (Table 1):

- » Assessment on the professional-total of eleven questions that were related specifically to the analysis of the patients interviewed in relation to the professionals who treated them. At no time was any comment from the interviewer on the professional;
- » Assessment in relation to orthodontic treatment, a total of six questions that were related to the conduct and expectations of orthodontic treatment by the clinician. To ensure confidentiality of the sample components, questionnaires were delivered in an envelope without any identification and sealed after filling.

Sample

For analysis and comparison of results, the sample was divided into two groups:

GROUP 1 (DISSATISFIED): Included 30 patients who considered themselves dissatisfied with the performance of the professional who did the previous treatment, and for this reason they moved to another professional. These patients answered the questionnaire in

accordance with the professional and prior treatment. No reference was made to the current treatment. The composition of this group included 18 females and 12 males, ages ranged from 16 to 40 years.

GROUP 2 (SATISFIED): This group was initially composed of 290 patients in orthodontic treatment, but to obtain a statistical parity, were eliminated invalid questionnaires (filled out incorrectly or incompletely), and randomly selected 30 questionnaires were . These patients were undergoing orthodontic treatment for over a year with the same professional. In this group only participated in the patients satisfied with treatment. Those patients who were more than a year in treatment, but dissatisfied with the choice of professional, do not participated of the sample. The composition of this group included 16 females and 14 males, ages ranged from 16 to 43 years.

Data Collection

The questionnaire allowed each patient to check one of three alternatives, each of 17 objective questions. The patients completed the questionnaire in the waiting rooms of clinics orthodontics. They were aware that the information collected was confidential (Statement of Consent) and be unavailable to anyone except the researchers. The questions are presented in Table 1.

Statistical Analysis

Resorted to descriptive analysis of data through charts and graphs. To test the hypothesis at work, we used the nonparametric test Chi-Square ". The significance level was 5% (0.05).

RESULTS

Tables 1 and 2 (on the professional assessment) and 3 and 4 (evaluation in relation to orthodontic treatment) described the results obtained.

QUESTIONNAIRE TO PATIENTS

Age: _____ Sex: _____	
1) You are in orthodontic treatment for over a year?	a) yes b) not
2) Are you satisfied with the choice of your orthodontist?	a) yes b) not
3) You have moved or changed your orthodontist in the last 12 months?	a) yes b) not
3.1) The transfer occurred because you were unhappy with the professional?	a) yes b) not
Answer the questions below according to their experience with your orthodontist. If you answered YES on question 3, answer according to his experience with the previous orthodontist.	
4) What is the financial aspect that influenced your decision to choose the orthodontist?	a) high cost of orthodontic treatment b) low cost of orthodontic treatment c) the cost of treatment did not influence
5) The environment of the office (waiting room, clinic) influenced the choice of orthodontist?	a) yes b) not
6) The title of the orthodontist (specialist, master or doctor), influenced the choice of the professional?	a) yes b) not
7) Would you recommend your orthodontist to your friends, relatives?	a) yes b) not
8) Who do your clinical care?	a) the orthodontist b) the auxiliary
9) You're motivated by his orthodontist (hygiene, use of accessories)?	a) yes b) not
10) How do you rate the information that you transmit your orthodontist?	a) educational b) punitive c) rude
11) How do you feel during the consultations?	a) the integrated office environment b) moved c) do not care about this relationship
12) How many patients are treated simultaneously during their consultations?	a) one b) two c) more than two
13) Your the orthodontist recognize you by the name?	a) yes b) not c) sometimes
14) Have you had any financial problems with your orthodontist?	a) yes b) not
15) When you have any criticisms or suggestions to your orthodontist:	a) my orthodontist never accepts my criticism and suggestions b) I have no opportunity to make comments and suggestions c) I am free to make criticisms and suggestions
16) How do you rate your personal relationship with your orthodontist?	a) very good b) good c) poor
17) How do you rate your orthodontist technically?	a) good b) very good c) poor

TABLE 1 - Percentage distribution of group study in relation to the professional.

DATA		GROUP 1 (n=30) (dissatisfied)		GROUP 2 (satisfied) (n= 30)		TOTAL (n=60)	
		NO	%	NO	%	NO	%
Satisfied with the professional's choice?	yes	0	0	30	100	30	50
	no	30	100	0	0	30	50
Transferred to a professional?	yes	30	100	0	0	30	50
	no	0	0	30	100	30	50
Influence of titles to choose?	yes	17	56,7	27	90	44	73,3
	no	13	43,3	3	10	16	26,7
Recommend the professional?	yes	0	0	30	100	30	50
	no	30	100	0	0	30	50
Are you motivated by the professional?	yes	9	30	26	86,6	35	58,3
	no	21	70	4	13,4	25	41,7
Information supplied:	educational	17	56,7	23	76,6	40	66,6
	punitive	8	26,7	5	16,6	13	21,6
	rude	5	16,6	2	6,8	7	11,8
Professional recognize you by the name?	yes	21	70	28	93,3	49	81,6
	no	9	30	2	6,7	11	18,4
Existence of financial problem with the professional?	yes	11	63,3	3	10	14	23,4
	no	19	36,7	27	90	46	76,6
Criticisms or suggestions:	The orthodontist never accepts	7	23,3	1	3,4	8	13,3
	I have no opportunity to	18	60	4	13,3	22	36,7
	I have freedom to present	5	16,7	25	83,3	30	50
Relationship with the professional:	very good	0	0	20	66,6	20	33,3
	good	4	13,3	10	33,4	14	23,4
	bad	26	86,7	0	0	26	43,3
Technical Rating:	good	12	40	18	60	30	50
	very good	2	6,7	12	40	14	23,3
	bad	16	53,3	0	0	16	26,7

TABLE 2 - Test result used in comparison of groups with respect to the professional.

Questions	Test result	Table value
Professional's titles	8,523	p<0,05
Would you recommend the professional	60	p<0,05
Do you feel encouraged?	19,817	P<0,005
The information transmitted	2,878	p>0,1
The professional recognizes the name	5,455	p>0,1
Had financial problems	5,962	p>0,1
The professional accepts criticism and suggestions	26,823	p<0,005
Personal relationship with the professional	48,571	p<0,005
Technical classification of professional	24,343	p<0,005

TABLE 3 - Percentage distribution of study group with respect to orthodontic treatment.

DATA	GROUP 1 (n=30)		GROUP 2 (n= 30)		TOTAL (n=60)	
	NO	%	NO	%	NO	%
Are you in orthodontic treatment for over a year?						
• yes	30	100	30	100	60	100
• no	0	0	0	0	0	0
Financial aspect that influenced the choice of professional						
• High cost of treatment	2	6,7	4	13,4	6	10
• Low cost of treatment	8	26,7	2	6,6	10	16,7
• the cost did not influence	20	66,6	24	80	44	73,3
The office environment has influenced the decision choice						
• yes	16	53,3	23	76,6	39	65
• no	14	46,7	7	23,4	21	35
How do you feel during consultations						
• Integrated environment	4	13,3	25	83,3	29	48,3
• displaced	18	60	1	3,3	19	31,7
• not care	8	26,7	4	13,4	12	20
How many patients are seen during the consultations?						
• one	5	16,7	16	53,3	21	35
• two	19	63,3	12	40,1	31	51,6
• more than two	6	20	2	6,6	08	13,4
Clinical work done by:						
• orthodontist	16	53,3	22	73,3	38	63,3
• dental assistants	14	46,7	8	26,7	22	36,7

TABLE 4 - Test results used in comparison of groups with respect to orthodontic treatment.

Questions	Test result	Table value
Cost of treatment	4,631	p>0,5
Office's environment	1,795	p>0,5
How do you feel during the consultations	31,750	p<0,005
How many patients are treated	9,343	p<0,05
Who does care clinical	2,583	p>0,1

DISCUSSION

In discussing the work, those questions statistically significant were considered, analyzing and formulating plausible conclusions when comparing patients who consid-

ered themselves satisfied, and patients who thought they were dissatisfied with the performance of the orthodontist. For a better use of data obtained in this study, the results were discussed in threads.

Titles

Regarding the title of the professional, were statistically significant differences between groups. More than half of professionals chosen by the dissatisfied patients had an extensive resume. The results suggest that not only experienced a curriculum to ensure patient satisfaction. Other factors are involved, especially the ability to have a good relationship with the patient.

According to Richter et al,²⁴ and the results achieved, another factor responsible for a patient stays in treatment with the same professional is your satisfaction with the conduct of treatment. Valle,³² determined that patients value the professional expertise and are seeking information against being fooled by professionals without adequate training.

Recommendation of professional

Considering the recommendation of the professional, were statistically significant differences between groups. Table 2 showed the distrust of patients who consider themselves unhappy, to recommend the professional to friends and relatives, doubting the benefits and results achieved by the treatment they could provide. On the other hand, it is clear the recommendation made by the patients who considered themselves happy, because it would indicate the professional to friends and relatives. Thus, it is noted that patient satisfaction was also determined by the indication of the professional to friends and relatives. For Morgens-tern et al,²⁰ a survey of students and teachers of Orthodontics, the main referral source for patients are the patients themselves (89.3%).

Nature of the information provided

Regarding the nature of the information provided, there were no statistically significant differences between groups. The majority of respondents in this study (both those who

considered themselves satisfied as those who considered themselves dissatisfied) claimed to have received educational information by the clinician. This means an average of great concern to professionals in guiding patients during orthodontic treatment.

The transmission of knowledge is an obligation of the professional, but according to our results, it is not a determinant of patient satisfaction. Patients prefer to receive educational information, which influenced the cooperation during treatment. Gerbert et al,¹⁵ assessed professional qualities that patients value. The authors showed that the technical competence, friendliness, courtesy and ability to inform patients about procedures, were very well evaluated by patients.

Patient care

One of the simplest characteristics of human relationships is the recognition of another person by name. In this study, the professional name recognized by most patients in both groups. This suggests that the professional / patient relationship is improving today, despite the presence of clinics that offer various professionals, in which the patient is treated by different people or in an environment where two or more patients are treated simultaneously.

Although no statistical difference between groups, the numerical difference was observed in patients who thought they were dissatisfied. Almost a third of these patients reported that nurses do not recognize them by name. For Cross and Cruz¹¹ probably this is due to the large turnover of patients, present in these clinical professionals, making difficult the task of differentiating them, especially when one considers the large clinics, which are currently booming. When patients realize that health professionals have forgotten your name, you are disappointed, less satisfied, less collaborate with the instructions required. Sinha et al²⁹ for the

psychological impact of a dissatisfied patient may manifest through higher anxiety, less cooperation and eventually poor orthodontic results.

Financial aspect

For most patients who consider themselves unhappy, the cost of treatment did not influence the professional's choice. Supposedly, for these patients, the professional choice could satisfy their aesthetic needs functional and emotional, related to orthodontic treatment. However, most of these patients was not successful in the professional's choice, so that transferred to another specialist.

Informally, it is observed in clinical practice that patients with financial problems becomes disinterested collaborating with the occupation. Similarly, the orthodontist also discouraging to give his utmost in the query. This ultimately compromises the outcome of orthodontic treatment.

Other factors such as failure to communicate with patients, lack of integration in the office setting due to little time for consultation or impatience of the professional, were probably responsible for the dissatisfaction and transfer of these patients. To Atta⁴ in Orthodontics, the tendency is for professionals seeking to treat more patients in less time and at a lower cost, but with favorable results to the professional and patient. The efficiency in clinical care allows the maximization of financial return to the professional.

Professional interactions and patient

With the acceptance of criticism and suggestions by the professional, were statistically significant differences between groups. In this study, among patients who thought they were dissatisfied, 60% had no freedom to express opinions and suggestions. This suggests a failure of communication that existed in more than half of the professionals who had trans-

ferred patients. This fact serves to alert professionals to spend more time cultivating a personal relationship with the patient.

The present study showed that the ability to hear and heed the suggestions of the patient, plus the technical skill of the trader, was important in the acquisition of patient satisfaction.

Chakraborty et al¹⁰ studied the preferences of patients and professionals have determined that the preferred responded to questions from patients, arguing about uncertainty, helping to overcome them. The communication skills were considered important in ensuring patient satisfaction. In this study, the ability of professionals to accept criticism and suggestions also was one of the determinants of patient satisfaction.

Patient's personal relationship with the professional

Considering the personal relationship between patient and professional, were statistically significant differences between groups. In the study, almost 90% of patients who thought they were dissatisfied (Table 1), had a bad relationship with the professional staff, and no patient reported having a very good relationship. These data suggest that patient satisfaction is strongly related to good personal relationship with the professional.

Abrams et al,¹ determined that the patient does not realize is receiving a high-level treatment simply by observing the technical quality of the professional. The critical factor, an indicator of quality of care for the patient, is the psychological attention given to it (a good personal relationship with the professional's patient).

Technical classification of professional

Concerning the classification of the professional technique, we found statistically significant differences between groups. In this study, more than half of patients who consider them-

selves unhappy, technically classified as poor professional, however, these patients may have been influenced by other factors to make such a classification.

Often, the lack of attention to it, plus the difficulty in expressing his opinion regarding the treatment and sense of displacement during the consultations can lead to this sort of professional. The technical classification of the professional was one of the determinants of patient satisfaction.

For Nanda and Kierl,²¹ patients need to choose professionals who treat them with kindness, friendship and expertise. Burke and Croucher⁹ conducted a patient survey to assess the criteria of good dental practice. The most important factors were determined by patient explanation of the procedures in the first place, sterilization and sanitation in second place and professional skills in third place. The factors that influenced the patients were less modern equipment and office setting (decor).

Patient motivation

Considering the motivation of patients were statistically significant differences between groups. In the present study, Table 2 showed that patient satisfaction in orthodontic treatment also depends on the motivation held by the professional. Among patients who considered themselves dissatisfied, 70% were not motivated. These professionals are not complying with their obligations, that is the motivation, guidance, encouragement of the patient.

It was evident the importance of this factor as a determinant of patient satisfaction, as nearly 90% of patients who considered themselves satisfied endorsed the actions of professionals chosen.

The concern of the professional to ensure the welfare of the patient's vital to win it. Sinha et al,²⁹ determined that when the trader does not motivate the patient, making negative

criticism, is impacting negatively on patient adherence to treatment.

Integration of the patient during consultations

There were no significant differences between groups, considering the integration of patients during consultations. In this study, 60% of dissatisfied patients felt displaced during the consultations, which suggests that these professionals often automated procedures performed, carefree in clarifying the doubts and anxieties, maintaining a poor personal relationship, resulting an unhappy patient.

Agreeing with Valle,³² we observed that patients are aware of Orthodontics of what occurs in clinical applications with stringent quality and reliability of professionals in the area.

Number of patients treated simultaneously

Considering the number of patients seen at the same time were statistically significant differences between groups. In this study, more than half of patients who thought they were dissatisfied was served concurrently with another patient in clinic, this seems to suggest that the lack of attention given to the patient, due to the extra volume of patients, also contributes to patient dissatisfaction. It was evident that one of the factors responsible for patient dissatisfaction is the lack of individual attention in attendance.

The patient is starved for attention, need explanation about the progress of treatment, has doubts and insecurities that need to be addressed by the professional.

For Cross and Cruz,¹¹ with the growing number of office-bearers of Orthodontics rooms with various clinical dental chairs, the trader eventually raise the number of patients in vezda quality of care.

Thus, there is devaluation of the patient

/ professional involvement and patient satisfaction with the professional's performance. Orthodontic patients are demanding and require individual attention from professional, otherwise seek another professional opinion.

Office environment

Taking as reference the authors as Hans and Valiathan,¹⁶ we observed that in the absence of a manual for assessing the quality of orthodontic appointment, patients are worth the office setting, personality and his professional team to make the choice of the specialist, although the environment the office is not one of the factors related to patient satisfaction study undertaken by us.

In this study, more than half of dissatisfied patients said it was important the office atmosphere in the choice of professionals. These patients reportedly sought benefits aesthetic, functional and psychological, when the professional's choice, based in the office setting. However, their expectations were not recognized by these professionals, who have invested in decorating the environment, new equipment and devalued the cultivation of communication skills with patients, failing to encourage you, motivate you and answer your questions.

Concluding Remarks

Based on the results presented and discussed, it became evident that patients' satis-

faction in relation to professional performance depends essentially on the good relationship with the professional staff of the patient. When present, the good relationship ensured the integration of the patient in the clinical setting, settled the question that the patient, providing an indication of the professional and the patient's relatives and friends.

The success of the work can be measured by the level of patient satisfaction, not only in relation to results achieved with changes in the treatment of occlusion of a systematic and effective, but also on the expectations addressed. The path to excellence is the knowledge accumulated over time applied in full, willing and hard.

CONCLUSIONS

With respect to this research, it was possible to draw the following conclusions:

- » The factors that were related to the level of patient satisfaction assessed by considering, in relation to the orthodontist, were: title, recommendation of professional motivation, classification technique, professional interactions and patient and personal relationship with the patient.
- » To consider the factors related to orthodontic treatment, those differences were significant at the level of patient satisfaction, were: number of patients treated simultaneously and integrating the patient during consultations.

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